

# BME Design-Spring 2026 - Katherine SATTEL

## Complete Notebook

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Freyja Heggeland

on

Apr 29, 2026 @02:02 PM CDT

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**Team contact Information**

Freyja Heggeland - Jan 30, 2026, 12:09 PM CST

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
		Advisor			
		Client			
		Leader			
Kalt	Therese	Communicator	tkalt@wisc.edu	(262)-765-6194	N/A
Awad	Noor	BSAC	nawad2@wisc.edu	6368915939	N/A
Heggeland	Freyja	BWIG	heggeland@wisc.edu	(608) 609-5827	N/A
Heggeland	Freyja	BPAG	^	^	^



## Project description

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Therese Kalt - Feb 01, 2026, 8:45 PM CST

**Course Number:**

**Project Name:**

**Short Name:**

**Project description/problem statement:**

**About the client:**



## 2026/02/02 - Client Meeting 1

---

Katherine SATTEL - Feb 02, 2026, 12:23 PM CST

**Title:** Client Meeting 1

**Date:** 2/2/2026

**Content by:** Katherine Sattel, Freyja Heggeland, Therese Kalt, Noor Awad

**Present:** All

**Goals:** Ask questions to gain an understanding of how to improve our prototype from previous semesters

**Content:**

Background: Works in a neuro-rehab hospital in Fitchburg; 80% of patients have brain injury/spinal cord injury; crude prototype to work on balance and visual scanning for patients (SN syndrome); used while walking to help turn head and keep balance, also uses it on balance form to increase difficulty. Patients work on multiple tasks at once and physician can grade the difficulty of the task and support patient.

1. What will be the budget for the semester? How do you want us to go about purchasing materials?
  - \$500ish (not a super hard limit, can be extended)
  - Has a lot of other projects
    - Whoever is the lead on purchasing --> send receipt and then client will Venmo cost back --> can do it per purchase or all at the end of semester
2. How much did the last prototype end up weighing and what kind of a weight decrease would you like to see?
  1. If we can't decrease the weight significantly, would it still be better to work on improving weight distribution and focusing weight in the handle?
    - YES! Definitely work on counterweight mechanism
3. Where did the last prototype fail in terms of durability?
  - The end screen fell off (3D printed housing fell off the rod and was hanging on by wires)
4. What did you like and dislike from the last prototype?
  - Dislikes: End was way too heavy, telescoping rod is too heavy (set length is preferred), screen too bright
  - Likes/wishes: Haptic feedback to the end, button to randomize colors for scanning activity, 3 in diameter for the display at the end (target can't be too small for patients w/o fine motor control), electronics in handle (counterweight), Red/Green color, ruler on pole
  - Ideal world: Push of a button to switch color of display, fiber optic cable to shine light onto a thin plastic disk to reduce weight
    - Can compare weight to his current prototype
5. ^ same but for the Fall '23 prototype that didn't get as far?
6. Feedback?
  - Auditory would be preferred
  - Haptic okay
7. From the previous semesters, are there any areas/design aspects that we should tackle first?
  - Prioritize weight for sure
8. Are there material preferences or sterilization needs?
  - Gets wiped down between patients

- Material cannot be porous because of this
  - Not PVC for the rod --> aluminum or kevlar tubing
9. How long would this prototype be used for/how many patients? (thinking life in service)
- Should be pretty durable
  - Withstand being hit by patients (purposefully or accidentally)
  - Can't just fall apart at the end
10. How long would this prototype be used in a single day for patients? (regarding battery life, charging, etc.)
- Used every single day
  - 10-15 mins per session per patient
  - Gets put away and taken down very often per day
11. How frequently would the device be used per week?
- Daily
12. What kinds of electrical components would you like added to the device? (leans into material preferences and the aesthetic choices)
- Audio
  - Or fiberoptic cable to preserve weight
13. Would you be interested in a different design that stands on its own? (doesn't require the therapist to hold it similar to competing designs)
1. Allows for a bigger screen
  2. More flexibility to fit the needs of the patient
    - They already have the BITS in their facility; uses auditory feedback
    - Doesn't like that it's a single plane, less DOF
14. Where will the device be stored when it is not being used?
15. Testing?
- Give client the prototype to test with patients
  - Take a tour of the hospital to see the process and get patient feedback (if they sign a release)
  - To test patient improvement:
    - Functional reach test -- patient reaches forward as far as they can without moving feet
    - Functional gait test
    - Dynamic gait test
      - Prototype should have ruler on the pole so that this can be measured

**Conclusions/action items:**

- Client will share patient videos of device being used
- He will give us the last prototype to collect measurements/weight
- Finish PDS with this info



## 2026/02/17 - Client Meeting 2

---

Katherine SATTEL - Apr 28, 2026, 1:02 PM CDT

**Title:** Client Meeting 2

**Date:** 2/17/2026

**Content by:** Katherine Sattel

**Present:** Katherine Sattel

**Goals:** Hand off prototype -- get some questions answered

**Content:**

- Images and specs in background research!
- Feedback:
  - Client indicated that he doesn't need the measured portion of the rod to be longer than 24in - said 22in was ideal
  - He showed how he handled the rod - has a lot of room behind his hand because he liked to have more control holding it closer to the rod (will attach photo)
  - Really hammered home the weight complaint; definitely agree with this
    - The previous prototypes both held the Arduino, breadboard, display, all of the electronics, in the end display box
    - The first prototype was a digital display -- think smart watch
    - Second prototype was a LED matrix; mentioned it was too bright for some patients
  - Asked if he would mind having the bulk of circuitry below his hand on the handle
    - Client liked this idea, he didn't think it would interfere with his grip and he also appreciated that it would likely act like a counterweight
  - Client liked the clean, finished, look of the first prototype compared to the second prototype
    - First prototype had the measurements backwards though, the ruler should go from the handle up, not the display
  - Liked that the second prototype just used 1 9V battery in the handle whereas the first one used a battery pack with an on/off switch in the display box

**Conclusions/action items:**

Use this to inform our preliminary design presentation

---

Katherine SATTEL - Apr 28, 2026, 1:02 PM CDT



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**IMG\_2904.HEIC (2.17 MB)** Photo showing how client holds device



## 2026/03/04 - Client Meeting 3

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Katherine SATTEL - Apr 28, 2026, 1:03 PM CDT

**Title: Client Meeting 3**

**Date:** 3/4/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Get feedback on CAD and ask more questions

**Content:**

- How are we reducing weight?
  - Display box has a thinner profile
  - Circuitry is in the handle
    - This holds the most hefty portion of the device as well as acting as a counterweight
- How many colors?
  - Common drill is reaching with right hand for red target and left hand for green target
  - Wants to be able to do random mode
  - We should do 2 buttons: one that cycles and one that flips between two colors
- Auditory feedback
  - Piezo speaker that is small and lightweight
  - Will need to do testing to ensure the volume is high enough for patients who are hard of hearing
- Carbon fiber
  - Specific weave that is easy to etch and manufacture with
    - Helps keep a more professional look
- Opportunity to go to hospital in Fitchburg to see our prototype in action
  - Great experience to see the clinical setting
- No worries about sharing patient videos -- she signed a release form
  - Can be included on final poster
- Project impact:
  - Aging population -- more and more people need rehabilitative care, people are very unaware of it in general
    - Stigma
  - BiTS device is too expensive for a lot of rural facilities
    - Limited usability for physician
  - This device brings engagement and helps the physician change difficulty and make the activity more fun for the patient
- Client gave permission to take apart old prototypes to use for parts and or/reverse engineering their work

**Conclusions/action items:**

Order materials tomorrow, begin circuitry this weekend



## 2026/03/23 - Client Meeting 4

---

Katherine SATTEL - Apr 28, 2026, 1:03 PM CDT

**Title:** Client Meeting 4

**Date:** 3/23/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Check in with client following advice after show & tell

**Content:**

- Likes the idea of circuitry being somewhere else to help the ease of clinician use
  - Hip: risks of tangling/pulling on wires
  - Arm: Less risk of tangling, might be uncomfortable/get in the way
- Buttons:
  - Client is good with the use of 1 button (long press to change to R/G mode)
- Battery:
  - Client is okay with 9V battery or rechargeable battery
- Number 1 priority is ease of use
- Colors:
  - Client uses red/green because right hand is associated with red target and left hand is associated with left hand
  - Could add another mode for color blind patients
    - Add a longer press on the button
  - Update to Red/Blue mode for accessibility reasons
- Overall: Make circuitry and test with the different methods of placing circuitry on the body vs. behind the hand

**Conclusions/action items:**

Fabricate!



## 2026/01/30 - Advisor Meeting 1

---

Katherine SATTEL - Jan 30, 2026, 12:40 PM CST

**Title:** Advisor Meeting 1

**Date:** 1/30/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Share progress

**Content:**

- Client meeting 2/2 at 12pm on Zoom
  - Don't be afraid to innovate from the previous design, not just improve
- Look into materials used in the outdoor space for lightweight, durable composite materials
  - Material Innovation
- Testing:
  - Balance -- force plates
  - Points of improvement

**Conclusions/action items:**

For next week:

- Split up PDS - Reminder to highlight sections with color per person
  - Upload non-colored version to website
- Write questions for client
- Bring printed job, cover letter, resume to lecture



## 2026/02/06 - Advisor Meeting 2

---

Katherine SATTEL - Feb 06, 2026, 1:16 PM CST

**Title:** Advisor Meeting 2

**Date:** 2/6/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Share progress for the week

**Content:**

- For testing:
  - Focus on material durability/mechanical properties
  - Fatigue testing -- mimic positions that client holds and see how comfortable
    - Rank on a scale of 5 or 7 points to gain "quantitative" data
- For standards research:
  - Library has great resources and can help us avoid paying \$100+ for a standard!!
- Reminders:
  - Use LabArchives as a notetaking app
  - 1-2 long or 3-4 medium entries per week (not concrete, just a suggestion)
  - Anything from sketches, prototyping, brainstorming, etc. count

**Conclusions/action items:**

- Team meeting after; plan next weeks goals
- Next week meeting might be affected by BPAG and BSAC meetings -- TBD



## 2026/02/13 - Advisor Meeting 3

---

Katherine SATTEL - Feb 13, 2026, 12:36 PM CST

**Title:** Advisor Meeting 3

**Date:** 2/13/2026

**Content by:** Katherine Sattel

**Present:** All except Freyja

**Goals:**

**Content:**

- Slides need to be printed out by Wednesday (2/18)
  - Use old prototype as "competing design"
    - Maybe bring up board design as well
- CAD models made for slide -- >Therese
- Idea: Make initial prototype with PVC tube to save money
  - Ensure attachments are all sized correctly and fit together
- Speaker can be put at end of display -- important for feedback alignment
  - Wires down rod
- Mention that we didn't make a new design matrix for electronics because last team had successful circuitry

**Conclusions/action items:**

- Divvy up preliminary report and presentation
- Meet with client 2/17 to exchange prototype



## 2026/03/13 - Advisor Meeting

---

Katherine SATTEL - Mar 13, 2026, 12:32 PM CDT

**Title:** Advisor Meeting

**Date:** 3/13/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Prepare for show and tell

**Content:**

- Review feedback for preliminary report
- Design Ideas:
  - Having a strap or something to make more ergonomic
    - Talk to someone in ECB design lab basement about the connections for the circuit housing
  - Remember to think about the battery
    - How are we going to ensure the battery is replaceable
  - Find a stand-in for circuitry to use for fatigue testing
    - Similar weight and size
  - For counterweight: Keep CAD design the same, edit the density of the infill and wall thickness to increase/decrease weight
  - For sensor:
    - Testing to find out the ideal sensitivity for the capacitive sensor
  - Handle grip - like a bicycle handle
  - Elbow attachment to add another pivot point away from the wrist

**Conclusions/action items:**

- Write survey questions for fatigue/comfort testing
- Make a stand-in circuit with weights and dimensions



## 2026/04/10 - Advisor Meeting

---

Katherine SATTEL - Apr 10, 2026, 12:30 PM CDT

**Title:** Advisor Meeting

**Date:** 4/10/2026

**Content by:** Katherine Sattel

**Present:** All except Noor

**Goals:** Check-in with advisor

**Content:**

- Feedback on executive summary this Monday
  - Meeting next week will be ECB 3150 in Ohnsorg's office
- Cricut vinyl cut for the ruler portion of the rod
  - Etching is not feasible right now because we'd have to use the CNC
- Talk to people in Maker Space about the supports breaking our 3D printed portion
  - Resin print maybe or ABS?
- Ask client about market research for our type of therapy
  - How common is this type of therapy?
  - Are there other PT's that do this therapy?
  - Do other PT's have injury/strain from performing these therapies?
- MTS testing:
  - Ask Dr. P about 3-point-bending attachment
  - Next week
- Data we want to present:
  - Stress-strain curve
  - Quantified data from survey
    - Average response bar graph with control vs. our prototype
    - Record deviation from a height line to measure fatigue
      - Shaking?
    - Time vs. fatigue for both
    - Accuracy of touch sensors - testing to support sensitivity of the sensors (not too far and not too close)

**Conclusions/action items:**

Sketch of poster to plan out what info we want to include -- rough outline by next Friday?



## 2026/03/20 - Show and Tell Notes and Feedback

---

Freyja Heggeland - Mar 20, 2026, 12:53 PM CDT

**Title:** Show and Tell Notes and Feedback

**Date:** March 20th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** show other groups what we've done so far this semester.

**Content:**

Suggestions from 402 students:

- Implement counterweight, could do something like a metal detector brace/sleeve
- Device (from 2 iterations ago) seems VERY bulky and does not need to be this way
- Maybe use an ESP32 instead of an Arduino
- Or a raspberry pi
- Counterweight like a fishing pole with the spool of fishing line (heavier portion near hand, rod very thin and lightweight)
- Look into attachments
- Add a time-gated portion for changing colors (set a while loop when the signal input is HIGH, add a counter, when counter gets to a certain point, do a new thing)
- Instead of the circuitry being in the handle, how difficult would it be to have it in a box that he can wear on his hip or something? Could have a cord running through the device.
- ^ like a fanny pack that has a cable connection to the device
- Rechargeable battery would be a good idea - may be more weight
- We should one of the patches that people wear when they're running to hold their phone but with the cables with the connection. The bulk of the weight could be located on the user's arm.
- Flexible breadboard????????

**Conclusions/action items:**

- We showed things and we told things.
- I took notes for the group.
- Update our CAD models and code as needed



# 2026/04/28 - Final Expense Sheet

Freyja Heggeland - Apr 28, 2026, 1:37 PM CDT

**Title:** Final expense sheet

**Date:** April 28th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** order materials and construct device

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 1:37 PM CDT



[Download](#)

Dynamic\_Balance\_Device\_Expense\_Spreadsheet\_-\_Sheet1.pdf (48.5 kB)

# 2026/03/11 - Circuitry Fabrication Protocol

Katherine SATTEL - Mar 18, 2026, 12:16 PM CDT

## Title: Circuitry Fabrication Protocol

Date: 3/11/2026

Content by: All

Present: All

Goals: Create a fabrication protocol for the circuitry portion of the design following the grading criteria

## Content:

### Fabrication Details:

1. Name of fabrication step/portion of prototype
  - Circuitry
2. Date to be completed:
  - 4/8/2026
3. Team Member(s) fabricating:
  - All
4. Detailed sketch of portion of prototype being fabricated (Include dimensions!)

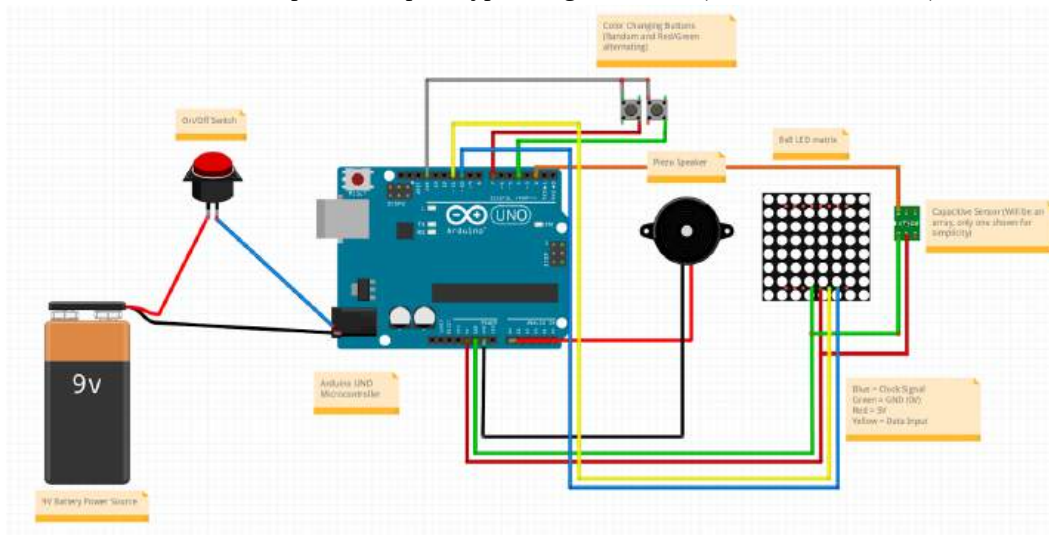


Figure 1: Fritzing diagram of circuitry

## 5. Detailed steps of fabrication

1. Acquire materials listed below:
  - a. Arduino UNO R4 Minima
  - b. 9V battery
  - c. 2x Tactile Switch Button
  - d. DPDT Waterproof Rocker Switch 20A
  - e. Piezo Speaker Module for Arduino Buzzer
  - f. 8x8 LED Matrix
  - g. TTP223B Capacitive Touch Sensor Switch for Arduino Raspberry Pi

- h. 400 Point breadboard
  - i. Flexible wires to connect circuit components
2. Construct Fritzing Diagram as shown.
- a. Connect red lead of the battery (+) into Vin of Arduino, negative lead to GND
  - b. Connect Arduino 5V pin to the red rail of breadboard, Arduino GND pin to black rail on breadboard
  - c. Connect center pin of Rocker switch to 5V, and outer pin to digital pin (insert number)
  - d. Connect a (value) resistor from the digital pin to GND.
  - e. Place each button between center of breadboard, connect one leg of each to 5V rail and diagonally opposite leg to Digital pin (#)
  - f. Connect 10k resistor from digital pin (#) to GND
  - g. Connect Vcc of capacitive touch sensor to 5V rail, and GND to ground rail. Connect output to digital pin (#)
  - h. Connect Vcc+ of piezo speaker to digital pin 5, and GND of buzzer to GND rail
  - i. Connect Vcc of 8x8 LED matrix to 5V rail, and GND to ground rail. Connect input of LED to Digital pin (#)
  - j. Implementing code
    - i. Cross check digital pin assignments to Arduino IDE definitions for both inputs and outputs
    - ii. Upload code to Arduino and double check for errors before turning power on. Optionally, the circuit can be tested with the Arduino powered by USB before the 9 V battery is in place.

**Fritzing diagram:**

See fabrication section. This diagram shows the complete fabrication of the electronic components, which leaves the physical and mechanical portions to be added to the rest of the device.

**Arduino Code:**

```
#include <Adafruit_NeoPixel.h>
```

```
#define LED_PIN 11
```

```
#define NUM_LEDS 64
```

```
#define RANDOM_BUTTON 7
```

```
#define RG_BUTTON 4
```

```
#define CAP_SENSOR 2
```

```
#define SPEAKER A0
```

```
Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);
```

```
bool randomMode = false;
bool rgMode = false;
bool currentRG = false;
```

```
unsigned long lastUpdate = 0;
int updateInterval = 500;
```

```
void setup() {
```

```
    pinMode(RANDOM_BUTTON, INPUT_PULLUP);
    pinMode(RG_BUTTON, INPUT_PULLUP);
    pinMode(CAP_SENSOR, INPUT);
    pinMode(SPEAKER, OUTPUT);
```

```
    matrix.begin();
    matrix.show();
```

```
    randomSeed(analogRead(A1));
}
```

```
void loop() {
```

```
    checkButtons();
    checkSensor();
    updateMatrix();
}
```

```
void checkButtons() {
```

```
    if (digitalRead(RANDOM_BUTTON) == LOW) {
        randomMode = true;
        rgMode = false;
        delay(200);
    }
```

```
    if (digitalRead(RG_BUTTON) == LOW) {
        rgMode = true;
```

```
    randomMode = false;
    delay(200);
  }
}

void checkSensor() {

  int sensorState = digitalRead(CAP_SENSOR);

  if (sensorState == HIGH) {

    tone(SPEAKER, 1200, 200);
  }
}

void updateMatrix() {

  if (millis() - lastUpdate < updateInterval) return;
  lastUpdate = millis();

  if (randomMode) {

    for (int i = 0; i < NUM_LEDS; i++) {

      int r = random(0,255);
      int g = random(0,255);
      int b = random(0,255);

      matrix.setPixelColor(i, matrix.Color(r,g,b));
    }

    matrix.show();
  }
}
```

```
if (rgMode) {

    uint32_t color;

    if (currentRG) {
        color = matrix.Color(255,0,0);
    } else {
        color = matrix.Color(0,255,0);
    }

    for (int i = 0; i < NUM_LEDS; i++) {
        matrix.setPixelColor(i, color);
    }

    matrix.show();

    currentRG = !currentRG;
}
}
```

UPDATED CODE 3/12

```
#include <Adafruit_NeoPixel.h>
```

```
#define LED_PIN 11
#define NUM_LEDS 64
```

```
#define RANDOM_BUTTON 7
#define RG_BUTTON 4
#define CAP_SENSOR 2
#define SPEAKER A0
```

```
Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);
```

```
bool randomMode = false;
bool rgMode = false;
```

```
bool currentRG = false;
```

```
unsigned long lastUpdate = 0;  
int updateInterval = 500;
```

```
unsigned long lastCapTouch = 0;
```

```
uint32_t currentRandomColor;
```

```
void setup() {
```

```
    pinMode(RANDOM_BUTTON, INPUT_PULLUP);  
    pinMode(RG_BUTTON, INPUT_PULLUP);  
    pinMode(CAP_SENSOR, INPUT);  
    pinMode(SPEAKER, OUTPUT);
```

```
    matrix.begin();  
    matrix.setBrightness(191); // 75% brightness (255 * 0.75)  
    matrix.show();
```

```
    randomSeed(analogRead(A1));  
}
```

```
void loop() {
```

```
    checkButtons();  
    checkSensor();  
    updateMatrix();  
}
```

```
void checkButtons() {
```

```
    if (digitalRead(RANDOM_BUTTON) == LOW) {
```

```
randomMode = true;
rgMode = false;
```

```
int choice = random(5);
```

```
if (choice == 0) currentRandomColor = matrix.Color(255,0,0); // red
if (choice == 1) currentRandomColor = matrix.Color(0,255,0); // green
if (choice == 2) currentRandomColor = matrix.Color(0,0,255); // blue
if (choice == 3) currentRandomColor = matrix.Color(255,255,0); // yellow
if (choice == 4) currentRandomColor = matrix.Color(128,0,128); // purple
```

```
delay(200);
}
```

```
if (digitalRead(RG_BUTTON) == LOW) {
```

```
    rgMode = true;
    randomMode = false;
```

```
    delay(200);
}
}
```

```
void checkSensor() {
```

```
    int sensorState = digitalRead(CAP_SENSOR);
```

```
    if (sensorState == HIGH) {
```

```
        lastCapTouch = millis();
        tone(SPEAKER, 1200);
    }
```

```
    if (millis() - lastCapTouch > 2000) {
        noTone(SPEAKER);
```

```
}  
}
```

```
void updateMatrix() {
```

```
    if (millis() - lastUpdate < updateInterval) return;  
    lastUpdate = millis();
```

```
    if (randomMode) {
```

```
        for (int i = 0; i < NUM_LEDS; i++) {  
            matrix.setPixelColor(i, currentRandomColor);  
        }
```

```
        matrix.show();  
    }
```

```
    if (rgMode) {
```

```
        uint32_t color;
```

```
        if (currentRG) {  
            color = matrix.Color(255,0,0);  
        } else {  
            color = matrix.Color(0,255,0);  
        }
```

```
        for (int i = 0; i < NUM_LEDS; i++) {  
            matrix.setPixelColor(i, color);  
        }
```

```
        matrix.show();
```

```
        currentRG = !currentRG;  
    }
```

}

**Conclusions/action items:**

Attached in PDF; submit to Canvas

Katherine SATTEL - Mar 18, 2026, 12:15 PM CDT

Team Name: Dynamic Balance Device  
 Team Members: Katherine Sattel, Thomas Kall, Noor Assad, and Freya Rogstad  
 Project Title: Dynamic Balance Device  
 Timeline (Gantt Chart):

Task	March				April			
	6	13	20	27	3	10	17	24
Acquire Materials								
Build Circuit Using Printing Design								
Final Arduino Code								
Testing								
Implementation of Circuitry to Device								
Additional Testing for Circuitry to Device								

Materials and Cost Table:

Part #	Part Name	Quantity	Unit Price	Total Price	Notes
1	Arduino Uno	1	15.00	15.00	
2	Resistor 10k	10	0.50	5.00	
3	Resistor 1k	10	0.50	5.00	
4	Resistor 100k	10	0.50	5.00	
5	Resistor 100k	10	0.50	5.00	
6	Resistor 100k	10	0.50	5.00	
7	Resistor 100k	10	0.50	5.00	
8	Resistor 100k	10	0.50	5.00	
9	Resistor 100k	10	0.50	5.00	
10	Resistor 100k	10	0.50	5.00	
11	Resistor 100k	10	0.50	5.00	
12	Resistor 100k	10	0.50	5.00	
13	Resistor 100k	10	0.50	5.00	
14	Resistor 100k	10	0.50	5.00	
15	Resistor 100k	10	0.50	5.00	
16	Resistor 100k	10	0.50	5.00	
17	Resistor 100k	10	0.50	5.00	
18	Resistor 100k	10	0.50	5.00	
19	Resistor 100k	10	0.50	5.00	
20	Resistor 100k	10	0.50	5.00	
21	Resistor 100k	10	0.50	5.00	
22	Resistor 100k	10	0.50	5.00	
23	Resistor 100k	10	0.50	5.00	
24	Resistor 100k	10	0.50	5.00	
25	Resistor 100k	10	0.50	5.00	
26	Resistor 100k	10	0.50	5.00	
27	Resistor 100k	10	0.50	5.00	
28	Resistor 100k	10	0.50	5.00	
29	Resistor 100k	10	0.50	5.00	
30	Resistor 100k	10	0.50	5.00	
31	Resistor 100k	10	0.50	5.00	
32	Resistor 100k	10	0.50	5.00	
33	Resistor 100k	10	0.50	5.00	
34	Resistor 100k	10	0.50	5.00	
35	Resistor 100k	10	0.50	5.00	
36	Resistor 100k	10	0.50	5.00	
37	Resistor 100k	10	0.50	5.00	
38	Resistor 100k	10	0.50	5.00	
39	Resistor 100k	10	0.50	5.00	
40	Resistor 100k	10	0.50	5.00	
41	Resistor 100k	10	0.50	5.00	
42	Resistor 100k	10	0.50	5.00	
43	Resistor 100k	10	0.50	5.00	
44	Resistor 100k	10	0.50	5.00	
45	Resistor 100k	10	0.50	5.00	
46	Resistor 100k	10	0.50	5.00	
47	Resistor 100k	10	0.50	5.00	
48	Resistor 100k	10	0.50	5.00	
49	Resistor 100k	10	0.50	5.00	
50	Resistor 100k	10	0.50	5.00	

Fabrication Details:

- Name of fabrication step/version of prototype:
  - Circuitry
- Date to be completed:
  - 4/5/2026
- Team Member(s) fabricating:
  - All
- Detailed sketch of portion of prototype being fabricated (include dimensions)

[Download](#)

Dynamic\_Balance\_Device-\_Protocol\_Development.pdf (551 kB)



## 2026/03/13 - Working with team after advisor meeting

---

Freyja Heggeland - Mar 13, 2026, 12:58 PM CDT

**Title: Prototyping and old design work**

**Date:** March 13th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** understand and comprehend our project's goals and how we can finance each component of the design

**Content:**

We started by ripping apart the old design and took the electronic aspects. We took the 8x8 LED board, Arduino, breadboard, various wire connections (weight negligible).

Total electronic weight is around 80g.

Electronics dimensions (mm, taken as rectangular dimensions): 98.25 long, 54 width, height doesn't matter as much due to our circular design

8x8 LED display: 80mm<sup>2</sup>, negligible height (will be accommodated for in the 3D designs)

Inch dimensions start at the handle side and end at the display.

**Conclusions/action items:**

- start building our prototypes for show and tell
- collect materials when they arrive
- We met with our advisor and learned more about where we want to continue with our project.



## 2026/04/11 - Soldering + Vinyl Cutting

---

Katherine SATTEL - Apr 12, 2026, 11:03 AM CDT

**Title: Team Fabrication**

**Date:** 4/11/2026

**Content by:** Katherine Sattel

**Present:** All except Noor

**Goals:** Complete fabrication

**Content:**

- Therese 3D printed the final display housing with fewer supports and a reinforced base
- Also printed a wider handle to improve comfort -- will need to drill holes for buttons
- Printed a box to hold the circuitry together in the arm band
- Ordered a flexible cord cover to help protect the wires from arm band to base of rod
- Soldered the speaker to the display common ground and acquired an on/off switch
- Created a stencil to paint a ruler on the rod

**Conclusions/action items:**

Use teamlab during the week to finish



## 2026/4/13 - Carbon fiber rod fabrication

---

Katherine SATTEL - Apr 13, 2026, 8:03 PM CDT

**Title: Carbon Fiber Rod Fabrication**

**Date:** 4/13/2026

**Content by:** Therese Kalt

**Present:** Therese Kalt

**Goals:** Complete rod fabrication

**Content:**

- Used the team lab to cut the rod to a length of 31.5 in/80.1 cm
  - Extra length to account for the 5 in handle and 2 in attachment for the display
- Drilled a small hole for feeding wires through the base of the rod
- Used a stencil to paint white inch lines along the rod
  - Number stickers will be added tomorrow when they arrive
    - Lines will be cleaned up with sharpie or acetone
- Handle fits on rod, will be secured fully using super glue
- Display housing needed to be re-printed b/c the 3D printed broke
  - Should be done within next days

**Conclusions/action items:**

Complete circuitry tomorrow, 4/14

## 2026/04/14 - Soldering

Katherine SATTEL - Apr 14, 2026, 7:16 PM CDT

**Title:** Soldering

**Date:** 4/14/2026

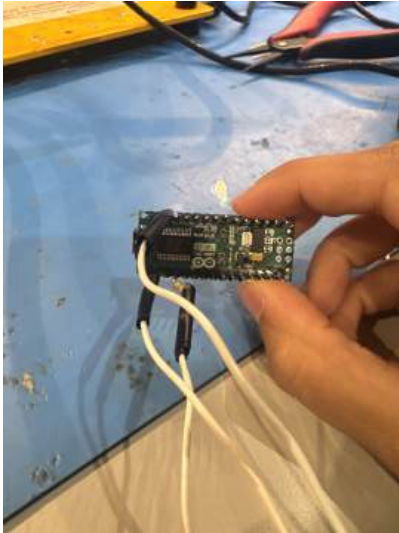
**Content by:** Katherine Sattel and Noor Awad

**Present:** Katherine Sattel and Noor Awad

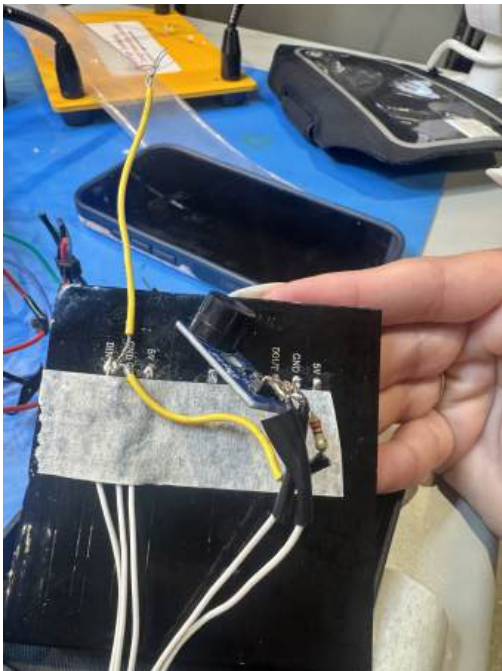
**Goals:** Complete majority of soldering work

**Content:**

- Connected LED and Speaker I/O to Arduino as well as common GND



- 
- Connected all of the circuitry for display housing, leaving space for ultrasonic sensor (to be picked up from 310 lab)



- 
- Sketched button holes on handle -- will cut out tmrw



### Conclusions/action items:

To do list:

- Connect voltages all to 1 wire and connect that to 3.3V
- Connect button and on/off switch to arduino
  - Buttons rails are connected across - GND and Arduino on bottom rail, Vcc on top rail
  - On/off switch needs to connect GND to Arduino and Vin to Arduino
  - DO THIS AFTER FEEDING THROUGH HANDLE CUT-OUTS
- Connect sensor to common ground in LED
  - Feed Voltage and trigger wires down rod and connect to Arduino
- LAST STEP IS CONNECTING EVERYTHING TO A COMMON VOLTAGE WIRE AND CONNECTING THAT TO 3.3V



## 2026/04/17 - Finished Circuitry

---

Katherine SATTEL - Apr 17, 2026, 4:47 PM CDT

**Title:** Finished Circuitry

**Date:** 4/17/2026

**Content by:** Katherine Sattel

**Present:** Noor Awad, Katherine Sattel

**Goals:** Complete the circuitry

**Content:**

- Soldered all connections to the perfboard --> Arduino
- Glued buttons in place, fed wires through handle and to battery/Arduino
- Tested sensitivity of ultrasonic sensor - very effective, will play around with threshold once sensor housing is 3D printed and attached
- LED functions, still need to test multi-functionality of button
- Attached numbers to inch markings, need to seal
- Video attached of using it with test code

**Conclusions/action items:**

Clean up circuitry and glue everything in place!

---

Katherine SATTEL - Apr 17, 2026, 4:48 PM CDT



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IMG\_4471.mov (2.9 MB)



## 2026/04/21 - Finishing Prototype

Katherine SATTEL - Apr 28, 2026, 1:11 PM CDT

### Title: Finishing Prototype

Date: 4/21/2026

Content by: Katherine Sattel

Present: All

Goals: Put everything together!

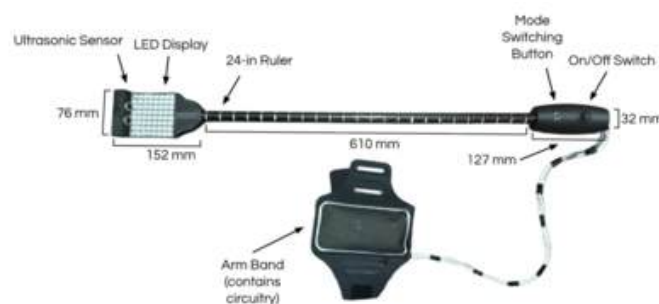
### Content:

- Arm Band:
  - Painted clear portion of arm band with black acrylic paint in Wendt Commons to hide circuitry
    - Temporary solution, hope to 3D print housing for arduino/perfboard/battery
- Circuitry:
  - Wrapped all of the exposed wire in electrical tape to improve durability
  - Superglued electronic components in place in the housing
  - Superglued acrylic cover onto LED display
  - Used electrical tape and duct tape to cover seams and make the display portion look more finished
- Code:
  - Updated code to include all components
  - Re-worked code to use the sensor for new 'Functional Reach Test' mode instead of speaker
    - Speaker hardware issue -- was going off without input because of voltage and current leaking from the display
    - In future iterations, using an active speaker, adding a parallel capacitor, or moving speaker location could help this
    - Move forward without speaker integration for now
- Rod:
  - Sealed the painted lines and stickers with UV resin to ensure durability
- Image of final prototype attached below

### Conclusions/action items:

Get ready to present at poster on Friday!

Katherine SATTEL - Apr 28, 2026, 1:10 PM CDT



[Download](#)

**Screenshot\_2026-04-28\_at\_1.10.54\_PM.png (324 kB)**

## 2026/4/28 - Final circuit diagram

NOOR AWAD (nawad2@wisc.edu) - Apr 28, 2026, 6:42 PM CDT

**Title:** Final circuit diagram

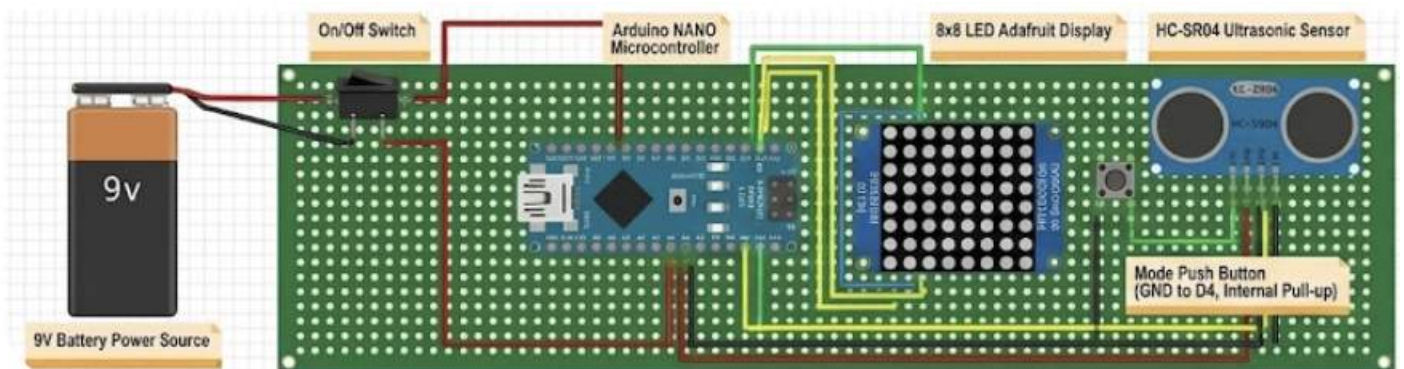
**Date:** 4/28/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Create final circuit diagram

**Content:**



**Conclusions/action items:**

This will go in final report under fabrication

# 2026/4/28 - Final Logic flow diagram

NOOR AWAD (nawad2@wisc.edu) - Apr 28, 2026, 6:45 PM CDT

**Title:** Final flow diagram

**Date:** 4/28/26

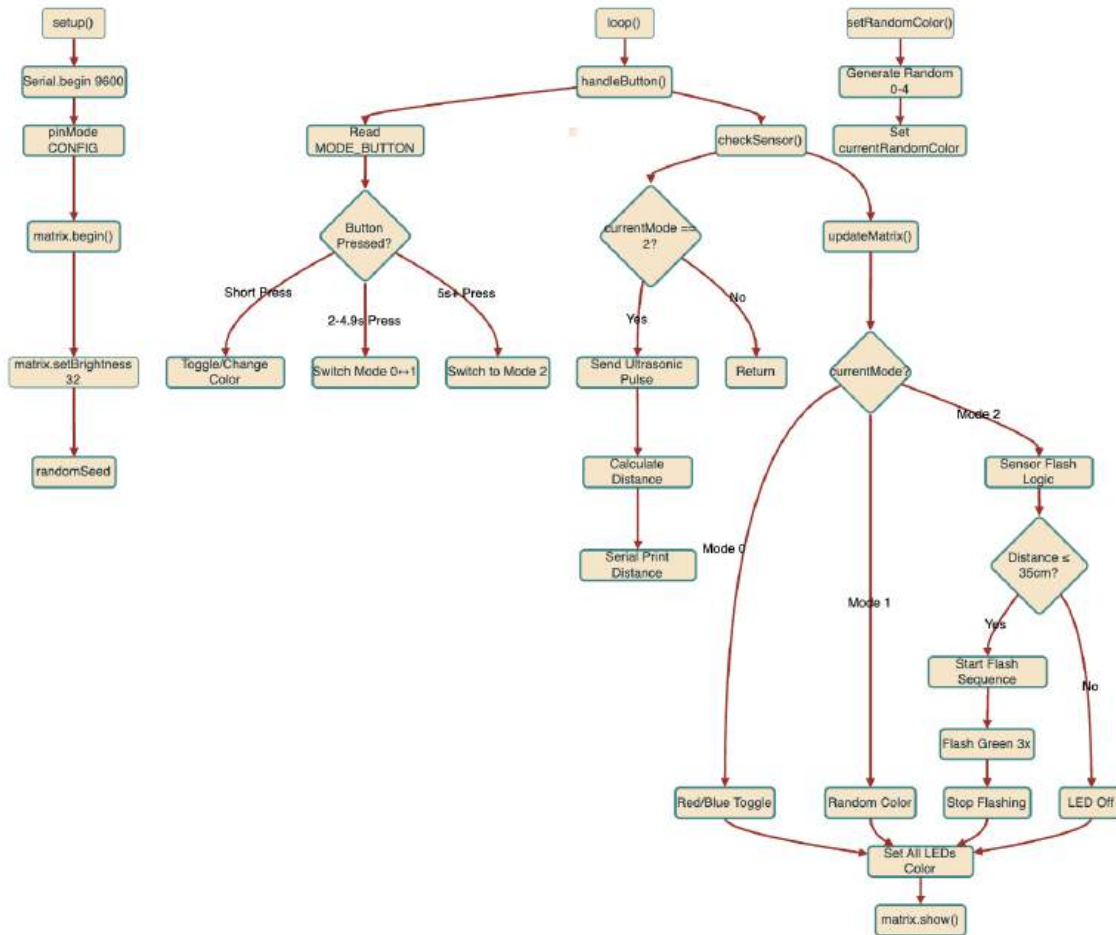
**Content by:** Noor Awad

**Present:** N/A

**Goals:** Create final logic flow diagram that reflects the removal of the speaker

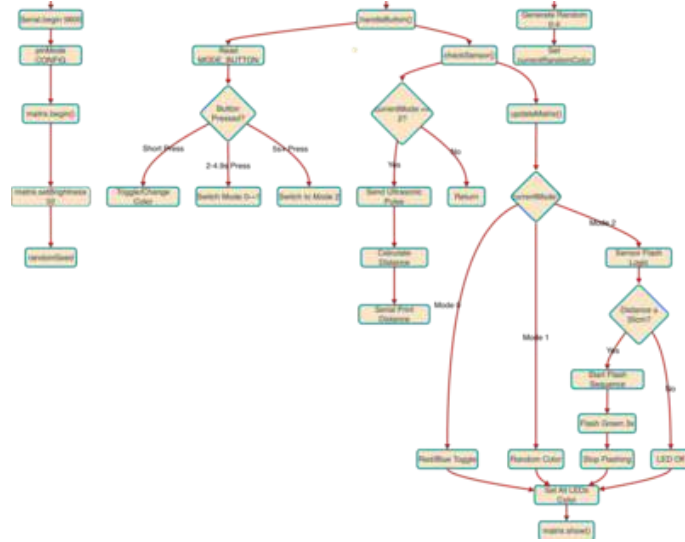
**Content:**

This was created using <https://app.diagrams.net/#>



**Conclusions/action items:**

This will go in final report under fabrication



[Download](#)

Logic\_diagram.drawio.png (340 kB)

# 2026/04/29 - Overall Fabrication Protocol

Katherine SATTEL - Apr 29, 2026, 12:00 PM CDT

**Title:** Overall Fabrication Protocol

**Date:** 4/29/2026

**Content by:** All

**Present:** N/A

**Goals:** Create final fabrication protocol for device

**Content:**

Attached in PDF

**Conclusions/action items:**

Include as appendix in final report

Katherine SATTEL - Apr 29, 2026, 12:00 PM CDT

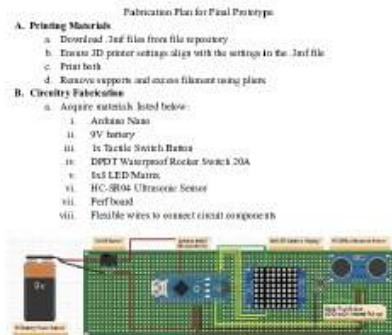


Figure 1: Wiring diagram of circuitry

- Construct Wiring Diagram as shown:
  - Connect red lead of the battery (+) positive lead of on/off switch, then, connect other lead of on/off switch to Vin pin of Arduino Nano, negative lead to GND
  - Connect Arduino 5V pin to the 5V rail of perf board, Arduino GND pin to GND on breadboard
    - Use small paper to create "rails" on ends of bread board to ensure all components can be connected properly
  - Connect one leg of button to 5V rail and diagonally opposite leg to Digital pin 7
  - Connect Vcc pin of ultrasonic sensor to 5V rail, trigger pin to Digital pin 2, echo pin to Digital pin 5, and GND pin to GND rail

[Download](#)

Overall\_Fabrication\_Protocol.pdf (533 kB)



## 2026/02/22 - MTS Testing Protocol

Katherine SATTEL - Apr 28, 2026, 1:14 PM CDT

**Title:** MTS Testing Protocol

**Date:** 2/26/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Create a protocol for the MTS testing of our material(s)

**Content:**

Safety:

- Always check in with Dr. Puccinelli or a faculty member to observe the first time you use the MTS machine.
- Make sure the machine has the correct load cell for your specimen and the bend fixture attached (shown below)



- Bottom safety stop unscrews and tightens down to mechanically stop the machine. Set stop accordingly.
- The handheld remote controls the machine to some extent, and itself is controlled by the lock button.
  - This button will transfer control between the handheld remote and the computer.
  - On the remote, the buttons control coarse movement and the wheel controls fine movement.
  - **\*\*Need to edit the rest -- still in progress\*\***

Before testing:

- Create team folder with descriptive labels
- Open TW Elite
- Open pre-made test template "BME 315 Failure Testing"

For each sample:

1. Make sure E stop is pushed, and place the sample on the bottom two rollers
  1. Use rubber bands if necessary to secure sample in place
2. Release E-stop by twisting the knob
3. Unlock the machine by hitting the unlock button on handset TWICE
4. Pre load sample by slowly lowering the toggle until the load reads 1N or less
  - a. With the coarse controls, bring the head of the machine close, but not touching, the top of the sample
  - b. Slower lower the head with the fine controls, watching the load display on the computer screen until it reaches about 1N
5. Zero the crosshead by right clicking and selecting "zero signal"
6. Send control back to the computer by pressing the lock button on the handheld remote
7. Press play on computer to run the test
  - a. When prompted, enter diameter and hit okay

- b. Test will run immediately after, hover mouse over stop button
8. Stop test at 2500 N or until test automatically stops
  - a. When prompted to return to zero, select “yes”
9. Drive crosshead up so you have clearance to remove the test part
10. Export raw data
  - a. Select “Export Raw Data” and send to a known location
  - b. Rename data in file explorer to reflect the name of the test part
11. Hit the E-stop
12. Optional: Hit “compare” to see consistency, and take pictures if desired
- 13. Repeat Steps 1-11 for at least 3 trials**

After testing all samples:

1. Move files to Google Drive folder
2. Close software without saving data

**Conclusions/action items:**

Use this protocol for testing



## 2026/02/22 - Fatigue Testing Protocol

---

Katherine SATTEL - Apr 28, 2026, 1:14 PM CDT

**Title:** Fatigue Testing Protocol

**Date:** 4/11/2026

**Content by:** Katherine Sattel and Freyja Heggeland

**Present:** N/A

**Goals:** Create testing protocol for fatigue testing

**Content:**

Link to form: [https://docs.google.com/forms/d/e/1FAIpQLSd3A79dLJpe5zix6pCuPhSksjfr\\_fmTCH-mJZsRNzyM0uUHRa/viewform](https://docs.google.com/forms/d/e/1FAIpQLSd3A79dLJpe5zix6pCuPhSksjfr_fmTCH-mJZsRNzyM0uUHRa/viewform)

Link to form with data points:

<https://docs.google.com/spreadsheets/d/1TGhTHoxKRbitWpMUwbCxP3SSIGUHgEEGkAxVTgBonA0/edit?resourcekey=&gid=327958055#gid=327958055>

Protocol:

1. Have participants complete tasks as noted by the testing survey. Their responses will be recorded and summarized.
2. Both the device from Fall 2024 and the current device will be used, so the team can perform a t-test discussing the difference between the two.

Fatigue Testing Survey

1. How difficult was it to hold the previous device with your arm extended for 30 seconds?
  - a. very easy
  - b. easy
  - c. not easy or difficult
  - d. difficult
  - e. very difficult
2. How long were you able to hold the previous device at one point until failure? (answer in seconds, round to the nearest second)
3. How difficult was it to hold the previous device in an arc for 30 seconds?
  - a. very easy
  - b. easy
  - c. not easy or difficult
  - d. difficult
  - e. very difficult

4. How long were you able to move the previous device in an arc until failure? (answer in seconds, round to the nearest second)
5. Where on your body would you say you felt the most discomfort while using the previous device?
  - a. Thumb
  - b. Palm of hand
  - c. Wrist
  - d. Forearm
  - e. Elbow
  - f. Upper arm
  - g. Shoulder
6. For the area in which you felt the most discomfort while holding the previous device, please rate that discomfort using the scale below:
  - a. 1 - I did not feel any discomfort
  - b. 2 - Barely uncomfortable
  - c. 3 - Slightly uncomfortable
  - d. 4 - Uncomfortable
  - e. 5 - Very uncomfortable
7. How difficult was it to hold the current device with your arm extended for 30 seconds?
  - a. very easy
  - b. easy
  - c. not easy or difficult
  - d. difficult
  - e. very difficult
8. How long were you able to hold the current device at one point until failure? (answer in seconds, round to the nearest second)
9. How difficult was it to hold the current device in an arc for 30 seconds?
  - a. very easy
  - b. easy
  - c. not easy or difficult
  - d. difficult
  - e. very difficult
10. How long were you able to move the current device in an arc until failure? (answer in seconds, round to the nearest second)
11. Where on your body would you say you felt the most discomfort while using the current device?
  - a. Thumb
  - b. Palm of hand
  - c. Wrist
  - d. Forearm
  - e. Elbow
  - f. Upper arm

## g. Shoulder

12. For the area in which you felt the most discomfort while holding the current device, please rate that discomfort using the scale below:

- a. 1 - I did not feel any discomfort
- b. 2 - Barely uncomfortable
- c. 3 - Slightly uncomfortable
- d. 4 - Uncomfortable
- e. 5 - Very uncomfortable

**Conclusions/action items:**

Follow this protocol for testing activities

---

Katherine SATTEL - Apr 28, 2026, 1:15 PM CDT



Figures 5, 6: Experimental set-up for fatigue testing

[Download](#)

Screenshot\_2026-04-28\_at\_1.15.07\_PM.png (435 kB)



## 2026/4/22 - MTS Testing results

NOOR AWAD (nawad2@wisc.edu) - Apr 22, 2026, 8:30 PM CDT

**Title:** MTS testing results

**Date:** 4/22/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Document MTS matlab code and results

**Content:**

```
D_out = 20.0;
```

```
D_in = 18.0;
```

```
L0 = 20.0;
```

```
A = (pi / 4) * (D_out^2 - D_in^2);
```

```
figure;
```

```
hold on;
```

```
strain1 = data1{:, 1} ./ L0;
```

```
stress1 = data1{:, 2} ./ A;
```

```
plot(strain1, stress1, 'LineWidth', 1.5, 'DisplayName', 'Test Run 1');
```

```
strain2 = data2{:, 1} ./ L0;
```

```
stress2 = data2{:, 2} ./ A;
```

```
plot(strain2, stress2, 'LineWidth', 1.5, 'DisplayName', 'Test Run 2');
```

```
strain3 = data3{:, 1} ./ L0;
```

```
stress3 = data3{:, 2} ./ A;
```

```
plot(strain3, stress3, 'LineWidth', 1.5, 'DisplayName', 'Test Run 3');
```

```
title('Stress-Strain Curve for Carbon Fiber Rod');
```

```
xlabel('Strain (mm/mm)');
```

```
ylabel('Stress (MPa)');
```

```
legend('show', 'Location', 'best');
```

```
xlim(0:1)
```

```
grid on;
```

```
hold off;
```

```
lower_strain1 = 0.0;
upper_strain1 = 0.120;

idx1 = (strain1 >= lower_strain1) & (strain1 <= upper_strain1);
lin_strain1 = strain1(idx1);
lin_stress1 = stress1(idx1);
fit1 = polyfit(lin_strain1, lin_stress1, 1);
E1 = fit1(1);
fprintf('Test Run 1: %.2f MPa\n', E1);
Test Run 1: 114.00 MPa
```

```
lower_strain2 = 0.0;
upper_strain2 = 0.1656;

idx2 = (strain2 >= lower_strain2) & (strain2 <= upper_strain2);
lin_strain2 = strain2(idx2);
lin_stress2 = stress2(idx2);
fit2 = polyfit(lin_strain2, lin_stress2, 1);
E2 = fit2(1);
fprintf('Test Run 2: %.2f MPa\n', E2);
Test Run 2: 93.42 MPa
```

```
lower_strain3 = 0.0;
upper_strain3 = 0.1469;

idx3 = (strain3 >= lower_strain3) & (strain3 <= upper_strain3);
lin_strain3 = strain3(idx3);
lin_stress3 = stress3(idx3);
fit3 = polyfit(lin_strain3, lin_stress3, 1);
E3 = fit3(1);
fprintf('Test Run 3: %.2f MPa\n', E3);
Test Run 3: 109.58 MPa
max_stress_3 = max(lin_stress3)
max_stress_3 = 16.8146
```



```

File Path: C:\Users\kateri\Downloads\Text Mat 4 04-22-2026 13 11 PM.DAQ
Crosshead: 1 [Timed_10]
Test: 0 [MTS] 3-Point Bore To Future-6 [Bore]
Test Mat: Text Mat 4
Date: 4/22/2026 3:05:25 PM

Crosshead Load Time
mm N %C
R.4054778480773500 0.545449401351100 0.13289999999993047
R.4054778480773500 1.347219100780126 0.23289999999992103
R.4054778480773500 2.727219100780126 0.33289999999992009
R.41160372614123256 4.074669730402620 0.43289999999992234
R.41160372614123256 5.29808462041012 0.53289999999992449
R.4074431827732000 6.21784212777318 0.63289999999992674
R.4074431827732000 7.499000000000000 0.73289999999992900
R.8208809187251773 9.59821967746607 0.83289999999993125
R.402077903105000 10.458031200000000 0.93289999999993350
R.6278434619933000 10.142000000000000 1.03289999999993575
R.402733131196484 11.800713000000000 1.13289999999993800
R.8308814801480483 12.321000000000000 1.23289999999994025
R.402077903105000 12.710000000000000 1.33289999999994250
R.402077903105000 13.248000000000000 1.43289999999994475
R.402077903105000 13.800000000000000 1.53289999999994700
R.402077903105000 14.368000000000000 1.63289999999994925
R.402077903105000 14.952000000000000 1.73289999999995150
R.402077903105000 15.552000000000000 1.83289999999995375
R.402077903105000 16.168000000000000 1.93289999999995600
R.402077903105000 16.800000000000000 2.03289999999995825
R.402077903105000 17.448000000000000 2.13289999999996050
R.402077903105000 18.112000000000000 2.23289999999996275
R.402077903105000 18.792000000000000 2.33289999999996500
R.402077903105000 19.488000000000000 2.43289999999996725
R.402077903105000 20.192000000000000 2.53289999999996950
R.402077903105000 20.904000000000000 2.63289999999997175
R.402077903105000 21.624000000000000 2.73289999999997400
R.402077903105000 22.352000000000000 2.83289999999997625
R.402077903105000 23.088000000000000 2.93289999999997850
R.402077903105000 23.832000000000000 3.03289999999998075
R.402077903105000 24.584000000000000 3.13289999999998300
R.402077903105000 25.344000000000000 3.23289999999998525
R.402077903105000 26.112000000000000 3.33289999999998750
R.402077903105000 26.888000000000000 3.43289999999998975
R.402077903105000 27.672000000000000 3.53289999999999200
R.402077903105000 28.464000000000000 3.63289999999999425
R.402077903105000 29.264000000000000 3.73289999999999650
R.402077903105000 30.072000000000000 3.83289999999999875
R.402077903105000 30.888000000000000 3.93289999999999999
R.402077903105000 31.712000000000000 4.03289999999999999
R.402077903105000 32.544000000000000 4.13289999999999999
R.402077903105000 33.384000000000000 4.23289999999999999
R.402077903105000 34.232000000000000 4.33289999999999999
R.402077903105000 35.088000000000000 4.43289999999999999
R.402077903105000 35.952000000000000 4.53289999999999999
R.402077903105000 36.824000000000000 4.63289999999999999
R.402077903105000 37.704000000000000 4.73289999999999999
R.402077903105000 38.592000000000000 4.83289999999999999
R.402077903105000 39.488000000000000 4.93289999999999999
R.402077903105000 40.392000000000000 5.03289999999999999
R.402077903105000 41.304000000000000 5.13289999999999999
R.402077903105000 42.224000000000000 5.23289999999999999
R.402077903105000 43.152000000000000 5.33289999999999999
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R.402077903105000 45.032000000000000 5.53289999999999999
R.402077903105000 46.084000000000000 5.63289999999999999
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R.402077903105000 48.212000000000000 5.83289999999999999
R.402077903105000 49.288000000000000 5.93289999999999999
R.402077903105000 50.372000000000000 6.03289999999999999
R.402077903105000 51.464000000000000 6.13289999999999999
R.402077903105000 52.564000000000000 6.23289999999999999
R.402077903105000 53.672000000000000 6.33289999999999999
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R.402077903105000 66.388000000000000 7.43289999999999999
R.402077903105000 67.592000000000000 7.53289999999999999
R.402077903105000 68.804000000000000 7.63289999999999999
R.402077903105000 70.024000000000000 7.73289999999999999
R.402077903105000 71.252000000000000 7.83289999999999999
R.402077903105000 72.488000000000000 7.93289999999999999
R.402077903105000 73.732000000000000 8.03289999999999999
R.402077903105000 74.984000000000000 8.13289999999999999
R.402077903105000 76.244000000000000 8.23289999999999999
R.402077903105000 77.512000000000000 8.33289999999999999
R.402077903105000 78.788000000000000 8.43289999999999999
R.402077903105000 80.072000000000000 8.53289999999999999
R.402077903105000 81.364000000000000 8.63289999999999999
R.402077903105000 82.664000000000000 8.73289999999999999
R.402077903105000 83.972000000000000 8.83289999999999999
R.402077903105000 85.288000000000000 8.93289999999999999
R.402077903105000 86.612000000000000 9.03289999999999999
R.402077903105000 87.944000000000000 9.13289999999999999
R.402077903105000 89.284000000000000 9.23289999999999999
R.402077903105000 90.632000000000000 9.33289999999999999
R.402077903105000 91.988000000000000 9.43289999999999999
R.402077903105000 93.352000000000000 9.53289999999999999
R.402077903105000 94.724000000000000 9.63289999999999999
R.402077903105000 96.104000000000000 9.73289999999999999
R.402077903105000 97.492000000000000 9.83289999999999999
R.402077903105000 98.888000000000000 9.93289999999999999
R.402077903105000 100.292000000000000 10.03289999999999999
R.402077903105000 101.704000000000000 10.13289999999999999
R.402077903105000 103.124000000000000 10.23289999999999999
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R.402077903105000 110.344000000000000 10.73289999999999999
R.402077903105000 111.812000000000000 10.83289999999999999
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R.402077903105000 114.772000000000000 11.03289999999999999
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R.402077903105000 178.888000000000000 14.93289999999999999
R.402077903105000 180.692000000000000 15.03289999999999999
R.402077903105000 182.504000000000000 15.13289999999999999
R.402077903105000 184.324000000000000 15.23289999999999999
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R.402077903105000 197.288000000000000 15.93289999999999999
R.402077903105000 199.172000000000000 16.03289999999999999
R.402077903105000 201.064000000000000 16.13289999999999999
R.402077903105000 202.964000000000000 16.23289999999999999
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R.402077903105000 238.532000000000000 18.03289999999999999
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R.402077903105000 242.644000000000000 18.23289999999999999
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R.402077903105000 257.288000000000000 18.93289999999999999
R.402077903105000 259.412000000000000 19.03289999999999999
R.402077903105000 261.544000000000000 19.13289999999999999
R.402077903105000 263.684000000000000 19.23289999999999999
R.402077903105000 265.832000000000000 19.33289999999999999
R.402077903105000 267.988000000000000 19.43289999999999999
R.402077903105000 270.152000000000000 19.53289999999999999
R.402077903105000 272.324000000000000 19.63289999999999999
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R.402077903105000 276.692000000000000 19.83289999999999999
R.402077903105000 278.888000000000000 19.93289999999999999
R.402077903105000 281.092000000000000 20.03289999999999999
R.402077903105000 283.304000000000000 20.13289999999999999
R.402077903105000 285.524000000000000 20.23289999999999999
R.402077903105000 287.752000000000000 20.33289999999999999
R.402077903105000 290.088000000000000 20.43289999999999999
R.402077903105000 292.432000000000000 20.53289999999999999
R.402077903105000 294.784000000000000 20.63289999999999999
R.402077903105000 297.144000000000000 20.73289999999999999
R.402077903105000 299.512000000000000 20.83289999999999999
R.402077903105000 301.888000000000000 20.93289999999999999
R.4
```



## 2026/4/22 - Comfort Testing Results

---

Katherine SATTEL - Apr 28, 2026, 1:20 PM CDT

**Title:** Comfort Testing Results

**Date:** 4/22/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Create plots for poster comparing comfort testing results

**Content:**

MATLAB script for discomfort by body part:

```
% --- Data ---
```

```
Elbow_old = 2; Thumb_old = 10; Wrist_old = 16; Forearm_old = 15; Shoulder_old = 8;
```

```
Elbow_new = 1; Shoulder_new = 14; Wrist_new = 2; Thumb_new = 2; Forearm_new = 3;
```

```
% --- Organize Data ---
```

```
% Column 1: Old | Column 2: New
```

```
data = [Elbow_old, Elbow_new;
```

```
        Thumb_old, Thumb_new;
```

```
        Wrist_old, Wrist_new;
```

```
        Forearm_old, Forearm_new;
```

```
        Shoulder_old, Shoulder_new];
```

```
body_parts = {'Elbow', 'Thumb', 'Wrist', 'Forearm', 'Shoulder'};
```

```
% --- Plotting ---
```

```
figure('Color', 'w');
```

```
b = bar(data);
```

```
% Set Y-limit to 20
```

```
ylim([0 20]);
```

```
% --- Styling ---
```

```
set(gca, 'XTickLabel', body_parts);
```

```
ylabel('Quantity');
```

```
title('Body Part Comparison: Old vs. New');
```

```
legend('Old', 'New', 'Location', 'northeast');
```

```
grid on;
```

```
% Add data labels on top of bars
```

```
for i = 1:numel(b)
```

```
    xtips = b(i).XEndPoints;
```

```
    ytips = b(i).YData;
```

```
    labels = string(b(i).YData);
```

```
    text(xtips, ytips, labels, 'HorizontalAlignment', 'center', ...
```

```
         'VerticalAlignment', 'bottom');
```

```
end
```

```
MATLAB script for overall average discomfort:
```

```
% --- Raw Data ---
```

```
Vec_old_static = [2 4 4 4 3 4 3 3 2 5 3 5 5];
```

```
Vec_old_dynamic = [2 4 5 4 4 4 3 4 1 5 4 4 4];
```

```
Vec_new_static = [1 2 2 1 2 2 1 3 1 4 1 4 2 4];
```

```
Vec_new_dynamic = [1 3 1 2 3 2 1 3 2 3 3 4 2 4];
```

```
% --- Calculate Averages ---
```

```
avg_old_static = mean(Vec_old_static);
```

```
avg_new_static = mean(Vec_new_static);
```

```
avg_old_dynamic = mean(Vec_old_dynamic);
```

```
avg_new_dynamic = mean(Vec_new_dynamic);
```

```
% --- Statistical Testing (T-Tests) ---
```

```
% Compare Old vs New for Static
```

```
[h_static, p_static] = ttest2(Vec_old_static, Vec_new_static);
```

```
% Compare Old vs New for Dynamic
```

```
[h_dynamic, p_dynamic] = ttest2(Vec_old_dynamic, Vec_new_dynamic);
```

```
% Display results in Command Window
```

```
fprintf('Static Condition: p-value = %.4f\n', p_static);
```

```
fprintf('Dynamic Condition: p-value = %.4f\n', p_dynamic);
```

```
% --- Plotting ---
```

```
% Matrix: Rows are Static/Dynamic, Columns are Old/New
```

```
data_matrix = [avg_old_static, avg_new_static;
```

```
                avg_old_dynamic, avg_new_dynamic];
```

```
figure('Color', 'w');
```

```
b = bar(data_matrix);
```

```
% Styling the axes
```

```
set(gca, 'XTickLabel', {'Static', 'Dynamic'});
```

```
ylabel('Average Discomfort Score');
```

```
title('Discomfort Comparison: Old vs. New');
```

```
legend('Old', 'New', 'Location', 'northeastoutside');
```

```
grid on;
```

```
ylim([0 5]); % Adjust limit to accommodate data range
```

```
% Add Value Labels and P-values to the plot
```

```
for i = 1:numel(b)

    xtips = b(i).XEndPoints;

    ytips = b(i).YData;

    labels = string(round(b(i).YData, 2));

    text(xtips, ytips, labels, 'HorizontalAlignment', 'center', ...

        'VerticalAlignment', 'bottom');

end

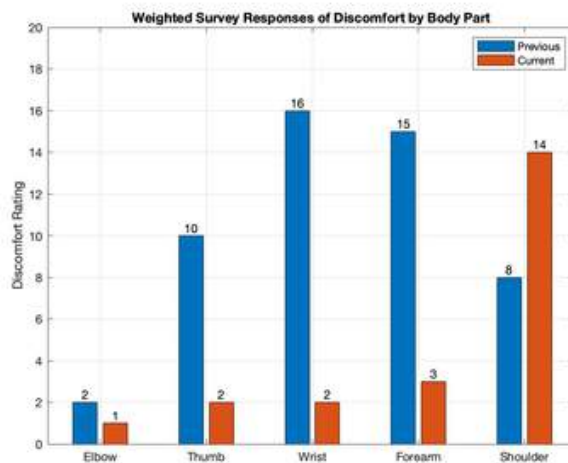
% Optional: Annotate the graph with p-values

text(1, 4.5, sprintf('p = %.4f', p_static), 'HorizontalAlignment', 'center', 'FontWeight', 'bold');

text(2, 4.5, sprintf('p = %.4f', p_dynamic), 'HorizontalAlignment', 'center', 'FontWeight', 'bold');
```

### Conclusions/action items:

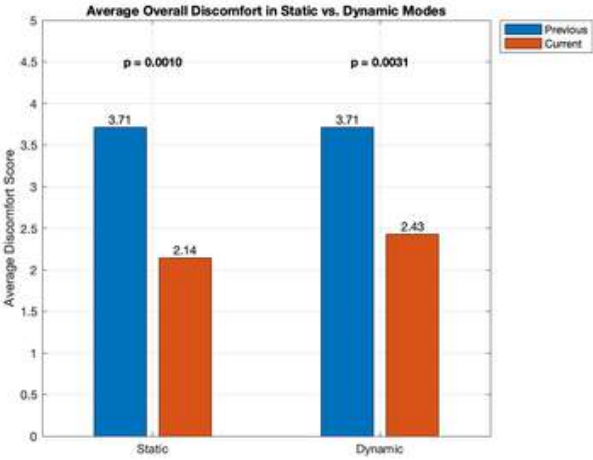
Katherine SATTEL - Apr 28, 2026, 1:20 PM CDT



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DiscomfortsAcrossBodyPartsPlot.png (36.2 kB)

Katherine SATTEL - Apr 28, 2026, 1:21 PM CDT



[Download](#)

OverallDiscomfortsPlot.png (36.9 kB)



## 2026/04/22- Failure Statistical Analysis

Therese Kalt - Apr 28, 2026, 1:26 PM CDT

**Title:** Failure Statistical Analysis

**Date:** 04/22/2026

**Content by:** Therese Kalt

**Present:** Whole team except Freyja

**Goals:** To analyze the data we collected during failure testing.

**Content:**

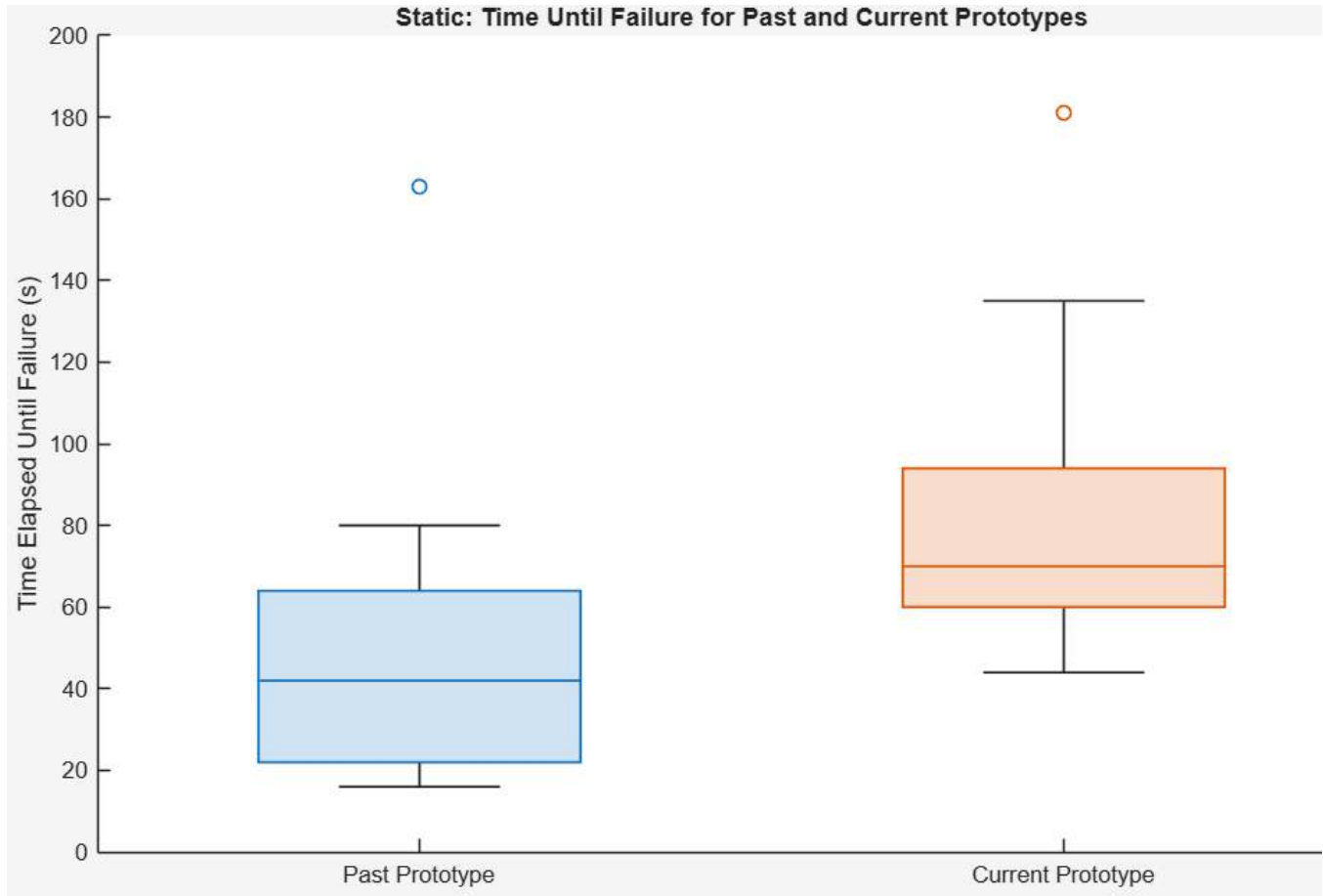
Matlab script:

```
% Time until failure
old_data_failure=[19 24 54 64 46 43 71 80 163 22 41 16 22 21];
new_data_failure=[44 60 70 80 59 70 94 135 181 80 114 63 70 59];
[h1,p1]=ttest(old_data_failure,new_data_failure)

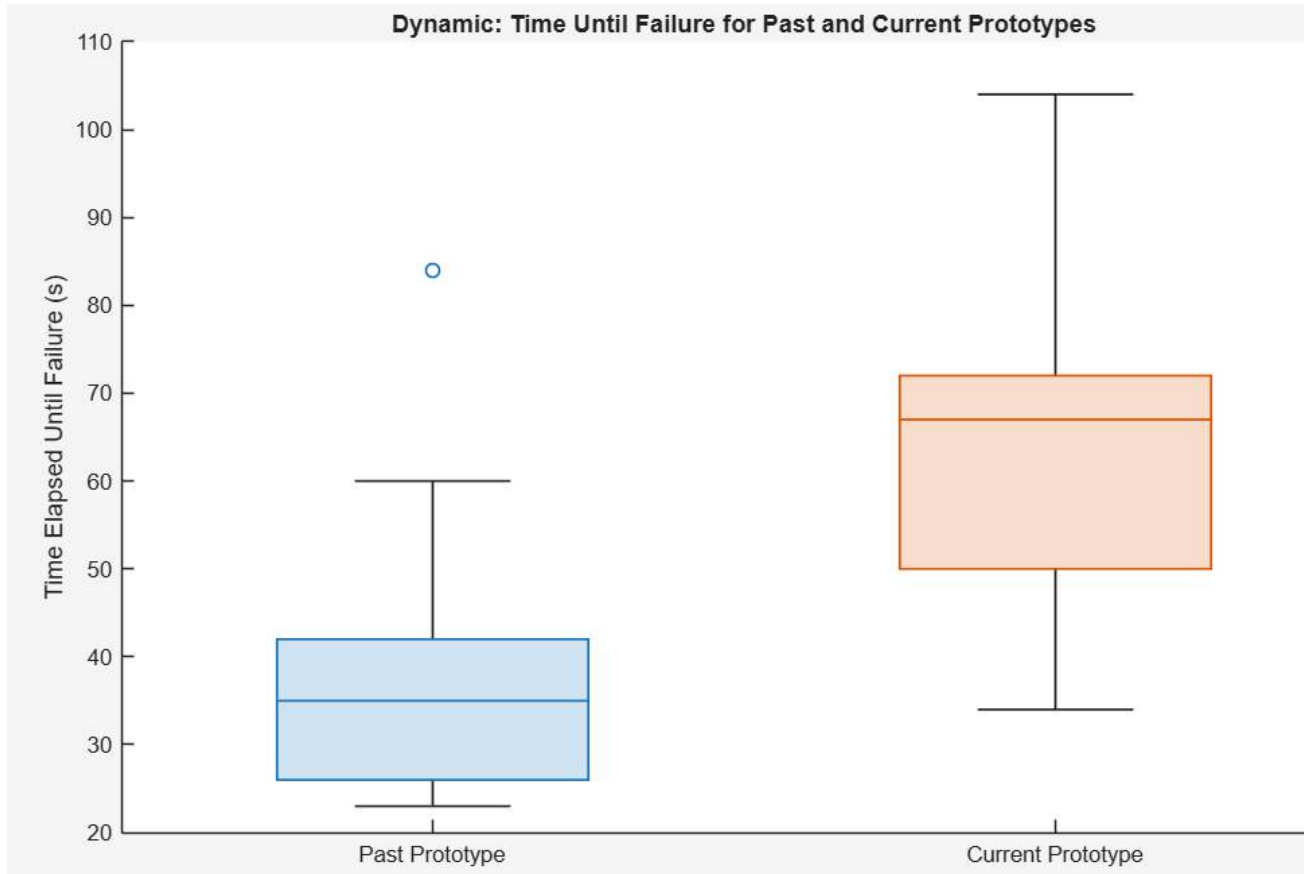
% Time arc
old_data_arc=[37 35 31 50 23 36 42 60 84 25 35 26 31 24];
new_data_arc=[71 50 82 60 70 60 70 93 104 64 72 34 41 50];
[h2,p2]=ttest(old_data_arc,new_data_arc)
figure(1)
% Place the first box at position 1
boxchart(ones(size(old_data_failure)), old_data_failure)
hold on
% Place the second box at position 2
boxchart(2 * ones(size(new_data_failure)), new_data_failure)
% Clean up the axes
xticks([1 2])
xticklabels({'Past Prototype', 'Current Prototype'})
ylabel('Time Elapsed Until Failure (s)')
title('Static: Time Until Failure for Past and Current Prototypes')
hold off
figure(2)
% Place the first box at position 1
boxchart(ones(size(old_data_arc)), old_data_arc)
hold on
% Place the second box at position 2
boxchart(2 * ones(size(new_data_arc)), new_data_arc)
% Clean up the axes
xticks([1 2])
xticklabels({'Past Prototype', 'Current Prototype'})
ylabel('Time Elapsed Until Failure (s)')
title('Dynamic: Time Until Failure for Past and Current Prototypes')
hold off
```

Time Until Failure:

Static failure-



Dynamic failure-



- P-value for static failure: 0.001
- P-value for dynamic failure: 0.0031

**Conclusions/action items:** Use these graphs and p-values to prove statistical significance.

# 2026/2/12 - Auditory Feedback Design Matrix

Katherine SATTEL - Feb 12, 2026, 2:06 PM CST

**Title:** Auditory Feedback Design Matrix

**Date:** 2/12/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Create criteria and rank auditory feedback systems accordingly

**Content:**

Attached in PDF

**Conclusions/action items:**

Make sure to include this in preliminary report and presentation!

Katherine SATTEL - Feb 12, 2026, 2:49 PM CST

BME Design: 200, 201, 300, 301, 400 and 402

Designs		Design 1: Sensor-activated speaker	Design 2: Sensor-Activated Button	Design 3: Manual Trigger			
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (5)	3/3	21	4/3	20	4/3	21
2	Ease of Use (10)	3/3	30	3/3	30	3/3	30
3	Ease of Fabrication (20)	4/3	16	3/3	6	4/3	16
4	Sound Variability (10)	5/5	10	3/3	6	3/3	6
5	Cost (5)	3/3	5	3/3	3	5/5	5
			80		75		74

**Criteria:**

**Weight (5):**

Weight is ranked as the most important criterion because excessive weight was a significant issue identified by the client in previous iterations of the device. Since the auditory feedback system is an additional feature being integrated into the existing design, it is essential that it does not increase the overall weight of the device by a large amount. The selected components must be lightweight and compact to ensure that the final prototype is lighter than previous versions.

**Ease of Use (10):**

[Download](#)

**Auditory\_Feedback\_Matrix\_Dynamic\_Balance\_Device- BME\_Design-Design\_matrix\_instructions.pdf (410 kB)**

# 2026/02/12 - Materials Design Matrix

Katherine SATTEL - Feb 12, 2026, 2:05 PM CST

**Title:** Materials Design Matrix

**Date:** 2/12/2026

**Content by:** Freyja, Katherine

**Present:** N/A

**Goals:** Create criteria and rank material options accordingly

**Content:**

Attached in PDF

**Conclusions/action items:**

Make sure to include this in preliminary report and presentation!

Katherine SATTEL - Feb 12, 2026, 2:49 PM CST

BME Design-200, 201, 300, 301, 400 and 402

Designs	Design 1: Carbon Fiber	Design 2: Aluminum Alloy	Design 3: PVC Tubing				
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (40)	3.0	120	2.0	80	2.0	80
2	Density (20)	5.0	100	3.0	60	4.5	90
3	Ease of Fabrication (15)	1.0	15	3.5	52.5	5.5	82.5
4	Ease of Etching (10)	2.0	20	4.0	40	4.0	40
5	Cost (15)	2.0	30	4.0	60	3.0	45
			300		232.5		232.5

**Criteria**

**Weight (40)**

Weight is ranked as the most important criteria because excessive weight was the primary concern stated by the client regarding the previous prototype. A reduction in weight is highly critical to improving overall usability. The selected material must be as lightweight as possible while still meeting strength requirements. This will improve user comfort and reduce physical strain, particularly in a clinical setting where the device will be used repeatedly throughout the day. Additionally, lowering the weight contributes to patient safety by minimizing the risk of injury if the device is dropped or mishandled.

**Density (20)**

Density is ranked as the second most important criteria due to issues with structural failure in previous prototypes. The final design is expected to have a minimum life in service of one year with minimal...

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**Material\_Matrix\_Dynamic\_Balance\_Device-\_BME\_Design-Design\_matrix\_instructions.pdf (1.37 MB)**

# 2026/02/12 - Overall Design Matrix

Katherine SATTEL - Feb 12, 2026, 2:04 PM CST

**Title:** Overall Design Matrix

**Date:** 2/12/2026

**Content by:** Therese, Noor

**Present:** N/A

**Goals:** Create criteria and rank design options accordingly

**Content:**

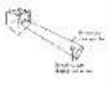


Attached in PDF

**Conclusions/action items:**

Make sure to include in preliminary report and presentation!

Katherine SATTEL - Feb 12, 2026, 2:49 PM CST

BME Design: 200, 201, 300, 301, 400 and 402

Designs	Design 1: Fixed Length Shaft	Design 2: Push Button Fix Shaft	Design 3: Hands Free Board				
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (25)	4/5	20	4/5	20	5/5	20
2	Usability (25)	5/5	25	4/5	20	4/5	20
3	User Comfort (20)	4/5	16	4/5	16	3/5	12
4	Ease of Fabrication (15)	5/5	15	3/5	9	5/5	15
5	Safety (10)	3/5	10	4/5	8	4/5	8
6	Cost (5)	5/5	5	4/5	4	3/5	3
			81		77		67

**Criteria:**

**Weight (25)**

Weight evaluates numerically and experimentally how heavy the final design will be perceived by the user. The product is intended to be in use while the client is physically supporting patients, so a manageable weight is a key factor in how easily this can be done. In addition, if the device is too heavy it might degrade faster or fail at attachments. Weight will be evaluated as better or worse than the previous design, which was deemed too heavy. If the device is too heavy and it hinders the client's ability to support the patient, the patient could face a safety risk. Since weight impacts comfort, durability, and safety, it is given the highest weighting of the criteria.

[Download](#)

Design\_Matrix\_Dynamic\_Balance\_Device-\_BME\_Design-Design\_matrix\_instructions.pdf (297 kB)

## 2026/02/20 - Preliminary Presentation

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Katherine SATTEL - Apr 28, 2026, 1:26 PM CDT

**Title:** Preliminary Presentation

**Date:** 2/20/2026

**Content by:** All

**Present:** N/A

**Goals:** Create preliminary presentation

**Content:**

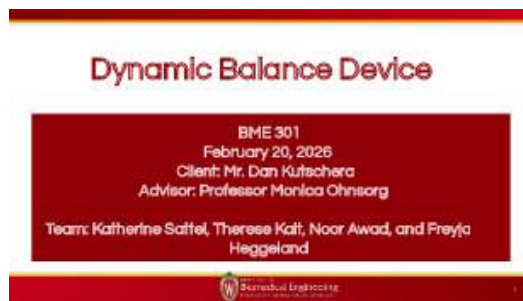
Attached in PDF

**Conclusions/action items:**

Present!

---

Katherine SATTEL - Apr 28, 2026, 1:26 PM CDT



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Dynamic\_Balance\_Device\_-\_Preliminary\_Design\_Presentation.pdf (1.35 MB)

# 2026/02/25 - Preliminary Report

Katherine SATTEL - Apr 28, 2026, 1:24 PM CDT

**Title:** Preliminary Report

**Date:** 2/25/2026

**Content by:** All

**Present:** N/A

**Goals:** Write preliminary report

**Content:**

Attached in PDF

**Conclusions/action items:**

Turn in on Canvas and website

Katherine SATTEL - Apr 28, 2026, 1:24 PM CDT



**Preliminary Report: Dynamic Balance Device**

Bioelectrical Engineering 381  
February 25, 2026

Client: Drs Katschens  
Advisor: Professor Ozanog

University of Wisconsin–Madison  
Department of Biomedical Engineering

**Team Members:**

Katherine Sattel (Team Leader) [ksattel@wisc.edu](mailto:ksattel@wisc.edu)  
Theresa Katt (Communicator) [tkatt@wisc.edu](mailto:tkatt@wisc.edu)  
Noah Anshel (BSAC) [anshel2@wisc.edu](mailto:anshel2@wisc.edu)  
Priya Maggalaad (BME/BIOM) [pmaggalaad@wisc.edu](mailto:pmaggalaad@wisc.edu)

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**Formatted\_Preliminary\_Report\_\_Dynamic\_Balance\_Device.pdf (4.77 MB)**

 **2026/4/17 - Executive Summary**

Katherine SATTEL - Apr 17, 2026, 4:50 PM CDT

**Title:** Executive Summary**Date:** 4/17/2026**Content by:** All**Present:** N/A**Goals:** Complete and prepare for judging**Content:**

Attached in PDF

**Conclusions/action items:**

Upload to website

Katherine SATTEL - Apr 17, 2026, 4:50 PM CDT

301 - 39 - Dynamic Balance Device - Executive Summary

**Dynamic Balance Device**Pragna Hegde, M.D., Nihar Anand, Katherine Sattel, Thanoa Kati  
Advisor: Professor Monica Okunog  
Clinic: Mr. Daniel Kutschev

According to the American Stroke Association, stroke patients are at an increased risk for developing spatial neglect syndrome, a neurological condition that decreases spatial awareness, depth perception, and balance. Currently, the client performs rehabilitative therapy by supporting the pointer with one hand, and moving a yastack with a colorful piece of paper at the end with the other, indicating which hand the pointer is intended to use to reach over and touch the paper. This method lacks features such as dynamic visual and audio feedback. Previous designs were difficult to hold for extended periods of time, due to heavy circuitry components. Therefore, it is important that design improvements are made to increase the availability of responsive and effective rehabilitative tools to physical therapists who currently lack access. Including us, work-related injuries for physical therapists will decrease, while improving overall patient outcomes.

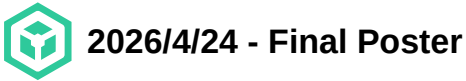
This design, a continuing biomedical engineering design project, improves upon existing methods by developing a more ergonomic design that is easier for the user to hold for extended periods of time. With the electronics placed on the user's arm and more weight in the handle, rather than the display, the device feels much more lightweight. It also has anti-flicker and accessibility through the use of color changing LEDs and sensor-activated speaker integration, allowing colorblind patients and those with limited sight to have more effective therapy options.

This full prototype will be tested by surveying biomedical students, gauging their ability to hold, manipulate, and use the device to its intended function. Participants will be surveyed after holding and manipulating a custom model of this design in comparison to the prototype. Their responses will be quantified and normalized based on body measurements, to ensure accurate data collection. The carbon fiber rod will be tested in 3-point bending to ensure that it is significantly more durable than previous prototypes, allowing for extended repairs.

Existing devices do not allow for cross-functional therapies because they are too heavy, too expensive, or are not complex enough to effectively improve balance. Some existing devices, such as the Biomec Integral Therapy System™ allow the patient to perform activities with an interactive touch screen. This design, while effective, costs up to \$127,000 per unit, meaning many clinics are unable to afford it. The affordability of this device for therapists and clinics alike is a key difference that makes the dynamic balance device more versatile and will allow the 7 million Americans living with stroke complications the opportunity to regain independence. Thus, the dynamic balance device is a promising development for physical therapy with patients in order to reduce the risk of spatial neglect.

[Download](#)

301 - 39 - Dynamic Balance Device - Executive Summary.pdf (69.6 kB)



Katherine SATTEL - Apr 28, 2026, 1:22 PM CDT

**Title:** Final Poster

**Date:** 4/24/2026

**Content by:** All

**Present:** N/A

**Goals:** Create and print final poster

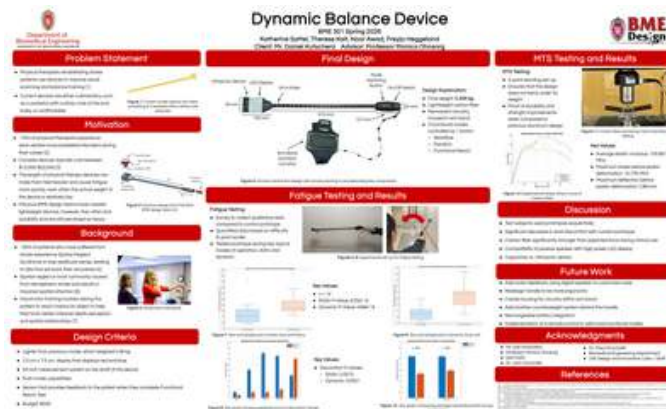
**Content:**

Attached as a png

**Conclusions/action items:**


Present!

Katherine SATTEL - Apr 28, 2026, 1:22 PM CDT



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Dynamic\_Balance\_Device\_Poster\_2026.png (1.26 MB)

 **2026/04/29 - Final Report**

Katherine SATTEL - Apr 29, 2026, 12:01 PM CDT

**Title:** Final Report

**Date:** 4/29/2026

**Content by:** All

**Present:** N/A

**Goals:** Create final report for project

**Content:**

Attached in PDF

**Conclusions/action items:**

Upload to Canvas and website

Katherine SATTEL - Apr 29, 2026, 12:45 PM CDT

BME Design: 200, 201, 202, 301, 400 and 402



**Final Report: Dynamic Balance Device**

Biomedical Engineering 301  
April 29, 2026

Client: Mr. David Katchen  
Advisor: Professor Morteza Ghazizadeh

University of Wisconsin–Madison  
Department of Biomedical Engineering

**Team Members:**  
Katherine Sattel (Team Leader) [katsk@wisc.edu](mailto:katsk@wisc.edu)  
Theresa Kati (Communicator) [tkati@wisc.edu](mailto:tkati@wisc.edu)  
Nayel Assad (BSAC) [nayel2@wisc.edu](mailto:nayel2@wisc.edu)  
Freya Heggelund (BWTG/BPAG) [heggelund@wisc.edu](mailto:heggelund@wisc.edu)

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**Final\_Report-\_Dynamic\_Balance\_Device.pdf (10.2 MB)**



# 2026/01/29 - Progress Report 1

Freyja Heggeland - Apr 28, 2026, 6:05 PM CDT

**Title:** Progress Report 1

**Date:** January 29th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 5:56 PM CDT

DME Design: 200, 300, 301, 400 and 402

**Dynamic Balance Device**

Date: 01/23/2026 - 01/29/2026

Client: Mr. David Katscheta

Advisor: Professor Monica Olsberg

**Team:**

Kat Starnel - Team Leader (starnel@wisc.edu)

Therese Kati - Communicator (kati@wisc.edu)

Noor Anad - BSAC (anadn2@wisc.edu)

Freyja Heggeland - BWG/BPAO (heggelnd@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-30% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Evelyn, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous static design. The device should be user-friendly so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** The team began researching and familiarizing themselves with the project. The team also contacted the client to begin asking questions and coordinated a weekly team meeting time.

**Difficulties / advice requested:** None to report.

**Current design:** None

**Materials and expenses:**

None to report, see table below.

Item	Description	Manufacturer	MFR Part	Quantity	Unit Cost	Date	Cost Each	Total	Link
<b>Category 1</b>									
								\$0.00	
								\$0.00	
<b>Category 2</b>									
								\$0.00	
								\$0.00	
								<b>TOTAL:</b>	<b>\$0.00</b>

[Download](#)

**Dynamic\_Balance\_Device\_Progress\_Report\_1.pdf (186 kB)**



# 2026/02/05 - Progress Report 2

Freyja Heggeland - Apr 28, 2026, 6:05 PM CDT

**Title:** Progress Report 2

**Date:** February 5th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 5:57 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 01/30/2026 - 02/20/26

Client: Mr. David Katscheta

Advisor: Professor Monica Olsberg

**Team:**

Kat Starnel - Team Leader (starnel@wisc.edu)

Therese Kati - Communicator (kati@wisc.edu)

Noor Anad - BSAC (anadn2@wisc.edu)

Freyja Heggeland - BWG(BPAG) (heggeland@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-30% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Evelyn Chen, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous static design. The device should be user-friendly so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** The team met with the client to ask questions about their abilities for the previous prototype. The team also completed the Product Design Specifications (PDS).

**Difficulties / advice requested:** None to report.

**Current design:** None

**Materials and expenses:**

None to report, see table below.

Item	Description	Manufacturer	MFR Part	Quantity	Unit Cost	Date	Cost Each	Total	Link
<b>Category 1</b>									
								\$0.00	
								\$0.00	
<b>Category 2</b>									
								\$0.00	
								\$0.00	
								<b>TOTAL:</b>	<b>\$0.00</b>

[Download](#)

**Dynamic\_Balance\_Device\_Progress\_Report\_2.pdf (189 kB)**



# 2026/02/12 - Progress Report 3

Freyja Heggeland - Apr 28, 2026, 6:05 PM CDT

**Title:** Progress Report 3

**Date:** February 12th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 5:58 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 02/12/2026 - 02/14/2026

Client: Mr. David Katscheta

Advisor: Professor Monica Olsberg

**Team:**

Kat Strind - Team Leader (katst@wisc.edu)

Therese Kati - Communicator (tkati@wisc.edu)

Noor Anad - BSAC (naano02@wisc.edu)

Freyja Heggeland - BWG/BPAO (heggelad@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-30% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katscheta, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous static design. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** The team used the information learned from the client and advisor meetings to create 3 design matrices for various components of the final design. The team began initial 3D modeling.

**Difficulties / advice requests:** None to report.

**Current design:** None

**Materials and expenses:**

None to report, see table below.

Item	Description	Manufacturer	MFR Part	Quantity	Unit Cost	Date	Cost Each	Total	Link
<b>Category 1</b>									
								\$0.00	
								\$0.00	
<b>Category 2</b>									
								\$0.00	
								\$0.00	
								<b>TOTAL:</b>	<b>\$0.00</b>

[Download](#)

**Dynamic\_Balance\_Device\_Progress\_Report\_3.pdf (2.02 MB)**



# 2026/02/19 - Progress Report 4

Freyja Heggeland - Apr 28, 2026, 6:06 PM CDT

**Title:** Progress Report 4

**Date:** February 19th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 5:59 PM CDT

DME Design: 200, 300, 304, 400 and 402

**Dynamic Balance Device**

Date: 02/19/2026 - 02/21/2026

Client: Mr. David Katscheta

Advisor: Professor Monica Olsberg

**Team:**

Kat Starnel - Team Leader (starnel@wise.edu)

Therese Kati - Communicator (kati@wise.edu)

Noah Anad - BSAC (anoad2@wise.edu)

Freyja Heggeland - BWG(BPA) (heggelaa@wise.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katscheta, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous no-stick design. The device should be user-friendly so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week the team acquired the old prototypes from the client in order to gather information about their specs and learn where to make improvements. The team also completed the preliminary design presentation and divided up work for the preliminary report.

**Difficulties / advice requested:** None to report

**Current design:** None

**Materials and expenses:**

None to report, see table below:

Item	Description	Manufacturer	Qty	Unit Price	Vendor	Vendor Cost	Date	Cost Each	Total	Link
Category 1										
									\$0.00	
									\$0.00	
Category 2										
									\$0.00	
									\$0.00	
									<b>TOTAL: \$0.00</b>	

Major team goals for the next week:

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**Dynamic\_Balance\_Device\_Progress\_Report\_4.pdf (198 kB)**



## 2026/02/26 - Progress Report 5

Freyja Heggeland - Apr 28, 2026, 6:06 PM CDT

**Title:** Progress Report 5

**Date:** February 26th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 6:00 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 02/22/2026 - 02/28/2026

Client: Mr. David Katschera

Advisor: Professor Meena Chaturvedi

#### Team:

Kat Starnel - Team Leader (starnel@wisc.edu)

Therese Kati - Communicator (kati@wisc.edu)

Noor Anad - BSAC (anadn2@wisc.edu)

Freyja Heggeland - BWG/BPAO (heggeland@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katschera, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous assist-stick design. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week, the team completed the preliminary report. This included creating test rig protocols, creating a final CAD sketch, and sourcing materials.

**Difficulties / advice requests:** None to report

**Current design:**



Figure 1: Dimensional CAD drawing of current design

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**Dynamic\_Balance\_Device\_Progress\_Report\_5.pdf (268 kB)**



## 2026/03/05 - Progress Report 6

Freyja Heggeland - Apr 28, 2026, 6:06 PM CDT

**Title:** Progress Report 6

**Date:** March 5th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 6:00 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 03/01/2026 - 03/07/2026

Client: Mr. David Katschena

Advisor: Professor Monica Okunorg

#### Team:

Kat Starnil - Team Leader (starnil@wise.edu)

Therese Kati - Communicator (kati@wise.edu)

Noor Anad - BSAC (anad02@wise.edu)

Freyja Heggeland - BWG/BPAO (heggeland@wise.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katschena, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous 3D-printed design. The device should be user-friendly so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week, the team created a list of materials for the client to order, met with the client, and improved previous CAD sketches.

**Difficulties / advice requests:** None to report

**Current design:**



Figure 1: Dimensional CAD drawing of current design

[Download](#)

**Dynamic\_Balance\_Device\_Progress\_Report\_6.pdf (266 kB)**



## 2026/03/12 - Progress Report 7

Freyja Heggeland - Apr 28, 2026, 6:06 PM CDT

**Title:** Progress Report 7

**Date:** March 12th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 6:01 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 03/08/2026 - 03/13/2026

Client: Mr. David Katschera

Advisor: Professor Monica Okunog

#### Team:

Kat Strind - Team Leader (katd@wisc.edu)

Therese Kati - Communicator (kati@wisc.edu)

Noor Anad - BSAC (noor12@wisc.edu)

Freyja Heggeland - BWG(BPA) (heggelad@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katschera, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous 3D-printed design. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week, the team ordered materials, updated CAD, and started creating a circuitry fabrication protocol.

**Difficulties / advice requests:** None to report.

**Current design:**



Figure 1: Dimensional CAD drawing of current design

[Download](#)

Dynamic\_Balance\_Device\_Progress\_Report\_7.pdf (315 kB)



## 2026/03/19 - Progress Report 8

Freyja Heggeland - Apr 28, 2026, 6:07 PM CDT

**Title:** Progress Report 8

**Date:** March 19th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 6:02 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 03/15/2026 - 03/21/2026

Client: Mr. David Katschena

Advisor: Professor Meena Chaturg

#### Team:

Kat Strind - Team Leader (katd@wisc.edu)

Therese Kati - Communicator (kati@wisc.edu)

Noor Anad - BSAC (noor12@wisc.edu)

Freyja Heggeland - BWG/BPAO (heggelaa@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katschena, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous 3D-printed design. The device should be user-friendly so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week, the team started making the circuitry, updated and printed a preliminary CAD model, and prepped for a show and tell.

**Difficulties / advice requests:** None to report

**Current design:**



Figure 1. CAD Model of the Display Portion of the Design

[Download](#)

**Dynamic\_Balance\_Device\_Progress\_Report\_8.pdf (1.31 MB)**



## 2026/03/26 - Progress Report 9

Freyja Heggeland - Apr 28, 2026, 6:07 PM CDT

**Title:** Progress Report 9

**Date:** March 26th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 6:02 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 03/26/2026 - 03/27/2026

Client: Mr. David Katschera

Advisor: Professor Monica Okunig

#### Team:

Kat Starnel - Team Leader (starnel@wisc.edu)

Therese Kati - Communicator (kati@wisc.edu)

Noor Anad - BSAC (anadn2@wisc.edu)

Freyja Heggeland - BWG(BPA) (heggeland@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katschera, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous 3D-printed design. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week, the team met with the client to go over feedback from show and tell, ordered a smaller microcontroller, and continued making updates to the CAD model(s).

**Difficulties / advice requests:** None to report

**Current design:**



Figure 1. CAD Model of the Display Portion of the Design

[Download](#)

**Dynamic\_Balance\_Device\_Progress\_Report\_9.pdf (1.32 MB)**



## 2026/04/09 - Progress Report 10

Freyja Heggeland - Apr 28, 2026, 6:07 PM CDT

**Title:** Progress Report 10

**Date:** April 9th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 6:03 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 04/5/2026 - 04/11/2026

Client: Mr. David Katscheta

Advisor: Professor Monica Okunog

#### Team:

Kat Strind - Team Leader (katd@wisc.edu)

Therese Kati - Communicator (kati@wisc.edu)

Noor Anad - BSAC (noor12@wisc.edu)

Freyja Heggeland - BWG/BPAO (heggelaa@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katscheta, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous no-stick design. The device should be user-friendly so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week, all materials ordered had arrived and the team began final fabrication. The team also completed a draft of the executive summary for design boards.

**Difficulties / advice requests:** None to report

**Current design:**



Figure 1. CAD Model of the Display Portion of the Design

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**Dynamic\_Balance\_Device\_Progress\_Report\_10.pdf (1.33 MB)**



## 2026/04/16 - Progress Report 11

Freyja Heggeland - Apr 28, 2026, 6:07 PM CDT

**Title:** Progress Report 11

**Date:** April 16th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 6:03 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 04/12/2026 - 04/18/2026

Client: Mr. David Katschera

Advisor: Professor Meena Chaturg

#### Team:

Kat Strind - Team Leader (katd@wisc.edu)

Therese Kati - Communicator (tkb@wisc.edu)

Noor Anad - BSAC (noor12@wisc.edu)

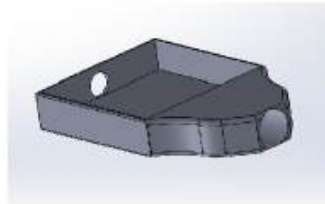
Freyja Heggeland - BWG/BPAO (heggelaa@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katschera, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous 3D-printed design. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week, the team spent time fabricating the final prototype and completed all protocols. The team also created an outline for the final poster.

**Difficulties / advice requests:** None to report

**Current design:**



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**Dynamic\_Balance\_Device\_Progress\_Report\_11.pdf (658 kB)**



## 2026/04/23 - Progress Report 12

Freyja Heggeland - Apr 28, 2026, 6:08 PM CDT

**Title:** Progress Report 12

**Date:** April 23th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** report our progress from across the semester

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 6:04 PM CDT

DME Design: 200, 300, 301, 400 and 402

### Dynamic Balance Device

Date: 04/20/2026 - 04/25/2026

Client: Mr. David Katschera

Advisor: Professor Monica Okunberg

#### Team:

Kat Strind - Team Leader (katst@wisc.edu)

Therese Kati - Communicator (tkati@wisc.edu)

Noor Anad - BSAC (nnoor12@wisc.edu)

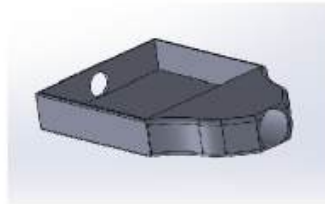
Freyja Heggeland - BWG/BPAO (heggeland@wisc.edu)

**Problem statement:** Patients that have suffered strokes have a 25-39% rate of developing spatial neglect syndrome. Symptoms of spatial neglect syndrome include loss of awareness of the body in space. Our client, Dr. Katschera, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that can be used to improve visual scanning and balance training that is an update from the previous 3D-printed design. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Brief status update:** This week, the team completed fabrication, performed MTS and fatigue testing, and created the final poster!

**Difficulties / advice requests:** None to report!

**Current design:**



[Download](#)

**Dynamic\_Balance\_Device\_Progress\_Report\_12.pdf (655 kB)**



## 2026/01/28 - "Prototype of Virtual Reality Game to Support Post-stroke Recovery in Patients with Spatial Neglect Syndrome"

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Katherine SATTEL - Jan 28, 2026, 3:42 PM CST

**Title: "Prototype of Virtual Reality Game to Support Post-stroke Recovery in Patients with Spatial Neglect Syndrome"**

**Date:** 1/28/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Understand spatial neglect syndrome/the digital feedback useful in rehabilitation

**Citation:** K. Matys-Popielska, K. Popielski, and A. Sibilska-Mroziewicz, "Prototype of Virtual Reality Game to Support Post-stroke Recovery in Patients with Spatial Neglect Syndrome," in Lect. Notes Networks Syst., Springer Science and Business Media Deutschland GmbH, 2023, pp. 314–319. doi: 10.1007/978-3-031-37649-8\_32.

### **Content:**

- 25-30% of post-stroke patients suffer from spatial neglect syndrome
  - Impaired perception of one's body and space
- This paper utilizes virtual reality (VR) for stroke rehabilitation but this can be useful in deciding what visual aspects will be the most important to implement in our device
- Physicians agree that both auditory and visual rehabilitation are necessary
  - Previous groups prototypes only implemented visual stimuli, not auditory
- Typical exercises include:
  - Grasping items on the neglected side
  - Bringing them to the non-neglected side
  - Anything involving crossing the body's midline
- Important takeaways:
  - Final prototype should include auditory stimuli along with visual
    - Could be an issue with weight as a speaker component could be heavy
  - Movement will be directed by physician, not the device
  - Certain colors are easier/more difficult for patients to interact with
    - Allows for a variation in "difficulty" as patients could start the rehabilitation process with certain colors and "level up" to harder ones at the direction of the physician

### **Conclusions/action items:**

Helps to answer criteria 2b, shows that a design specification should include an auditory element as well as the visual element (barring weight concerns). Use this research to further find out what stimuli are best for stroke rehabilitation.



## 2026/01/28 - "Prevalence of spatial neglect post-stroke: A systematic review"

Katherine SATTEL - Jan 28, 2026, 3:41 PM CST

**Title:** Prevalence of spatial neglect post-stroke: A systematic review

**Date:** 1/28/2026

**Content by:** Katherine Sattel

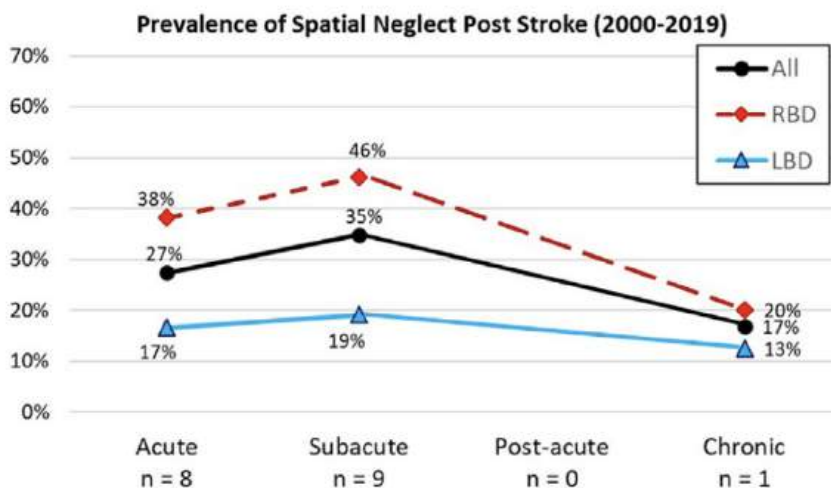
**Present:** N/A

**Goals:** Understand connections between various demographics and increased risk of developing spatial neglect syndrome

**Citation:** E. Esposito, G. Shekhtman, and P. Chen, "Prevalence of spatial neglect post-stroke: A systematic review," *Annals of Physical and Rehabilitation Medicine*, vol. 64, no. 5, p. 101459, Sep. 2021, doi: 10.1016/j.rehab.2020.10.010.

### Content:

- Spatial neglect more common in patients with right brain damage than left brain damage
  - This means more patients with spatial neglect have issues with the left side of their body/personal space
- It is also more severe than left-brain damage
  - (neural networks related to spatial perception are more focused on the right hemisphere of the brain)
- This does not factor in time post-stroke (typically a key factor in prevalence of different issues that come with having a stroke)



- The decrease in SN prevalence over time is thought to be attributed to the improved rehabilitation practices that have developed over the 21st century
  - Contributes to the impact of this biomedical device
  - Improved rehabilitation abilities/equipment --> improved patient outcomes and reduction of fall risk for stroke survivors

**Conclusions/action items:**

Connects this project to criteria 4b, showing the impact of improved rehabilitation methods. Use this research to continue to dive into specific treatments focusing on RBD



## 2026/01/28 - "Treating Neurovisual Deficits and Spatial Neglect"

Katherine SATTEL - Jan 28, 2026, 3:56 PM CST

### Title: Treating Neurovisual Deficits and Spatial Neglect

Date: 1/28/2026

Content by: Katherine Sattel

Present: N/A

Goals: Understand existing treatment options for stroke patients

Citation: G. Kerkhoff, G. Rode, and S. Clarke, "Treating Neurovisual Deficits and Spatial Neglect," in *Clinical Pathways in Stroke Rehabilitation: Evidence-based Clinical Practice Recommendations*, T. Platz, Ed., Cham (CH): Springer, 2021. Accessed: Jan. 28, 2026. [Online]. Available: <http://www.ncbi.nlm.nih.gov/books/NBK585577/>

### Content:

- Stroke patients >65 yrs old are at a much higher risk for developing neurovisual disorders such as spatial neglect
  - Key demographic to focus on
- Common presentations include:
  - Time consuming/inefficient visual search patterns
  - Minimized visual field
    - Leads to slow reading
  - Shift in where the patient believes straight ahead to be
- Treatment methods:
  - 1. Scanning training
    - visual and auditory targets are presented time-locked in identical locations of the visual field, and the patient has to look to them. This training induces similar improvements as conventional visual scanning training but requires additional technical facilities
    - "visual scanning training (VST or exploration training), patients typically look at a visual display (on a table, a computer screen, or a large projection wall) on which different classes of visual stimuli (i.e. stars, circles, numbers, photos from real objects) are shown, and the patient is required to look for a specific class of stimuli ("Search for all stars and point to them", with a stick or laser pointer or on a touch screen). Patients are verbally instructed to look to the neglected side ("cueing of attention"), search systematically row by row as in reading in order to acquire a systematic search strategy"
  - 2. Hemianopic reading training
    - letters, syllables, words, and numbers are presented in a single text line which float from the right to the left side on a computer screen, while the patient is instructed to read the words in the middle of the screen
  - 3. Restorative visual field training
    - Less research on if this method is effective, it seems it is minimally effective when compared to the previous 2 methods
  - 4. Optokinetic/smooth pursuit therapy

- "patients are instructed to make following (pursuit) eye movements to visual stimuli that move slowly towards the neglected field. The stimuli are usually presented on a computer screen or via beamer to a large projection wall via specific software. When the patient has reached with his eyes the neglected side of space, he is instructed to remain there with his eyes for some seconds, before the task is repeated"
- 5. Visuo-motor feedback
  - "The patient has to lift wooden or metal rods with his ipsilesional hand (index finger and thumb), so that their left and right half are balanced and the rod does not fall to one side. As the patient ignores initially the contralesional side of the rod (due to his neglect), he will grasp it more to the right side and consequently the bar will fall to the left side. This "natural" feedback leads to a subsequent adaptation of the patient's lifting behavior, thus lifting the rods more accurately in the middle part during the course of the therapy"
- Lots of various nerve therapies
  - Not relevant to the scope of this project

**Conclusions/action items:**

Lots of valuable information on the variety of different treatments for SN, it is clear that our prototype needs to have a lot of variety in what it displays so as to allow it to be helpful for a range of patients all at different stages of the rehabilitation process



## 2026/01/28 - "Occupational therapy for adults with problems in activities of daily living after stroke"

Katherine SATTEL - Jan 28, 2026, 4:09 PM CST

**Title:** Occupational therapy for adults with problems in activities of daily living after stroke

**Date:** 1/28/2026

**Content by:** Katherine Sattel

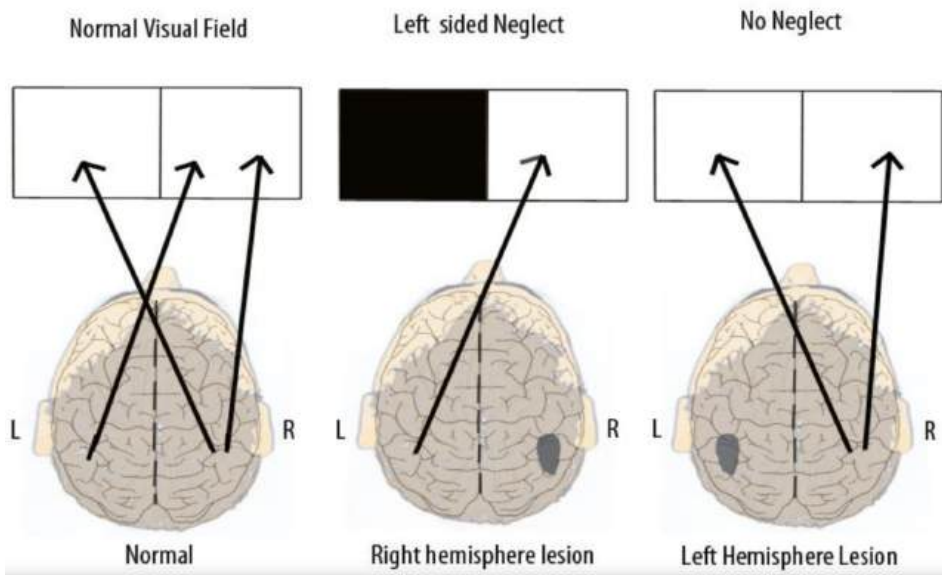
**Present:** N/A

**Goals:** Understand the types of tasks our final prototype must be capable of performing/emulating

**Citation:** L. A. Legg, S. R. Lewis, O. J. Schofield-Robinson, A. Drummond, and P. Langhorne, "Occupational therapy for adults with problems in activities of daily living after stroke - Legg, LA - 2017 | Cochrane Library", Accessed: Jan. 28, 2026. [Online]. Available: <https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD003585.pub3/full>

**Content:**

- n = 994
- Those who received occupational therapy (similar to what our client provides to his patients) were able to become more independent in daily life ( $p = 0.005$ )
- Occupational therapy did not significantly affect mortality or mood/mental health outcomes
- Computer-based visual scanning therapy and virtual reality treatment for neglect appears to be effective in improving visual perception



**Conclusions/action items:**

Final product should be able to allow patient to mimic things they would have to do at home so as to increase their independence and decrease risks. The device should account for the fact that different stroke patients will have varying degrees of neglect focused on different sides of their body



## 2026/02/18 - Old Prototype Specs

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Katherine SATTEL - Feb 18, 2026, 7:07 PM CST

**Title:** Old Prototype Specs

**Date:** 2/18/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Gather data for dimensions and weight of old prototypes

**Content:**

1st Prototype:



- Length of entire device: 33 in
- Display area:
  - Total: 15.9 in<sup>2</sup>
  - Display only: 7 in<sup>2</sup>
- Rod diameter: 1 in
- Handle length: 8 in
- Length etched: 22 in (this is fully extended)
  - When fully retracted, only 9in
- Weight: 0.8lb = 0.36kg

2nd Prototype:



- Length of entire device: 36 in / 3 ft
- Display area:
  - Box: 3 3/8 in x 3 3/8 in (11.39 in<sup>2</sup>)
  - LED portion: 3 x 3 in (9 in<sup>2</sup>)
- Rod diameter: 1 in
- Handle length: 5.5 in
- Length etched: 23 in
- Weight: 0.8lb = 0.36kg

#### Conclusions/action items:

Make sure to include these in PDS, report, presentation, etc. to compare quantitative values



## 2026/02/03 - Carbon Fiber Material Research

---

Katherine SATTEL - Feb 03, 2026, 9:58 PM CST

### Title: Carbon Fiber Material Research

Date: 2/3/2025

Content by: Katherine Sattel

Present: N/A

Goals: Understand the material properties of carbon fiber as a material option

### Citation(s):

[1] "Carbon fiber properties," Gernitex. Accessed: Feb. 03, 2026. [Online]. Available:

<https://gernitex.com/resources/carbon-fiber-properties/>

[2] "Carbon Fiber Pultruded Tubing - ACP Composites." Accessed: Feb. 03, 2026. [Online]. Available:

<https://acpcomposites.com/shop/tubes-rods/carbon-fiber-tubes/carbon-fiber-pultruded-tubing>

### Content:



- Carbon fiber has a low density compared to other commonly used engineering materials (steel, aluminum, etc.) with an incredible high strength-to-weight ratio
  - This will maximize durability while minimizing weight
- Carbon fiber is typically sold in spools and requires large scale manufacturing to form it into a particular shape
- Carbon fiber tubing is available (typically used for aerospace applications)
  - Vendors include: Rock West Composites, ACP Composites, Clearwater Composites, DragonPlate, and WestCoast Products
- Cheapest variant is: Carbon Fiber Protruded Tubing
  - Ideal for bending and tension applications
    - Our application would fall under bending due to the weight being at the end of the rod
  - \$10-\$50 depending on length
  - Specs say that this type is great for structural components, frames and support, and recreational equipment

### Conclusions/action items:

Look into purchasing for our prototype after conferring with team and weighing the last group's prototype to ensure a weight decrease. Possibly contact a company and inquire about our project



## 2026/03/09 - Ordering Materials

---

**Title:** Ordering Materials

**Date:** 3/09/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Order materials for the project

**Content:**

1. Arduino UNO Rev 3 Microcontroller - \$27.60 - Not ordering, using the one from last semester, per clients request
2. 8x8 LED Display - \$8.95 - Not ordering, using the one from last semester
3. Piezo Buzzer - \$4.21 [https://vetco.net/products/vupn6344\\_piezo\\_speaker\\_module\\_for\\_arduino\\_buzzer\\_d46?variant=42879384027273](https://vetco.net/products/vupn6344_piezo_speaker_module_for_arduino_buzzer_d46?variant=42879384027273)
4. Tentative CF rod - \$54.25 <https://www.amazon.com/Pultruded-Customizable-Lightweight-Robotics-4x3x1000MM/dp/B0DJJTX3SQ?th=1>
5. On/Off Switch - \$9.99 [https://vetco.net/products/nte-54-250w\\_dpdt\\_waterproof\\_rocker\\_switch\\_on\\_-\\_off\\_-\\_on\\_20a?variant=42879045042313](https://vetco.net/products/nte-54-250w_dpdt_waterproof_rocker_switch_on_-_off_-_on_20a?variant=42879045042313)
6. Buttons (x2) - \$1.72 [https://vetco.net/products/vupn1504\\_tact\\_switch\\_66mm\\_5mm\\_through\\_hole?variant=42879324749961](https://vetco.net/products/vupn1504_tact_switch_66mm_5mm_through_hole?variant=42879324749961)
7. 9V Battery Connector - \$0.69 [https://vetco.net/products/vupn8981\\_9v\\_battery\\_connector\\_-\\_straight\\_style?variant=42879483871369](https://vetco.net/products/vupn8981_9v_battery_connector_-_straight_style?variant=42879483871369)
8. Sensor (x4) \$18.0  
<https://store-usa.arduino.cc/products/grove-touch-sensor> (sold out)  
Ordered this instead: [https://www.ebay.com/itm/177296732195?chn=ps&var=476948216484&norover=1&mkevt=1&mkrid=711-117182-37290-0&mkcid=2&mkscid=101&itemid=476948216484\\_177296732195&targetid=&device=c&mktype=pla&googleloc=9018948&poi=&campaignid=23517807505&mkgr=Cg\\_1wGclpmg9VaLi\\_B876sOfVp1&qclid=Cj0KCQjw37nNBhDkARIsAEBG18NvePYkRjP-lkW6vkXU9rUWqy0jXmoF6mkpVe1RSebhtZUZHrqgqMaAgHmEALw\\_v](https://www.ebay.com/itm/177296732195?chn=ps&var=476948216484&norover=1&mkevt=1&mkrid=711-117182-37290-0&mkcid=2&mkscid=101&itemid=476948216484_177296732195&targetid=&device=c&mktype=pla&googleloc=9018948&poi=&campaignid=23517807505&mkgr=Cg_1wGclpmg9VaLi_B876sOfVp1&qclid=Cj0KCQjw37nNBhDkARIsAEBG18NvePYkRjP-lkW6vkXU9rUWqy0jXmoF6mkpVe1RSebhtZUZHrqgqMaAgHmEALw_v)

Total: \$94.22

Electronic components (Vetco) arriving 3/13

Sensors arriving 3/30

Carbon fiber rod arriving 4/8

**Conclusions/action items:**

Begin assembling circuitry when materials arrive



## 2026/02/03 - Overview of Standards for Electronics in Medical Devices

Katherine SATTEL - Feb 04, 2026, 2:29 PM CST

### Title: Overview of Standards for Electronics in Medical Devices

**Date:** 2/3/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Understand the standards applicable to our project for writing my sections of the PDS

### Citation:

[1] "Overview of IEC 60601-1 Standards and References." Accessed: Feb. 03, 2026. [Online]. Available: <https://www.intertek.com/medical/regulatory-requirements/iec-60601-1/>

[2] "Essential Guide to Medical Electronic Device Design." Accessed: Feb. 04, 2026. [Online]. Available: <https://www.chemtronics.com/essential-guide-to-medical-electronic-device-design?srsId=AfmBOoohOZI3uF7Y3JpwKR3uLJTEJ3gA0t8Fzy4uaZQVCM5LJv6BDuP>

### Content:

- IEC 60601 is an international standard for electrical components in medical devices
  - Ensures devices don't pose risk to patients, providers, or environment during life in service
  - Device becomes "601 compliant"
- Medical devices defined as "electrical equipment having an applied part or transferring energy to or from the patient or detecting such energy to or from the patient"
  - Under this definition, our product does not need to be 601 compliant because its electrical components are not directly applied to the patient
    - Examples include EKGs, HR monitors, glucose sensors, ultrasound devices, pacemakers, etc.
  - Nevertheless, there are still good takeaways that should be applied to creating a safe, reliable product
- Important tests:
  - To be 601 compliant, device must pass EMI/EMC tests to ensure the device is compatible with an electromagnetic environment
  - Must also not be susceptible to radio frequency interference
  - Power supply must withstand instability to prevent shock

	Minor	Moderate	Serious	Major	Catastrophic
Certain	CA	CA	Unacceptable	Unacceptable	Unacceptable
Expected	CA	CA	CA	Unacceptable	Unacceptable
Likely	Acceptable	CA	CA	CA	Unacceptable
Unlikely	Acceptable	Acceptable	CA	CA	Unacceptable
Rare	Acceptable	Acceptable	Acceptable	CA	CA

- Use of a risk management matrix is recommended

- Devices are still approved by the FDA for the American market (pathway our device would follow)

**Conclusions/action items:**

Use this research to inform my paragraph for the PDS on standards and specifications

# 2026/02/10 - Audio Research - Incorporating Speaker

Katherine SATTEL - Feb 11, 2026, 10:01 AM CST

**Title:** Research on Audio Implementation

**Date:** 2/10/2026

**Content by:** Katherine Sattel

**Present:** N/A

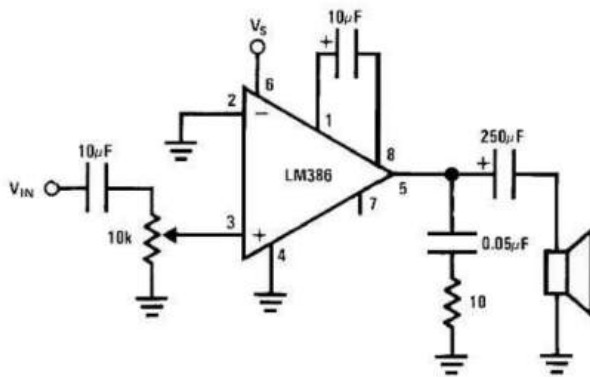
**Goals:** Look into the ease of implementing a speaker into our design

**Citation:**

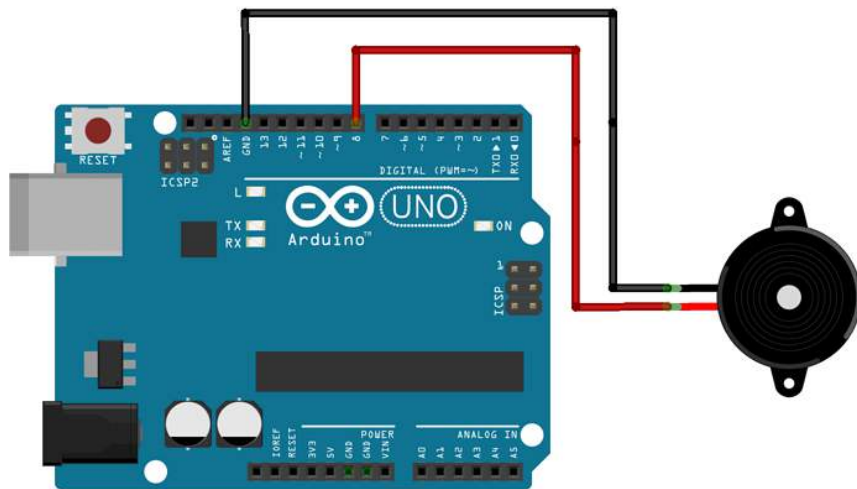
[1] Accessed: Feb. 10, 2026. [Online]. Available: <https://docs.arduino.cc/tutorials/generic/simple-audio-player/>

[2] "Speaker with a RF receiver," Arduino Forum. Accessed: Feb. 11, 2026. [Online]. Available: <https://forum.arduino.cc/t/speaker-with-a-rf-receiver/578264/4>

**Content:**



LM386 electronic schematic



fritzing

- **Pros:**
  - Relatively simple circuitry (seen above)
  - Effective
  - Can be coded to play a variety of sounds and different volumes (more variability than other options)
- **Cons:**
  - Seems like it can only be done with a higher-end Arduino model, not the Uno model that we all have in our electronics kits
  - Requires audio amplifier such as this one: <https://www.sparkfun.com/sparkfun-mono-audio-amp-breakout-tpa2005d1.html>
  - Adds weight to the device
- **Code:**

```
#include <SD.h>

#include <SPI.h>

#include <AudioZero.h>

void setup()
{

    // debug output at 115200 baud

    Serial.begin(115200);

    // setup SD-card

    Serial.print("Initializing SD card...");

    if (!SD.begin(4)) {

        Serial.println(" failed!");

        while(true);

    }
```

```
Serial.println(" done.");

// 44100kHz stereo => 88200 sample rate

AudioZero.begin(2*44100);
}

void loop()
{

int count = 0;

// open wave file from sdcard

File myFile = SD.open("test.wav");

if (!myFile) {

// if the file didn't open, print an error and stop

Serial.println("error opening test.wav");

while (true);

}

Serial.print("Playing");
```

```
// until the file is not finished
```

```
AudioZero.play(myFile);
```

```
Serial.println("End of file. Thank you for listening!");
```

```
while (true) ;
```

```
}
```

**Conclusions/action items:**

Use this research to help ranking the designs in the audio design matrix



## 2026/02/11 - Sensor Research (preliminary)

Katherine SATTEL - Feb 11, 2026, 10:39 AM CST

**Title:** Arduino sensor research/brainstorming

**Date:** 2/11/2026

**Content by:** Katherine Sattel

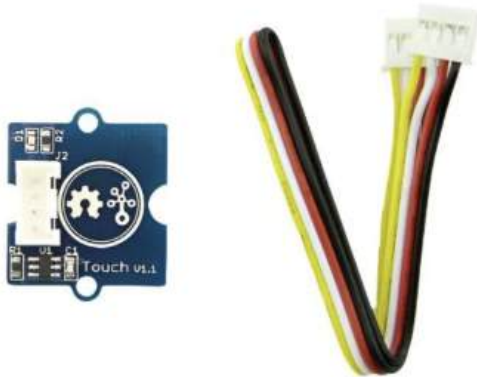
**Present:** N/A

**Goals:** Research sensor options for Arduino to implement audio feedback

**Citation:**

[1] "Grove - Touch Sensor," Arduino Online Shop. Accessed: Feb. 11, 2026. [Online]. Available: <https://store-usa.arduino.cc/products/grove-touch-sensor>

**Content:**



- Arduino has touch sensors available that detect a change in capacitance when touch is detected nearby
  - Doesn't require you to fully touch it to sense
  - This means we could buy fewer sensors to cover the whole screen
    - Reduces cost and bulk
  - Specs for sensor:
    - Operating Voltage: 2.0 - 5.5V
    - Operating Current(Vcc=3V):1.5 - 3.0μA
    - Operating Current(VDD=3V):3.5 - 7.0μA
    - Output Response Time: 60 - 220mS
    - Used Chipset: TTP223-BA6
- These are very easy to implement into a circuit according to various Arduino forums
- Idea:
  - Patients touch sets off sensor --> sensor output causes a (likely) 3D printed trigger to release --> sound created
    - This pathway would require a small moving part like a motor to move the sensor
- Alternative pathway:

- Patient touch sets of sensor --> sensor activates a speaker to make a noise (speaker can be located in handle to help with counterweight)
- YT video to show how to set up circuit: <https://www.youtube.com/shorts/4kQGsGd5p3M>

**Conclusions/action items:**

Use this information to inform rankings in the design matrix



## 2026/02/11 - Audio Design Matrix

Katherine SATTEL - Feb 12, 2026, 2:02 PM CST

**Title:** Audio Design Matrix

**Date:** 2/11/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Choose criteria and rankings for design matrix

**Content:**

- Criteria:
  - Weight (35): Weight is ranked as the most important criteria because it is a huge priority for the client and we don't want to add too much bulk to the design just to add an auditory component, most important thing to keep in mind
    - Highest score goes to both trigger options because they would likely be 3D printed plastic which is more lightweight than adding a speaker
  - Ease of use (30): This covers how difficult it would be for the client to use. Ideally, we don't want to give the client another thing to think about so any manual option would be less favorable because it would be another button to press, anything sensor-controlled is preferred
    - Highest scores go to the sensor-activated options because they involve no user input to function
  - Ease of fabrication (20): This refers to how complicated it would be for us to add this into the existing circuitry; due to time constraints we want to include something that will not be too difficult to add to the circuitry and will not add too much extra bulk that will have to fit within the rod
    - Highest score goes to manual trigger as it would involve the least amount of extra work to implement
  - Sound variability (10): This criteria is due to the fact that the clients patients may all have different levels of hearing and it would be helpful to have the option to turn the volume of the sound up or down accordingly. For the trigger options, they both wouldn't be adjustable meaning they produce the same sound every time which could be less favorable
    - Highest goes to speaker because volume can be adjusted as well as different tones
  - Cost (5): This is the lowest weighted criteria because, although its still something to keep in mind, cost is not a priority due to us having a large and flexible budget graciously given to us by our client. Additionally, all of these options would be relatively low cost
    - Highest goes to manual trigger because a small piece of 3D printed plastic would cost <\$1 compared to the cost of multiple sensors (\$15-20)

Auditory feedback			
-------------------	--	--	--

Design Criteria:	Sensor-activated Speaker	Sensor-Activated Trigger	Manual Trigger
Weight (35)	3/5	4/5	4/5
Ease of use (30)	5/5	5/5	3/5
Ease of fabrication (20)	4/5	2/5	4/5
Sound Variability (10)	5/5	3/5	3/5
Cost (5)	3/5	3/5	5/5
Weighted Total:	80	75	74

**Conclusions/action items:**

Expand on these criteria and explain rankings in design matrix included in preliminary report/presentation



## 2026/03/04 - Piezo Speaker

Katherine SATTEL - Mar 04, 2026, 6:58 PM CST

### Title: Piezo Speaker Research

Date: 3/4/2026

Content by: Katherine Sattel

Present: N/A

Goals: Find a suitable speaker to use for our project

### Citation:

[1] "What is a Piezo Buzzer: Benefits, How to Use it & How it Works:News::Fullhorn Electronics Company Limited." Accessed: Mar. 04, 2026. [Online]. Available: [https://fhdmfg.com/news/news\\_detail/piezo-buzzers](https://fhdmfg.com/news/news_detail/piezo-buzzers)

### Content:

- Type of speaker that generates high pitch buzzing noises -- typically used in toys, consumer electronics, fire alarms, pet training devices, etc.
- Come in a variety of sizes to produce a variety of frequencies
  - To fit user needs, should generate a frequency below 10,000 Hz so that all ages can hear it
- Low power consumption -- won't affect battery life
- Can be soldered to the Arduino, creating a lower profile circuit and preserving space



- Works through voltage being applied to two metal plates around a piezoelectric disc, this causes the plates to vibrate, producing a sound
- Super cost effective
- Easily integrated into circuitry
- Produces sounds from 80-120 dB
  - Plenty loud enough for patients who may be slightly hard of hearing/have limited hearing
- They are most efficient (power-wise) at their resonance frequency which ranges from 1 kHz to 5 kHz

### Conclusions/action items:

Find one to order to add to the materials order list for client



## 2026/03/11 - Preliminary Arduino Code

---

Katherine SATTEL - Mar 12, 2026, 3:56 PM CDT

**Title:** Preliminary Arduino Code

**Date:** 3/11/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Begin writing software for the final project

**Citation:**

[1] adafruit/Adafruit\_NeoPixel. (Mar. 09, 2026). C++. Adafruit Industries. Accessed: Mar. 12, 2026. [Online]. Available: [https://github.com/adafruit/Adafruit\\_NeoPixel](https://github.com/adafruit/Adafruit_NeoPixel)

**Content:**

```
#include <Adafruit_NeoPixel.h>
```

```
#define LED_PIN 11
```

```
#define NUM_LEDS 64
```

```
#define RANDOM_BUTTON 7
```

```
#define RG_BUTTON 4
```

```
#define CAP_SENSOR 2
```

```
#define SPEAKER A0
```

```
Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);
```

```
bool randomMode = false;
```

```
bool rgMode = false;
```

```
bool currentRG = false;
```

```
unsigned long lastUpdate = 0;
```

```
int updateInterval = 500;
```

```
unsigned long lastCapTouch = 0;
```

```
uint32_t currentRandomColor;
```

```
void setup() {
```

```
    pinMode(RANDOM_BUTTON, INPUT_PULLUP);
```

```
    pinMode(RG_BUTTON, INPUT_PULLUP);
```

```
    pinMode(CAP_SENSOR, INPUT);
```

```
    pinMode(SPEAKER, OUTPUT);
```

```
    matrix.begin();
```

```
    matrix.setBrightness(191); // 75% brightness (255 * 0.75)
```

```
    matrix.show();
```

```
    randomSeed(analogRead(A1));
```

```
}
```

```
void loop() {
```

```
    checkButtons();
```

```
    checkSensor();
```

```
    updateMatrix();
```

```
}
```

```
void checkButtons() {
```

```
if (digitalRead(RANDOM_BUTTON) == LOW) {

    randomMode = true;

    rgMode = false;

    int choice = random(5);

    if (choice == 0) currentRandomColor = matrix.Color(255,0,0); // red
    if (choice == 1) currentRandomColor = matrix.Color(0,255,0); // green
    if (choice == 2) currentRandomColor = matrix.Color(0,0,255); // blue
    if (choice == 3) currentRandomColor = matrix.Color(255,255,0); // yellow
    if (choice == 4) currentRandomColor = matrix.Color(128,0,128); // purple

    delay(200);
}

if (digitalRead(RG_BUTTON) == LOW) {

    rgMode = true;

    randomMode = false;

    delay(200);
}

}

void checkSensor() {

    int sensorState = digitalRead(CAP_SENSOR);
```

```
if (sensorState == HIGH) {
```

```
    lastCapTouch = millis();
```

```
    tone(SPEAKER, 1200);
```

```
}
```

```
if (millis() - lastCapTouch > 2000) {
```

```
    noTone(SPEAKER);
```

```
}
```

```
}
```

```
void updateMatrix() {
```

```
    if (millis() - lastUpdate < updateInterval) return;
```

```
    lastUpdate = millis();
```

```
    if (randomMode) {
```

```
        for (int i = 0; i < NUM_LEDS; i++) {
```

```
            matrix.setPixelColor(i, currentRandomColor);
```

```
        }
```

```
        matrix.show();
```

```
    }
```

```
    if (rgMode) {
```

```
        uint32_t color;
```

```
if (currentRG) {  
  
    color = matrix.Color(255,0,0);  
  
} else {  
  
    color = matrix.Color(0,255,0);  
  
}  
  
for (int i = 0; i < NUM_LEDS; i++) {  
  
    matrix.setPixelColor(i, color);  
  
}  
  
matrix.show();  
  
currentRG = !currentRG;  
  
}  
  
}
```

**Conclusions/action items:**

Include this in circuitry fabrication protocol









## 2026/02/25 - Universal Design and Our Project

---

Katherine SATTEL - Feb 25, 2026, 1:57 PM CST

**Title:** Universal Design in Our Project

**Date:** 2/25/2026

**Content by:** Katherine Sattel

**Present:** All except Noor

**Goals:** Identify components of our design that can be more universal

**Content:**

- What can be improved?
  - Ergonomics
  - Weight distribution
  - Overall look and sleekness
  - Auditory Feedback
- Which principals are we addressing?
  - Simple and intuitive use --> addition of feedback for the patient
  - Low tolerance for error --> lighter weight = more safe, more durable materials = less risk of shattering and creating sharp edges
  - Low physical effort --> improved ergonomics to make the therapists job easier to do/minimize fatigue
- How to make improvements?
  - 1. Addition of sensor-activated auditory feedback so that the patient has instant feedback to if they performed the exercise correctly
  - 2. Using lightweight and durable material choices to make the overall design less prone to breakage and creation of hazards
  - 3. Adding a counterweight at the end of the handle to improve ergonomics of device

**Conclusions/action items:**

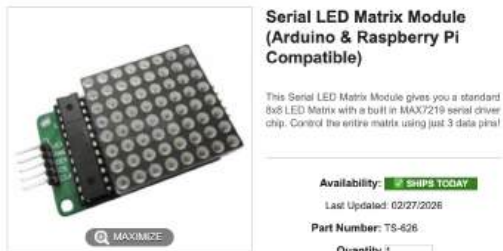
Share with the rest of BME 301 lecture

**Title: Circuitry Research****Date:** 2/27/2026**Content by:** Katherine Sattel**Present:** N/A**Goals:** Create a fritzing diagram for our circuitry - light and audio**Citations:**

- [1] "Serial LED Matrix Module (Arduino & Raspberry Pi Compatible)," Tinkersphere. Accessed: Feb. 27, 2026. [Online]. Available: <http://tinkersphere.com/led-matrix-panels/626-serial-led-matrix-module-arduino-compatible.html?srsltid=AfmBOooixGgpZ1QDvqkkZDDN9oQzdwXrJRO57G4Gz0IBOmW-3wVQJdSi858>
- [2] Accessed: Feb. 27, 2026. [Online]. Available: <https://docs.arduino.cc/learn/microcontrollers/analog-output/>

**Content:**

- Display:
  - This is the display used by the previous group -- client said it was too bright for most patients



- **\$8.95**
- Can be dimmed via resistors or a potentiometer which would be good for the client to be able to adjust brightness
  - Would need to find a good place to put the potentiometer in the handle if client wanted this feature
  - Otherwise, choose one brightness setting as a team
- Other option: Use a PWM and a transistor
  - This allows brightness to be adjusted via software rather than hardware
  - Takes more time, but better results
  - Use analogWrite(127) for half brightness
    - ADC value
- Attached is previous semesters Fritzing diagram and a new, updated one with a speaker and touch sensors

**Conclusions/action items:**

Continue research on a speaker and display to purchase before next client meeting

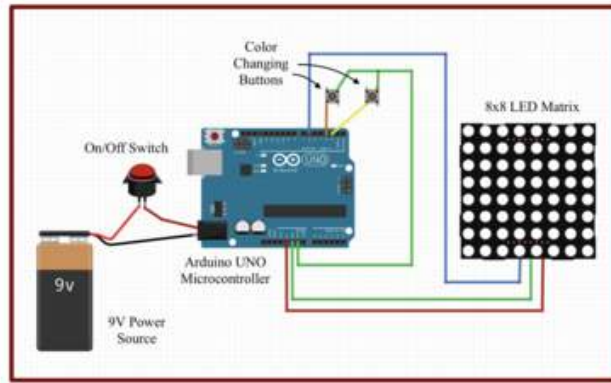
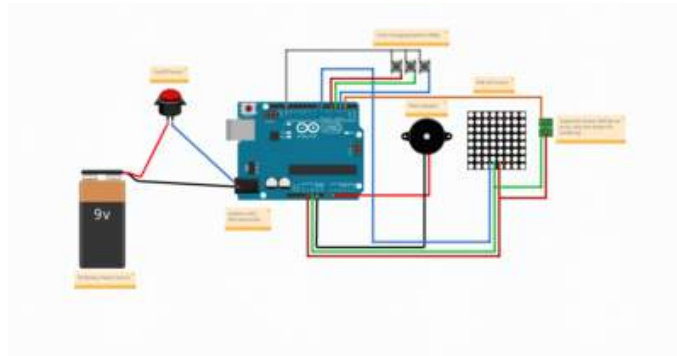


Figure 3: Fritzing Diagram of the Electronics

[Download](#)

Screenshot\_2026-02-27\_at\_3.27.28\_PM.png (890 kB)

Katherine SATTEL - Feb 27, 2026, 4:18 PM CST



[Download](#)

Screenshot\_2026-02-27\_at\_4.18.02\_PM.png (390 kB)

# 2026/03/11 - Updated Fritzing Diagram

Katherine SATTEL - Mar 11, 2026, 5:17 PM CDT

**Title:** Updated Fritzing Diagram

**Date:** 3/11/2026

**Content by:** Katherine Sattel

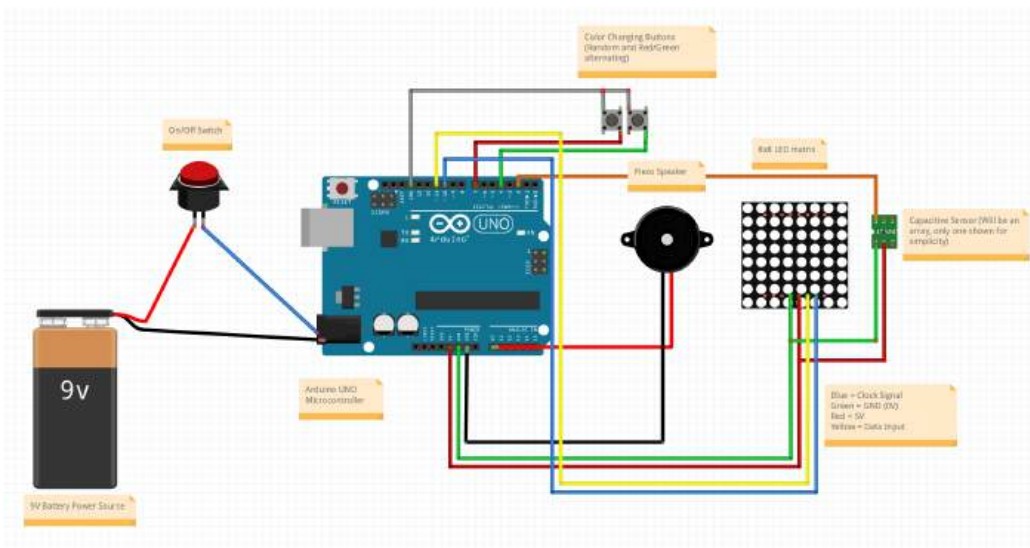
**Present:** N/A

**Goals:** Change Fritzing diagram to align with client's needs

**Content:**

Attached below

Changes made included: reducing buttons to 2 (one for alternating between Red/Green and one for random color), adding additional sensors, updated display pins to the correct ones listed on manufacturer's website



**Conclusions/action items:**

Include this in the circuitry fabrication protocol

Katherine SATTEL - Mar 11, 2026, 5:17 PM CDT

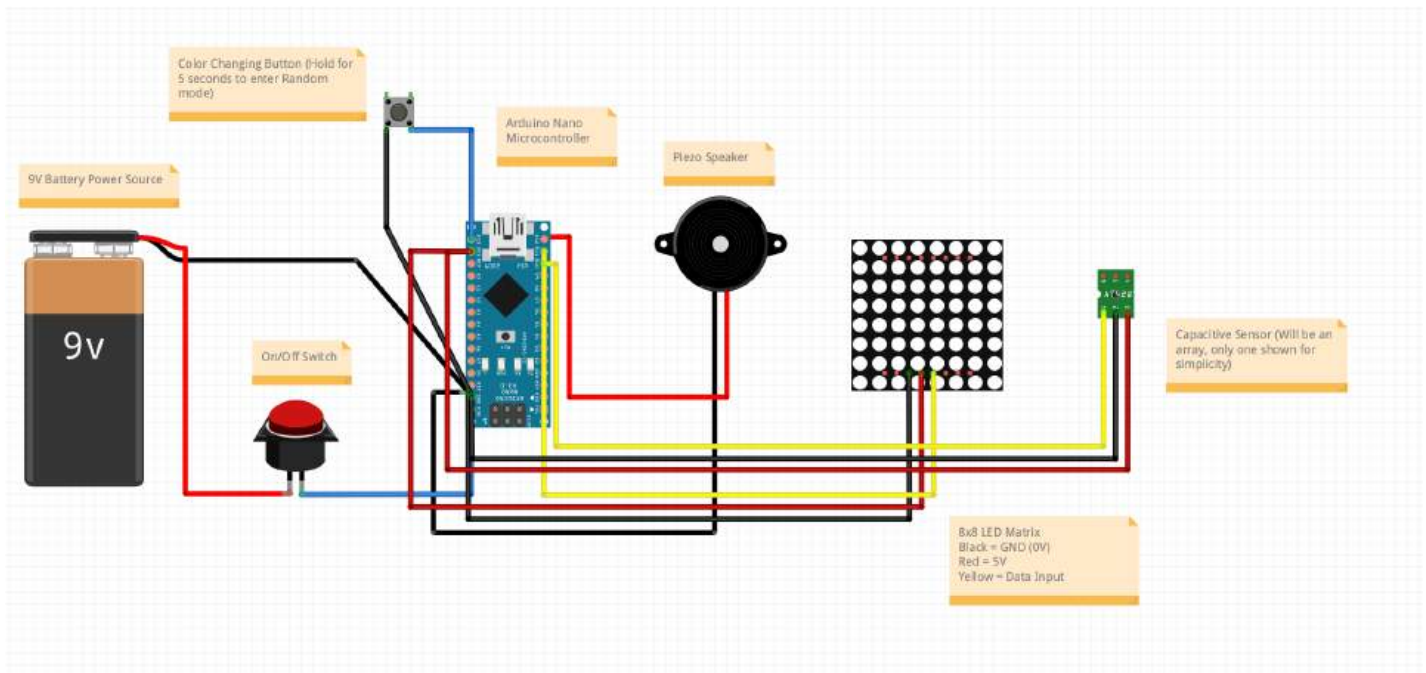


[Download](#)

2026\_.fzz (8.82 kB)

# 2026/04/11 - Final Fritzing Diagram

Katherine SATTEL - Apr 11, 2026, 12:38 PM CDT

**Title:** Final Fritzing Diagram**Date:** 4/11/2026**Content by:** Katherine Sattel**Present:** N/A**Goals:** Create final Fritzing diagram**Content:****Conclusions/action items:**

Include in poster

Katherine SATTEL - Apr 11, 2026, 12:39 PM CDT

[Download](#)

2026\_.fzz (7.27 kB)



## 2026/4/11 - Handle CAD

Katherine SATTEL - Apr 17, 2026, 7:49 PM CDT

**Title:** Handle CAD

**Date:** 4/11/2026

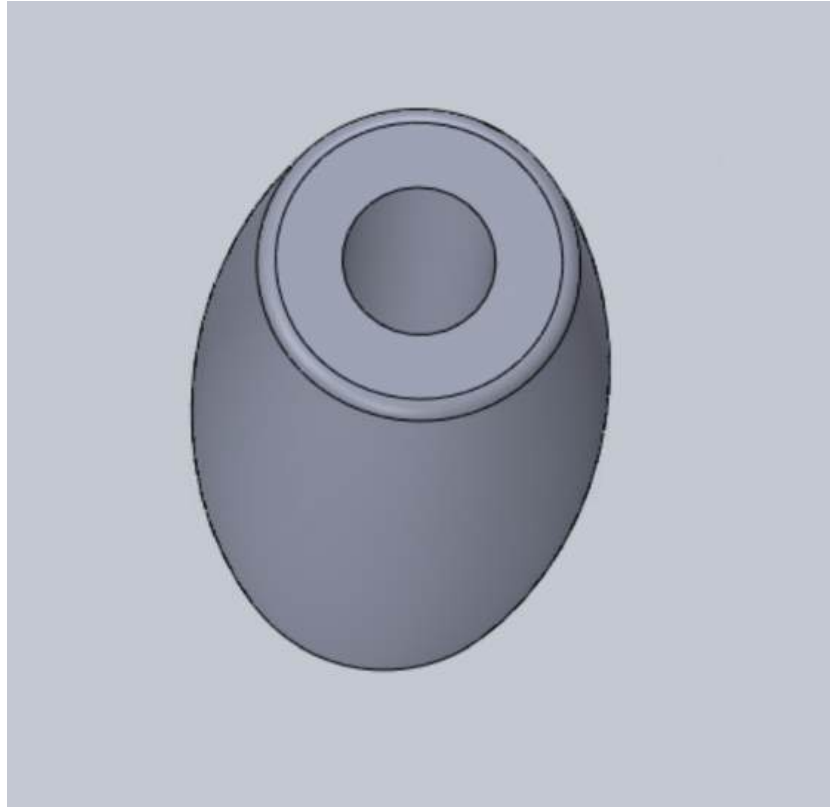
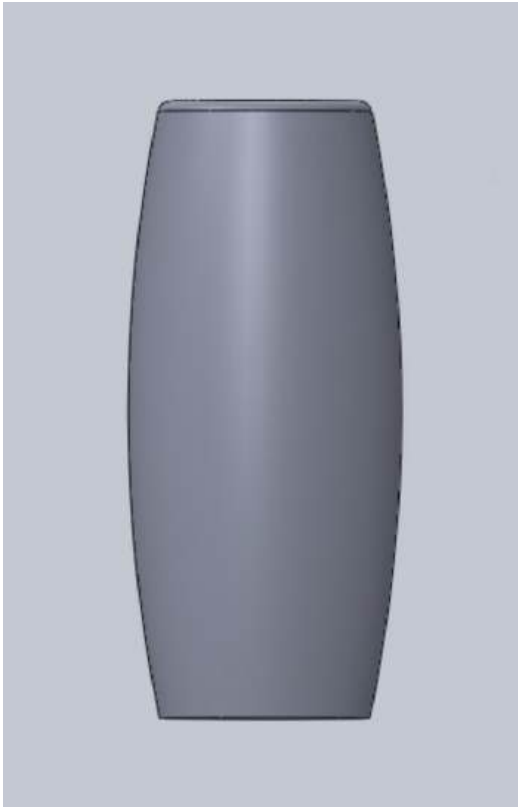
**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Create handle to 3D print for design

**Content:**

Images of CAD:



**Conclusions/action items:**

Print out of PLA-CF

Katherine SATTEL - Apr 17, 2026, 4:52 PM CDT



[Download](#)

handle.SLDPRT (126 kB)



## 2026/04/12 - (not) Final Arduino Code

---

Katherine SATTEL - Apr 12, 2026, 3:36 PM CDT

**Title:** Final Arduino Code

**Date:** 4/12/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Update code for single button usage; red/blue toggle

**Content:**

```
#include <Adafruit_NeoPixel.h>
```

```
#define LED_PIN 11
```

```
#define NUM_LEDS 64
```

```
#define MODE_BUTTON 7
```

```
#define CAP_SENSOR 2
```

```
#define SPEAKER A0
```

```
Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);
```

```
// Modes
```

```
bool randomMode = false;
```

```
bool toggleMode = true; // default mode: red/blue toggle
```

```
// Toggle state
```

```
bool redState = true;
```

```
// Button timing
```

```
unsigned long buttonPressTime = 0;
```

```
bool buttonWasDown = false;
```

```
// Random color
```

```
uint32_t currentRandomColor;
```

```
// Sensor timing
```

```
unsigned long lastCapTouch = 0;
```

```
// LED timing
```

```
unsigned long lastUpdate = 0;
```

```
int updateInterval = 500;
```

```
void setup() {
```

```
    pinMode(MODE_BUTTON, INPUT_PULLUP);
```

```
    pinMode(CAP_SENSOR, INPUT);
```

```
    pinMode(SPEAKER, OUTPUT);
```

```
    matrix.begin();
```

```
    matrix.setBrightness(191);
```

```
    matrix.show();
```

```
    randomSeed(analogRead(A1));
```

```
}
```

```
void loop() {
```

```
    handleButton();
```

```
    checkSensor();
```

```
    updateMatrix();
```

```
}
```

```
/* ----- BUTTON LOGIC ----- */
```

```
void handleButton() {
```

```
    bool buttonDown = (digitalRead(MODE_BUTTON) == LOW);
```

```
    // Detect press start
```

```
    if (buttonDown && !buttonWasDown) {
```

```
        buttonPressTime = millis();
```

```
        buttonWasDown = true;
```

```
    }
```

```
    // While held
```

```
    if (buttonDown && buttonWasDown) {
```

```
        unsigned long heldTime = millis() - buttonPressTime;
```

```
        // LONG PRESS (5s)
```

```
        if (heldTime >= 5000) {
```

```
            if (!randomMode) {
```

```
                // ENTER random mode
```

```
                randomMode = true;
```

```
                toggleMode = false;
```

```
                setRandomColor();
```

```
            }
```

```
        else {
```

```
            // EXIT random mode → back to default toggle mode
```

```
    randomMode = false;

    toggleMode = true;

    redState = true; // optional reset to red
}

delay(300); // debounce so it doesn't instantly retrigger

buttonWasDown = false; // reset press cycle
}
}

// On release → short press action
if (!buttonDown && buttonWasDown) {

    unsigned long heldTime = millis() - buttonPressTime;

    if (heldTime < 5000) {

        if (randomMode) {
            // short press in random mode → new random color
            setRandomColor();
        }
        else {
            // toggle red/blue
            redState = !redState;
        }
    }
}

buttonWasDown = false;
}
```

```
}
```

```
/* ----- RANDOM COLOR ----- */
```

```
void setRandomColor() {
```

```
    int choice = random(5);
```

```
    switch (choice) {
```

```
        case 0: currentRandomColor = matrix.Color(255,0,0); break; // red
```

```
        case 1: currentRandomColor = matrix.Color(0,255,0); break; // green
```

```
        case 2: currentRandomColor = matrix.Color(255,255,0); break; // yellow
```

```
        case 3: currentRandomColor = matrix.Color(0,0,255); break; // blue
```

```
        case 4: currentRandomColor = matrix.Color(128,0,128); break; // purple
```

```
    }
```

```
}
```

```
/* ----- SENSOR ----- */
```

```
void checkSensor() {
```

```
    int sensorState = digitalRead(CAP_SENSOR);
```

```
    if (sensorState == HIGH) {
```

```
        lastCapTouch = millis();
```

```
        tone(SPEAKER, 1200);
```

```
    }
```

```
    if (millis() - lastCapTouch > 2000) {
```

```
        noTone(SPEAKER);
```

```
    }
```

```
}

/* ----- LED UPDATE ----- */

void updateMatrix() {

    if (millis() - lastUpdate < updateInterval) return;

    lastUpdate = millis();

    uint32_t color;

    if (randomMode) {
        color = currentRandomColor;
    }
    else {
        color = redState ? matrix.Color(255,0,0)
            : matrix.Color(0,0,255);
    }

    for (int i = 0; i < NUM_LEDS; i++) {
        matrix.setPixelColor(i, color);
    }

    matrix.show();
}
```

**Conclusions/action items:**

Include in appendix of final report



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**Dynamic\_Balance\_Device\_4\_12.ino (3.35 kB)**



## 2026/4/17 - Sensor Housing CAD

---

Katherine SATTEL - Apr 17, 2026, 8:38 PM CDT

**Title:** Sensor Housing CAD

**Date:** 4/17/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Update CAD for sensor housing

**Content:**

- Changes made:
  - Sensor housing will now be perpendicular with display housing following testing with the ultrasonic sensor
    - This angle made the sensor more accurate
  - Hole for the speaker will be on the top
  - Holes for sensor have been increased in size
  - Box is fully hollow
  - Thickness increased from 2mm to 3mm

**Conclusions/action items:**

3D print this on Sunday

---

Katherine SATTEL - Apr 17, 2026, 8:37 PM CDT



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**UpdatedSensorHousingv2.SLDPRT (88.9 kB)**

 **3/12/2026 - Machining Training**

Katherine SATTEL - Mar 12, 2026, 10:10 AM CDT

**Title:** Machining Training

**Date:** 3/12/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Show proof of machining training

**Content:**



**Kat SATTEL**  
 ID Number: 908533778  
 1  
 Eligibility: CoE  
 Students

Profile

My Memberships				
Membership Type	Start Date	Expiry Date	Renew	Card Info
Machining	Tue, Aug 20 2024	Permanent	Not Renewable	N/A
Laser Cutter	Tue, Aug 20 2024	Thu, Jan 2 3000	Not Renewable	N/A
Laser Cutter	Wed, May 17 2023	Wed, Jan 1 3000	Not Renewable	N/A
Shop Tools	Thu, May 11 2023	Wed, Jan 1 3000	Not Renewable	N/A
Lab Orientation	Sun, Jan 1 2023	Tue, Dec 30 3000	Not Renewable	N/A

**Conclusions/action items:**

Complete 1 new training by 3/20



## 03/12/2026 - Biosafety and Chemical Lab Training

Katherine SATTEL - Mar 12, 2026, 10:11 AM CDT

**Title:** Biosafety and Chemical Lab Training

**Date:** 3/12/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Show proof of biosafety and OSHA chemical lab safety trainings

**Content:**

**WISCONSIN**  
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Kat Sattel has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	9/14/2024	9/14/2029
Chemical Safety: The OSHA Lab Standard	Final Quiz	9/10/2024	

Data Last Imported: 10/12/2024 01:45 PM

**Conclusions/action items:**

Complete 1 new training by 3/20



## 03/12/2026 - CITI Training

---

Katherine SATTEL - Apr 06, 2026, 1:04 PM CDT

**Title:** CITI Training

**Date:** 3/12/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Show completion of training from Fall 2025

**Content:**

Attached

**COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)**  
**COMPLETION REPORT - PART 1 OF 2**  
**COURSEWORK REQUIREMENTS\***

\* Scores on this [Requirements Report](#) (Part 1) reflect quiz completions at the time all requirements for the course were met. The Transcript Report (Part 2) lists more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Katherine Sattel (ID: 14979083)
- **Institution Affiliation:** University of Wisconsin - Madison (ID: 1160)
- **Institution Email:** sattel@wisc.edu
  
- **Curriculum Group:** Basic/Refresher Course - Human Subjects Research
- **Course Learner Group:** UW Human Subjects Protections Course
- **Stage:** Stage 1 - Level 1
  
- **Record ID:** 72935013
- **Completion Date:** 13-Oct-2025
- **Expiration Date:** 13-Oct-2028
- **Minimum Passing:** 85
- **Reported Score\*:** 97

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
UW-Madison Human Subjects Research Infrastructure (ID: 16392)	13-Oct-2025	No Quiz
Investigator Responsibilities (ID: 16391)	13-Oct-2025	4/4 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	13-Oct-2025	5/5 (100%)
History and Ethical Principles - SBE (ID: 490)	13-Oct-2025	5/5 (100%)
Informed Consent - SBE (ID: 504)	13-Oct-2025	5/5 (100%)
Assessing Risk - SBE (ID: 503)	13-Oct-2025	5/5 (100%)
Populations in Research Requiring Additional Considerations and/or Protections (ID: 16680)	13-Oct-2025	4/5 (80%)
University of Wisconsin - Madison (ID: 12133)	13-Oct-2025	No Quiz
Research with Decisionally Impaired Subjects (ID: 16610)	13-Oct-2025	5/5 (100%)
Introduction To Community-Engaged Research (CErR) (ID: 16994)	13-Oct-2025	5/5 (100%)

**For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.**

This document was generated on 13-Oct-2025. Verify at:  
[www.citiprogram.org/verify/?k60ab158c-f3e0-4d05-9c82-16685a174c90-72935013](http://www.citiprogram.org/verify/?k60ab158c-f3e0-4d05-9c82-16685a174c90-72935013)

**Collaborative Institutional Training Initiative (CITI Program)**  
 101 NE 3rd Avenue  
 Suite 320  
 Fort Lauderdale, FL 33301 US

Email: [support@citiprogram.org](mailto:support@citiprogram.org)  
 Phone: 888-529-5929  
 Web: <https://www.citiprogram.org>

**Conclusions/action items:**

Submit to Canvas

**COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)  
COMPLETION REPORT - PART 1 OF 2  
COURSE REQUIREMENTS\***

\* Score on PE (Requirements Report - Part 1) reflects compliance at the time of requirements on the course were met. The Follow-up Report (Part 2) will more closely evaluate, including based on optional supplements, the no-alternate.

**Name:** Katherine Sattel (ID: 14979083)  
**Institution/Division:** University of Wisconsin - Madison (ID: 149)  
**Institutional Email:** ksattel@wisc.edu

**Course Number:** 2001/2001/2001 - Human Subjects Research  
**Course Level Group:** 2001 - Level 1  
**Site ID:**

**Phase/ID:** 72935013  
**Completion Date:** 13-Oct-2025  
**Expiration Date:** 13-Oct-2028  
**Minimum Passing:** 80  
**Required Score:** 80

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
UW-Madison Human Subjects Research Fundamentals (ID: 8036)	13-Oct-2025	No. Qm
Biological Research (ID: 9031)	13-Oct-2025	64 (100%)
Calculus Research with Human Subjects - 2001 (ID: 807)	13-Oct-2025	88 (100%)
History and Ethics Research - 2001 (ID: 808)	13-Oct-2025	8/8 (100%)
Humanitarian Research (ID: 805)	13-Oct-2025	8/8 (100%)
Research with Human Subjects (ID: 804)	13-Oct-2025	9/9 (100%)
Population Research: Planning, Addressing, Coordinators and/or Protocols (ID: 1008)	13-Oct-2025	4/5 (80%)
University of Wisconsin - Madison (ID: 1210)	13-Oct-2025	No. Qm
Research with Human Subjects - 2001 (ID: 804)	13-Oct-2025	8/8 (100%)
Introduction to Community-Engaged Research (ID: 1004)	13-Oct-2025	5/5 (100%)

**For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program submitting institution identified above at the time of their last successful Learning.**

**This document was generated on 13-Oct-2025. Verify at:**  
<https://www.citiprogram.com/track/14979083/14979083/72935013>

**Collaborative Institutional Training Initiative (CITI Program)**  
 100 N. 3rd Avenue  
 Suite 300  
 Fort Lauderdale, FL 33303-1574

**Email:** [help@citiprogram.com](mailto:help@citiprogram.com)  
**Phone:** 888-524-1982  
**Web:** <https://www.citiprogram.com>



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**citiCompletionReport\_14979083\_72935013\_1\_.pdf (78.6 kB)**

# 03/12/2026 - HIPAA Training

Katherine SATTEL - Apr 06, 2026, 1:02 PM CDT

**Title:** HIPAA Training

**Date:** 3/12/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Show completion of 1 new training

**Content:**

Attached

2025-2026 HIPAA Privacy & Security Training > Grades > Katherine Sattel

Home  
Modules  
Assignments  
Grades

Grades for Katherine Sattel

Print Grades

Total: 100%

Show All Details

Course assignments are not weighted.

Calculate based only on graded assignments

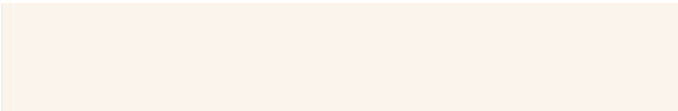
You can view your grades based on What-If scores so that you know how grades will be affected by upcoming or resubmitted assignments. You can test scores for an assignment that already includes a score, or an assignment that has yet to be graded.

Name	Due	Submitted	Status	Score
2025-2026 HIPAA Privacy & Security Training Assignments	Mar 12 at 2:08pm			
Assignments			100%	100.00 / 100.00
Total			100%	100.00 / 100.00

**Conclusions/action items:**

None

Katherine SATTEL - Mar 12, 2026, 2:12 PM CDT



[Download](#)

**Screenshot\_2026-03-12\_at\_2.10.54\_PM.png (361 kB)**



## 2026/01/28 - Library Session 1

---

Katherine SATTEL - Jan 28, 2026, 1:53 PM CST

**Title:** Library Session 1

**Date:** 1/28/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Understand how to utilize library resources for our project

**Content:**

- Search engines index information
- Chatbots are trained on internet data
  - Not search engines -- don't evaluate materials for accuracy/validity and can make up facts
- Databases directly include indexes
- Evaluating sources:
  - Relevance: What is the source about?
  - Authority: Who created this?
  - Quality: Why was this written and how does that affect the information?
    - Bias; trade journals
  - Currency: When was this source created?
- Library website --> databases --> search by subject --> browse available databases --> once searched, can jump off of authors, citations, keywords, etc. --> view pdf
- Zotero
  - Connected to browser
  - Can be used to create a bibliography without the need for excessive formatting
- Technical reports:
  - Publish the results of government funded research
    - Databases include: DTIC, NTRL, OSTI

**Conclusions/action items:**

Search engines index information while chatbots are trained on internet data and may generate inaccurate content, whereas library databases directly index evaluated sources. Effective research involves evaluating relevance, authority, quality, bias, and currency of sources, using library databases and tools like Zotero, and accessing technical reports from databases such as DTIC, NTRL, and OSTI.



## 2026/02/11 - Lecture 4

---

Katherine SATTEL - Feb 11, 2026, 1:40 PM CST

### **Title: Lecture 4: Presentations and Interviews**

**Date:** 2/11/2026

**Content by:** Katherine Sattel

**Present:** BME 301

**Goals:** Learn tips for presentations and interviews

### **Content:**

- Presentations:
  - Consistent font choice
  - No single hanging bullets -- just combine w/ above
  - Use a logical flow in terms of organization -- make it look like one person wrote it
  - Pictures should have a purpose
  - 6x6 rule
    - 6 words, 6 lines, 1 minute per slide
  - Keep audience interested:
    - Share project impact
    - Don't talk down to your audience
    - Positive presence
    - Keep in mind body language, eye contact, etc.
  - You can't cover everything -- highlight
  - Include figure captions for images, graphs, tables, etc. and don't forget citations
    - Include thoughtful descriptions
  - For CAD graphics:
    - Only include 1 or 2 clear images
    - Don't use the schematic drawing, use a screenshot
    - Labels and scale required
  - Can use sketches, but ensure background is removed, clean and clear lines, include measurements
  - For results:
    - Show statistical analysis when possible
    - Don't include raw data
    - Think about the size and ease of viewing the data
    - Normalize scales to help with comparison
  - Think about effective storytelling through figures --> exploded view, block diagrams, etc.
- Interviewing:
  - Bring a small portfolio
  - Be specific and personal to stand out against other BME's
    - Undergrad research/independent study
    - Design projects and relevant leadership
    - FDA/regulatory knowledge

- Extracurriculars
- Shadowing
- Technical skills and soft skills
- Be prepared to answer the common questions
- Ask thoughtful questions
  - Do company research so you can ask about certain products, etc.

**Conclusions/action items:**

Submit interview activity



## 2026/02/25 - Diversity and Inclusion in Engineering

---

Katherine SATTEL - Feb 25, 2026, 1:48 PM CST

### **Title: Diversity and Inclusion in Engineering**

**Date:** 2/25/2026

**Content by:** Katherine Sattel

**Present:** BME 301

**Goals:** Understand what diversity means in engineering design

### **Content:**

- What does diversity mean in engineering design?
  - Designing for more than just one demographic
  - Thinking outside the box
  - When testing, have a diverse group of people
  - Ask questions, keep an open mind
  - Consider people's religious and cultural backgrounds
- What does universal design mean?
  - Designing for as wide a range of people as possible
    - Making something easy to use and understand for people with different backgrounds
  - Trying to create something that is "One size fits most"
  - Intuitive design
    - Use design elements to make something make sense, not words
  - Simple design
  - Being aware of things that may make your design less inclusive/universal
- Principals of Universal Design:
  - Equitable use: useful and marketable to people with diverse abilities
  - Flexibility in use: Accommodates a wide range of preference and abilities
  - Simple and intuitive use: Use of the design is easy to understand regardless of user's experience, language, knowledge, etc. --> provide feedback during use and remove unnecessary complexity
  - Perceptible information: Design communicates necessary info effectively to the user
  - Tolerance for error: Minimizes hazards and adverse consequences if used not as intended
  - Low physical effort: Can be used with a minimum amount of fatigue for weaker users
  - Size and space for Approach and Use: Appropriate size and space is provided for approach, reach, manipulation, regardless of size and mobility
- How does this relate to ethics?
  - It would be unethical to leave out large groups of people, especially based on their socioeconomic class or demographic
- BME Code of Ethics

### **Conclusions/action items:**

Do the in-class activity based on BME code of ethics



## 2026/03/04 - Library Session 2

---

Katherine SATTEL - Mar 04, 2026, 2:08 PM CST

**Title: Library Session 2: Patents, Standards, and Other Resources for Design**

**Date:** 3/4/2026

**Content by:** Katherine Sattel

**Present:** BME 301

**Goals:** Understand the resources available to us to help with standards, trademarks, and patents

**Content:**

- Standards
  - Full text via database of:
    - ASTM
    - ASABE
    - IEEE
    - ISO
    - Historical Print Collection
  - Use the "request a standard" form
  - Market and industry sources
    - Use business databases
      - Data Axle Reference Solutions - businesses and demographic information on customers
      - IBISWorld Industry Reports - market research reports
      - ProQuest One Business - full-text database
- Patents and Prior Art
  - Patent examiners evaluation applications against prior art which includes: inventions disclosed in US and foreign patents, patent applications, etc.

**Conclusions/action items:**

Use these resources to write Tong Design Application



## 2026/03/06 - Tong Lecture

---

Katherine SATTEL - Mar 06, 2026, 1:43 PM CST

**Title:** "From Imagination to Implantation: Turning Science Fiction into Brain Technology"

**Date:** 3/6/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Learn about Dr. Williams biomedical engineering career

**Content:**

- Justin Williams, PhD
  - Key points:
    - Know your market and find the right market: Know how what the areas of your market can be filled and where your product will fit into that, is it a growing/shrinking market?, etc.
    - Start with the end in mind: Don't waste time, have a plan from the beginning, think with the future in mind
    - Timing is crucial: Things might not work out just because of time, not because the idea is bad, look for a good window of time
    - Keep it simple: Sometimes less is more, try not to overthink the solution to a problem
    - Work with good people: You are the company you keep, surround yourself with other motivated and hard-working people
    - Find your motivation: What is it that is making your want to work on a project, what is it's impact to you. Find your "why"
    - Show up: Everything starts with just showing up and trying

**Conclusions/action items:**

Follow these ideas in my future in design and industry, follow up with Dr. Williams and the WITNe



## 2026/03/11 - Lecture 8

---

Katherine SATTEL - Mar 11, 2026, 1:42 PM CDT

### **Title: Protocol Development**

**Date:** 3/11/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Understand planning and execution of protocols

### **Content:**

- "Fail fast and fail forward"
  - Low fidelity
  - Test individual pieces
  - Documentation is still required
- Preliminary testing/analysis: Circuit diagrams, fittings, simple calculations, free body diagrams, mechanics of materials
- Materials
  - Detailed list -- match the expense table
    - Name of material
    - Amount/quantity
    - Manufacturer and PN
    - Purpose of material
    - List of equipment needed
    - Include references
- Methods
  - Step by step plan
  - Mix -- for how long, what vigor, etc.
  - Cut -- with what tool, what size, etc.
  - Needs to be repeatable by an unfamiliar reader
- 3D printing
  - Include the 3D printer brand and model
  - Include gCode file
  - Include 3D print settings that you edited so that it can be re-created
- Manufacturing
  - Can't manufacture everything you can 3D print
  - Consider manufacturing processes throughout design process
    - Common methods:
      - Molding (injection, blow, thermoforming, extrusion, etc.)
      - Machining (lathe, mill, waterjet, laser cutters, etc.)
      - Joining (welding, soldering, screwing, riveting, etc.)
- Seek professional advice
  - Design Innovation Labs
  - Faculty SME's

- Deliberately organize fabrication and testing plans

**Conclusions/action items:**

Use these tips to create testing protocols and fabrication plans



## 2026/3/25 - Ethics in Engineering

---

Katherine SATTEL - Mar 25, 2026, 2:04 PM CDT

**Title:** Ethics in Engineering

**Date:** 3/25/2026

**Content by:** Katherine Sattel

**Present:** BME 301

**Goals:** Understand the ethical applications of our design project

**Content:**

- Where do ethics come from?
  - Family/how you're raised
  - School
  - Social interactions
  - Observations
- Is there a difference between "personal" ethics and "professional" ethics?
  - Yes, you would behave differently in a professional setting vs. a social setting
  - Different ways that would be deemed "polite" to communicate/interact about
  - Different ways to evaluate decisions "ethically"
- COE instructors perceive that instructors and students value ethics at different levels. Why?
  - Disconnect between older generations and younger generations view on ethics
- [BME Code of Ethics](#)
- Ethical Problem-Solving
  - Establish a Need
  - Understand the Problem
  - Generate Solutions
  - Evaluate Solutions
  - Go back and Iterate
- Types of tests:
  - Harm test - fewer negative consequences than another option?
  - Publicity test - if this came out in the news would the GP accept?
  - Reversibility test - How you would feel if a loved one was affected by this?
  - Universality test - what if everyone adopted this?
  - Respect for persons test - does this respect the rights of others?
  - Utilitarian test - does this do the greatest good for the greatest # of people?
  - Etc.
- Ethics in our project:
  - In your design teams, identify components (at least 2) of your design that could face ethical dilemmas or have an ethical dimension (for example, safety is often a trade-off).
    - b. Our design could not be accessible for colorblind patients as the screen uses red and green colors.
    - c. The design may not be accessible for therapists that cannot properly hold it up throughout the whole therapy session.

- Consider the appropriate language in ABET Outcome 4: an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
  - a. **Done**
- Read through BME code of ethics: <https://www.bmes.org/bmes2023-policies>
- Review the [Code of Ethics for Engineers and Ethical decision-making system](#)
- Type up your answers and add to the case study answers (Q 1-4 above) – upload to Canvas. Copy and paste your design-specific ethics responses into your design notebook.
  - What components of your design have ethical dimensions (be specific and list at least 2)?
    - **The display component of the design- not everyone can differentiate between certain colors**
    - **The weight of the entire design may be too much for the therapist to use**
  - How will your team address the ethical dimensions? (What is your action plan?)
    - **For each component:**
    - **We could make the device have a red and blue screen to accommodate for patients with red/green colorblindness**
    - **We could lower the perceived weight even further and add an additional support so it could maybe support itself.**

### **Conclusions/action items:**

Complete the ethics activity



## 4/8/2026 - Engineering Judgement

---

Katherine SATTEL - Apr 08, 2026, 1:39 PM CDT

**Title:** Engineering Judgement

**Date:** 4/8/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Learn about engineering judgement

**Content:**

- Engineering Judgement: The process of making informed decisions when there isn't a clear-cut correct answer. Weigh information, past experiences, and principles to arrive at a reasonable solution
- ABET outcome 6:
  - ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgement to draw conclusions
- How to learn engineering judgement?
  - Real-world engineering problems
  - Open-ended problems
  - Teamwork/Collaboration
  - Critical thinking
  - Communication
  - Handling uncertainty and changing conditions
  - Intuition
  - Ask questions
  - Embracing life-long learning
- 3-Domain Model
  - Attitudes: What you feel/believe
  - Behavior: What you actually do
  - Cognitive: What you know

**Conclusions/action items:**

Complete model for engineering judgement activity



## 2026/4/15 - Poster Presentations

---

Katherine SATTEL - Apr 15, 2026, 1:45 PM CDT

**Title:** Poster Presentations

**Date:** 4/15/2026

**Content by:** Katherine Sattel

**Present:** BME 301

**Goals:**

**Content:**

- Print at Steenbock
- What makes a good poster?
  - Helpful images/graphs
  - Clear introduction/background to introduce people to your topic
  - Legible font
  - Flow that makes sense
  - Visually appealing
  - Consistent formatting
- What makes a bad poster?
  - Too small of font
  - No figure descriptions
  - Unnecessary pictures
  - Raw data
  - Too wordy
  - Single hanging bullets
  - Funky fonts
- Poster should be self-explanatory
  - Labels of figures
  - Don't include just CAD drawings
  - Include scale in images when possible
  - No need to show all of your results
  - High-res pictures
  - Captions: Figure #, title, description, citation (if necessary)
  - Avoid harsh colors (bright yellow, etc.)
  - Include enough white space to separate sections/different topics
- Context of Use and Workflow
  - Start with user and setting (who, where)
    - Show workflow (before --> during --> after) in our case, inputs/outputs
    - Include user-device interaction
  - Place in a larger system
  - Color/grouping to show organization
  - Use labels with minimal text
  - Keep it high-level and understandable at a glance
- At conferences

- At conferences
  - Handouts such as business cards, copies or poster, surveys, etc.
- Have several people proofread
  - Especially, people who are unfamiliar with the project

**Conclusions/action items:**

Work on poster for next week



## 2026/01/30 - Team Meeting 1

---

Katherine SATTEL - Feb 04, 2026, 2:34 PM CST

**Title:** Team Meeting 1

**Date:** 1/30/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Plan upcoming week; split up PDS

**Content:**

- 19 sections in PDS, 4 team members:
  - Noor: Title page, function, client requirements
  - Therese: Performance requirements, safety, accuracy and reliability, life in service, shelf life
  - Freyja: Operating environment, ergonomics, size, weight, materials, aesthetics/appearance/finish, quantity, product cost
  - Kat: Standards and specifications, customer, patient-related concerns, competing designs
- Each section must be clearly labeled with who wrote it
  - Finish by Wednesday 2/4 to allow time to edit before due date
- Team wrote questions to ask client
  - Ensure these questions are applicable to/answer the sections of the PDS
- Reflected on feedback from advisor meeting

**Conclusions/action items:**

Write the PDS and brainstorm questions for client



## 2026/02/02 - Client Meeting 1

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Katherine SATTEL - Feb 04, 2026, 2:42 PM CST

**Title:** Client Meeting 1

**Date:** 2/2/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Understand the improvements/changes the client wants to make from the last team's prototype

**Content:**

- Key takeaways:
  - DURABILITY
  - WEIGHT
  - New design needs to find a happy medium between prioritizing a durable final prototype that lasts at least a year with heavy use (up to 5-6 hours per day, 5x a week, usually for 15 mins at a time)
  - Client will send videos of him using the previous prototype so we can get a better understanding of what this device looks like in use
    - Need to coordinate a time for a hand-off of the old prototype so we can collect weight and dimensions, examine the failure point
  - It seems like the last one failed in the 3D printed chassis that was supporting the screen at the end
    - If we still need to have some sort of casing for the screen, look into more durable 3D printable options
      - PET-G, ABS, PET-CF, etc.
  - Important to have measurements on rod so that he can still perform the functional reach test on patients
  - Auditory feedback would be nice in an ideal world
    - Would add weight, however, speaker could be located in handle too with the other electronics
  - Seems like the most difficult aspect of this project won't be the electronics, it's gonna be making concrete improvements to the previous designs without sacrificing the capability of the electronic components (don't want to downsize too much)
  - For testing:
    - If a patient signs a release, we can observe the final prototype in use
    - Testing should not focus on efficacy of prototype—we know this type of therapy is effective, it should focus on fatigue testing, how strong/durable the prototype is, etc.

**Conclusions/action items:**

Have communicator follow up with client to coordinate prototype hand-off and obtain in-use videos



## 2026/02/06 - Team Meeting 2

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Katherine SATTEL - Feb 06, 2026, 12:58 PM CST

**Title:** Team Meeting 2

**Date:** 2/6/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Divvy up work for the next week

**Content:**

- 1 design idea each -- sketch or CAD
- Continue research and choose design criteria and weights
- Teams:
  - Materials: Freyja and Kat
  - Design: Therese and Noor
  - Audio Feedback: Everyone
    - Speaker, user-activated trigger, or sensor-activated
- No electronics design matrix -- using circuit from previous semester because there aren't any complaints with the circuitry

**Conclusions/action items:**

- Finish design matrices by next Thursday night
- Ensure research is kept in LabArchives



## 2026/02/17 - Client Meeting 2

---

Katherine SATTEL - Feb 18, 2026, 5:56 PM CST

**Title:** Client Meeting 2

**Date:** 2/17/2026

**Content by:** Katherine Sattel

**Present:** Katherine Sattel

**Goals:** Hand off prototype -- get some questions answered

**Content:**

- Images and specs in background research!
- Feedback:
  - Client indicated that he doesn't need the measured portion of the rod to be longer than 24in - said 22in was ideal
  - He showed how he handled the rod - has a lot of room behind his hand because he liked to have more control holding it closer to the rod (will attach photo)
  - Really hammered home the weight complaint; definitely agree with this
    - The previous prototypes both held the Arduino, breadboard, display, all of the electronics, in the end display box
    - The first prototype was a digital display -- think smart watch
    - Second prototype was a LED matrix; mentioned it was too bright for some patients
  - Asked if he would mind having the bulk of circuitry below his hand on the handle
    - Client liked this idea, he didn't think it would interfere with his grip and he also appreciated that it would likely act like a counterweight
  - Client liked the clean, finished, look of the first prototype compared to the second prototype
    - First prototype had the measurements backwards though, the ruler should go from the handle up, not the display
  - Liked that the second prototype just used 1 9V battery in the handle whereas the first one used a battery pack with an on/off switch in the display box

**Conclusions/action items:**

Use this to inform our preliminary design presentation

Katherine SATTEL - Feb 18, 2026, 5:50 PM CST



[Download](#)

**IMG\_2904.HEIC (2.17 MB)** Photo showing how client holds device



## 2026/02/27 - Team Meeting

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Katherine SATTEL - Feb 27, 2026, 12:49 PM CST

**Title:** Team Meeting

**Date:** 2/27/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Plan next week, set individual goals

**Content:**

- Next Wednesday, 3/4, team will begin preliminary circuitry
  - Materials we'll need to order: Arduino UNO, speaker, capacitive sensors, PVC tubing 1" OD, Carbon fiber 1" OD
- Need to decide on filament choice
  - Likely not PLA
  - Prioritize durability over weight for this
- In final report: Change order of design matrices to have overall design first, then the other two
- Tentative client meeting: 3/4 7pm

**Conclusions/action items:**



## 2026/03/04 - Client Meeting 3

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Katherine SATTEL - Mar 04, 2026, 7:17 PM CST

**Title: Client Meeting 3**

**Date:** 3/4/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Get feedback on CAD and ask more questions

**Content:**

- How are we reducing weight?
  - Display box has a thinner profile
  - Circuitry is in the handle
    - This holds the most hefty portion of the device as well as acting as a counterweight
- How many colors?
  - Common drill is reaching with right hand for red target and left hand for green target
  - Wants to be able to do random mode
  - We should do 2 buttons: one that cycles and one that flips between two colors
- Auditory feedback
  - Piezo speaker that is small and lightweight
  - Will need to do testing to ensure the volume is high enough for patients who are hard of hearing
- Carbon fiber
  - Specific weave that is easy to etch and manufacture with
    - Helps keep a more professional look
- Opportunity to go to hospital in Fitchburg to see our prototype in action
  - Great experience to see the clinical setting
- No worries about sharing patient videos -- she signed a release form
  - Can be included on final poster
- Project impact:
  - Aging population -- more and more people need rehabilitative care, people are very unaware of it in general
    - Stigma
  - BiTS device is too expensive for a lot of rural facilities
    - Limited usability for physician
  - This device brings engagement and helps the physician change difficulty and make the activity more fun for the patient
- Client gave permission to take apart old prototypes to use for parts and or/reverse engineering their work

**Conclusions/action items:**

Order materials tomorrow, begin circuitry this weekend



## 2026/03/23 - Client Meeting 4

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Katherine SATTEL - Mar 23, 2026, 12:30 PM CDT

**Title:** Client Meeting 4

**Date:** 3/23/2026

**Content by:** Katherine Sattel

**Present:** All

**Goals:** Check in with client following advice after show & tell

**Content:**

- Likes the idea of circuitry being somewhere else to help the ease of clinician use
  - Hip: risks of tangling/pulling on wires
  - Arm: Less risk of tangling, might be uncomfortable/get in the way
- Buttons:
  - Client is good with the use of 1 button (long press to change to R/G mode)
- Battery:
  - Client is okay with 9V battery or rechargeable battery
- Number 1 priority is ease of use
- Colors:
  - Client uses red/green because right hand is associated with red target and left hand is associated with left hand
  - Could add another mode for color blind patients
    - Add a longer press on the button
  - Update to Red/Blue mode for accessibility reasons
- Overall: Make circuitry and test with the different methods of placing circuitry on the body vs. behind the hand

**Conclusions/action items:**

Fabricate!



## 2026/04/10 - Team Meeting

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Katherine SATTEL - Apr 10, 2026, 1:01 PM CDT

**Title:** Team Meeting

**Date:** 4/10/2026

**Content by:** Team

**Present:** All except Noor

**Goals:** Make actionable goals for this weekend

**Content:**

Actionable Items:

- Circuitry needs to be soldered- Saturday (ideally 2 people)
- Speaker dimensions need to be measured- Saturday
  - CAD file needs to be updated to fit speaker- Saturday
- Circuitry and code tested - Saturday (accuracy of touching the sensor and accuracy of buttons switching)
- Update and upload poster layout - prep for next Friday meeting (include pictures of MTS testing,
- Survey data summarized in either sheets/excel and matlab/something idk
- MTS testing- Wednesday after lecture (2 people)
- Make box with room for arduino nano, breadboard, and battery (this is for the armband thing) - tomorrow
- Update display portion to be more durable (add rectangles and cut them)- tomorrow
- Layer of electrical tape for exposed wires, brainstorm another layer- tomorrow
- Buy/borrow a roll of electrical tape at the Makerspace- tomorrow
- Talk to someone in the Makerspace about the Cricket- tomorrow
- Make the survey for qualitative data- tomorrow (freyja)
- Write fabrication protocols (write them while you're doing them)
- Write testing protocols (write them while you're doing them)
- Make poster outline - today
- Make final executive summary

Meet at union south at 10 ish OR wendt at noon 4/11 and do ^^^^

**Conclusions/action items:**

Do this!!!

 **2026/02/17 - Design Matrix Work**

Katherine SATTEL - Feb 25, 2026, 7:00 PM CST

**Title:** Design Matrix Work

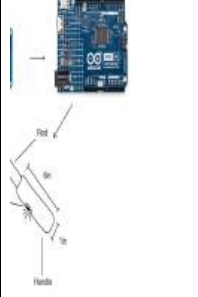
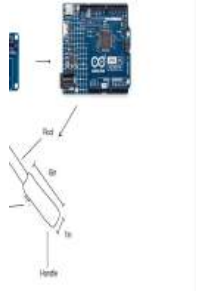
**Date:** 2/17/2026

**Content by:** Katherine Sattel

**Present:** N/A

**Goals:** Complete the auditory feedback and material design matrices

**Content:**

<i>Designs</i>		Design 1: Sensor-activated Speaker		Design 2: Sensor-Activated Button		Design 3: Manual Trigger	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (35)	3/5	21	4/5	28	4/5	28
2	Ease of Use (30)	5/5	30	5/5	30	3/5	18
3	Ease of Fabrication (20)	4/5	16	2/5	8	4/5	16
4	Sound Variability (10)	5/5	10	3/5	6	3/5	6
5	Cost (5)	3/5	3	3/5	3	5/5	5
Total:			80		75		74

**Criteria:**

*Weight (35):*

Weight is ranked as the most important criterion because excessive weight was a significant issue identified by the client in previous iterations of the device. Since the auditory feedback system is an additional feature being integrated into the existing design, it is essential that it does not increase the overall weight of the device by a large amount. The selected components must be lightweight and compact to ensure that the final prototype is lighter than previous versions.

*Ease of Use (30):*

Ease of use refers to the level of additional input required from the physician in order to activate or receive auditory feedback. The device should operate intuitively and integrate seamlessly into therapy sessions without requiring extra switches, buttons, or manual inputs. This ensures that the clinician can focus entirely on supporting and monitoring the patient rather than managing device controls. This criteria is weighted highly in order to prioritize patient safety and so as to not give extra work to the client.

*Ease of Fabrication (20):*




Ease of fabrication evaluates how complex it would be to integrate the auditory feedback system into the existing device architecture. This includes considerations such as modifying current circuitry, writing and debugging additional code, integrating new sensors or output components, such as a speaker, and producing any required 3D-printed housings or mounts.

*Sound Variability (10):*

Sound variability refers to the system’s ability to adjust volume or tone to accommodate different patient needs. For example, patients with hearing impairments may require higher volume levels or specific frequency ranges to perceive feedback effectively, that may be too loud for other patients. Additionally, varied sounds for positive or negative feedback can potentially improve patient outcomes. Although customizable auditory feedback would enhance usability and inclusivity, it is not essential for basic device functionality. Therefore, this criteria is weighted lower than core functional considerations such as weight and ease of use.

*Cost (5):*

Cost is assigned the lowest weight because the project does not have strict financial constraints. The client has provided a flexible budget, allowing design decisions to prioritize performance, reliability, and usability over price. Furthermore, the potential design options are expected to fall within a similar cost range, reducing the impact of cost differences on decision-making. Therefore, cost will likely not be a determining factor.

<i>Designs</i>		Design 1: Carbon Fiber		Design 2: Aluminum Alloy		Design 3: PVC Tubing	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (40)	5/5	40	2/5	16	3/5	24
2	Durability (30)	5/5	30	5/5	30	4/5	24
3	Ease of Fabrication (15)	1/5	3	3/5	9	5/5	15
4	Ease of Engraving	2/5	4	4/5	8	4/5	8

	(10)						
5	Cost (5)	3/5	3	4/5	4	5/5	5
Total:			80		67		76

### Criteria

#### *Weight (40):*

Weight is ranked as the most important criteria because excessive weight was the primary concern raised by the client regarding the previous prototype. A reduction in weight is therefore critical to improving overall usability. The selected material must be as lightweight as possible while still meeting strength requirements. This will improve user comfort and reduce physical strain, particularly in a clinical setting where the device will be used repeatedly throughout the day. Additionally, lowering the weight contributes to patient safety by minimizing the risk of injury if the device is dropped or mishandled.

#### *Durability (30):*

Durability is ranked as the second most important criteria due to issues with structural failure in previous prototypes. The final design is expected to have a minimum life in service of one year with minimal maintenance. Therefore, the selected material must possess sufficient strength in order to not bend or break due to bending stresses from normal use. It should also demonstrate resistance to wear and impact from patients that can be encountered in a clinical environment. Ensuring durability will increase longevity and overall performance of the device.

#### *Ease of fabrication (15):*

Ease of fabrication is given a slightly lower weighting because the design requirements involve minimal complex manufacturing processes. The material will be purchased in tubular form, reducing the need for most fabricating techniques. Any additional fabrication such as cutting, drilling, or finishing will be carried out using tools available in the TEAMLab on campus. Although the fabrication process will be straightforward, the material should still be compatible with available tools and processes to ensure safe and accurate construction of the prototype.

#### *Ease of Engraving (10):*

Ease of engraving evaluates how effectively measurement markings can be permanently applied to the material. The final prototype must incorporate a clear and accurate measurement system so that the client can collect reliable data during functional reach tests. The material should allow for precise engraving, etching, or marking without compromising structural integrity. While this is an important feature for usability and data accuracy, it is not weighted as highly because alternative marking methods such as vinyl decals, adhesive scales, or stenciling can be used if direct engraving is outside of the scope of this project.

#### *Cost (5):*

Cost is assigned a lower weighting because performance characteristics such as weight and durability are of greater importance for this project. As only a single prototype will be manufactured, material cost does not significantly impact the overall design. Furthermore, the client has provided a flexible budget, allowing material selection to be guided primarily by functionality rather than price constraints. However, cost is still considered to ensure responsible purchasing choices and to maintain the potential for future scalability if additional units are to be made.

### Conclusions/action items:

Include these in the preliminary design presentation!

 **2026/02/23 - Preliminary Report Sections**

Katherine SATTEL - Feb 25, 2026, 7:01 PM CST

**Title:** Preliminary Report Sections**Date:** 2/23/2026**Content by:** Katherine Sattel**Present:** N/A**Goals:** Complete assigned sections of the preliminary report**Content:***A. MTS Testing*

The primary method of collecting quantitative data for the final device will be through MTS testing. The shaft material will be tested using a 3 point bending testing protocol, as shown in Figure X. The elastic modulus and toughness will be calculated. These values will be compared to that of the previous prototypes in order to prove a statistically significant improvement in strength and durability. Additionally, testing will be performed on the 3D printed attachments, including the handle and display housing, as this was a failure point in the previous prototype.



Figure X: 3 point bending in an MTS machine [X]

*B. Qualitative testing*

In order to gauge the user comfort of the device, a survey will be conducted. The participant will mimic normal usage of the balance device, as shown in Figures X and X. This includes holding the device in front of the body with the arm extended for 15 minutes at a time. Participants will then complete a survey consisting of multiple questions on a 5 point scale in order to gain feedback on the weight distribution of the device, the counterweight action, and overall comfort of the handle design.

Figure X, X: Client using the balance device with a patient in order to measure their spatial awareness and depth perception (patient face redacted for privacy)

### *C. Battery Life*

With the addition of the auditory component, the battery life will likely decrease when compared to the last semester's prototype. The device will be turned on and used until the battery drains so that the client can be informed of how many hours of battery life can be expected based on typical usage.

## ***Discussion***

No results are currently available, as testing has not yet been conducted. Potential sources of error include biases of the participants of the qualitative testing, variations from the 3D printers and their infill density, and various assumptions made about typical usage patterns of the client. The device will accommodate varying colors, brightness, and volume, however, this still may not meet the needs of some patients. Additionally, the final prototype is being made for the needs of our client, which may vary from the needs of other physical therapists, especially considering that 70% of physical therapists are female [X]. Design changes will be made based on the results of the quantitative and qualitative testing results.

## ***Conclusions***

Approximately 30% of stroke survivors develop Spatial Neglect syndrome during their recovery [X]. This increases the patient's risk of falls and other injuries, slowing the recovery process. The client, a physical therapist specializing in neurorehabilitation, requires a dynamic device that can be used to assist patients in improving their sense of balance, depth perception, and spatial awareness. The final design combines a display with associated auditory feedback at the end of a graduated rod that is both lighter and more durable than previous prototypes. The design aims to increase user comfort and ergonomics when compared to the top-heavy prototypes of past semesters. Currently, only one prototype is to be created, however, should the need for more arise, the fabrication techniques and materials used shall be replicable. Future work includes improvements made to the display resolution, a more compact and portable design, and continued communication with the client on the performance of the final device.

### **Conclusions/action items:**

Include these in the submitted preliminary report



## 2026/01/27- "The effects of dynamic motion instability system training on motor function and balance after stroke: A randomized trial"

Therese Kalt - Jan 29, 2026, 8:30 PM CST

**Title:** "The effects of dynamic motion instability system training on motor function and balance after stroke: A randomized trial"

**Date:** 01/27/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn about the overall effectiveness of DMIST (dynamic motion instability system training) after stroke.

**Search Term:** Pubmed: Effects of stroke therapy

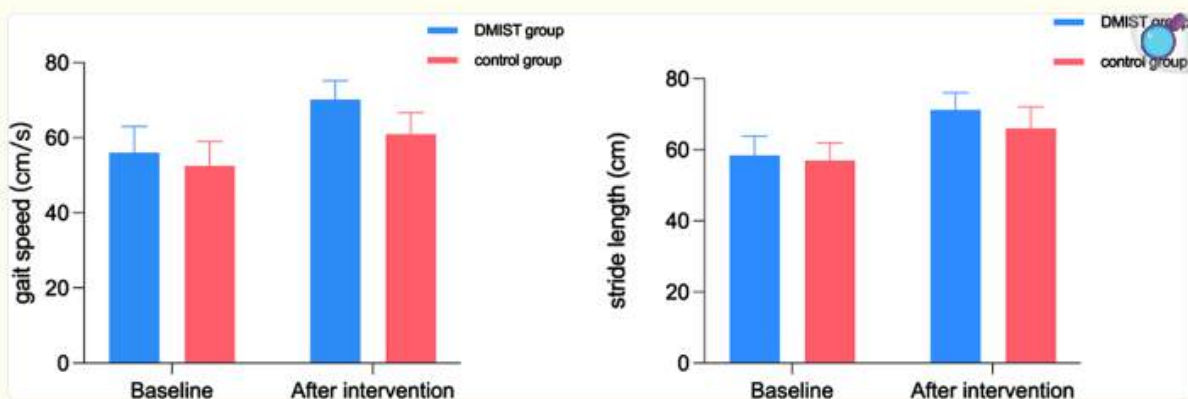
**Citation:** J. Shen *et al.*, "The effects of dynamic motion instability system training on motor function and balance after stroke: A randomized trial," *NeuroRehabilitation*, vol. 53, no. 1, pp. 121–130, Aug. 2023, doi: <https://doi.org/10.3233/nre-230008>.

**Link:** <https://pubmed.ncbi.nlm.nih.gov/37424480/>

**Content:**

- Imbalance and abnormal gait are greatly caused by impairments in vision and vestibular sense, both of which are affected when an individual has a stroke
- Participants received 20 minutes of DMIST 5 times a week for 8 weeks
- Highly effective for treating lower-limb motor function
  - Major improvements for FMA-LE, gait speed and stride length
  - FMA-LE is a quantitative evaluation tool for stroke patients that assesses hip, knee, and ankle mobility
    - Consists of 17 elements totaling 34 points
- BBS, balance, did not show a statistically significant difference so DMIST may not be the most helpful for improving balance

Fig. 2.



- FMA-LE and BBS may be helpful tools in the future for testing our device and ensuring that it is helping a stroke patient improve these scores
- The method that our device hopes to follow has proven to work to increase stride length among stroke patients already, if we tried to incorporate components to our device that improve balance, that would make our device even better

**Conclusions/action items:** Connects with criteria 4b as it explains the effect of stroke rehabilitation. Continue researching for the project to find more information about current techniques, pitfalls of competing designs, etc. Also, keep this information in mind when it comes to testing in the future.



## 2026/01/28- "Impact of Stroke"

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Therese Kalt - Jan 29, 2026, 8:33 PM CST

**Title:** "Impact of Stroke"

**Date:** 01/28/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To better understand the overall global impact of strokes.

**Search Term:** Global impacts of strokes

**Citation:** World Stroke Organization, "Impact of Stroke," *World Stroke Organization*, 2025. <https://www.world-stroke.org/world-stroke-day-campaign/about-stroke/impact-of-stroke>

**Link:** <https://www.world-stroke.org/world-stroke-day-campaign/about-stroke/impact-of-stroke>

**Content:**

- 12 million people a year suffer from strokes
  - About 6.5 million of these 12 million people die every year
- Over 100 million people in the world have experienced stroke during their life
- 60% of strokes happen to people age 70 or less and 16% of strokes happen to people age 50 or less
- 25% of adults over the age of 25 will have a stroke in their lifetime
- Most survivors live with disability or impairment after suffering a stroke
  - Causes practical, emotional, and financial challenges
- Common effects of stroke: pain, depression, changes in cognition, communication difficulties, spasticity

**Conclusions/action items:** Dives into criteria 4b as it describes the overall global impact associated with stroke. Continue researching global impacts of stroke treatment and potential design constraints.



## 2026/01/29- "Mass distribution and shape influence the perceived weight of objects"

Therese Kalt - Jan 29, 2026, 9:41 PM CST

**Title:** "Mass distribution and shape influence the perceived weight of objects"

**Date:** 01/29/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn more about how shape and mass distribution impact perceived weight to develop specifications for the final product.

**Search Term:** UW Library Articles: Objects feel heavier with greater length

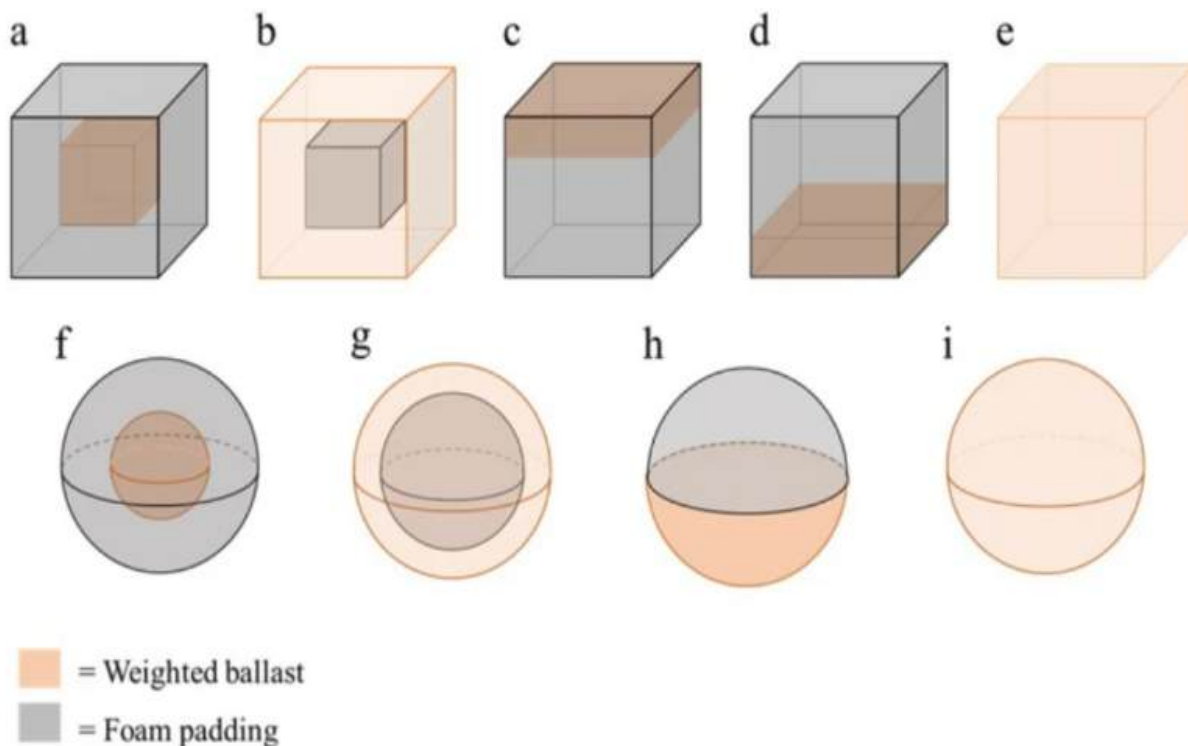
**Citation:** Harris and P. A. Chouinard, "Mass distribution and shape influence the perceived weight of objects," *Attention, Perception, & Psychophysics*, Sep. 2023, doi: <https://doi.org/10.3758/s13414-023-02780-8>.

**Link:** <https://link-springer-com.ezproxy.library.wisc.edu/article/10.3758/s13414-023-02780-8>

**Content:**

- "An interaction effect was found where the mass distribution and lifting approach both associated with the lowest rational dynamics made the stimulus appear lighter compared to other combinations"

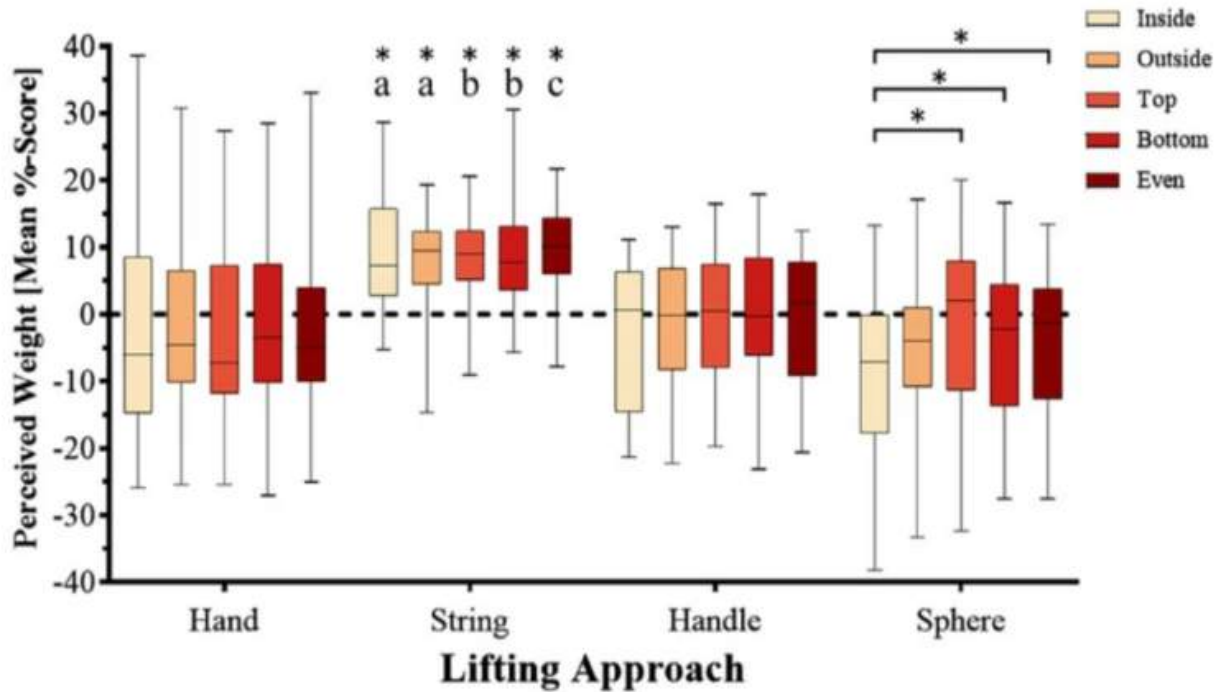
**Fig. 2**



- - Used different shapes and different mass distributions
- The objects were lifted with different techniques
  - One consisted of a pinching motion between the index finger and the thumb

- Another consisted of holding a string that was connected to the object
- The last allowed the participants to lift the object using their entire hand
- Objects with inside mass distributions were perceived as lighter compared to objects with even or bottom mass distributions
  - The handle of our design should have an inside mass distribution due to the long-term use by the client

Fig. 3



- Inside with handle is likely the best approach for our project due to the fact that the product would not be able fully be held in the hand and this gives the lowest perceived weight

**Conclusions/action items:** This demonstrates the 2b criteria of the rubric as it helps to develop specifications for the product design specification document. Continue research for other specifications that may be helpful when creating the product design specification document.



## 2026/01/29- "Advances in lightweight composite structures and manufacturing technologies: A comprehensive review"

Therese Kalt - Feb 04, 2026, 10:17 AM CST

**Title:** "Advances in lightweight composites structures and manufacturing technologies: A comprehensive review"

**Date:** 01/29/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To find materials that would support the length of our product without allowing the product to bend.

**Search Term:** Lightweight materials that can withstand bending at greater length

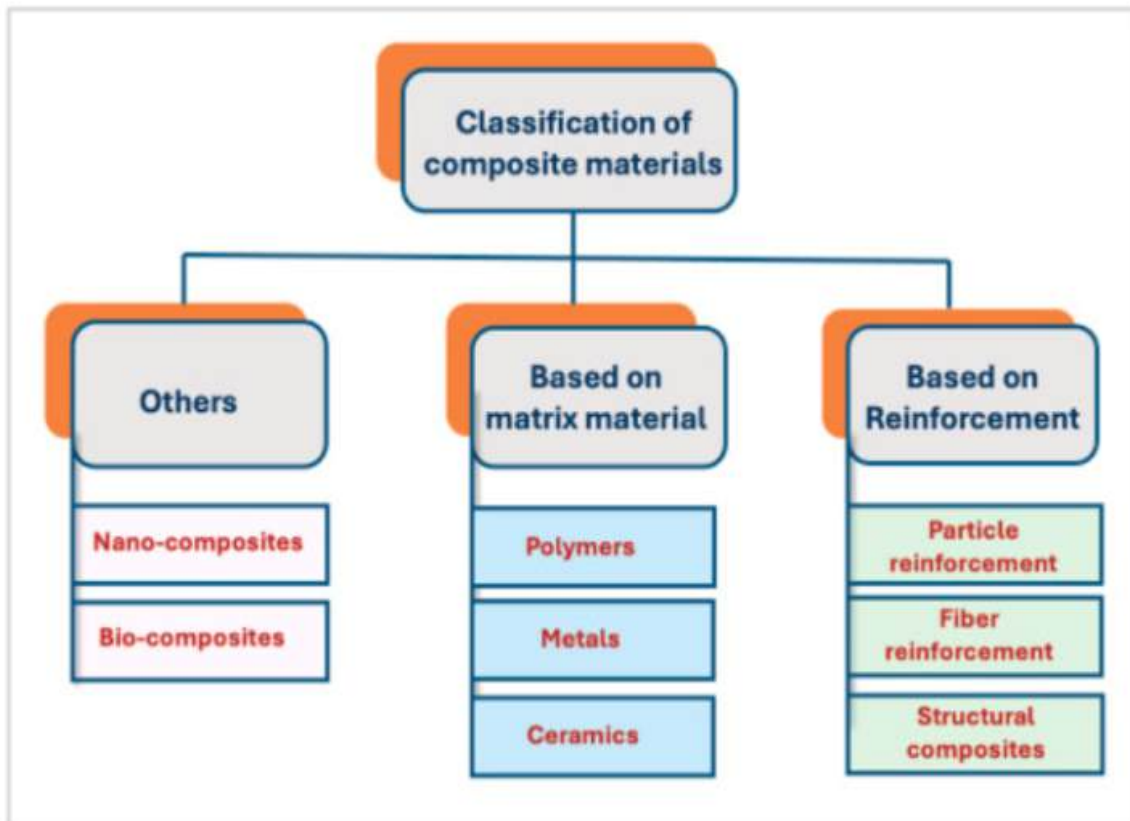
**Citation:** R. Phiri, S. Mavinkere Rangappa, S. Siengchin, O. P. Oladijo, and T. Ozbakkaloglu, "Advances in lightweight composite structures and manufacturing technologies: A comprehensive review," *Heliyon*, vol. 10, no. 21, p. e39661, Oct. 2024, doi: <https://doi.org/10.1016/j.heliyon.2024.e39661>.

**Link:** <https://www.sciencedirect.com/science/article/pii/S2405844024156927>

**Content:**

- Composite materials have distinct properties that differ from their individual components
- Classifications of composite materials:

◦



- Fiber reinforcement distributes the load among the fibers
- Structural composites
  - Combine homogenous and composite materials

- Designed to be lightweight but strong, something that we would need for our project
- The core of the material often consists of a low strength material; however, it helps the material to not bend due to the sandwich composite and density
- Core materials are often polyurethane, polyvinylchloride, polyethylene, or polystyrene
- Core also prevents buckling from transverse shear loads

**Conclusions/action items:** Connects with criteria 2b as it helps to develop criteria for the product design specification document regarding material choice. Continue researching for the product design specification document and meet with the client to further understand the design criteria for this product.



## 2026/02/04- "The Functional Reach Test: Strategies, performance and the influence of age"

Therese Kalt - Feb 06, 2026, 12:09 PM CST

**Title:** "The Functional Reach Test: Strategies, performance and the influence of age"

**Date:** 02/04/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn more about the functional reach test so that we can include it in our product design specification document and incorporate it into our design.

**Search Term:** PubMed: Functional reach test

**Citation:** "The Functional Reach Test: Strategies, performance and the influence of age," Annals of Physical and Rehabilitation Medicine, vol. 57, no. 6–7, pp. 452–464, Aug. 2014, doi: <https://doi.org/10.1016/j.rehab.2014.03.003>.

**Link:** <https://pubmed.ncbi.nlm.nih.gov/24928146/>

**Content:**

- Clinical assessment for the risk of falls
- Study involved 29 subjects called "non-fallers". They were asked to perform the functional reach test
  - Asked the individuals to complete different tasks, our client asks individuals to reach to a specific value on a ruler (usually around 10 inches)
  - They then measured the center of pressure

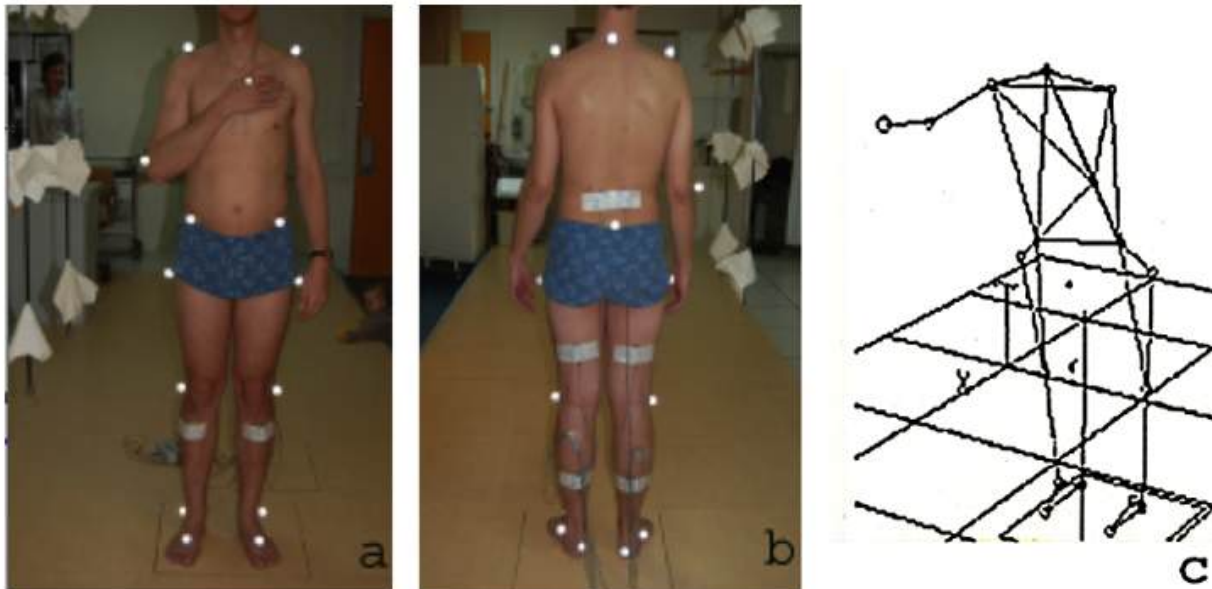


Fig. 1. The marker positions.

- ◦ Used markers to test center of pressure
- Found that the older individuals in the study had a smaller center of pressure path, indicating worse balance than the younger individuals in the study

**Conclusions/action items:** Include the functional reach test in the product design specification document and think about ways to include the ruler on our design.



## 2026/02/05- "Best Tent Poles and Material"

Therese Kalt - Feb 05, 2026, 4:14 PM CST

**Title:** "Best Tent Poles and Material"

**Date:** 02/05/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn more about lightweight materials that we could use to make our device.

**Search Term:** What material makes camping tent poles so light and strong

**Citation:** K. Froggatt, "Best Tent Poles & Material (Solved) - Wilderness Redefined," *wildernessredefined.com*, Jan. 04, 2022. <https://wildernessredefined.com/best-tent-pole-material/>

**Link:** <https://wildernessredefined.com/best-tent-pole-material/>

### Content:

- Best material for a tent pole is aluminum based on the durability, cost, and strength
  - Our budget is not concerned very much with cost so it may be helpful to find a more lightweight material that may be more expensive

Tent Pole Material	Weight	Strength	Price	Durability	Flexibility	Total
Aluminum Alloys	3/5	4/5	4/5	4/5	3/5	3.6/5 ★
Fiberglass	3/5	3/5	5/5 ★	3/5	3/5	3.4/5
Composite	5/5 ★	4/5	1/5	3/5	4/5	3.4/5
Steel Poles	1/5	5/5 ★	4/5	5/5 ★	1/5	3.2/5
Carbon Fiber	4/5	4/5	1/5	3/5	2/5	2.8/5
Air Beams	N/A part of the tent	3/5	2/5	3/5	5/5 ★	N/A

- Table created by a group of frequent campers
- Aluminum poles:
  - Some of the best strength-to-weight ratios
  - Bends and is flexible, may not be great in terms of our project
- Fiberglass poles:
  - Cheapest poles available
  - Strong
  - Need to be careful handling and is less durable, may not be great for our project since he has had issues with durability in the past
  - Prolonged use often results in a rough surface that can give the user splinters
- Carbon Fiber poles:
  - Strongest, most durable, and lightest

- Biggest drawback is cost, which likely is not an issue for this project due to the large budget
- Do not hold up in terms of flexibility, also not worrisome for this project since we do not want it to bend or be flexible
- Steel poles:
  - Strong, cheap, and rigid
  - Heavy, would not work for the project
- Composite poles:
  - Strong, light, flexible, and durable
  - Expensive
  - Very flexible, may not work for the project since we do not want the finished product to bend

**Conclusions/action items:** Look into if carbon fiber would be a suitable option for a material to use using the design criteria in the design matrix.



## 2026/02/19- "Spatial Neglect"

Therese Kalt - Feb 19, 2026, 10:11 PM CST

**Title:** "Spatial Neglect"

**Date:** 02/19/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn more about spatial neglect syndrome and how it affects stroke patients

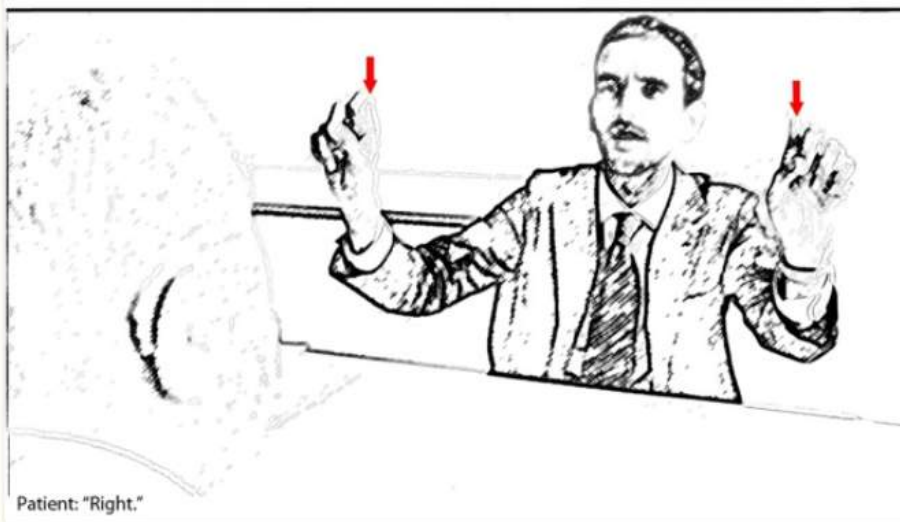
**Search Term:** PubMed: Spatial Neglect

**Citation:** K. Li and P. A. Malhotra, "Spatial Neglect," *Practical Neurology*, vol. 15, no. 5, pp. 333–339, May 2015, doi: <https://doi.org/10.1136/practneurol-2015-001115>.

**Link:** <https://pmc.ncbi.nlm.nih.gov/articles/PMC4602245/>

### Content:

- Spatial neglect is a common consequence of unilateral brain injury
  - Common with stroke and often results from damage to the right hemisphere
- Spatial neglect is defined as an "inability to perceive, report and orient to sensory events towards one side of space, contralateral to the side of the lesion, with or without a primary sensory deficit"
- Spatial neglect is related to the phenomenon of sensory extinction



- - Inability to say both to this situation due to damage to the brain
  - Often neglect the left side of the visual field
- Variety of related impairments associated with spatial neglect:

**Related impairments**

Anosognosia	Unawareness of a specific deficit. Patients may be unaware of neglect and also unaware of hemiplegia.
Somatoparaphrenia	A delusional belief relating to the contralesional limbs or side of the body, such that a patient does not believe that the limb/side belongs to them.
Allochiria	A patient responds to a stimulus to one side of the body as if it had been to the other side. It can also be present in drawings where items from the contralesional side are transposed to the ipsilesional side.
Constructional apraxia	The inability to draw or copy complex diagrams. This is often associated with right hemisphere damage and persists after rightward bias has resolved. It is not related to motor apraxia.

o

**Conclusions/action items:** Use this to better explain the background section of the preliminary presentation so that the audience better understands spatial neglect syndrome.



## 2026/02/19- "Visuomotor Training to Enhance Proprioception of Contralateral Wrist Based on the Cross-Transfer Effect"

Therese Kalt - Feb 19, 2026, 10:20 PM CST

**Title:** "Visuomotor Training to Enhance Proprioception of Contralateral Wrist Based on the Cross-Transfer Effect"

**Date:** 02/19/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To better understand the rehabilitation techniques that our client performs with his patients

**Search Term:** PubMed: "Visuomotor Training"

**Citation:** Y. Wang, L. Huang, Z. Wang, and T. Liu, "Visuomotor Training to Enhance Proprioception of Contralateral Wrist Based on the Cross-Transfer Effect," CNS Neuroscience & Therapeutics, vol. 31, no. 9, Sep. 2025, doi: <https://doi.org/10.1111/cns.70504>.

**Link:** <https://pubmed.ncbi.nlm.nih.gov/40931616/>

**Content:**

- Rehabilitation for patients with loss of proprioception
  - Very relevant for our project as stroke patients with spatial neglect syndrome suffer from lack of spatial awareness



- This training was proven to be effective
- Very similar to the training done by our client
- Helps patients improve skills like depth perception

**Conclusions/action items:** Use this in the background section of the preliminary presentation to explain the therapy that our client is doing with his patients.



## 2026/03/05- "3D Printer Filament Strength Chart: Understanding Strength, Toughness, and Print Behavior"

Therese Kalt - Mar 05, 2026, 9:37 PM CST

**Title:** "3D Printer Filament Strength Chart: Understanding, Strength, Toughness, and Print Behavior"

**Date:** 03/05/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn about durable filaments for 3D printing.

**Search Term:** 3D printer filaments durability and weight

**Citation:** B. O'Neill, "3D Printer Filament Strength Chart: Understanding Strength, Toughness, and Print Behavior," Wevolver, Dec. 22, 2025. <https://www.wevolver.com/article/3d-printer-filament-strength-chart-understanding-strength-toughness-and-print-behavior>

**Link:** <https://www.wevolver.com/article/3d-printer-filament-strength-chart-understanding-strength-toughness-and-print-behavior>

**Content:**

Tensile Strength (MPA):

PLA- 55-65

PLA tough- 50-60

ABS- 35-40

ASA- 40-50

PETG- 45-55

PET- 50-60

HIPS- 30-40

PP- 25-35

TPU- 30-40

TPE- 20-30

Nylon 6- 50-70

Nylon 66- 65-80

Nylon 12- 45-55

POM- 60-70

PMMA- 60-70

PC- 60-70

PPS- 70-90

PSU- 65-75

PEKK- 80-100

PEEK- 90-100

Slower printing results in higher durability

Composite Filament	Base Polymer	Reinforcement Type	Mechanical Effect	Printability Notes
PLA-CF	PLA	Chopped carbon fiber	Higher stiffness; reduced creep	More brittle; hardened nozzle recommended
PETG-CF	PETG	Chopped carbon fiber	Improved rigidity; better dimensional stability	Less stringing; abrasive
ABS-GF	ABS	Chopped glass fiber	Improved toughness and heat resistance	Enclosure required; abrasive
Nylon-CF	PA6 / PA12	Chopped carbon fiber	High stiffness-to-weight; reduced warp	Moisture sensitive; abrasive
Nylon-GF	PA6 / PA66	Chopped glass fiber	Improved impact resistance and stability	Higher extrusion temps; abrasive
PC-CF	Polycarbonate	Chopped carbon fiber	Very high stiffness and heat resistance	High temps; enclosure mandatory

**Conclusions/action items:** Continue to look for materials with high durability that are also lightweight to print the 3D modeling components of the device.



## 2026/01/27- Bioness Integrated Therapy System

Therese Kalt - Jan 27, 2026, 5:00 PM CST

**Title:** Bioness Integrated Therapy System

**Date:** 01/27/2026

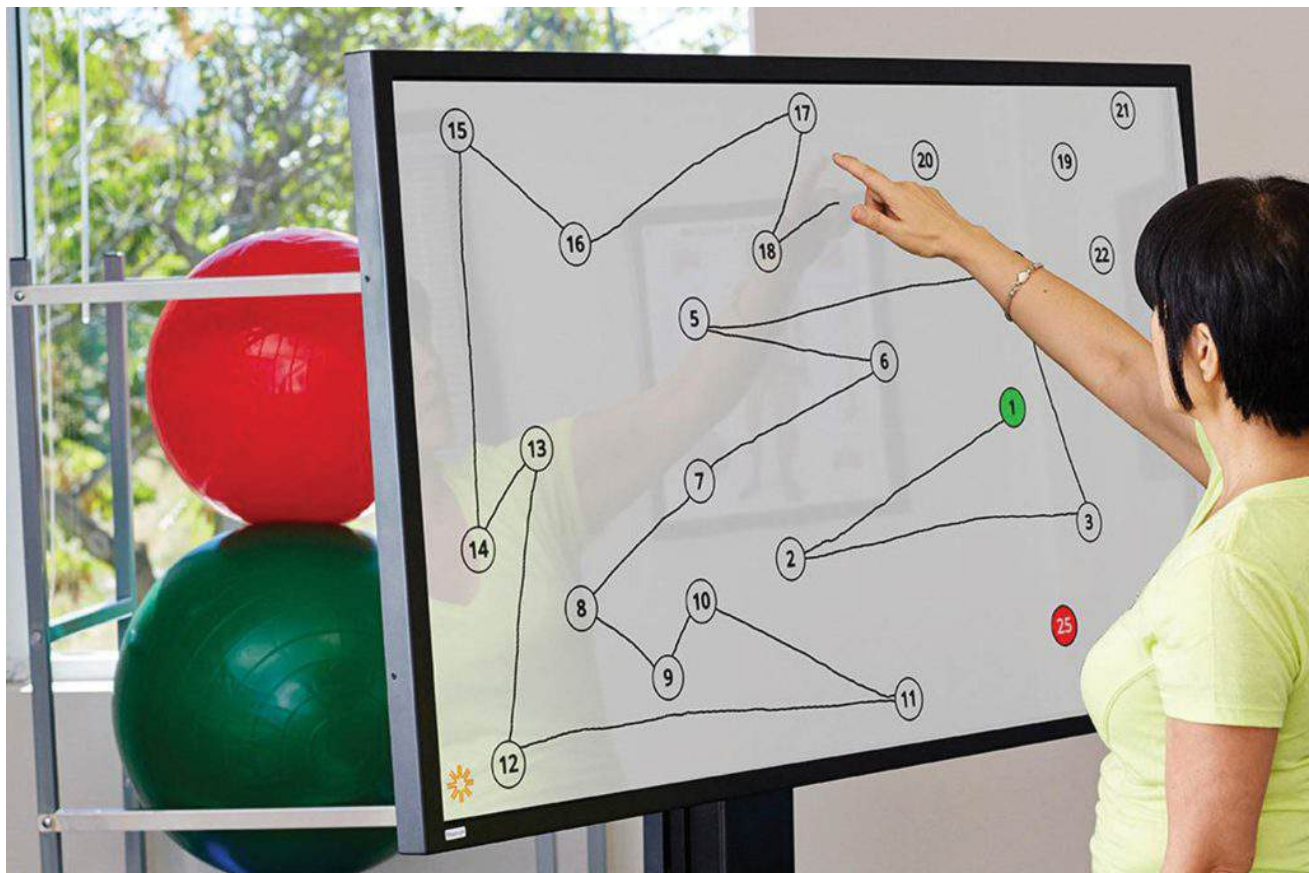
**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To research competing designs to see what is positive about them and understand where improvement could occur.

**Citation:** Northwestern Medicine, "The Bioness Integrated Therapy System (BITS®)," *Northwestern Medicine*, 2024. <https://www.nm.org/conditions-and-care-areas/treatments/bioness-integrated-therapy-system-bits>

**Content:**



- Used to improve cognitive training, hand-eye coordination, peripheral awareness, reaction time, and standing tolerance
- Very adjustable to the needs of the client
- Uses a touchscreen that has a variety of therapy programs
  - The therapist then has the opportunity to choose the program that suits the patient the best

**Conclusions/action items:** Share this at the next team meeting and see if there could be a way to integrate a touch screen into our design so that our design is more adjustable for each patient.





## 2026/02/11- Previous Design

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Therese Kalt - Feb 12, 2026, 2:14 PM CST

**Title:** Previous Design Idea

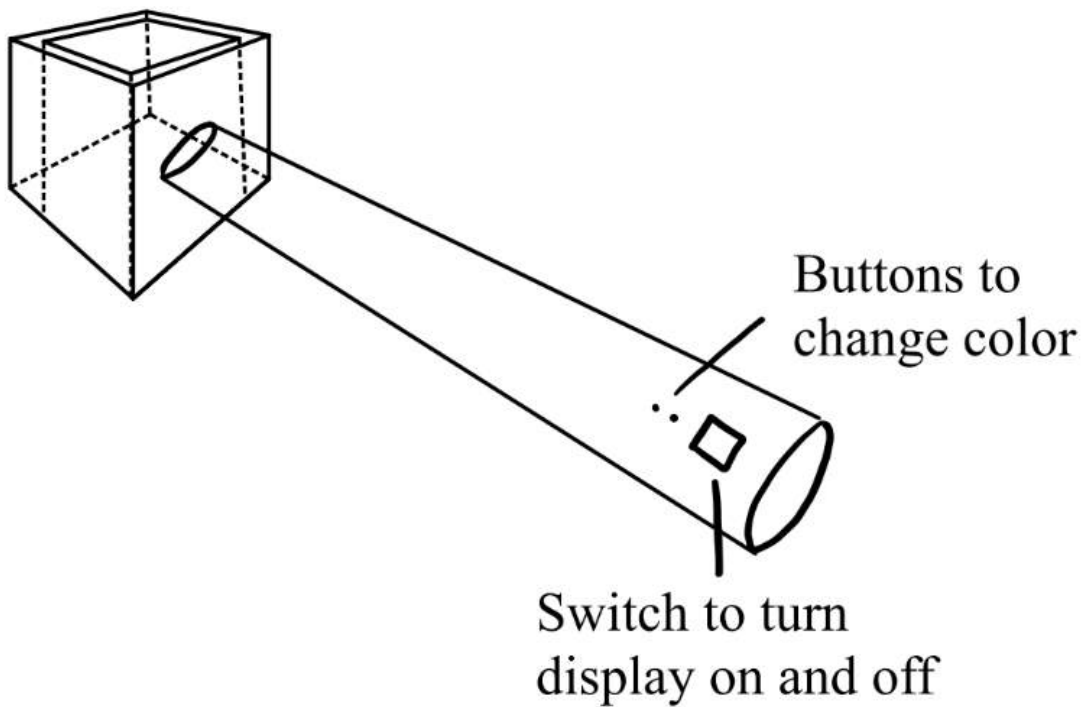
**Date:** 02/11/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To draw a sketch of the previous team's design to use for our design matrix.

**Content:**



**Conclusions/action items:** Use this design in the design matrix and rank it using the design criteria.



## 2026/02/12- Hands Free Board Design

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Therese Kalt - Feb 12, 2026, 2:13 PM CST

**Title:** Hands Free Board Design

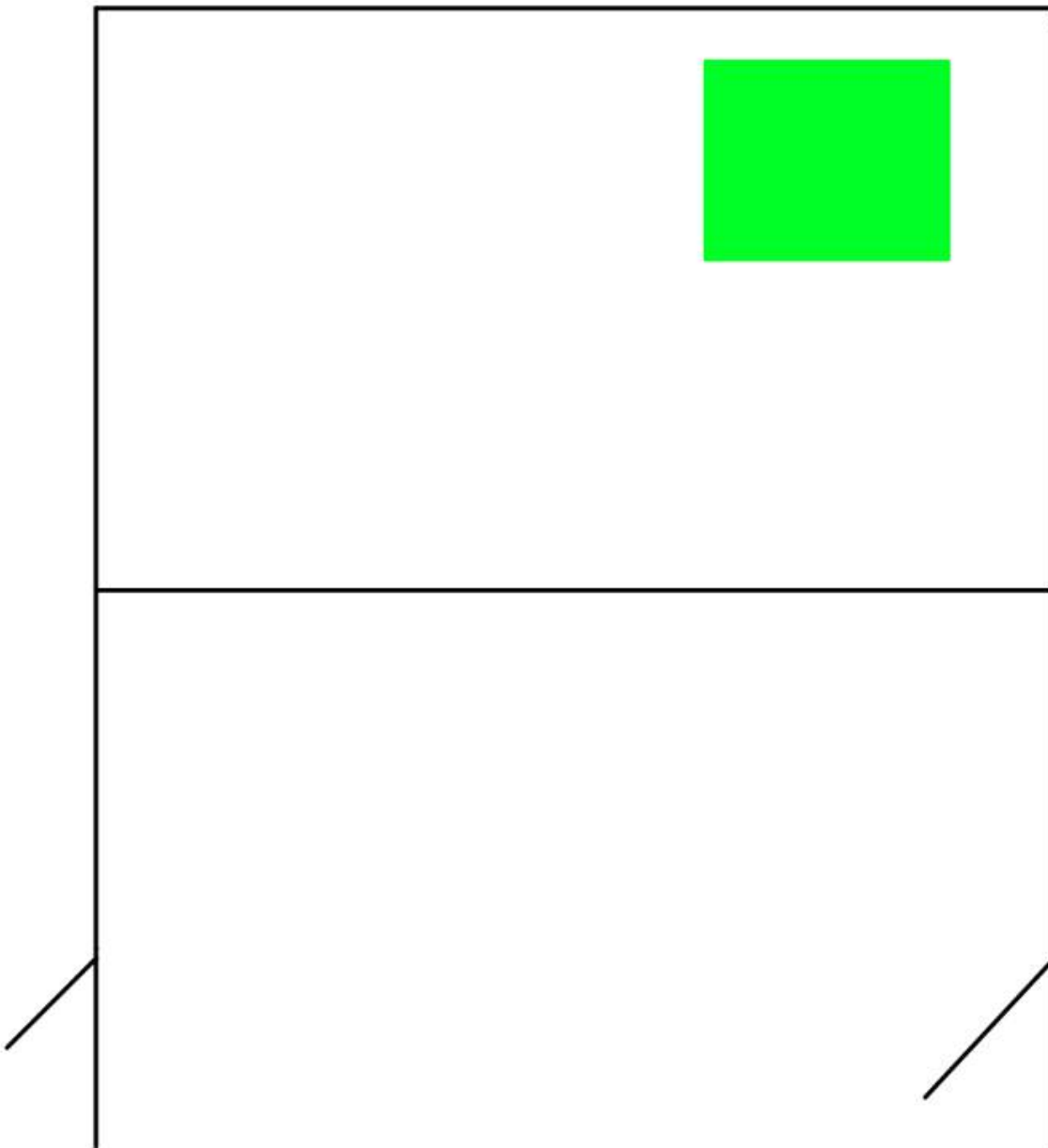
**Date:** 02/12/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To create another design that is different from previous designs for the design matrix.

**Content:**



**Conclusions/action items:** Rank this design using the criteria in the design matrix to decide if this would be a suitable design moving forward.



## 2026/02/22- SolidWorks Drawing of Proposed Final Design

Therese Kalt - Feb 24, 2026, 9:48 AM CST

**Title:** SolidWorks Drawing of Proposed Final Design

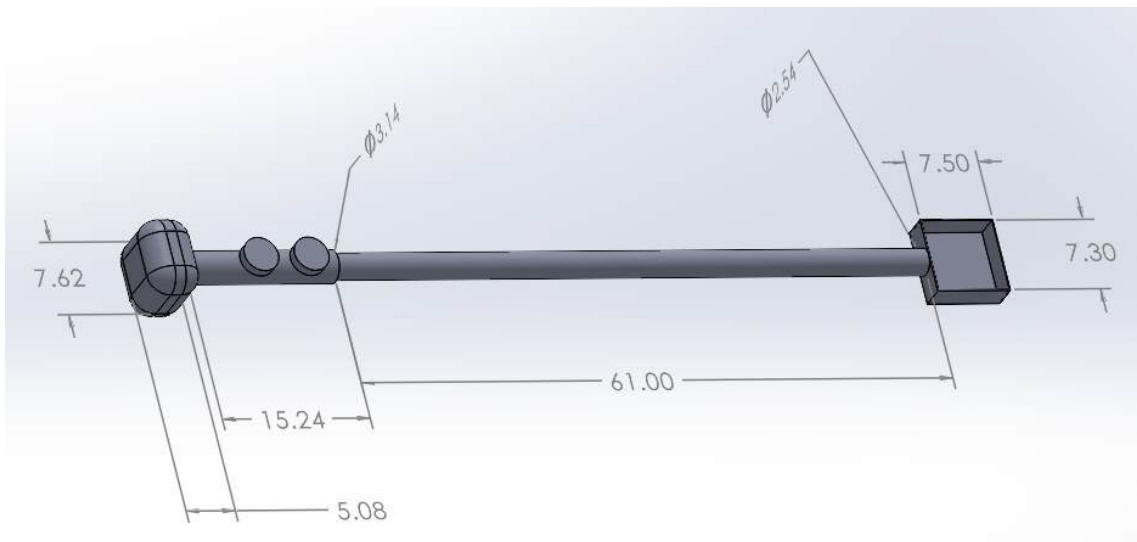
**Date:** 02/22/2026

**Content by:** Therese Kalt

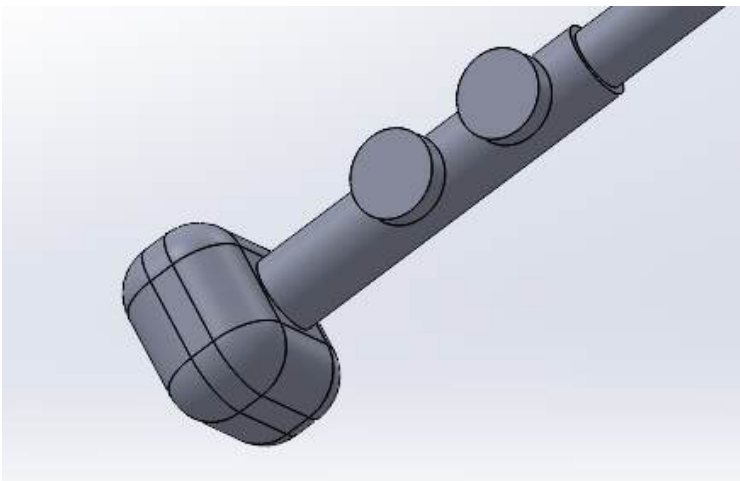
**Present:** N/A

**Goals:** To create a SolidWorks model of the proposed final design for the preliminary report.

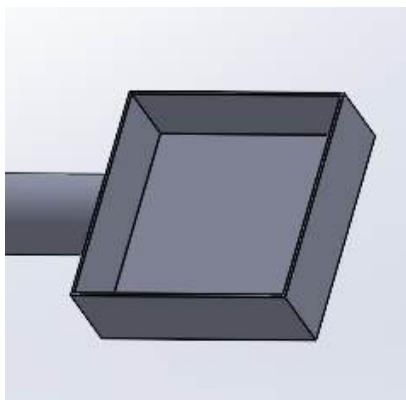
**Content:**



- Entire device with dimensions



- Handle with electronic box at the end, same size as previous teams but on the other end of the device
- 2 buttons indicate off/on button and changing colors button



- Display box
- Less thick than previous teams to be more lightweight because electronics will be near the handle instead

**Conclusions/action items:** Add these drawings to the preliminary report to clearly demonstrate what the proposed final design is.



## 2026/02/25- Universal Design in Our Project

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Therese Kalt - Feb 25, 2026, 2:00 PM CST

**Title:** Universal Design in Our Project

**Date:** 02/25/2026

**Content by:** Therese Kalt

**Present:** Whole team except Noor

**Goals:** To identify what parts of the design we are working on can be improved

**Content:**

- What component of the design can be improved?
  - Weight
  - Ergonomics of the handle
- Which of the 7 principles are you addressing
  - Low physical effort, can be accomplished by improving the ergonomics of the handle and reducing the effects of torque
  - Low tolerance for error, making the device lighter and more durable reduces the safety risk of the device breaking in use or dropping on the floor
  - Simple and intuitive use, implementing auditory feedback makes the device easier to use, it lets the patient know right away if they did the correct action or not
- How can you make these improvements?
  - Use a durable and lightweight material
  - Use a counterweight and distribute mass in a way that reduces the perceived weight of the device to improve ergonomics

**Conclusions/action items:** Continue working on the design with these improvements in mind to make a more ergonomic, safe, and intuitive final product.



## 2026/03/09- Updated SolidWorks Counterweight

Therese Kalt - Mar 09, 2026, 10:54 PM CDT

**Title:** Updated SolidWorks Counterweight

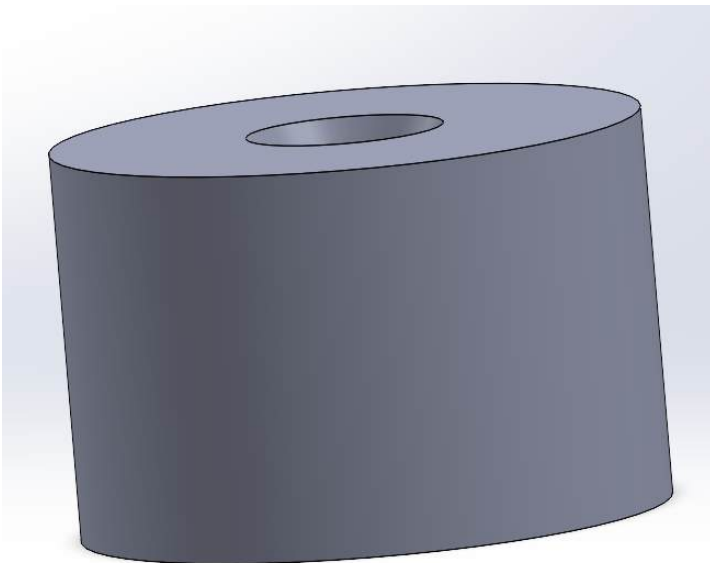
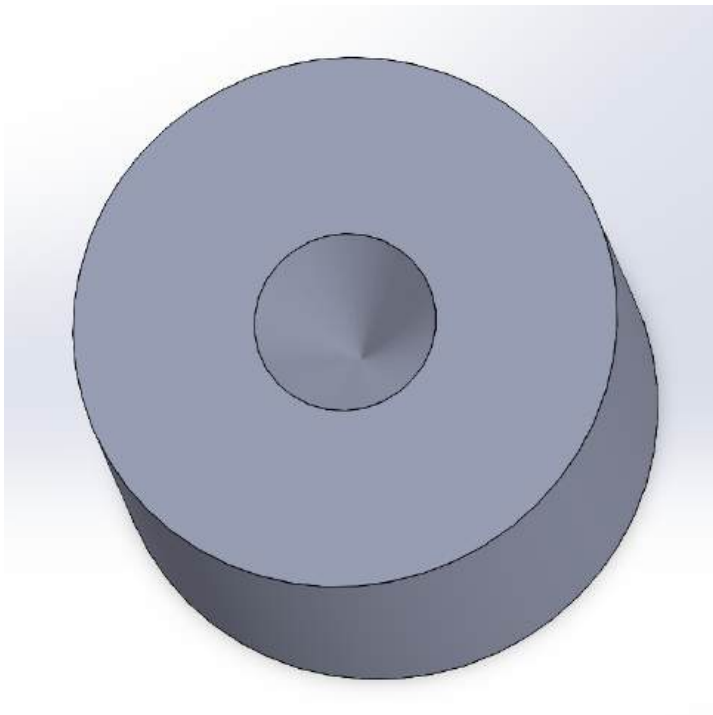
**Date:** 03/09/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To update the SolidWorks drawings so that they are able to be used for the final design.

**Content:**



Counterweight could be circular, might look more professional!

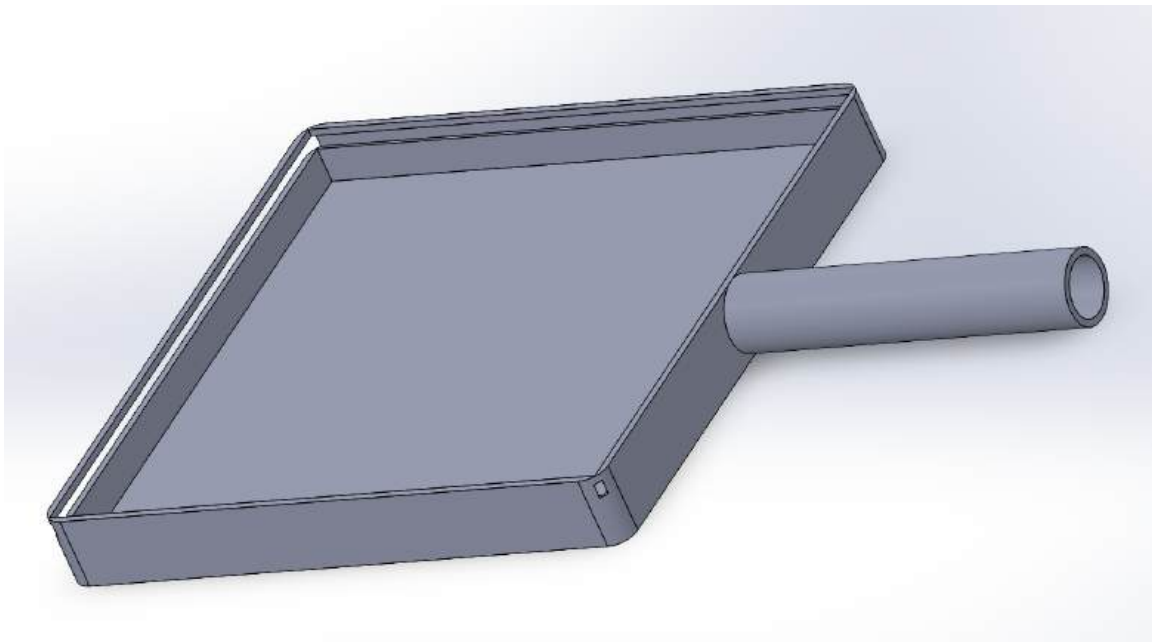
- Counterweight could be circular, might look more professional
- Opening for carbon fiber rod, friction fit

- Need to come up with a way for the client to comfortably hold it, maybe a handle?

**Conclusions/action items:** Continue working on the SolidWorks part for the final design.

 **2026/03/15- Updated Display SolidWorks**

Therese Kalt - Mar 15, 2026, 1:24 PM CDT

**Title:** Updated Display SolidWorks**Date:** 03/15/2026**Content by:** Therese Kalt**Present:** Kat**Goals:** To create an updated display portion of the design**Content:**

- Hollow cylinder with inner diameter matching outer diameter of the carbon fiber rod ordered
- Grooves to allow easier fabrication, acrylic cover will go here
- Fillets to ensure safety and no sharp edges

**Conclusions/action items:** Print out a model of this design to ensure that it will hold the display accurately and continue working on the other SolidWorks model.



## 2026/03/19- Diameter Updated for Display Design

Therese Kalt - Mar 19, 2026, 12:04 PM CDT

**Title:** Diameter Updated for Display Design

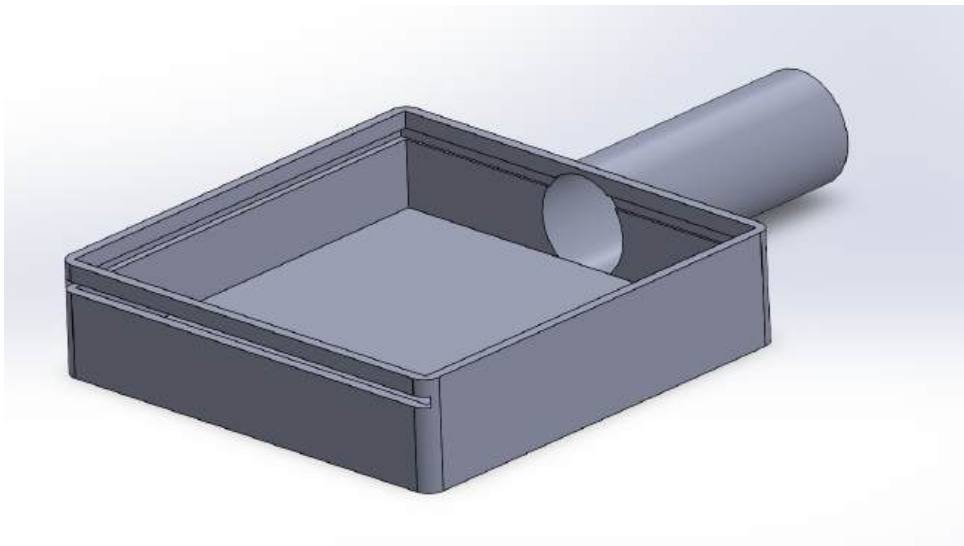
**Date:** 03/19/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To improve the display portion of the design to match the new carbon fiber rod.

**Content:**



- Updated diameter from 10mm to 20mm
- Increased the thickness so it is more durable and will allow the acrylic to easily slide in during fabrication
- Cut through the rod completely so the wires are able to attach to the rest of the device

**Conclusions/action items:** Continue working on the handle of the device so that it is comfortable to hold while also containing the circuitry.



## 2026/04/12- Final Display Portion of Design

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Therese Kalt - Apr 12, 2026, 7:39 PM CDT

**Title:** Final Display Portion of Design

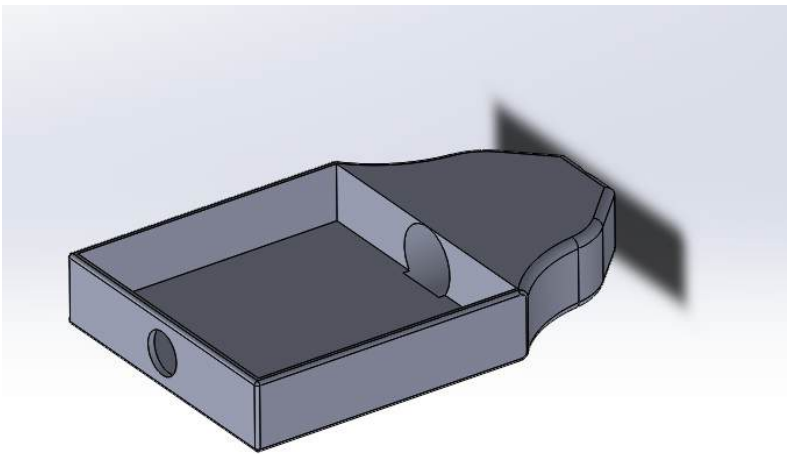
**Date:** 04/12/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To finalize the display portion of the design so that it can be printed and added to the design.

**Content:**



- Additional supports where the rod attaches to improve durability
- Hole for the speaker to ensure it is loud enough
- Updated dimensions to ensure the acrylic smoothly fits without additional fabrication

**Conclusions/action items:** Print out the display portion of the design so that it can be put on the rod.



## 2026/02/11- Design Criteria Ideas

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Therese Kalt - Feb 11, 2026, 8:28 PM CST

**Title:** Design Criteria Ideas

**Date:** 02/11/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To create criteria for the design matrix so that we can rank our preliminary designs using this criteria.

**Content:**

*Comfortability (20):*

Comfortability evaluates how easy it will be for the user to effectively use the final product. This includes how much the user's hand needs to extend to change the color of the light displayed at the end of the device and the grip used to hold the device for extended periods of time. This criteria is important because this design has previously lacked comfortability for the user.

*Ease of Fabrication (15):*

Ease of fabrication describes the complexity of the design and evaluates how complicated the design would be to fabricate. This includes any 3D printing, machining, and circuitry. This criteria is important in order to determine if the proposed design would be able to be fabricated during the timeframe for this project and with the given resource constraints. However, this criteria is not the most important as there is only one prototype being fabricated opposed to multiple that need to be easily replicated.

*Safety (10):*

Safety describes the potential risk of injury due to sharp edges, exposed circuitry, etc. in order to choose a design that reduces the risk of injury for the user. This criteria is weighted low as all of the design ideas will have the circuitry safely enclosed and include rounded edges in order to avoid harming the user.

*Cost (5):*

Cost evaluates the expense for fabricating each design. This criteria is weighted the lowest because all of the designs have a similar complexity and will easily remain in the budget provided. The overall cost will ultimately be determined by the material chosen which will be evaluated in the material matrix.

**Conclusions/action items:** Use this criteria to rank our 3 preliminary designs so that we can move forward with the best prototype for our client.

 **2026/02/12- Design Matrix Ranking**

Therese Kalt - Feb 12, 2026, 2:19 PM CST

**Title:** Design Matrix Ranking

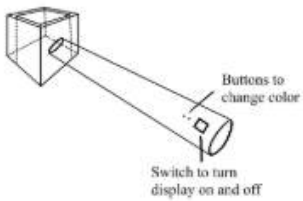

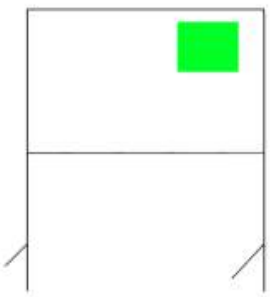
**Date:** 02/12/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To rank the 3 designs using the design matrix to decide on a final design to move forward with.

**Content:**

<i>Designs</i>		Design 1: Fixed Length Shaft		Design 2: Push Button Pin Shaft		Design 3: Hands Free Board	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (25)	4/5	20	4/5	20	5/5	20
2	Durability (25)	5/5	25	4/5	20	4/5	20
3	User Comfort (20)	4/5	16	4/5	16	3/5	12
4	Ease of Fabrication (15)	5/5	15	3/5	9	2/5	6
5	Safety (10)	5/5	10	4/5	8	4/5	8
6	Cost (5)	5/5	5	4/5	4	1/5	1
			81		77		67

**Conclusions/action items:** Continue with the fixed length shaft design and begin drafting a CAD model of this design for the preliminary report and presentation.





## 2026/02/12- Updated Design Criteria

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Therese Kalt - Feb 12, 2026, 2:26 PM CST

**Title:** Updated Design Criteria

**Date:** 02/12/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** Update the comfortability section of the design criteria so that it includes the user's comfortability to learn something new or change their previous ways of treating patients.

**Content:**

*User Comfort (20):*

User comfort evaluates how easy it will be for the user to effectively use the final product. This includes how much the user's hand needs to extend to change the color of the light displayed at the end of the device, the grip used to hold the device for extended periods of time, and the user's confidence with using the final product for therapy. This criteria is important because this design has previously lacked comfortability for the user.

**Conclusions/action items:** Add this to the design matrix and update rankings with this new definition for user comfort.



## 2026/02/23- Introduction Section of the Preliminary Report

Therese Kalt - Feb 23, 2026, 10:24 PM CST

**Title:** Introduction Section of the Preliminary Report

**Date:** 02/23/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To create the introduction section of the preliminary report to provide the reader with adequate information about the project.

**Content:**

### ***Introduction***

#### *A. Motivation*

Falls are the leading cause of injury-related death in adults aged 65+, attributed to decreases in balance and mobility that come with old age [x]. Stroke is a common disease that about 25% of adults over the age of 25 will experience during their life [x]. Among stroke survivors, about 30% of patients experience Spatial Neglect Syndrome or lose vestibular sense, leading to falls that set back their recoveries [x]. Spatial Neglect Syndrome is most commonly caused from hemispheric stroke and is more severe and persistent in acute cases caused by damage to the right hemisphere of the brain [x]. In these acute cases, about 50% of patients suffer from Spatial Neglect Syndrome. Spatial Neglect Syndrome severely impairs the patient's ability to understand spatial relationships such as depth perception and representation of space. Physical therapists have found successful therapies to retrain the brain to better understand these spatial relationships following stroke, however, existing devices are either too expensive or too heavy for practical use. The client for this project, Mr. Daniel Kutschera, saw a need to improve the complexity and ergonomics of devices used for Spatial Neglect Syndrome rehabilitation. The goal of this project is to create a device that implements both auditory feedback and color-coded visual feedback to these devices to aid in the rehabilitation of stroke patients suffering from Spatial Neglect Syndrome.

#### *B. Existing Devices*

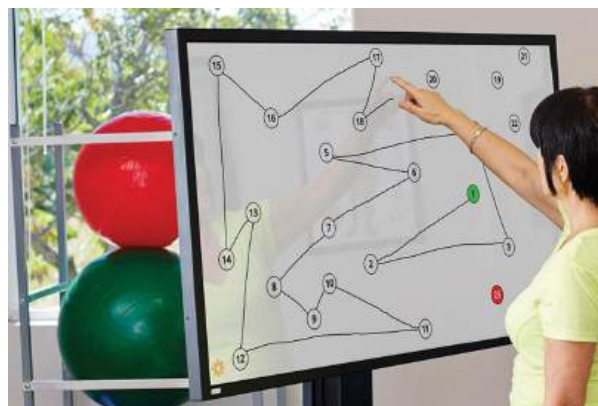


Figure 1: Bioness Integrated Therapy System [x]

The Bioness Integrated Therapy System (Figure 1) is an existing device used to improve cognitive training, hand-eye coordination, peripheral awareness, reaction time, and standing tolerance [x]. This device is a touch screen that has a variety of programs that are used to personalize the therapy to match where the patient is at in their recovery. It also allows for the physical therapist to use both of their hands to help support the patient. This device typically ranges from \$12,000 to \$22,000 depending on whether the therapist would like additional accessories or needs additional permits [x].

Previous BME design teams have developed devices to improve upon the client's current device, a yardstick with a sticky note at the end. These devices have implemented electronic components with changing colors and buttons to control the colors shown on the display screen. However, these devices have been too heavy for practical use and have not been durable enough to withstand the therapy that the client does.

### *C. Problem Statement*

Patients that have suffered strokes have a 30% rate of developing Spatial Neglect Syndrome [x]. Symptoms of Spatial Neglect Syndrome include loss of awareness of the body in space and impaired spatial relationships. Our client, Mr. Daniel Kutschera, a physical therapist, helps patients to regain strength and balance following a stroke. The client is currently using a yardstick with a sticky note at the end and asks patients to reach towards the sticky note to help rebuild spatial relationships in their brain. The client seeks to develop a device that can be used to improve visual scanning and balance training that is lightweight and more complex than his previous design. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

**Conclusions/action items:** Continue to edit the report so it is cohesive and begin working on the background section of the preliminary report.



## 2026/02/23- Background Section of Preliminary Report

Therese Kalt - Feb 23, 2026, 10:26 PM CST

**Title:** Background Section of the Preliminary Report

**Date:** 02/23/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To create the background section of the preliminary report to provide helpful information about research the team has completed, client information, and product design specifications.

**Content:**

### ***Background***

#### *A. Background Research*



Figure 2: Visuomotor Training [x]

Stroke patients are at an increased risk for developing Spatial Neglect Syndrome, resulting in a lack of understanding the representation of space and impaired spatial attention [x]. Specifically, about 30% of patients that have suffered from stroke experience Spatial Neglect Syndrome and patients that have had damage to the right hemisphere of the brain are at an even greater risk [x]. Spatial Neglect Syndrome often results in an increased risk for falling due to difficulty balancing that can significantly slow down the recovery process. Physical therapists use targeted therapies with patients suffering from Spatial Neglect Syndrome to improve spatial relationships. One of these therapies is called visuomotor training which involves the physical therapist asking the patient to reach towards an object to help the patient's brain relearn depth perception and spatial relationships [x]. This therapy typically lasts about 15 minutes per patient and is performed by the physical therapist 5-6 hours a day, 5 days a week. Due to the fact that the device needs to be held in an extended outward position by the physical therapist, strain is common due to the prolonged and repetitive use of these devices.

#### *B. Design Research*

In order to create a device that can be comfortably held for prolonged periods of time, it is necessary that the bulk of the electronics are distributed in a way that makes the perceived weight of the device less than or equal to the actual weight [x]. Therefore, the electronic components must be at the end of the device with the handle in order to reduce the effects of torque. To help stabilize the device, a counterweight will be added, likely the electronic components, to help stabilize the mechanism for the physical therapist. A counterweight works by providing an equal and opposite torque on one side of the device to balance the torque generated from the opposite side [x]. For the auditory component of the device, capacitive sensors are a helpful electronic device that can be

implemented to provide ease for both the client and patient. These sensors are activated by introducing stimuli close to them. The capacitive sensors vary in sensitivity which will make it so that the patient does not need to perfectly reach the desired length for the sensors to accurately activate.

### *C. Client Information*

Mr. Daniel Kutschera is a physical therapist for ThedaCare, an acute stroke clinic in Fitchburg, WI. His therapy specializes in stroke rehabilitation, specifically for patients suffering from Spatial Neglect Syndrome.

### *D. Design Specifications*

The device must meet specific requirements outlined by the client and follow the Product Design Specification outlines [see Appendix A]. The device must be 10% lighter than the previous design which weighed 0.36 kg and the electronic display at the end must be 7.5 cm<sup>2</sup>. The electronic display must have the ability to display various colors. The shaft of the device must be at least 61 cm long and include a measurement system that allows the client to perform a functional reach test with his patients to track their progress. The device must also be made using a material that can be frequently sanitized and durable. The total cost of the project must not exceed \$500.

**Conclusions/action items:** Continue to edit this section and other sections of the report so that they are all cohesive and accurately reflect the project at this point.



## 2026/04/21- Initial Edits of Introduction and Background for Final Report

Therese Kalt - Apr 27, 2026, 8:01 PM CDT

**Title:** Initial Edits of Introduction and Background for Final Report

**Date:** 04/21/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To complete and edit my sections for the final report.

**Content:**

### *A. Problem Statement*

Physical therapists rehabilitating stroke patients use devices to improve visual scanning and balance training. Current devices for stroke rehabilitation are either incredibly rudimentary, such as a yardstick with a sticky note at the end, bulky, or unaffordable. Our client, Mr. Daniel Kutschera, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that is lighter and more complex than his previous design, which weighed 0.36 kg. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

### *B. Motivation*

Falls are the leading cause of injury-related death in adults aged 65+, attributed to decreases in balance and mobility that come with old age [x]. Among stroke survivors, about 30% of patients experience Spatial Neglect Syndrome or lose vestibular sense, leading to falls that set back their recoveries [x]. Physical therapists have found successful therapies to retrain the brain to better understand these spatial relationships following stroke, however, these methods often involve using devices that may pose injury risks to therapists. The length of physical therapy devices can make them feel heavier and cause fatigue more quickly, even when the actual weight of the device is relatively low. Approximately 75% of physical therapists develop musculoskeletal disorders during their careers [x]. Two previous BME design teams have worked on this project and have had success creating lightweight devices, however, they have lacked durability and are still perceived as heavy. Complex devices for stroke rehabilitation typically cost between \$12,000-\$22,000, making them inaccessible to many physical therapists [x]. The client for this project, Mr. Daniel Kutschera, saw a need to improve the complexity and ergonomics of devices used for Spatial Neglect Syndrome rehabilitation. The goal of this project is to create a device that implements both auditory feedback and color-coded visual feedback to these devices to aid in the rehabilitation of stroke patients suffering from Spatial Neglect Syndrome.

### *C. Existing Devices*

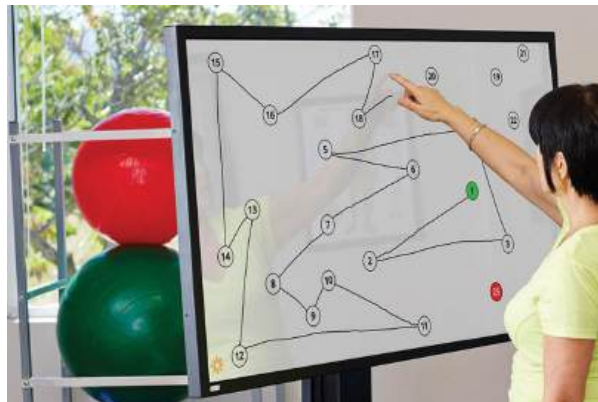


Figure X: Bioness Integrated Therapy System [x]

The Bioness Integrated Therapy System (Figure X) is an existing device used to improve cognitive training, hand-eye coordination, peripheral awareness, reaction time, and standing tolerance [x]. This device is a touch screen that has a variety of programs that are used to personalize the therapy to match where the patient is at in their recovery. It also allows for the physical therapist to use both of their hands to help support the patient. This device typically ranges from \$12,000 to \$22,000 depending on whether the therapist would like additional accessories or needs additional permits [x].

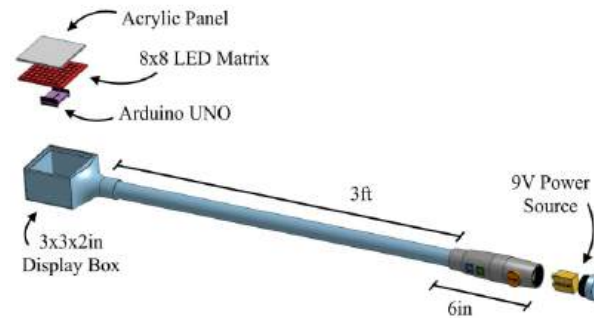


Figure X: Previous design from Fall 2024 created by another BME design team [x].

Previous BME design teams have developed devices to improve upon the client's current device, a yardstick with a sticky note at the end. These devices (Figure X) have implemented electronic components with changing colors and buttons to control the colors shown on the display screen. However, these devices have been too heavy for practical use and have not been durable enough to withstand the therapy that the client does.

- Motivation/Global and/or societal impact. Why is your device necessary? What are the demographics and context of the problem/unmet need? This should go beyond the needs of the client – use the literature to support the need. What your client wants may not be the best solution to the problem\*
- Existing devices/Current Methods (include patents and products on the market)\*
- Problem Statement (Focus on the problem, not on the client except under special circumstances)
- \*\*\*Must cite sources--the bulk of your introduction should be well cited \*\*\*

## Background

### A. Background Research



## Figure 2: Visuomotor Training [x]

Stroke patients are at an increased risk for developing Spatial Neglect Syndrome, resulting in a lack of understanding the representation of space and impaired spatial attention [x]. Specifically, about 30% of patients that have suffered from stroke experience Spatial Neglect Syndrome and patients that have had damage to the right hemisphere of the brain are at an even greater risk [x]. Spatial Neglect Syndrome often results in an increased risk for falling due to difficulty balancing that can significantly slow down the recovery process.

Physical therapists use targeted therapies with patients suffering from Spatial Neglect Syndrome to improve spatial relationships. One of these therapies is called visuomotor training which involves the physical therapist asking the patient to reach towards an object to help the patient's brain relearn depth perception and spatial relationships [x]. This therapy typically lasts about 15 minutes per patient and is performed by the physical therapist 5-6 hours a day, 5 days a week. Due to the fact that the device needs to be held in an extended outward position by the physical therapist, strain is common due to the prolonged and repetitive use of these devices.

### *B. Design Research*

### *C. Client Information*

Mr. Daniel Kutschera is a physical therapist for ThedaCare, an acute stroke clinic in Fitchburg, WI. His therapy specializes in stroke rehabilitation, specifically for patients suffering from Spatial Neglect Syndrome.

### *D. Design Specifications*

The device must meet specific requirements outlined by the client and follow the Product Design Specification outlines (see Appendix X). The device must be 10% lighter than the previous design which weighed 0.36 kg and the electronic display at the end must be 7.5 cm across or 56.25 cm<sup>2</sup> to ensure that it is large enough for the patient to see it. The electronic display must have the ability to display red and blue with two different settings. The first setting must switch between red and blue, where red indicates the patient reaching toward the device with their right hand and blue indicates reaching toward the device with their left hand. The second setting must switch between these colors randomly so that . The shaft of the device must be at least 61 cm long as this provides a challenge for the patient to reach to the end of the device without being too long. The shaft of the device must also include a measurement system that allows the client to perform a functional reach test with his patients to track their progress. The device must also be made using a material that can be frequently sanitized and durable. The total cost of the project must not exceed \$500.

- Still need to update the design specification section and background based on feedback in the preliminary report
- Motivation and problem statement have been updated to be more focused toward our client.

**Conclusions/action items:** Finish the design specification and background section of the final report.



## 2026/04/28- Final Edits of Introduction and and Background Section of Final Report

Therese Kalt - Apr 28, 2026, 1:23 PM CDT

**Title:** Final Edits of Introduction and Background Section of Final Report

**Date:** 04/28/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To finish my sections of the final report.

**Content:**

### *A. Problem Statement*

Physical therapists rehabilitating stroke patients use devices to improve visual scanning and balance training. Current devices for stroke rehabilitation are either incredibly rudimentary, such as a yardstick with a sticky note at the end, bulky, or unaffordable. Our client, Mr. Daniel Kutschera, a physical therapist, helps patients to regain strength and balance following a stroke. The client seeks to develop a device that is lighter and more complex than his previous design, which weighed 0.36 kg. The device should be multi-functional so as to help patients with varying degrees of need and be effective in the rehabilitation treatment.

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Falls are the leading cause of injury-related death in adults aged 65+, attributed to decreases in balance and mobility that come with old age [x]. Among stroke survivors, about 30% of patients experience Spatial Neglect Syndrome or lose vestibular sense, leading to falls that set back their recoveries [x]. Physical therapists have found successful therapies to retrain the brain to better understand these spatial relationships following stroke, however, these methods often involve using devices that may pose injury risks to therapists. The length of physical therapy devices can make them feel heavier and cause fatigue more quickly, even when the actual weight of the device is relatively low. Approximately 75% of physical therapists develop musculoskeletal disorders during their careers [x]. Two previous BME design teams have worked on this project and have had success creating lightweight devices, however, they have lacked durability and are still perceived as heavy. Complex devices for stroke rehabilitation typically cost between \$12,000-\$22,000, making them inaccessible to many physical therapists [x]. The client for this project, Mr. Daniel Kutschera, saw a need to improve the complexity and ergonomics of devices used for Spatial Neglect Syndrome rehabilitation. The goal of this project is to create a device that implements both auditory feedback and color-coded visual feedback to these devices to aid in the rehabilitation of stroke patients suffering from Spatial Neglect Syndrome.

### *C. Existing Devices*

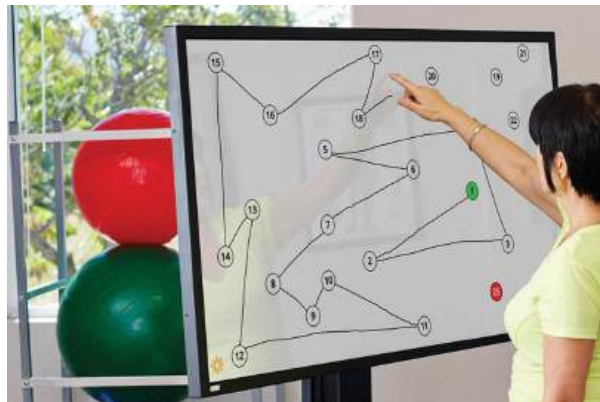


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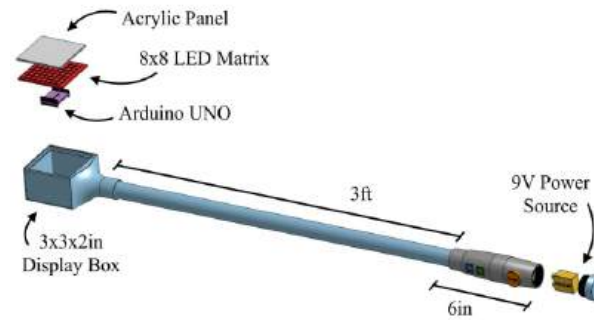


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## Background

### A. Background Research



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Stroke patients are at an increased risk for developing Spatial Neglect Syndrome, resulting in a lack of understanding the representation of space and impaired spatial attention [x]. Specifically, about 30% of patients that have suffered from stroke experience Spatial Neglect Syndrome and patients that have had damage to the right hemisphere of the brain are at an even greater risk [x]. Spatial Neglect Syndrome often results in an increased risk for falling due to difficulty balancing that can significantly slow down the recovery process.

Physical therapists use targeted therapies with patients suffering from Spatial Neglect Syndrome to improve spatial relationships. One of these therapies is called visuomotor training which involves the physical therapist asking the patient to reach towards an object to help the patient's brain relearn depth perception and spatial relationships [x]. This therapy typically lasts about 15 minutes per patient and is performed by the physical therapist 5-6 hours a day, 5 days a week. Due to the fact that the device needs to be held in an extended outward position by the physical therapist, strain is common due to the prolonged and repetitive use of these devices.

### *B. Design Research*

In order to create a device that can be comfortably held for prolonged periods of time, it is necessary that the bulk of the electronics are distributed in a way that makes the perceived weight of the device less than or equal to the actual weight [x]. Therefore, the electronic components must be at the end of the device with the handle in order to reduce the effects of torque. To help stabilize the device, a counterweight will be added, likely the electronic components, to help stabilize the mechanism for the physical therapist. A counterweight works by providing an equal and opposite torque on one side of the device to balance the torque generated from the opposite side [x].

Auditory and visual feedback provide clear, real-time feedback to confirm that the patient has successfully completed the task properly. Capacitive sensors are a helpful electronic device that can be implemented to provide ease for both the client and patient. These sensors are activated by introducing stimuli close to them. The capacitive sensors vary in sensitivity which will make it so that the patient does not need to perfectly reach the desired length for the sensors to accurately activate. These sensors would then be used to either trigger a speaker or visual component to successfully provide feedback.

### *C. Client Information*

Mr. Daniel Kutschera is a physical therapist for ThedaCare, an acute stroke clinic in Fitchburg, WI. His therapy specializes in stroke rehabilitation, specifically for patients suffering from Spatial Neglect Syndrome.

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**Conclusions/action items:** Help other team members finish their section of the final report by Wednesday.



## 2026/03/11- Biosafety Required Training and Chemical Safety Training

Therese Kalt - Mar 12, 2026, 7:40 PM CDT

**Title:** Biosafety Required Training and Chemical Safety Training

**Date:** 03/11/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn more about safe practices to use in the lab

**Content:**

Certificate of completion:



This certifies that Therese Kalt has completed training for the following course(s):

[Expand All](#) [Collapse All](#)

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	2/2/2025	2/2/2030
Chemical Safety: The OSHA Lab Standard	Final Quiz	2/2/2025	

Data Last Imported: 02/08/2025 12:45 PM

**Conclusions/action items:** Use what I learned during these two trainings to ensure that I am practicing safe procedures in the lab for the future.



## 2026/03/11- Intro to Machining Training

Therese Kalt - Mar 12, 2026, 7:40 PM CDT

**Title:** Intro to Machining Training

**Date:** 03/11/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn how to use the lathe and mill in the machine shop

**Content:**

Certificate of completion:


The screenshot shows the Design Innovation Lab user interface. At the top left is the logo with the text "Design Innovation Lab" and "Fostering hands-on, interdisciplinary design". A search bar contains "Search Programs". On the right are icons for a shopping cart, a bell, and the user profile "TKALT".

The user profile section for "Therese Kalt" includes a profile picture, ID Number: 908526899, Eligibility: CoE Students, and a navigation menu with options: Profile, Program Registrations, Bookings, Memberships (highlighted), and Orders.

The "My Memberships" table is as follows:

Membership Type	Start Date	Expiry Date	Renew	Card Info
Machining	Tue, Aug 20 2024	Permanent	Not Renewable	N/A
Laser Cutter	Wed, May 17 2023	Wed, Jan 1 3000	Not Renewable	N/A
Shop Tools	Thu, May 11 2023	Wed, Jan 1 3000	Not Renewable	N/A
Lab Orientation	Sun, Jan 1 2023	Tue, Dec 30 3000	Not Renewable	N/A

**Conclusions/action items:** Use what I learned during the machining training for projects in the future that require machining.

 **2026/03/11- CITI Training**

Therese Kalt - Mar 12, 2026, 7:41 PM CDT

**Title:** CITI Training**Date:** 03/11/2026**Content by:** Therese Kalt**Present:** N/A**Goals:** Show completion of CITI training**Content:**

See pdf attached below.

**Conclusions/action items:** Complete assignment in Canvas showing completion of training.

Therese Kalt - Oct 16, 2025, 11:14 PM CDT

[Download](#)


CITI\_Completion\_Certificate.pdf (65.3 kB)

**2026/03/12- HIPAA Training**

Therese Kalt - Mar 12, 2026, 7:42 PM CDT

**Title:** HIPAA Training**Date:** 03/12/2026**Content by:** Therese Kalt**Present:** N/A**Goals:** To complete a new training for this semester.**Content:**

**OVCR Training Information Lookup Tool**
**University of Wisconsin-Madison**


WISCONSIN  
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Therese Kalt has completed training for the following course(s):

Expand All
Collapse All

Course	Assignment	Completion	Expiration
2025-2026 HIPAA Privacy & Security Training	2025-2026 HIPAA Privacy & Security Training	3/11/2026	
Biosafety Required Training	Biosafety Required Training Quiz 2024	2/2/2025	2/2/2030
Chemical Safety: The OSHA Lab Standard	Final Quiz	2/2/2025	
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	10/17/2025	10/17/2028

Data Last Imported: 03/12/2026 09:55 AM

**Conclusions/action items:** Continue completing trainings in future semesters to further develop my professional skills.



## 2026/01/28- Lecture 1

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Therese Kalt - Jan 28, 2026, 1:53 PM CST

**Title:** Lecture 1: Library Session

**Date:** 01/28/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn about resources available through the library and understand how to use citation managers.

**Content:**

- AI chatbots as research tools
  - Are predictive text generators, not search engines
  - Do not evaluate for accuracy, bias, or credibility
  - Can generate factually incorrect statements and make up sources
  - Do not respond to prompts consistently
  - Are trained on undisclosed data
- Evaluating your sources
  - Relevance, authority, quality, currency
- Citation managers
  - Zotero is a helpful citation generator to become familiar with
- Technical reports
  - Technical reports publish the results of scientific or technical research, often using federal funds. The research is performed and reports are produced by companies, universities, and government laboratories
  - Find information on technical reports in the libraries technical reports research guide
  - Some recommend databases include:
    - DTIC
    - NTRL
    - OSTL

**Conclusions/action items:** Use this information to help find four primary sources by tomorrow for research.



## 2026/02/11- Lecture 4

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Therese Kalt - Feb 11, 2026, 1:40 PM CST

**Title:** Lecture 4- Presentation Tips and Job Interviews

**Date:** 02/11/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To learn more about how to present and interview well.

**Content:**

Presentations:

- Layout and content:
  - Bullets
    - Top left bullet should line up for all slides
    - Never have a single hanging bullet
  - Fonts
  - Organization- use a logical flow
  - Use your content- do not use pictures that you will not discuss
- Keep your audience interested
  - So what? Use your project's impact to stimulate interest
  - Attitude: Don't talk down to your audience
  - Presence: It is your topic, be excited!
  - Mannerisms: Talk to your audience
- Figure captions
  - For images: Figure X, what it is, citation if not your own
  - For graphs: Figure X, what is measured, data represented
  - For comparison plots: Figure X, comparison of variable across conditions demonstrating a specific result
- Graphics- CAD
  - Use one or two 3D models
- Graphics- sketches
  - Remove background, clean lines, labels and scale required
- Results- pointers
  - Graph it! NEVER raw data
  - Appropriate font sizes
- Results-USE THIS- Good example
  - Legible fonts, font sizes, clear legend, detailed caption, statistics
- Effective storytelling through figures
  - Show how the design works
    - Exploded view
    - Block diagram

Interviewing:

- Bring a small portfolio
- How to stand out among other BMEs: Be specific/Personal
- Be prepared to answer common questions with specific answers
- Ask thoughtful questions that demonstrate you researched them
- Reference specific products and/or company policies

**Conclusions/action items:** Use this information as we begin drafting our preliminary presentation for next week and for interviewing in the future.



## 2026/02/18- Lecture 5

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Therese Kalt - Feb 18, 2026, 1:51 PM CST

**Title:** Lecture 5: Presentation peer review

**Date:** 02/18/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To get feedback about our preliminary presentation before we present on Friday.

**Content:**

- Preliminary report due Wednesday
- Preliminary presentation needs to be on the website and canvas by 10am
- Paper and self-evaluation due next Wednesday
- Peer review instructions
  - Be professional
  - Utilize the resources
  - Find another team
    - Pair up
    - Introduce yourself and get to know each other briefly
    - Trade slides
    - Take a picture of the annotations you make-upload to Canvas

**Conclusions/action items:** Update the slides based on the feedback received so that the team is ready to present on Friday.



## 2026/02/25- Lecture 6

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Therese Kalt - Feb 25, 2026, 1:49 PM CST

**Title:** Lecture 6 - Diversity and Inclusion in Design

**Date:** 02/25/2026

**Content by:** Therese Kalt

**Present:** BME 301

**Goals:** To understand what diversity and inclusion means in design

**Content:**

- What does diversity mean in engineering design?
  - Having different ideas
  - Asking questions
  - Accounting for multiple groups of people
  - Taking into consideration people's cultural and religious beliefs
- What does universal design mean?
  - Making a design for a wide range of people
  - "One size fits most"
  - Fits a variety of different people based on age, religion, race, sex
  - Usable in all countries
  - Accessible in low income and high-income areas
  - Not limited by demographic
  - Intuitive so people don't have to have a lot of background knowledge to use it
  - Textbook definition: "Universal design is design that's usable by all people, to the greatest extent possible, without the need for adaptation or specialized design"
- 7 Principles of Universal Design:
  - Equitable Use: the design is useful and marketable to people with diverse abilities
  - Flexibility in Use: the design accommodates a wide range of individual preferences and abilities
  - Simple and Intuitive: use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level
  - Perceptible Information: the design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities
  - Tolerance for Error: the design minimizes hazard and the adverse consequences of accidental or unintended actions
  - Low Physical Effort: the design can be used efficiently and comfortably and with a minimum of fatigue
  - Size and Space for Approach and Use: appropriate size and space is provided for use
- Does this relate to ethics? How?
  - It is not ethical to make a design that only one group of people can use
- Biomedical Engineering Code of Ethics

**Conclusions/action items:** Use this to make designs more diverse and inclusive in the future.





## 2026/03/04- Lecture 7

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Therese Kalt - Mar 04, 2026, 1:56 PM CST

**Title:** Lecture 7- Library Session 2: Patents, Standards, and Other Resources for Design

**Date:** 03/04/2026

**Content by:** Therese Kalt

**Present:** BME 301

**Goals:** To learn more about resources available to us through the school library.

**Content:**

- Market/industry sources
  - Find information on companies, industries, consumer trends, with business databases
  - Library research guides to help you get started with these databases
    - Company research
    - Industry research
    - Market research
  - Specific recommendations:
    - Data Axle Reference Solutions
    - IBISWorld Industry Reports
    - ProQuest One Business
- Patents and Prior Art
  - Patent examiners evaluate applications against prior art
    - Inventions Disclosed in U.S. and Foreign Patents and Patent Applications
    - Inventions Disclosed in Publications
    - Inventions Currently for Sale or in Public Use
  - Evaluation
    - Patent examiners evaluate for usefulness, novelty, and non-obviousness
    - Claims
      - Define legally enforceable aspects of patent
      - Every utility patent has at least one claim
      - Each claim is a single sentence
      - Independent: standalone

**Conclusions/action items:** Use this information moving forward as we continue the design process to use other patents to help guide us and ensure our design does not infringe upon any existing patents.



## 2026/03/06- Tong Lecture

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Therese Kalt - Mar 06, 2026, 4:47 PM CST

**Title:** Tong Lecture- From Imagination to Implantation: Turning Science Fiction Into Brain Technologies

**Date:** 03/06/2026

**Content by:** Therese Kalt

**Present:** All

**Goals:** To learn more about how biomedical engineers have created a successful future for themselves.

**Content:**

- Created many businesses, many of them were unsuccessful at the start
- Found the need for a device but realized it was not going to be profitable, adjusted the device to fit a greater need
- Made connections, put in a lot of time and effort

**Conclusions/action items:** Be inspired as I begin my career as a biomedical engineer to push myself to be successful.



## 2026/03/11- Lecture 8

Therese Kalt - Mar 11, 2026, 1:55 PM CDT

**Title:** Lecture 8- Protocol Development

**Date:** 03/11/2026

**Content by:** Therese Kalt

**Present:** BME 300

**Goals:** To learn more about testing and fabrication protocols in order to make them detailed enough so that people can understand without having done it themselves.

**Content:**

- Fail fast and fail forward
  - Perfection is not important
    - Low fidelity-cardboard
    - Start early!
    - Test individual pieces
  - Documentation still required!
  - Check out the 1080 ECB closet
- Preliminary Testing/Analysis
  - Low fidelity prototyping
  - Circuit diagrams and circuit testing
  - Fittings (connection points)
  - Simple calculations
  - Free body diagrams
  - Mechanics of materials
- Planning general concepts for fab and testing
  - Materials- desired list=match material expense table and more
    - Name of the material
    - Concentration, amount or starting dimensions
    - Manufacturer and part number
    - Purpose of the material
    - List of equipment needed (manufacturer and model number if known)
    - Include references to papers or research in other parts of the notebook
  - Methods- step by step plan- list
    - Mix- for how long and with what vigor, etc.
    - Cut- with what tool and what size, etc.
  - Rule #1- repeatable by unfamiliar reader
- 3D printing
  - Same rules apply- plus more
  - Materials
    - Manufacturer and model of the printer
    - Filament material, diameter, and model number
  - Methods- printer settings
    - Layer thickness

- Layer thickness
- Infill, speed, etc.
- Support type and style
- gCode file
- Manufacturing
  - Consider throughout the process
  - Cannot manufacture everything you can 3D print
  - Common methods: molding, machining/subtractive manufacturing, joining
- Seek professional advice
  - Design Innovation labs
    - Design hub
    - Makerspace
  - Use experts in the field-faculty!
- Use fabrication plans- template
- Testing plan- additional considerations
  - Think about statistics! before you start
  - What controls are needed?
  - Do you have to design something to ensure precision and accuracy?
  - Reference and discuss the PDS criterion being tested
  - Testing plan should match fabrication plan

**Conclusions/action items:** Use this information when developing the testing and fabrication calls for our prototype this semester to ensure that everyone can understand our protocols fully.



## 2026/03/25- Lecture 10

Therese Kalt - Mar 25, 2026, 2:03 PM CDT

**Title:** Lecture 10- Engineering Ethics

**Date:** 03/25/2026

**Content by:** Therese Kalt

**Present:** BME 301

**Goals:** To discuss ethics in engineering and where they come from

**Content:**

- Where do ethics come from?
  - Life experiences, how you are raised
- Is there a difference between "personal" ethics and "professional" ethics?
- COE instructors perceive that instructors and students value ethics at different levels
- Ethical problem-solving is similar to the design process
  - Steps in design: establish a need, understand the problem, generate solutions, evaluate solutions, develop detailed design, document and test
- - In your design teams, identify components (at least 2) of your design that could face ethical dilemmas or have an ethical dimension (for example, safety is often a trade-off).
    - b. Our design could not be accessible for colorblind patients as the screen uses red and green colors.
    - c. The design may not be accessible for therapists that cannot properly hold it up throughout the whole therapy session.
  - Consider the appropriate language in ABET Outcome 4: an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
  - e. Done
- Read through BME code of ethics: <https://www.bmes.org/bmes2023-policies>
- Review the [Code of Ethics for Engineers and Ethical decision-making system](#)
- Type up your answers and add to the case study answers (Q 1-4 above) – upload to Canvas. Copy and paste your design-specific ethics responses into your design notebook.
  - What components of your design have ethical dimensions (be specific and list at least 2)?
    - The display component of the design- not everyone can differentiate between certain colors
    - The weight of the entire design may be too much for the therapist to use
  - How will your team address the ethical dimensions? (What is your action plan?)
    - For each component:
    - We could make the device have a red and blue screen to accommodate for patients with red/green colorblindness
    - We could lower the perceived weight even further and add an additional support so it could maybe support itself.

**Conclusions/action items:** Continue to think about ethics as design engineers to ensure that the proper protocols are being followed and people are being treated fairly.



## 2026/04/08- Lecture 12

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Therese Kalt - Apr 15, 2026, 1:09 PM CDT

**Title:** Lecture 12: Engineering Judgement

**Date:** 04/08/2026

**Content by:** Therese Kalt

**Present:** BME 300

**Goals:** To learn more about what engineering judgement is and what it means to me.

**Content:**

- Expectation of becoming an engineer:
  - ABET outcome 6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- How do you learn engineering judgement?
  - Real-world engineering problems
  - Open-ended problems
  - Teamwork and collaboration with others
  - Critical thinking- evaluate solutions, testing/analysis
  - Communication- all forms
  - Handling uncertainty, including incomplete information and changing conditions
- Three domains of the model
  - Attitudes, behavior, and cognitive capabilities

**Conclusions/action items:** Continue to think about what I can do to improve my engineering judgement.



## 2026/04/15- Lecture 13

---

Therese Kalt - Apr 15, 2026, 1:45 PM CDT

**Title:** Lecture 13- Poster Presentations

**Date:** 04/15/2026

**Content by:** Therese Kalt

**Present:** BME 301

**Goals:** To learn how to create a good poster for the final poster presentations.

**Content:**

- What makes a good poster?
  - Visually appealing
  - Words and figures that can be read from far away
  - Sections flow together
  - Clear introduction and background
  - Pictures depicting final prototype, testing, etc.
  - Consistent formatting
- What makes a bad poster?
  - Too small of font
  - Lack of figure captions
  - No flow
  - Unnecessary pictures
  - Raw data
  - Single hanging bullets
- Formatting
  - Captions-all figures and graphics must have captions
  - Fonts-- style must be easy to read
  - Colors- use for ease of reading to separate sections, and to highlight important points
- Context of Use and Workflow
  - Start with user and setting
    - Show workflow
    - Include user-device interaction
  - Place in a larger system
  - Use color/grouping to organize/show what belongs together
  - Use labels with minimal text
  - Keep it high-level and understandable at a glance

**Conclusions/action items:** Begin working on the final poster for the final poster presentation.



## 2026/04/22- Lecture 14

---

Therese Kalt - Apr 22, 2026, 1:45 PM CDT

**Title:** Lecture 14- Presentation peer review

**Date:** 04/22/2026

**Content by:** Therese Kalt

**Present:** BME 301

**Goals:** To receive feedback about our final poster before the final poster presentations on Friday.

**Content:**

- One team member needs to be at ECB by 10:30am
- Present until 2:15, help clean up!
- Final deliverables due next Wednesday
- Need more figures on our final poster so that the viewer can understand our project and testing

**Conclusions/action items:** Finish the final testing and poster by tonight!



## 2026/01/30- Team Meeting 1

---

Therese Kalt - Feb 05, 2026, 3:52 PM CST

**Title:** Team Meeting 1

**Date:** 02/05/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To make a plan for the following week and divide sections of the PDS.

**Content:**

Summary of first team meeting:

- Split up PDS
  - I have the following sections: performance requirements, safety, accuracy and reliability, life in service, and shelf life
- Finish by Tuesday/Wednesday to allow time for edits
- Begin brainstorming design criteria for design matrix
- Put questions in client meeting document
  - Ask questions that pertain to sections of PDS

**Conclusions/action items:** Meet with client, complete PDS, and begin brainstorming criteria for design matrix.



## 2026/02/02- Client Meeting 1

---

Therese Kalt - Feb 05, 2026, 3:52 PM CST

**Title:** Client Meeting 1

**Date:** 02/02/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To learn more about client requirements and understand the scope of the project better.

**Content:**

Summary of client meeting:

- Needs measurements on the device for functional reach test
- Would like auditory feedback
- Can deliver previous prototypes from past semesters
- Liked the size of the old screen but it was too heavy
  - Could potentially add a counterweight like a fishing rod so it requires less effort to hold
- Could have us tour the facility and watch him work with a patient
- Testing should be more focused on his comfort, not if the device is improving their symptoms

**Conclusions/action items:** Research more about the functional reach test and draft the product design specification document with these client requirements.



## 02/06/2026- Advisor Meeting 2

---

Therese Kalt - Feb 06, 2026, 12:33 PM CST

**Title:** Advisor Meeting 2

**Date:** 02/06/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To share what the team has worked on this week.

**Content:**

- Come up with fatigue study to test weight and torque of the prototype
- 5-7 scale, completely agree to disagree
- Kat researched standards for electronics in medical devices, not applicable because the device does not transfer energy to the patient
  - Not classified as a medical device
- Carbon fiber might be a good option
  - Different types that range in price
- Working on technical writing for preliminary reports
  - Maybe use advisor meeting to go over feedback for writing
- Check in with advisor about expectations, provide feedback for us to improve
- Use LabArchives as a notes tool
  - Document everything!
  - Can be more informal as the semester continues
- Can use a trigger for auditory feedback
- Could look into telescoping or snapping smaller when not in use

**Conclusions/action items:** Begin preliminary design ideas and preliminary deliverables.



## 02/06/2026- Team Meeting 2

---

Therese Kalt - Feb 06, 2026, 12:51 PM CST

**Title:** Team Meeting 2

**Date:** 02/06/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To set team goals for next week and divide work for the week.

**Content:**

- One design idea each
- Noor and I will work on criteria and matrix for design matrix, not material matrix
- Need to have done by Thursday night so the entire team can look over matrix
- No electronics matrix because there were no prior issues from previous groups
- Should look into auditory feedback
- Everyone works on 3rd design matrix for auditory feedback

**Conclusions/action items:** Finish design matrices for next week advisor meeting. Also, update resume and cover letter for final submission next week.



## 2026/02/13- Advisor Meeting 3

---

Therese Kalt - Feb 13, 2026, 12:38 PM CST

**Title:** Advisor Meeting 3

**Date:** 02/13/2026

**Content by:** Therese Kalt

**Present:** Whole team except Freyja

**Goals:** To work on choosing a design to move forward with and present what we did last week.

**Content:**

- Order sensors for electronics
- Work on CAD models for preliminary presentation
- Preliminary presentation needs to be printed by Wednesday (can be a draft)
- Need to include previous designs
- Should initially model with PVC, create tolerances before cutting into carbon fiber
  - Weight difference between PVC and carbon fiber
- Talk about what the previous group did really well and what needs to be improved
- Risk of breaking when drilling carbon fiber so you don't crack the whole pole of carbon fiber

**Conclusions/action items:** Divide sections of the preliminary report and presentation to present next week.



## 2026/02/13- Team Meeting 3

---

Therese Kalt - Feb 13, 2026, 12:48 PM CST

**Title:** Team Meeting 3

**Date:** 02/13/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To divide sections of the report and presentation to be ready for next week.

**Content:**

- My sections for the presentation are overview, problem statement, introduction, background and competing designs
- These will also be my sections for the preliminary report
- Need to be good enough to print out by Tuesday night

**Conclusions/action items:** Work on my specific sections for both the presentation and report and have them ready by Tuesday.



## 2026/02/27- Team Meeting 4

---

Therese Kalt - Feb 27, 2026, 12:50 PM CST

**Title:** Team Meeting 4

**Date:** 02/27/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To divide the work up for next week to continue moving forward with the project

**Content:**

- Schedule meeting with client, me
- Meet with client, tell client what we need him to order
  - Update CAD model based on client feedback
- Meet as a team next Wednesday to begin preliminary circuitry
- Order materials
- Research filaments for the SolidWorks aspect of the project, me

**Conclusions/action items:** Meet with the client next week and continue working on the project.



## 2026/03/04- Client Meeting 2

---

Therese Kalt - Mar 04, 2026, 7:17 PM CST

**Title:** Client Meeting 2

**Date:** 03/04/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To go over preliminary deliverables and decide on next steps for the project.

**Content:**

- Use different colors to toggle back and forth that indicate right or left hand
- Would like a button for each color (maybe go back and forth between red and green)
- Maybe another button that causes a "random" mode
- Brightness should be easy to fix with software
- Lightweight speaker, operate by vibrating creating a buzzing noise
  - Some are very hard of hearing
  - Can test how many we need for how loud it is
- Found weave of carbon fiber that is good for etching
- Can come visit in Fitchburg, understand what a rehab hospital is like
- Videos are fine to put pictures on report, signed a release
- Cheaper option, more degrees of freedom
- Can dissect previous prototypes for parts

**Conclusions/action items:** Begin fabricating the preliminary prototype and reach out over email if the team has any questions.



## 2026/03/11- Team Meeting 5

---

Therese Kalt - Mar 12, 2026, 8:28 PM CDT

**Title:** Team Meeting 5

**Date:** 03/11/2026

**Content by:** Whole team

**Present:** Whole team

**Goals:** To create a fabrication protocol for the circuitry that is specific and repeatable.

**Content:**

Me:

- Create outline for fabrication protocol
- Create Gantt chart

Other team members:

- Material and cost table
- Detailed sketch for fabrication
- Detailed steps for fabrication

**Conclusions/action items:** Create the Gantt chart and help my other team members as needed.



## 2026/03/13- Advisor Meeting 4

---

Therese Kalt - Mar 13, 2026, 12:26 PM CDT

**Title:** Advisor Meeting 4

**Date:** 03/13/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To meet with the advisor about how the project is going so far and next steps.

**Content:**

- Could create a mock weight of the circuitry to start doing fatigue testing earlier
- Maybe different colors than red and green for color blind patients
- Could screw the carbon fiber rod into the handle (can ask people working in ECB)
- Handle is likely a good idea to reduce strain
- Could secure on elbow for better weight dispersion
- Complete survey questions

**Conclusions/action items:** Continue working on the project and prepare for show and tell next week.



## 2026/03/18- Team Meeting 6

---

Therese Kalt - Mar 19, 2026, 11:47 AM CDT

**Title:** Team Meeting 6

**Date:** 03/18/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To discuss the display portion of the device and what needs to be improved

**Content:**

- Ordered a new carbon fiber rod with a larger diameter, 8mm is too small
- 1mm is too small for the groove to hold the acrylic, broke off when being printed so needs to be stronger
- The rod portion that is hollow needs to extend through the display section so that the wires can go all the way through
- Otherwise looks good so far, very lightweight which is ideal

**Conclusions/action items:** Continue to modify the display portion of the design so that it is lightweight but also durable and matches the new diameter of the carbon fiber rod.



## 2026/04/10- Advisor Meeting 5

---

Therese Kalt - Apr 10, 2026, 12:30 PM CDT

**Title:** Advisor Meeting 5

**Date:** 04/10/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To discuss where the team is at with the project.

**Content:**

- ECB 3150 next week
- Fabrication with the carbon fiber rod, more PPE required
- Stick and peel away on cricket instead of etching
- Talk to someone in the makerspace about the SolidWorks print
- ABS plastic
- Could look into resin printers, easier to get the supports off
  - Not as dramatic print lines
- How specialized is this device to him
  - How many physical therapists also do this type of therapy
- Musculoskeletal disorders of physical therapists
- Take a picture of MTS testing
- Include that we improved on color blindness
- Accuracy of the touch sensor
- Make poster before so we know what we need on it

**Conclusions/action items:** Continue working on the design to get ready for the end of the semester.



## 2026/04/10- Team Meeting 7

Therese Kalt - Apr 10, 2026, 2:27 PM CDT

**Title:** Team Meeting 7

**Date:** 04/10/2026

**Content by:** Therese Kalt

**Present:** Whole team except Noor

**Goals:** To plan the rest of the semester so that we are able to finish everything on time.

### Content:

#### Actionable Items:

- Circuitry needs to be soldered- Saturday (ideally 2 people)
- Speaker dimensions need to be measured- Saturday
  - CAD file needs to be updated to fit speaker- Saturday
- Circuitry and code tested - Saturday (accuracy of touching the sensor and accuracy of buttons switching)
- Update and upload poster layout - prep for next Friday meeting (include pictures of MTS testing)
- Survey data summarized in either sheets/excel and matlab/something idk
- MTS testing- Wednesday after lecture (2 people)
- Make box with room for arduino nano, breadboard, and battery (this is for the armband thing) - tomorrow
- Update display portion to be more durable (add rectangles and cut them)- tomorrow
- Layer of electrical tape for exposed wires, brainstorm another layer- tomorrow
- Buy/borrow a roll of electrical tape at the Makerspace- tomorrow
- Talk to someone in the Makerspace about the Cricket- tomorrow
- Make the survey for qualitative data- tomorrow (freyja)
- Write fabrication protocols (write them while you're doing them)
- Write testing protocols (write them while you're doing them)
- Make poster outline - today
- Make final executive summary

**Conclusions/action items:** Meet tomorrow and start fabrication so that we are able to finish on time.





## 2026/04/11- Team Meeting 8

---

Therese Kalt - Apr 14, 2026, 7:48 PM CDT

**Title:** Team Meeting 8

**Date:** 04/11/2026

**Content by:** Therese Kalt

**Present:** Whole team except Noor

**Goals:** To divide the remaining work for the rest of the semester and figure out the game plan for today.

**Content:**

- Worked on creating fabrication protocols
- Divided sections of the report and preliminary presentation
- Freyja and Kat will focus on soldering
- I will create the measurement system, update the display portion of the design and print it

**Conclusions/action items:** Paint the rod for the lines in the measurement system and order stickers to mark the lines.



## 2026/04/11- Individual Meeting 1

---

Therese Kalt - Apr 14, 2026, 8:02 PM CDT

**Title:** Individual Meeting 1

**Date:** 04/11/2026

**Content by:** Therese Kalt

**Present:** Therese Kalt

**Goals:** To create the file for the cricut, cut the template, and update the CAD.

**Content:**

- Created the cricut file to create the vinyl cutout for the rod
  - The cricut was unable to cut letters as small as we needed them
  - Tried about 4 times and then decided to try something else
- Decided to use the tick marks from the paper cutout to paint the rod instead and find stickers with numbers
- Asked the Makerspace about paint
- Printed the updated display portion of the design

**Conclusions/action items:** Create the CAD model for the box that will fit in the arm band.



## 2026/04/13- Individual Meeting 2

---

Therese Kalt - Apr 14, 2026, 7:56 PM CDT

**Title:** Individual Meeting 2

**Date:** 04/13/2026

**Content by:** Therese Kalt

**Present:** Therese Kalt

**Goals:** To cut the carbon fiber rod, create a hole for the wires to go through, and paint the tick marks on the rod.

**Content:**

- Picked up handle for device to ensure it fits on the rod
  - This can be glued to the rod as soon as the handle has a matching drilled hole for the wires to go through
- Followed up about the display portion of the design and had to move it to another printer
- Went to team lab and cut rod down to 31.5 in (more complicated because team lab has greater precautions for carbon fiber)
- Created a hole within the first 5 in of the rod for the wires to go through and go to the handle of the device
- Wrapped the cricut cut out around the rod and secured tightly with tape
  - Painted layer of black first and then 2 layers of white

**Conclusions/action items:** Clean up the lines of the tick marks, glue the display portion and handle to the rod, and continue to help with fabrication.



## 2026/04/14- Team Meeting 9

---

Therese Kalt - Apr 21, 2026, 3:52 PM CDT

**Title:** Team Meeting 9

**Date:** 04/16/2026

**Content by:** Therese Kalt

**Present:** Therese and Noor

**Goals:** To drill additional holes in the rod for the circuitry

**Content:**

- We met to drill holes to fit the switches on the rod
- Unfortunately, the size of the holes we needed to drill were too big and would have broken the rod
- We ended up cutting off an additional 4 inches of the rod so that the switch would be able to fit
- Printed updated sensor portion of the design to house the sensors and speaker

**Conclusions/action items:** Continue fabrication until we are done with the prototype.



## 2026/04/21- Team Meeting 10

---

Therese Kalt - Apr 21, 2026, 4:13 PM CDT

**Title:** Team Meeting 10

**Date:** 04/21/2026

**Content by:** Therese

**Present:** Whole team except Freyja

**Goals:** To MTS test the carbon fiber to determine how strong it is

**Content:**

- Tried to set up MTS machine
  - Faced issues with changing the load cell and getting set up
  - Emailed 315 team and Dr. P
  - Made plans to do it tomorrow

**Conclusions/action items:** Complete testing within the next day to make sure the final poster is ready.



## 2026/04/22- Team Meeting 11

Therese Kalt - Apr 27, 2026, 7:56 PM CDT

**Title:** Team Meeting 11

**Date:** 04/22/2026

**Content by:** Therese Kalt

**Present:** Whole team

**Goals:** To complete all testing and finalize the poster for the poster presentation.

**Content:**

MTS testing:



- Average elastic modulus: 105.667 MPa
- Maximum stress before plastic deformation: 15.776 MPa
- Maximum deflection before plastic deformation: 2.88 mm

Failure testing:

- Gathered participants in ECB for testing
- Placed marking on the wall to indicate when the participant reached failure
- Collected data in the google sheet

**Conclusions/action items:** Analyze the data to see if there is a statistically significant difference between the previous prototype and current prototype.



## 2026/03/12- Gantt Timeline

Therese Kalt - Mar 12, 2026, 8:31 PM CDT

**Title:** Gantt Timeline

**Date:** 03/12/2026

**Content by:** Therese Kalt

**Present:** N/A

**Goals:** To create the Gantt timeline for the fabrication protocol for the circuit.

**Content:**

Task	March				April			
	6	13	20	27	3	10	17	24
Acquire Materials	■							
Build Circuit Using Fritzing Diagram		■						
Finish Arduino Code		■						
Testing				■				
Implementation of Circuitry to Device						■		
Additional Testing for Circuitry in Device							■	

**Conclusions/action items:** Continue to work on the fabrication protocol for the circuit.



## 2026/04/22- Failure Statistical Analysis

Therese Kalt - Apr 28, 2026, 1:26 PM CDT

**Title:** Failure Statistical Analysis

**Date:** 04/22/2026

**Content by:** Therese Kalt

**Present:** Whole team except Freyja

**Goals:** To analyze the data we collected during failure testing.

**Content:**

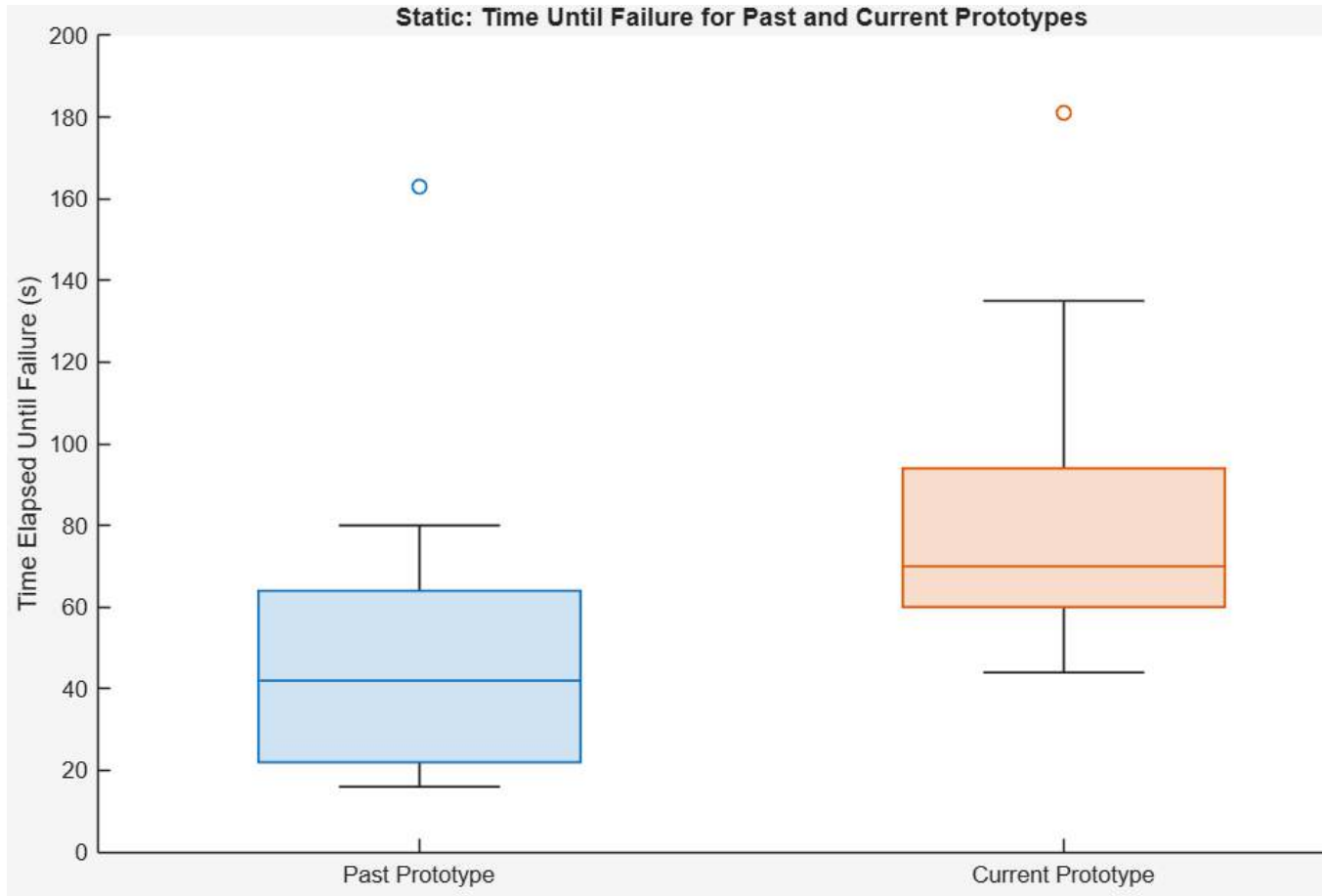
Matlab script:

```
% Time until failure
old_data_failure=[19 24 54 64 46 43 71 80 163 22 41 16 22 21];
new_data_failure=[44 60 70 80 59 70 94 135 181 80 114 63 70 59];
[h1,p1]=ttest(old_data_failure,new_data_failure)

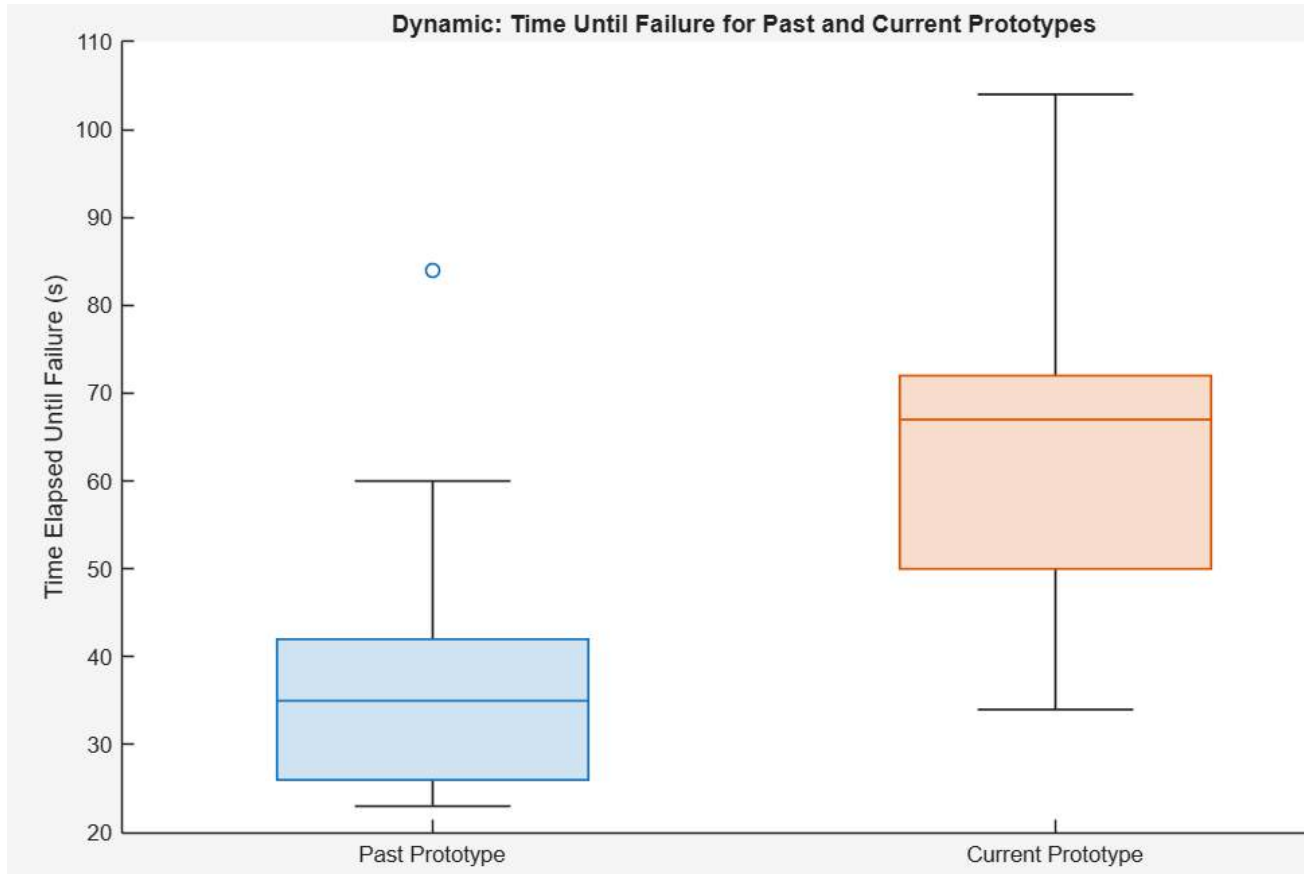
% Time arc
old_data_arc=[37 35 31 50 23 36 42 60 84 25 35 26 31 24];
new_data_arc=[71 50 82 60 70 60 70 93 104 64 72 34 41 50];
[h2,p2]=ttest(old_data_arc,new_data_arc)
figure(1)
% Place the first box at position 1
boxchart(ones(size(old_data_failure)), old_data_failure)
hold on
% Place the second box at position 2
boxchart(2 * ones(size(new_data_failure)), new_data_failure)
% Clean up the axes
xticks([1 2])
xticklabels({'Past Prototype', 'Current Prototype'})
ylabel('Time Elapsed Until Failure (s)')
title('Static: Time Until Failure for Past and Current Prototypes')
hold off
figure(2)
% Place the first box at position 1
boxchart(ones(size(old_data_arc)), old_data_arc)
hold on
% Place the second box at position 2
boxchart(2 * ones(size(new_data_arc)), new_data_arc)
% Clean up the axes
xticks([1 2])
xticklabels({'Past Prototype', 'Current Prototype'})
ylabel('Time Elapsed Until Failure (s)')
title('Dynamic: Time Until Failure for Past and Current Prototypes')
hold off
```

Time Until Failure:

Static failure-



Dynamic failure-



- P-value for static failure: 0.001
- P-value for dynamic failure: 0.0031

**Conclusions/action items:** Use these graphs and p-values to prove statistical significance.



**Title:** Effectiveness of physiotherapy interventions in brain plasticity, balance and functional ability in stroke survivors: A randomized controlled trial

**Date:** 1/29/26

**Content by:** Noor Awad

**Citation:** Rahayu et al., "Effectiveness of Physiotherapy Interventions in Brain Plasticity, Balance and Functional Ability in Stroke Survivors."

**Present:** N/A

**Goals:** Gain understanding of how patient mobility is affected by stroke, which serves as background and motivation for this project.

## Content:

- Brain injuries such as strokes cause damage and death of the neuron cells.
- Neuroplasticity is the ability of the brain to redevelop its neuron network at the healthy part of the brain to take over the damaged part.
- Exposure on frequent activities in an individual's daily life stimulates the brain.
- Neuroplasticity impacts physical recovery and is mostly generated during the early six month post stroke before achieving plateau.
- Activities comprised of position change, breathing exercise, and exercise therapy in passive and active mobilization.
- BDNF level was analyzed through blood sample of the participants (This was their way of measuring neuroplasticity)
- Barthel Index evaluates activities of daily living on ten aspects: feeding, bathing, grooming, dressing, bladder, bowel, toilet use, transfers, mobility, climbing stairs.
- The intervention group had a significant improvement in neuroplasticity regeneration. When compared between the two groups, the neurorestoration intervention group had a greater effectiveness compared to the conventional physiotherapy intervention in terms of functional performance and balance, but did not achieve statistical difference in neuroplasticity regeneration.
- This study indicates that physiotherapy interventions either being done conventionally or using standard protocols are beneficial in improving the condition of stroke patients
- Neurorestoration combined with several established interventions was effective in improving balance and functional ability of stroke patients in only seven days.

## Conclusions/action items:

This article was a good way to get a basis for the existing research on stroke rehabilitation. I also appreciated the parts about neuroplasticity and I think that would be good to include for the background and motivation of this project. In addition, there are some guidelines we can model our testing after



Brain injuries such as strokes cause damage and death of the neurons of the brain, damage to peripheral nervous system, and motor function. Impaired motor function is a common problem for stroke patients. Stroke patients suffering from hemiparesis are unable to move their affected limbs, which makes it difficult for them to wear their clothes. However, the brain has the capacity on neuroplasticity to improve the patient's condition and regain functionality (Jiang et al., 2015).

Neuroplasticity is the ability of the brain to make up for neuron network in the healthy part of the

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**rahayu-et-al-2020-effectiveness-of-physiotherapy-interventions-in-brain-plasticity-balance-and-functional-ability-in.pdf (138 kB)**



## The effects of exercise-based rehabilitation on balance and gait for stroke patients: a systematic review

NOOR AWAD (nawad2@wisc.edu) - Jan 29, 2026, 6:49 PM CST

**Title:** The effects of exercise-based rehabilitation on balance and gait for stroke patients: a systematic review

**Date:** 1/29/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Learn about balance and gait for stroke patients, apply to background and motivation

**Content:**

- Background: Among stroke survivors, about 15%-30% are permanently disabled and 20% still require institutional care at 3 months after onset, indicating dependence on others to perform their daily activities, because of impaired walking ability.
- Rehabilitation is essential for stroke survivors to optimally recover mobility and functional abilities so that they can live independently, participate in the community, and experience fewer secondary complications.
- Restoration of independent gait and balance is a main aim of rehabilitation for patients living with stroke, because it is associated with independent mobility and reduced fall risk.
- Results indicate that treadmill training combined with a conventional rehabilitation program provides additional benefit in improvement in walking speed in chronic stroke.
- The concept of dual task exercise involves the performance of two tasks at the same time and is helpful in reflecting the broader dimensions in community ambulation
- Results: aerobic exercise is shown to improve balance in chronic stroke survivors.
- Ideal exercise intervention for stroke survivors includes a combination of gait, balance, and aerobic exercises.
- Current evidence indicates that exercise behavior is helpful in recovering function and independence, reducing disability and secondary complications, and preventing secondary stroke, all of which are more likely to improve quality of life.

**Conclusions/action items:**

Based on this article, I got a better sense of other ways that strokes are rehabilitated now. This could be used to justify why the balance device is needed because it could make it easier to do things like aerobic exercise, which is discussed in this article in depth.



## "Balance Training for Stroke Recovery" - 2/5/26

NOOR AWAD (nawad2@wisc.edu) - Feb 06, 2026, 12:05 PM CST

**Title:** "Balance Training for Stroke Recovery"

**Date:** 2/5/26

**Content by:** Noor Awad

**Citation:** Mileski, "Balance Training for Stroke Recovery."

**Present:** N/A

**Goals:** Learn about existing balance therapy, benefits, any areas that are unaddressed that we could incorporate for this project.

### Content:

- A stroke can disrupt the intricate communication network between the brain and body, leading to a loss of balance and coordination.
- Evidence behind balance training:
  - After a stroke, the brain undergoes neuroplasticity, where it forms new connections and pathways.
  - Targeted balance exercises encourages neural retraining, helping to restore lost functions and improve overall stability.
  - Balance exercises improved balance performance in the moderately severe stroke population
  - Personalized balance training can improve balance and confidence of stroke patients and reduce the incidence and fear of falls.
- Individualized approach
  - Postural assessment
  - Sensory testing
  - Range of motion testing
  - Spasticity assessment
    - Neurological tone or tightness, particularly in the adductors, hamstring and gastrocnemius muscles can impact ability to weight bear or move the affected leg during standing and moving.
- Measures to help reassess level of recovery
  - Berg balance scale
  - Timed up and go
  - Balance evaluation systems test
  - community balance and mobility score
  - dynamic gait index

### Conclusions/action items:

I actually expected this article to give me some competing designs, but it mostly helped reaffirm what the client told us about balance training. I do plan to use the measures to help reassess level of recovery, because they are in addition to the ones the client told us about. Based on this article I want to learn more about existing devices people are using for balance training.

NOOR AWAD (nawad2@wisc.edu) - Feb 05, 2026, 7:37 PM CST





[Download](#)

**Balance\_Training\_for\_Stroke\_Recovery\_-\_Propel\_Physiotherapy.pdf (9.05 MB)**



## 2/12/26 - Piezo Buzzer

NOOR AWAD (nawad2@wisc.edu) - Feb 13, 2026, 11:02 AM CST

**Title:** Piezo Buzzer

**Date:** 2/12/26

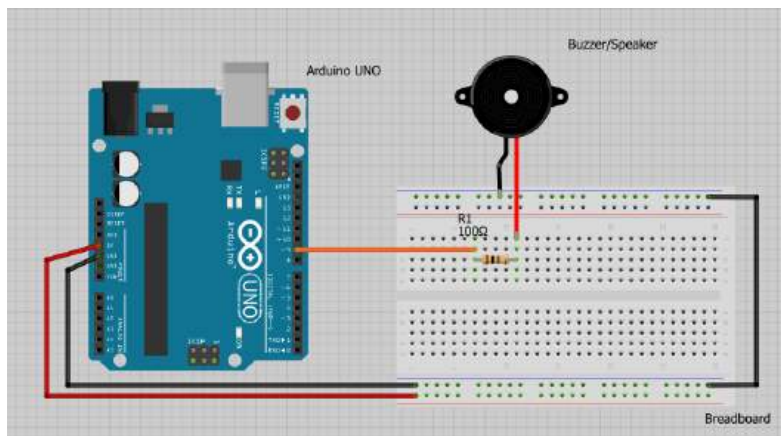
**Content by:** Noor Awad

**Citation:** Arduino Project Hub, "USE a BUZZER MODULE (PIEZO SPEAKER) USING ARDUINO UNO."

**Present:** N/A

**Goals:** Find out if the Piezo buzzer is suitable for the auditory feedback portion of this project

**Content:**



CODE PORTION:

```
const int buzzer = 9; //buzzer to arduino pin 9

void setup(){
  pinMode(buzzer, OUTPUT); // Set buzzer - pin 9 as an output
}

void loop(){
  tone(buzzer, 1000); // Send 1KHz sound signal...
  delay(1000);      // ...for 1 sec
  noTone(buzzer);  // Stop sound...
  delay(1000);     // ...for 1sec
}

const int buzzer = 9; //buzzer to arduino pin 9
```

```
void setup(){

  pinMode(buzzer, OUTPUT); // Set buzzer - pin 9 as an output

}

void loop(){

  tone(buzzer, 1000); // Send 1KHz sound signal...
  delay(1000);      // ...for 1 sec
  noTone(buzzer);  // Stop sound...
  delay(1000);     // ...for 1sec

}
```

This buzzer can be used in conjunction with a relay or ultrasonic sensor so that we could do a hands-free trigger, or we could use it with a button depending on client needs/group's decision.

**Conclusions/action items:**

Based on this I have learned what the circuitry would look like if we decide to use this, and have the exact code we need for arduino.



## Virtual Reality for Stroke Rehabilitation

NOOR AWAD (nawad2@wisc.edu) - Jan 29, 2026, 7:56 PM CST

**Title:** Virtual reality for stroke rehabilitation

**Date:** 1/29/26

**Content by:** Noor Awad

**Present:** N/A

**Citation:** Laver et al., "Virtual Reality for Stroke Rehabilitation."

**Goals:** Explore how virtual reality can be used to rehabilitate after stroke, use as competing design

**Content:**

- Objective of this study was to determine the efficacy of virtual reality compared with an alternative intervention or no intervention on: gait and balance, global motor function, cognitive function, activity limitation, participation restriction, quality of life, and adverse events.
- Study found that the use of virtual reality and interactive video gaming was not more beneficial than conventional therapy approaches in improving upper limb function.
- Virtual reality may be beneficial in improving upper limb function when used as an ADJUNCT to usual care.
- Trend suggesting that higher dose was preferable as were customised virtual reality programs
- **Conclusions/action items:**
  - While this article is more focused on upper limb activity, this is a good starting point in researching competing designs. Although we are not currently thinking about virtual reality for our project, the pros and cons of other competing designs should still be explored.

NOOR AWAD (nawad2@wisc.edu) - Jan 29, 2026, 7:56 PM CST



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# The Use of Portable Devices for the Instrumental Assessment of Balance in Patients with Chronic Stroke: A Systematic Review

NOOR AWAD (nawad2@wisc.edu) - Jan 29, 2026, 8:16 PM CST

**Title:** The Use of Portable Devices for the Instrumental Assessment of Balance in Patients with Chronic Stroke: A Systematic Review

**Date:** 1/29/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Explore a competing design that is portable, apply to our project if possible

**Citation:** Mallo-López et al., "The Use of Portable Devices for the Instrumental Assessment of Balance in Patients with Chronic Stroke."

## **Content:**

- Stroke is the disease that produces the greatest disability worldwide, and its economic cost has increased in recent decades
- One of the main causes of disability in patients who have suffered a stroke is an impaired balance. The lack of stability increases the risk of falls, restricts patients' basic activities of daily life, and reduces their participation in the society. Falls are one of the most common secondary complications of stroke; **it was reported that 70% of stroke patients will suffer falls over the first year.**
- Traditionally, clinical scales have been used to identify balance deficits and the risk of falls. These tools are **quick and easy to use and do not require expensive materials.**
- However, they offer a subjective evaluation and are less sensitive for the detection of changes in patients. In addition, **these scales do not assess the systems involved in balance, the biomechanical aspects related to posture, or the compensatory strategies. In this sense, instrumental systems to measure postural control are more effective for balance evaluation**
- Posturography is the more common instrumental method to assess balance. It uses systems that incorporate force platforms that provide quantitative data. This allows knowing the contribution of the visual, proprioceptive, and vestibular systems in postural control. Kinematic information can be offered by motion capture systems, accelerometers, or electrogoniometers
- However, the technological development has allowed the design of low-cost systems that are more accessible and easier to handle. Force platforms, motion capture systems originally designed for videogames, wearables accelerometers, and virtual reality devices are some of them
- these portable devices could be especially useful for **patient's associations and in daycare centers and small private neurorehabilitation centers where resources are limited and users are frequently chronic patients**
- BioRescue, the Biodex Bio-Sway Balance System, and an Android smartphone app to evaluate standing balance, the Sway Star Balance System and Xsens ForceShoes to evaluate dynamic balance during walking.

## **Conclusions/action items:**

Based on this article, I now know about the different devices currently used for balance rehabilitation. This article also discussed the importance of postural control, which is something the group should focus on for this project.

NOOR AWAD (nawad2@wisc.edu) - Jan 29, 2026, 8:16 PM CST

### THE USE OF PORTABLE DEVICES FOR THE INSTRUMENTAL ASSESSMENT OF BALANCE IN PATIENTS WITH CHRONIC STROKE: A SYSTEMATIC REVIEW

Ara Mallat-López<sup>1,2,3</sup>, Pilar Fernández-González<sup>4,5</sup>, Patricia Sánchez-Herrera-Basso<sup>6,7</sup>, Alicia Cuenca-Gómez<sup>1,2</sup>, Francisco Muñoz-Rodríguez<sup>4,5</sup> and Ángela Aguilera-Rodríguez<sup>6,7</sup>

<sup>1</sup> International Doctorate School, Rey Juan Carlos University, 28002 Madrid, Spain  
<sup>2</sup> Department of Physiotherapy, Faculty of Sport Sciences, Universidad Francisco de Madrid, Villavieja de Gata, 28070 Madrid, Spain  
<sup>3</sup> Neurosciences, Neurological Physiotherapy Center 28002 Madrid, Spain  
<sup>4</sup> Motor Analysis, Ergonomics, Biomechanics and Motor Control Laboratory (LABMBC) Only  
<sup>5</sup> Department of Physical Therapy, Occupational Therapy, Rehabilitation and Physical Medicine, Faculty of Health Sciences, Rey Juan Carlos University, 28002 Madrid, Spain  
<sup>6</sup> Correspondence: patibasso@urj.es; Tel.: +34 914886888

**Abstract:** Improving balance remains a challenge in stroke rehabilitation. The technological development has allowed the design of more accessible and user-friendly systems for assessing postural control. Objective: The aim of this review was to analyze portable devices for the instrumental assessment of balance in patients with chronic stroke. Methods: PRISMA guidelines were used to carry out the systematic review. The literature search was restricted to articles written in English or Spanish published from 2012 to December 2022 in PubMed, Web of Science, Scopus, PEDro, and CINAHL. Of the 307 search results, 229 unique references were included after duplicates were removed. The PRISMA table was applied to evaluate the methodological quality of the included papers, and the degree of evidence and level of measurement were determined through the Oxford Centre for Evidence-Based Medicine, Results. A total of seven articles reporting on five different balance testing devices were included in this systematic review: they employed iROBotic, a smartphone application, and the iWalk-Balancing Balance System for three studies of standing balance, and iWalk for Balance and iWalk for iBalance<sup>TM</sup> for the evaluation of dynamic balance during walking. Conclusions: The use of portable devices that assess balance in stroke patients with chronic stroke is scarce.

**Keywords:** assessment; balance; device; postural control; stroke; technology

**Check for updates**  
Citation: Mallat-López A, Fernández-González P, Sánchez-Herrera-Basso P, Cuenca-Gómez A, Muñoz-Rodríguez F, Aguilera-Rodríguez A. The Use of Portable Devices for the Instrumental Assessment of Balance in Patients with Chronic Stroke: A Systematic Review. *Int J Environ Res Public Health* 2023; 20(16): 25488. <https://doi.org/10.3390/ijerph20160710008>  
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#### 1. Introduction

Stroke causes a neurological deficit due to a focal injury with vascular origin in the central nervous system, whose etiology can be diverse. It is the disease that produces the greatest disability worldwide, and its economic cost has increased in recent decades [1,2].

One of the main causes of disability in patients who have suffered a stroke is an impaired balance. The lack of stability increases the risk of falls, restricts patients' basic activities of daily life, and reduces their participation in the society [3]. Falls are one of the most common secondary complications of stroke. It was reported that 70% of stroke patients will suffer falls over the first year [4].

Postural control requires different sensory, neuromuscular, biomechanical, and cognitive components, involving complex processes of sensory integration and voluntary motor response [5]. Due to the stroke, this complex, multifunctional process is altered, making it extremely difficult to identify the main cause of the balance impairment. Improving balance requires a greater challenge for neurorehabilitation [3,6].

Balance assessment instruments and scales are essential to evaluate the postural control. Traditionally, clinical scales have been used to identify balance deficits and the risk of falls [7]. These tests are quick and easy to use and do not require expensive materials.

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[ijerph-19-10948.pdf \(824 kB\)](#)



## "Neofect Smart Balance"

NOOR AWAD (nawad2@wisc.edu) - Feb 05, 2026, 7:50 PM CST

**Title:** Neofect Smart Balance

**Date:** 2/5/26

**Content by:** Noor Awad

**Present:** N/A

**Citation:** "Neofect Smart Balance."

**Goals:** Learn about a competing design that is also geared towards post stroke balance rehabilitation, take note of what I do and don't like from the design, see if anything is applicable to a future design

**Content:**



- The smart balance is a balance pad shown here with a screen for visual component, although it can be used without that
- This is compatible with the Romberg test, which measures change in the pressure center with both eyes open and closed
- Real world training scenarios
- Accommodates both a wheelchair
- Visual and auditory feedback

### Conclusions/action items:

This is obviously much more complex than something we could make, but it was a good visual. I also appreciated that they were advertising the same things our client asked of us, so we know what it is very important to a clinician and required of us. I also liked that they focused on postural assessment, which I believe the client did not mention. This could be something to ask about, or could expand the scope of the project.

NOOR AWAD (nawad2@wisc.edu) - Feb 05, 2026, 7:51 PM CST

Smart Balance

## A Foot Ahead in Stroke Rehabilitation



### Why Smart Balance?

It encourages regular balance practice for people after stroke.

<http://www.dorland.com/neofect>

2/1

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**Smart\_Balance\_\_Neofect.pdf (3.08 MB)**



## 2/11/26 - Criteria Ideas

---

NOOR AWAD (nawad2@wisc.edu) - Feb 11, 2026, 6:19 PM CST

**Title:** Criteria Ideas

**Date:** 2/11/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Document some criteria and explanations that can be used for the design matrix

**Content:**

Weight evaluates numerically and experimentally how easy it will be for the client to hold/operate this product. The product is intended to be in use while the client is physically supporting patients, so a manageable weight is a key factor in how easily this can be done. In addition, if the device is too heavy it might degrade faster or fail at attachments. Weight will be evaluated as better or worse than the previous design, which was deemed too heavy. If the device is too heavy and it hinders the client's ability to support the patient, the patient could face a safety risk. Since weight impacts comfort, durability, and safety, it is given the highest weighting for the criteria.

Durability refers to the device's ability to withstand use for 8 hours a day 5 days a week. The device will be durable if it does not require frequent servicing. Durability also specifies that the attachments should be especially secure, since the previous designs have failed at the attachments. Durability can include the material strength and also the integrity of the design. If the device is not durable enough the device will be unsafe for the patient, so durability is very important for the chosen design.

**Conclusions/action items:**

Based on this criteria we will evaluate the different designs and rank them out of 5.



## 2/12/26 - Sensor Activated Button

---

NOOR AWAD (nawad2@wisc.edu) - Feb 12, 2026, 5:57 PM CST

**Title:** Sensor activated button

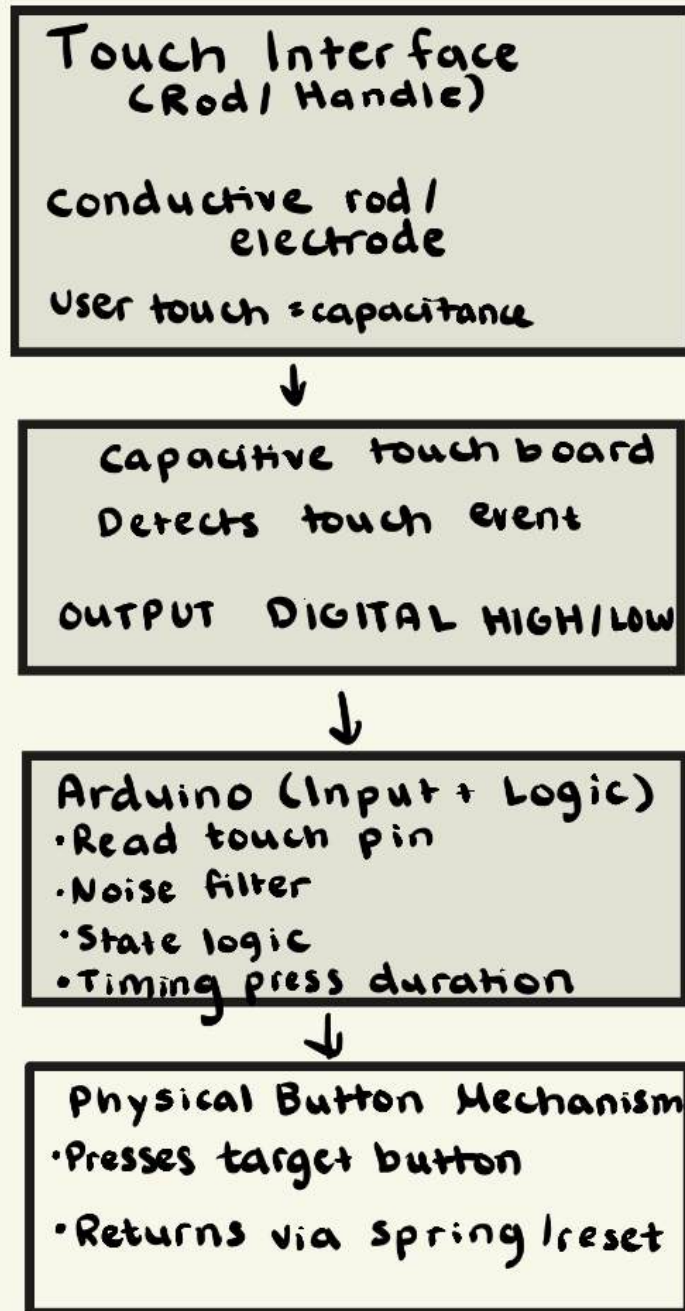
**Date:** 2/12/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Draw ideas for sensor activated button block diagram

**Content:**



Conclusions/action items:

Based on this block diagram we can create fritzing diagrams for a more formal representation



## 2/12/26 - Manual trigger

NOOR AWAD (nawad2@wisc.edu) - Feb 12, 2026, 6:10 PM CST

**Title:** Ultrasonic or Motion Sensor

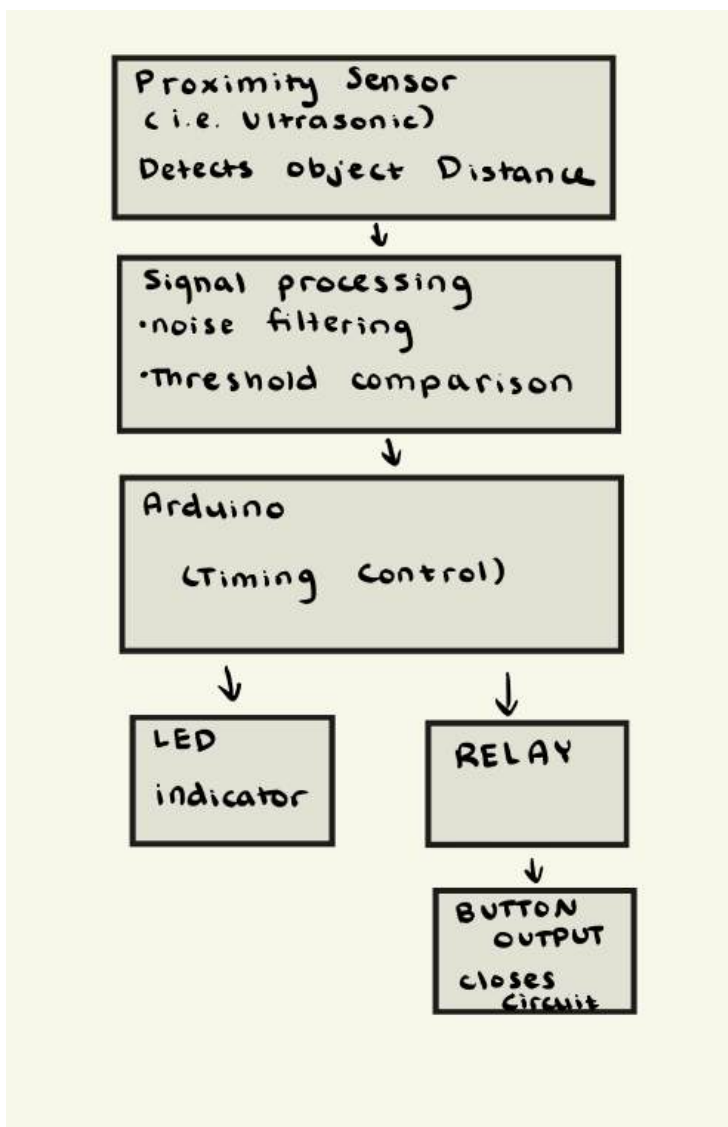
**Date:** 2/12/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Provide other option for auditory feedback

**Content:**







## 3/5/26 - Sensor idea

---

NOOR AWAD (nawad2@wisc.edu) - Mar 06, 2026, 10:52 AM CST

**Title:** Sensor option

**Date:** 3/5/26

**Content by:** Noor Awad

**Link:** <https://www.digikey.com/en/products/detail/adafruit-industries-llc/1374/1528-1782-ND/6238002>

**Content:**



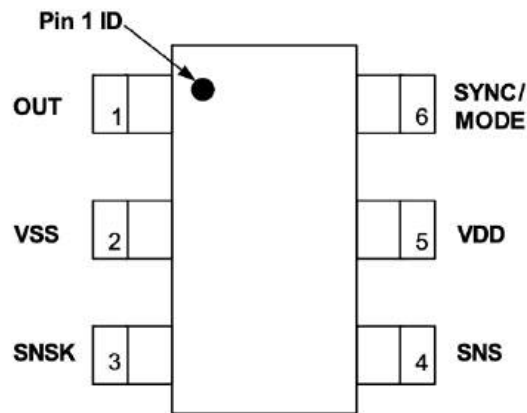
1528-1782-ND

Cost: \$5.95

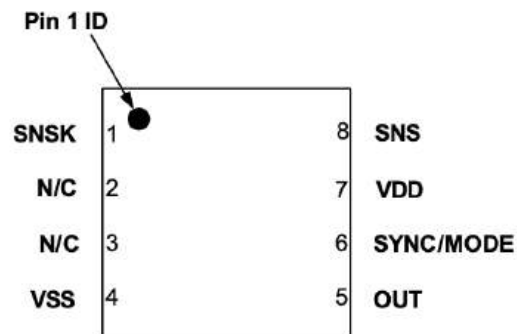
Dimensions: 20mm / 0.8" x 28mm / 1.1"

Weight: 1.87g

### 1.1.1 6-pin SOT23-6



### 1.1.2 8-pin UDFN/USON



The AT42QT1010 (QT1010) is a digital burst mode charge-transfer (QT™) sensor that is capable of detecting near-proximity or touch, making it ideal for implementing touch controls.

With the proper electrode and circuit design, the self-contained digital IC will project a touch or proximity field to several centimeters through any dielectric like glass, plastic, stone, ceramic, and even most kinds of wood. It can also turn small metal-bearing objects into intrinsic sensors, making them responsive to proximity or touch. This capability, coupled with its ability to self-calibrate, can lead to entirely new product concepts.

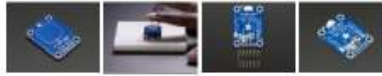
### Conclusions/action items:

Based on this research, this is another option that we could order for sensor



## Standalone Momentary Capacitive Touch Sensor Breakout – AT42QT1010

Product ID: 1374



### Description

This breakout board is the simplest way to create a project with a single "momentary" capacitive touch sensor. No microcontroller is required here – just power with 1.8 to 5.5VDC and touch the pad to activate the sensor.

When a capacitive load is detected (e.g. a person touches the sensor-pad area) the red LED lights up and the output pin goes high. You can also solder a wire to the middle pad and create your own capacitive pad if the built-in one isn't suited to your project.

If you want to save power, the LED can be disconnected from the output pin (cut the trace between the jumper marked as such). We designed this breakout to have the more-responsive "fast mode" which draws about 0.5mA. If you need ultra-low (< 50uA) power usage, the mode jumper can be cut on one side & soldered closed on the other to fix it into that mode. Check the datasheet for specific power usage measurements.

[Download](#)

1374\_Web.pdf (107 kB)

NOOR AWAD (nawad2@wisc.edu) - Mar 06, 2026, 10:52 AM CST

#### Features

- Number of keys:
  - One
  - Configurable as either a single key or a proximity sensor
- Technology:
  - Patented spread-spectrum charge-transfer (direct mode)
- Key outline sizes:
  - 8 mm x 8 mm or larger (panel thickness dependent); widely different sizes and shapes possible
- Electrode design:
  - Ball or ring electrode shapes
- PCB Layers required:
  - One
- Electrode materials:
  - Etched copper, silver, carbon, Indium Tin Oxide (ITO)
- Electrode substrates:
  - PCB, FRPCB, plastic films, glass
- Panel materials:
  - Polycarbonate, glass, composites, painted surfaces (fine particle density materials possible)
- Panel thickness:
  - Up to 12 mm glass, 8 mm plastic (electrode size and Cu dependent)
- Key sensitivity:
  - Adjustable via capacitor (Ca)
- Interfaces:
  - Digital output, active high
- Moisture tolerance:
  - Good
- Power:
  - 1.8V – 5.5V; 17 µA at 1.8V typical
- Package:
  - 5-pin SOT23-6 RoHS compliant
  - 3-pin LED/NO/NCN RoHS compliant
- Signal processing:
  - Self calibration, auto dE compensation, noise filtering
- Applications:
  - Control panels, consumer appliances, proximity sensor applications, toys, lighting controls, mechanical switch or buttons
- Features:
  - QTouch® (patented charge-transfer method)
  - NearBrew™ (monitoring health of device)

**One-channel  
Touch Sensor  
IC**

---

**AT42QT1010**

www.atmel.com

[Download](#)

AT42QT1010.pdf (714 kB)



## 3/11/26 - Sensor Research

NOOR AWAD (nawad2@wisc.edu) - Mar 12, 2026, 8:19 PM CDT

**Title:** DIY Sensor

**Date:** 3/11/26

**Content by:** Noor Awad

**Citation:** Maker.io Staff, "How to Add Capacitive Sensing to Any Arduino Project," *DigiKey Maker.io*, 2021. [Online]. Available: <https://www.digikey.com/en/maker/tutorials/2021/how-to-add-capacitive-sensing-to-any-arduino-project>. [Accessed: Mar. 11, 2026].

**Goals:** Learn how to make capacitive sensor before we order

### Content:

- conductive object to form one plate of the sensor, an Arduino, a relatively large value resistor, and a few jumper wires to build a simple capacitive proximity sensor. The resistor connects D2 and D12 of the Arduino. Additionally, pin D2 also connects one side of the resistor to a metal object such as a paperclip, a piece of aluminum foil, or a tool

```
#include <CapacitiveSensor.h>

CapacitiveSensor sensor = CapacitiveSensor(2,12);

void setup()
{
  Serial.begin(9600);

  // Disable the automatic re-calibration feature of the
  // capacitive sensor library
  sensor.set_CS_Autocal_Millis(0xFFFFFFFF);
}

void loop()
{
  long current_millis = millis();
  long capacitance = sensor.capacitiveSensor(30);

  // Print the result of the sensor reading
  // Note that the capacitance value is an arbitrary number
```

### Conclusions/action items:

Based on this article, the group could practice using this sensor until we decide/are waiting on the actual sensor to arrive.





## 3/12/26 - Circuit Protocol writing

NOOR AWAD (nawad2@wisc.edu) - Mar 12, 2026, 8:18 PM CDT

**Title:** Circuit Protocol writing

**Date:** 3/12/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Create a step by step fabrication protocol. This will be use in conjunction with the Fritzing diagram, but it specifies the order and the pin connections.

**Content:**

### 5. Detailed steps of fabrication

#### 1. Acquire materials listed below:

- a. Arduino UNO R4 Minima
- b. 9V battery
- c. Tactile Switch Button
- d. DPDT Waterproof Rocker Switch 20A
- e. Piezo Speaker Module for Arduino Buzzer
- f. 8x8 LED Board
- g. TTP223B Capacitive Touch Sensor Switch for Arduino Raspberry Pi
- h. Wires to connect parts of the circuit

#### 2. Construct Fritzing Diagram as shown.

- a. Connect red lead of the battery into Vin of Arduino, negative lead to GND
- b. Connect Arduino 5 V pin to the red rail of breadboard, Arduino GND pin to black rail on breadboard
- c. Connect center pin of Rocker switch to 5V, and outer pin to digital pin (insert number)
- d. Connect a (value) resistor from the digital pin to GND.
- e. Place each button between center of breadboard, connect one leg of each to 5V rail and diagonally opposite leg to Digital pin (#)
- f. Connect 10k resistor from digital pin (#) to GND
- g. Connect Vcc of capacitive touch sensor to 5V rail, and GND to ground rail. Connect output to digital pin (#)
- h. Connect Vcc+ of piezo speaker to digital pin 5, and GND of buzzer to GND rail
- i. Connect Vcc of 8x8 LED matrix to 5V rail, and GND to ground rail. Connect input of LED to Digital pin (#)
- j. Implementing code
  - i. Cross check digital pin assignments to Arduino IDE definitions for both inputs and outputs
  - ii. Upload code to Arduino and double check for errors before turning power on. Optionally, the circuit can be tested with the Arduino powered by USB before the 9 V battery is in place.

**Conclusions/action items:**

Based on this protocol, we can test the building of the circuit with someone who did not write the protocol to ensure it is easy to follow.



## 4/14/26 Testing speaker code

---

NOOR AWAD (nawad2@wisc.edu) - Apr 17, 2026, 6:31 PM CDT

**Title:** Speaker testing code

**Date:** 4/14

**Content by:** Noor Awad

**Present:** Noor and Kat

**Goals:** Create code that simply tests if the speaker is working, with/without button

**Content:**

```
#define MODE_BUTTON 7
```

```
#define SPEAKER A0
```

```
void setup() {
```

```
  pinMode(MODE_BUTTON, INPUT_PULLUP);
```

```
  pinMode(SPEAKER, OUTPUT);
```

```
}
```

```
void loop() {
```

```
  // Check if the button is pressed
```

```
  if (digitalRead(MODE_BUTTON) == LOW) {
```

```
    // Play a 1000Hz tone
```

```
    tone(SPEAKER, 1000);
```

```
  }
```

```
  else {
```

```
    // Stop the sound when the button is released
```

```
    noTone(SPEAKER);
```

```
  }
```

```
}
```

**Conclusions/action items:**

Use this code to isolate the behavior of the speaker



## 4/12/26 Testing display code

---

NOOR AWAD (nawad2@wisc.edu) - Apr 17, 2026, 6:32 PM CDT

**Title:** Display testing code

**Date:** 4/12/26

**Content by:** Noor Awad

**Present:** Noor

**Goals:** Test hardware connections of the display

**Content:**

```
#include "LedControl.h"
```

```
// DIN: 11, CLK: 13, CS: 10, Number of displays: 1
```

```
LedControl lc = LedControl(11, 13, 10, 1);
```

```
void setup() {
```

```
    lc.shutdown(0, false);    // Wake up the MAX7219
```

```
    lc.setIntensity(0, 8);    // Set brightness (0-15)
```

```
    lc.clearDisplay(0);      // Clear the matrix
```

```
}
```

```
void loop() {
```

```
    // Light up each LED one by one
```

```
    for (int row = 0; row < 8; row++) {
```

```
        for (int col = 0; col < 8; col++) {
```

```
            lc.setLed(0, row, col, true);
```

```
            delay(50);
```

```
            lc.setLed(0, row, col, false);
```

```
        }
```

```
    }
```

```
}
```

**Conclusions/action items:**

Use this code to isolate behavior of the display



## 4/14/26 Testing button code

---

**Title:** Button testing code

**Date:** 4/14/26

**Content by:** Noor

**Present:** Noor and Kat

**Goals:** Use this code to isolate the behavior of the buttons

**Content:**

```
#include <Adafruit_NeoPixel.h>
#define LED_PIN 11#define NUM_LEDS 64#define MODE_BUTTON 7
Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);
void setup() { pinMode(MODE_BUTTON, INPUT_PULLUP); // Internal pullup - no power wire needed matrix.begin(); matrix.setBrightness(127); // 50% brig
void loop() { // If button is pressed (connected to GND) if (digitalRead(MODE_BUTTON) == LOW) { // Fill with a test color (Purple) for (int i =
matrix.show();}
```

**Conclusions/action items:**

Use this code to test the function of the buttons with the battery connected.

**4/21/26 - FINAL CODE**

---

NOOR AWAD (nawad2@wisc.edu) - Apr 21, 2026, 6:55 PM CDT

**Title:** Final code**Date:** 4/21/26**Content by:** Noor Awad**Present:** Noor, Kat, Freyja**Goals:** Document final code**Content:**

```
#include <Adafruit_NeoPixel.h>
```

```
#define LED_PIN 11
```

```
#define NUM_LEDS 64
```

```
#define MODE_BUTTON 7
```

```
#define TRIG_PIN 3
```

```
#define ECHO_PIN 5
```

```
Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);
```

```
// --- MODES ---
```

```
// 0 = Red/Blue Toggle Mode
```

```
// 1 = Random Mode
```

```
// 2 = Sensor Mode (Flashes Green at 35cm)
```

```
int currentMode = 0;
```

```
// Toggle state
```

```
bool redState = true;
```

```
// Button timing
```

```
unsigned long buttonPressTime = 0;
```

```
bool buttonWasDown = false;
```

```
// Random color tracking
```

```
uint32_t currentRandomColor;
```

```
int lastChoice = -1;
```

```
// Sensor & Flashing variables
```

```
int currentDistance = 0;
```

```
const int distanceThreshold = 35; // Bumped threshold to 35 cm
```

```
bool isFlashing = false;
```

```
int flashCount = 0;
```

```
unsigned long lastFlashTime = 0;
```

```
bool flashState = false;
```

```
// Timing variables
```

```
unsigned long lastUpdate = 0;
```

```
int updateInterval = 50;
```

```
unsigned long lastSerialPrint = 0;
```

```
// =====
```

```
// FUNCTION PROTOTYPES
```

```
// =====
```

```
void handleButton();
```

```
void checkSensor();
```

```
void updateMatrix();
```

```
void setRandomColor();
```

```
void setup() {  
  Serial.begin(9600);  
  
  pinMode(MODE_BUTTON, INPUT_PULLUP);  
  pinMode(TRIG_PIN, OUTPUT);  
  pinMode(ECHO_PIN, INPUT);  
  
  matrix.begin();  
  matrix.setBrightness(127); // 50% brightness  
  matrix.show();  
  
  randomSeed(analogRead(A1));  
  
  Serial.println("System Started... 3 Modes Available.");  
}  
  
void loop() {  
  handleButton();  
  checkSensor();  
  updateMatrix();  
}  
  
/* ----- BUTTON LOGIC ----- */  
void handleButton() {  
  bool buttonDown = (digitalRead(MODE_BUTTON) == LOW);  
  
  if (buttonDown && !buttonWasDown) {  
    buttonPressTime = millis();
```

```
    buttonWasDown = true;

}

if (!buttonDown && buttonWasDown) {

    unsigned long heldTime = millis() - buttonPressTime;

    // SUPER LONG PRESS (5+ Seconds)

    if (heldTime >= 5000) {

        currentMode = 2;

        isFlashing = false; // Reset flash state if switching into this mode

        Serial.println("Switched to: SENSOR MODE (35cm Threshold)");

    }

    // LONG PRESS (2 to 4.9 Seconds)

    else if (heldTime >= 2000) {

        if (currentMode == 0) {

            currentMode = 1;

            setRandomColor();

            Serial.println("Switched to: RANDOM MODE");

        } else {

            currentMode = 0;

            redState = true;

            Serial.println("Switched to: RED/BLUE TOGGLE");

        }

    }

    // SHORT PRESS (Under 2 Seconds)

    else {

        if (currentMode == 0) {

            redState = !redState;

            Serial.println("Color Toggled");

        }

    }

}
```

```
    }

    else if (currentMode == 1) {

        setRandomColor();

        Serial.println("Random Color Changed");

    }

}

    buttonWasDown = false;

}

}

/* ----- RANDOM COLOR (NO REPEATS) ----- */

void setRandomColor() {

    int choice;

    do {

        choice = random(5);

    } while (choice == lastChoice);

    lastChoice = choice;

    switch (choice) {

        case 0: currentRandomColor = matrix.Color(255,0,0); break;

        case 1: currentRandomColor = matrix.Color(0,255,0); break;

        case 2: currentRandomColor = matrix.Color(255,255,0); break;

        case 3: currentRandomColor = matrix.Color(0,0,255); break;

        case 4: currentRandomColor = matrix.Color(128,0,128); break;

    }

}
```

```
/* ----- SENSOR LOGIC ----- */  
  
void checkSensor() {  
  if (currentMode != 2) return;  
  
  digitalWrite(TRIG_PIN, LOW);  
  delayMicroseconds(2);  
  digitalWrite(TRIG_PIN, HIGH);  
  delayMicroseconds(10);  
  digitalWrite(TRIG_PIN, LOW);  
  
  long duration = pulseIn(ECHO_PIN, HIGH, 30000);  
  currentDistance = duration * 0.034 / 2;  
  
  if (millis() - lastSerialPrint > 250) {  
    Serial.print("Distance: ");  
    if (currentDistance == 0) {  
      Serial.println("Out of range");  
    } else {  
      Serial.print(currentDistance);  
      Serial.println(" cm");  
    }  
    lastSerialPrint = millis();  
  }  
}  
  
/* ----- LED UPDATE ----- */  
  
void updateMatrix() {  
  if (millis() - lastUpdate < updateInterval) return;
```

```
lastUpdate = millis();

uint32_t color = matrix.Color(0, 0, 0);

if (currentMode == 0) {
    color = redState ? matrix.Color(255,0,0) : matrix.Color(0,0,255);
}
else if (currentMode == 1) {
    color = currentRandomColor;
}
else if (currentMode == 2) {

    // 1. Start the flash sequence if hand is detected
    if (!isFlashing && currentDistance > 0 && currentDistance <= distanceThreshold) {
        isFlashing = true;
        flashCount = 0;
        flashState = true;
        lastFlashTime = millis();
        Serial.println("Target Detected! Fast flashing sequence started.");
    }

    // 2. Handle the non-blocking flashes
    if (isFlashing) {
        if (millis() - lastFlashTime >= 150) { // Dropped to 150ms for a quick, short flash
            lastFlashTime = millis();
            flashState = !flashState; // Toggle lights on/off

            if (flashState == false) {
                flashCount++; // Count goes up every time the light turns off
            }
        }
    }
}
```

```
    }  
  }  
  
  // Stop flashing after 3 full cycles  
  if (flashCount >= 3) {  
    isFlashing = false;  
    flashState = false;  
    currentDistance = 0; // Force a fresh sensor read so it doesn't loop instantly  
  }  
  
  // Apply the color based on whether we are currently "on" or "off" in the flash cycle  
  color = flashState ? matrix.Color(0, 255, 0) : matrix.Color(0, 0, 0);  
  
} else {  
  // Not triggered, sit completely off  
  color = matrix.Color(0, 0, 0);  
}  
}  
  
for (int i = 0; i < NUM_LEDS; i++) {  
  matrix.setPixelColor(i, color);  
}  
matrix.show();  
}
```

**Conclusions/action items:**

Use this in case code needs to be reloaded onto arduino



[Download](#)

**FINAL\_PROJECT\_CODE.ino (5.56 kB)**



## 4/22/26 - final code with correct brightness

---

NOOR AWAD (nawad2@wisc.edu) - Apr 22, 2026, 7:41 PM CDT

**Title:** Final code

**Date:** 4/21/26

**Content by:** Noor Awad

**Present:** Noor, Kat, Freyja

**Goals:** Document final code with correct brightness

**Content:**

```
#include <Adafruit_NeoPixel.h>
```

```
#define LED_PIN 11
```

```
#define NUM_LEDS 64
```

```
#define MODE_BUTTON 7
```

```
#define TRIG_PIN 3
```

```
#define ECHO_PIN 5
```

```
Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);
```

```
// --- MODES ---
```

```
// 0 = Red/Blue Toggle Mode
```

```
// 1 = Random Mode
```

```
// 2 = Sensor Mode (Flashes Green at 35cm)
```

```
int currentMode = 0;
```

```
// Toggle state
```

```
bool redState = true;
```

```
// Button timing
```

```
unsigned long buttonPressTime = 0;
```

```
bool buttonWasDown = false;
```

```
// Random color tracking
```

```
uint32_t currentRandomColor;
```

```
int lastChoice = -1;
```

```
int currentDistance = 0;
```

```
const int distanceThreshold = 35; // Bumped threshold to 35 cm
```

```
bool isFlashing = false;
```

```
int flashCount = 0;
```

```
unsigned long lastFlashTime = 0;
```

```
bool flashState = false;
```

```
// Timing variables
```

```
unsigned long lastUpdate = 0;
```

```
int updateInterval = 50;
```

```
unsigned long lastSerialPrint = 0;
```

```
void handleButton();
```

```
void checkSensor();
```

```
void updateMatrix();
```

```
void setRandomColor();
```

```
void setup() {
```

```
Serial.begin(9600);
```

```
pinMode(MODE_BUTTON, INPUT_PULLUP);
```

```
pinMode(TRIG_PIN, OUTPUT);
```

```
pinMode(ECHO_PIN, INPUT);
```

```
matrix.begin();
```

```
matrix.setBrightness(32);
```

```
matrix.show();
```

```
randomSeed(analogRead(A1));
```

```
Serial.println("System Started... 3 Modes Available.");
```

```
}
```

```
void loop() {
```

```
  handleButton();
```

```
  checkSensor();
```

```
  updateMatrix();
```

```
}
```

```
//BUTTON
```

```
void handleButton() {
```

```
  bool buttonDown = (digitalRead(MODE_BUTTON) == LOW);
```

```
  if (buttonDown && !buttonWasDown) {
```

```
    buttonPressTime = millis();
```

```
    buttonWasDown = true;
```

```
  }
```

```
if (!buttonDown && buttonWasDown) {  
    unsigned long heldTime = millis() - buttonPressTime;  
  
    // LONG PRESS  
    if (heldTime >= 5000) {  
        currentMode = 2;  
        isFlashing = false; // Reset flash state if switching into this mode  
        Serial.println("Switched to: SENSOR MODE (35cm Threshold)");  
    }  
  
    // LONG PRESS (2 to 4.9 Seconds)  
    else if (heldTime >= 2000) {  
        if (currentMode == 0) {  
            currentMode = 1;  
            setRandomColor();  
            Serial.println("Switched to: RANDOM MODE");  
        } else {  
            currentMode = 0;  
            redState = true;  
            Serial.println("Switched to: RED/BLUE TOGGLE");  
        }  
    }  
  
    // SHORT PRESS (Under 2 Seconds)  
    else {  
        if (currentMode == 0) {  
            redState = !redState;  
            Serial.println("Color Toggled");  
        }  
        else if (currentMode == 1) {
```

```
    setRandomColor();

    Serial.println("Random Color Changed");

}

}

    buttonWasDown = false;

}

}

//RANDOM MODE

void setRandomColor() {

    int choice;

    do {

        choice = random(5);

    } while (choice == lastChoice);

    lastChoice = choice;

    switch (choice) {

        case 0: currentRandomColor = matrix.Color(255,0,0); break;

        case 1: currentRandomColor = matrix.Color(0,255,0); break;

        case 2: currentRandomColor = matrix.Color(255,255,0); break;

        case 3: currentRandomColor = matrix.Color(0,0,255); break;

        case 4: currentRandomColor = matrix.Color(128,0,128); break;

    }

}

//SENSOR LOGIC
```



```
uint32_t color = matrix.Color(0, 0, 0);
```

```
if (currentMode == 0) {
```

```
    color = redState ? matrix.Color(255,0,0) : matrix.Color(0,0,255);
```

```
}
```

```
else if (currentMode == 1) {
```

```
    color = currentRandomColor;
```

```
}
```

```
else if (currentMode == 2) {
```

```
    // 1. Start the flash sequence if hand is detected
```

```
    if (!isFlashing && currentDistance > 0 && currentDistance <= distanceThreshold) {
```

```
        isFlashing = true;
```

```
        flashCount = 0;
```

```
        flashState = true;
```

```
        lastFlashTime = millis();
```

```
        Serial.println("Target Detected! Fast flashing sequence started.");
```

```
    }
```

```
    // 2. Handle the non-blocking flashes
```

```
    if (isFlashing) {
```

```
        if (millis() - lastFlashTime >= 150) { // Dropped to 150ms for a quick, short flash
```

```
            lastFlashTime = millis();
```

```
            flashState = !flashState; // Toggle lights on/off
```

```
        if (flashState == false) {
```

```
            flashCount++; // Count goes up every time the light turns off
```

```
        }
```

```
    }
```

```
// Stop flashing after 3 full cycles

if (flashCount >= 3) {

  isFlashing = false;

  flashState = false;

  currentDistance = 0; // Force a fresh sensor read so it doesn't loop instantly

}

// Apply the color based on whether we are currently "on" or "off" in the flash cycle

color = flashState ? matrix.Color(0, 255, 0) : matrix.Color(0, 0, 0);

} else {

  // Not triggered, sit completely off

  color = matrix.Color(0, 0, 0);

}

}

for (int i = 0; i < NUM_LEDS; i++) {

  matrix.setPixelColor(i, color);

}

matrix.show();

}
```

**Conclusions/action items:**

Use this in case code needs to be reloaded onto arduino



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**citiCompletionCertificate\_15029138\_73348273.pdf (77.4 kB)**



## 3/20/26 HIPAA training

NOOR AWAD (nawad2@wisc.edu) - Mar 20, 2026, 11:56 AM CDT

**Title:** HIPAA training documentation

**Date:** 3/20/26

**Content by:** Noor Awad

**Present:** N/A

**Goals:** Learn about Hipaa restrictions and complete training

**Content:**

See attached

**Conclusions/action items:**

Based on this, I will have guidelines if we do testing with real patients, also have guidelines for the videos/materials we are allowed to show in presentations etc.

NOOR AWAD (nawad2@wisc.edu) - Mar 20, 2026, 4:04 PM CDT

This certifies that Noor Awad has completed training for the following course(s):


[Expand All](#) [Collapse All](#)

Course	Assignment	Completion	Expiration
2025-2026 HIPAA Privacy & Security Training	2025-2026 HIPAA Privacy & Security Training	3/20/2026	
Biosafety Required Training	Biosafety Required Training Quiz 2024	11/14/2024	11/14/2029
Chemical Safety: The OSHA Lab Standard	Final Quiz	3/8/2025	
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	10/31/2025	10/31/2028

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Screenshot\_2026-03-20\_at\_4.02.45\_PM.png (205 kB)

 **4/3/26 - All training**

NOOR AWAD (nawad2@wisc.edu) - Apr 03, 2026, 10:58 PM CDT

**Title:** All Trainings


**Date:** 4/3/26

**Content by:** Noor Awad

**Present:**

**Goals:**

**Content:**



**NOOR AWAD**  
ID Number: 9981221014  
Eligible: O&E Graduate

Profile  
Program Registrations  
Bookings  
**Memberships**  
Orders  
Services

**My Memberships**

Membership Type	Start Date	Expiry Date	Renew	Card Info
Shop Tools	Fri, Feb 21 2023	Permanent	Not Renewable	N/A
Machining	Tue, Aug 21 2024	Permanent	Not Renewable	N/A
Shop Tools - Training Eligible	Tue, Aug 21 2024	Wed, Dec 31 2026	Not Renewable	N/A
Machining - Training Eligible	Tue, Aug 21 2024	Wed, Dec 31 2026	Not Renewable	N/A
Lab Orientation	Tue, Aug 21 2024	Wed, Dec 31 2026	Not Renewable	N/A



This certifies that Noor Awad has completed training for the following course(s):

Expand All
Collapse All

Course	Assignment	Completion	Expiration
2025-2026 HIPAA Privacy & Security Training	2025-2026 HIPAA Privacy & Security Training	3/20/2026	
Biosafety Required Training	Biosafety Required Training Quiz 2024	11/14/2024	11/14/2029
Chemical Safety: The OSHA Lab Standard	Final Quiz	3/8/2025	
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	10/31/2025	10/31/2028

Data Last Imported: 04/03/2026 09:55 PM

**Conclusions/action items:**

 **4/9/26 Shop Training**

NOOR AWAD (nawad2@wisc.edu) - Apr 09, 2026, 10:53 AM CDT

**Title:** Design Innovation Lab trainings

**Date:** 4/9/26 (completion dates shown below)

**Content by:**

**Present:**

**Goals:**

**Content:**



**NOOR AWAD**  
 ID Number: 9086121614  
 Eligibility: CoE Students

Profile

My Memberships				
Membership Type	Start Date	Expiry Date	Renew	Card Info
Shop Tools	Fri, Feb 21 2025	Permanent	Not Renewable	N/A
Machining	Tue, Aug 20 2024	Permanent	Not Renewable	N/A
Shop Tools - Training Eligible	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable	N/A
Machining - Training Eligible	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable	N/A
Lab Orientation	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable	N/A

**Conclusions/action items:**

Based on these trainings I am able to use the makerspace to fabricate our carbon fiber and etchings.



## 1/28/26 - Lecture 2

---

NOOR AWAD (nawad2@wisc.edu) - Jan 28, 2026, 1:53 PM CST

### **Title: Library Session 1**

**Date:** 1/28/26

**Content by:** Librarian

**Present:** BME 301

**Goals:** Learn how to use citation manager and evaluate sources

### **Content:**

- 
- How the technology works
  - Chatbots and search engines both learn from the internet, but databases pull their information from a set of sources
  - If using chatbots, keep in mind they are not search engines and don't always generate factually correct sources (they can make up their own sources)
  - Do not always respond to prompts consistently
  - Trained on undisclosed data
- Search database library
  - might need to look outside of the engineering category
  - Usually use scopus
    - related category biomedical engineering
    - multidisciplinary
    - narrow down
  - Can use findit@uw to get journal articles, might have to wait.
- Using zotero
  - Can integrate this into google doc/word
- Evaluating your sources
  - Relevance
  - Authority
  - Quality
  - Currency
  - Tip: Read laterally!
- Technical reports
  - DETIC publishes all government funded research

### **Conclusions/action items:**

Based on this lecture I have learned how to manipulate search terms to find the most relevant sources. I also learned how to integrate zotero into my research process and how to use zotero to export a final bibliography. When beginning to find primary sources for my project I will use these strategies and my group is going to start a group zotero folder.



## 2/4/26 - Lecture 3

---

NOOR AWAD (nawad2@wisc.edu) - Feb 04, 2026, 2:01 PM CST

**Title:** BME 301 Lecture 3

**Date:** 2/3/26

**Content by:** Noor Awad

**Present:** BME 301

**Goals:** Gain feedback on resume and cover letter, learn more about professional development

**Content:**

- Photo of materials will be uploaded to canvas
- Trading resumes and cover letters with peers, giving feedback based on rubric

**Conclusions/action items:**

Based on this activity I will make the edits to my resume and cover letter and upload to next week's assignment



## 2/11/26 - Lecture 4

---

NOOR AWAD (nawad2@wisc.edu) - Feb 11, 2026, 1:37 PM CST

### **Title: Presentation Tips and Job Interviews**

**Date:** 2/11/26

**Content by:** Dr. P

**Present:** BME 301

**Goals:** Prep for presentations next week, get interviewing tips and feedback

### **Content:**

- Bring printout of team's slides to next lecture, 6 pages per sheet, fit to printable area, need a copy per team member
- upload slides to canvas and website by 10
- never have a hanging bullet
- top left bullet should line up across all slides
- be consistent with font style
- legible including on all graphs and images
- organization - pick a logical flow
- use your content - don't use a picture that you're not going to talk about
- 6 words x 6 lines per slide and 1 minute per slide
- Design ideas should be presented in the same order in all places - initial designs and then within the design matrix
- Keep audience interested
  - So What?
  - Attitude
    - don't talk down to your audience, don't say as you should know
  - Presence
  - Mannerisms
- Hit the highlights on design matrix, USE TEMPLATE, say most important criteria and explain the weight
- Figure captions
  - GO BACK TO SLIDE
- Think about highlighting testing data from continuing projects
- Graphics - CAD
  - One or two clear images
  - Never use a drawing from CAD
  - Use one view, with clear labels
  - Graphics remove background
  - Clean and clean lines
  - Labels and scale required
  - Always put drawings into iPad
- Testing
  - minimum of 3 times
  - always graphical

- bin trials - average  $\pm$  standard deviation
- graphed on same scale, allows comparisons
- Effective storytelling through figures
  - visualize and describe context of use
  - show how the design works
    - exploded view
    - Block diagrams (REVISIT THIS IDEA FOR ELECTRONICS)

**Conclusions/action items:**

Based on this lecture, I want to make sure to check our presentation against these guidelines. Also, I want to create a flow diagram for the electronics portion. Also, I will make sure to follow this for testing, because I have made these common errors before.



## 2/18/26 - Lecture 5

---

NOOR AWAD (nawad2@wisc.edu) - Feb 18, 2026, 1:26 PM CST

**Title:** 2/18/26 Lecture

**Date:** 2/18/26

**Content by:** Noor Awad

**Present:** BME 301

**Goals:** Get feedback on presentation.

**Content:**

Presentation peer review

**Conclusions/action items:**



## 3/4/26 - Lecture 7

---

NOOR AWAD (nawad2@wisc.edu) - Mar 04, 2026, 2:00 PM CST

**Title:** BME 301 Library Session 2: Patents, Standards, and other Resources

**Date:** 3/4/26

**Content by:** Dave Bloom

**Present:** BME 301

**Goals:** Learn more about patents and standards for research for our project

**Content:**

- Market/Industry sources
  - Data axle
  - IBIS world
  - ProQuest One Business
- Tong award has business element with market analysis required
- Patents and Prior art
  - Searching
  - Take 5 minutes to explore [lens.org](https://lens.org)
  - Evaluation
    - Usefulness
    - Novelty
    - Non-obviousness
      - bar is set higher for novelty and non-obviousness
  - Claims
    - define legally enforceable aspects of patent
    - every utility patent has at least one claim
  - dependent claims
    - must refer to previous claims
    - must further limit the claim
    - includes all limitations of claim it refers to

**Conclusions/action items:**

Based on this lecture, I have learned how to use [lens.org](https://lens.org) to view patents and know how to compare them. I will use this when doing research to compare our device



## 3/6/26 - Tong Lecture

---

NOOR AWAD (nawad2@wisc.edu) - Mar 06, 2026, 12:09 PM CST

**Title:** Tong Lecture

**Date:** 3/6/26

**Content by:** Dr. Williams

**Present:** BME Design

**Goals:**

**Content:**

**Conclusions/action items:**



## 3/11/26 - Lecture 8

---

NOOR AWAD (nawad2@wisc.edu) - Mar 11, 2026, 1:59 PM CDT

**Title:** Protocol Development

**Date:** 3/11/26

**Content by:** Dr. P

**Present:** BME 301

**Goals:**

**Content:**

1. Fail fast and fail forward
2. low-fidelity, cardboard
3. Documentation
4. test individual components
5. Preliminary testing/analysis
  1. circuit diagrams
  2. fittings
  3. connection points
  4. simple calculations
  5. free body diagrams
  6. MOM
6. Planning general concept for fab and testing
  1. Materials - detailed list
  2. methods - step by step plan
7. Methods
  1. Step by step plan
  2. rule #1 - repeatable by unfamiliar reader
8. 3D printing
  1. Same rules apply plus more
  2. materials, methods
  3. gCode file
9. Manufacturing
  1. Consider throughout the process
  2. Cannot manufacture everything you can print
  3. Common methods
    1. Molding - Blow, injection, thermoforming, extrusion, rotational
    2. Machining - mill/lathe, waterjet
    3. Joining - welding, soldering, screwing, riveting, adhesives
10. Fabrication plans
  1. use template from slides
  2. sketches for each component with labels
11. Testing plan - additional considerations
  1. Think about statistics before you start

2. What controls are needed

3. Do you have to design something to ensure precision and accuracy

1. test fixture for MTS

2. apparatus to hold items in a fixed position

12. Spent rest of lecture building protocol

**Conclusions/action items:**

Based on this lecture the group is going to create a fabrication protocol for electronic fabrication, handle construction.



## 3/18/26 - Lecture 9

---

NOOR AWAD (nawad2@wisc.edu) - Mar 18, 2026, 1:40 PM CDT

**Title:** Lecture 9

**Date:** 3/18/26

**Content by:** Dr. P

**Present:** BME 301

**Goals:** Learn tips and tricks for writing in technical reports and elevator pitches

**Content:**

- Elevator pitches
  - Succintly and effectively communicate your ideas
  - seize opportunities
  - goal
    - Capture attention
    - Generate interest
    - Leave a memorable impression
    - come away with a win
  - Crafting
    - Know your audience
    - Practice
    - Be authentic
    - Keep it simple
    - Adapt and irate
  - General structure
    - Attention grabber
      - Start with a hook
    - Introduction - we are working on project X
    - Value proposition - that is trying to solve Y
      - Clearly articulate what you offer and the problem you solve
      - Target customer
      - Demonstrate what you already have
    - Benefits
      - Highlight the key benefits or advantages
      - Unique features and benefits of your product
    - Call to action
      - We are struggling to model Z, what are your suggestions?
  - Tong award
    - Attention grabber
      - We've developed a device to do X
    - Introduction - we are working on project X
    - Value proposition - currently there is not a device to do X as existing technologies and patents fail because of Y

- Benefits - it is estimated that Z people would benefit from this device which has a potential market of \$, we have filed for a patent with WARF. Demonstrate the prototype fully
- Call to action
  - Do you have any questions
- Dos and Donts of elevator pitches
  - Do
    - maintain eye contact and exude confidence
    - Do keep it concise and focused
    - Do tailor your pitch to different audiences
  - Don'ts
    - Don't overwhelm with unnecessary details
    - Don't forget to listen to audience
    - Don't sound rehearsed or robotic
- Structure of an Executive Summary based on different awards changes
  - crafting
    - Know your audience
    - focus on the essentials
    - Use clear and concise language
    - Highlight key points
    - Maintain professionalism
- Purpose of an abstract
  - Provides a clear and concise and specific summary of your work
  - helps readers decide if they want to read the full paper
  - journals may require a longer executive summary style abstract
  - typically 150-300 words
  - Write it last!
- Technical reports - writing concisely
  - Eliminate extraneous text
  - avoid conversational text
  - Spell out acronyms when first introduced
  - remove redundancies
  - Do not include raw data - could go in an appendix
  - Proofread thoroughly - entire document

### **Conclusions/action items:**

Based on this lecture, I have learned about how to stay concise in these different writing settings and will apply it to show and tell and final presentations.



## 3/25/26 - Lecture 10

NOOR AWAD (nawad2@wisc.edu) - Mar 25, 2026, 2:05 PM CDT

**Title:** Ethics in Engineering

**Date:** 3/25/26

**Content by:** Noor Awad

**Present:** BME 301

**Goals:**

**Content:**

- How do you define ethics? Is there a difference between "personal" ethics and "professional" ethics?
  - BMES has a code of ethics, board of your company defines ethics
- In your design teams, identify components (at least 2) of your design that could face ethical dilemmas or have an ethical dimension (for example, safety is often a trade-off).
  - a. Our design could not be accessible for colorblind patients as the screen uses red and green colors.
  - b. The design may not be accessible for therapists that cannot properly hold it up throughout the whole therapy session.
- Consider the appropriate language in ABET Outcome 4: an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
  - a. Done
- Read through BME code of ethics: <https://www.bmes.org/bmes2023-policies>
- Review the [Code of Ethics for Engineers and Ethical decision-making system](#)
- Type up your answers and add to the case study answers (Q 1-4 above) – upload to Canvas. Copy and paste your design-specific ethics responses into your design notebook.
  - What components of your design have ethical dimensions (be specific and list at least 2)?
    - The display component of the design- not everyone can differentiate between certain colors
    - The weight of the entire design may be too much for the therapist to use
  - How will your team address the ethical dimensions? (What is your action plan?)
    - For each component:
    - We could make the device have a red and blue screen to accommodate for patients with red/green colorblindness
    - We could lower the perceived weight even further and add an additional support so it could maybe support itself.

**Conclusions/action items:**

Based on this lecture I learned about ethical codes we should follow, and how this applies to our project



## 4/8/26 - Lecture 11

---

NOOR AWAD (nawad2@wisc.edu) - Apr 08, 2026, 2:04 PM CDT

**Title:** Engineering Judgement

**Date:** 4/8/26

**Content by:** Dr. P

**Present:** BME 301

**Goals:** Learn about engineering judgement

**Content:**

- How do you learn engineering judgement?
  - Real world engineering problems
  - Open ended problems
  - Teamwork and collaboration with others
  - Critical thinking
  - Communication
  - Handling uncertainty
  - Intuition
  - Ask questions
  - Embrace life long learning
- Filled out handout

**Conclusions/action items:**

Based on this activity I learned about the three parts of the engineering judgement model and applied it to past experiences



## 4/15/26 - Lecture 13

---

NOOR AWAD (nawad2@wisc.edu) - Apr 15, 2026, 1:52 PM CDT

**Title:** Poster presentation tips

**Date:** 4/15/26

**Content by:** Dr. P

**Present:** BME 301

**Goals:** Review poster presentation guidelines and get feedback

**Content:**

- What makes a good poster
  - Clear introduction, if people don't understand from the beginning they might be disengaged
  - Useful figures that are all referenced
  - good information flow, organization
  - Limiting blank space
  - Not too overwhelming to look at
  - if comparing graphs, having them on the same scale
  - Labelling figures
  - Having things in alignment
  - No single hanging bullet
- What makes a bad poster
  - raw data
  - not having clear design criteria that you can refer back to
- Getting started
  - Show best results, not all results
  - High res photo
- Captions for everything
  - 4 parts: Figure label, title, description, citation if needed
- Context of use and workflow
  - Start with user and setting
  - Place in larger system
  - Use color/grouping to organize what belongs together
  - Use labels with minimal text
  - high level and understandable at a glance
- 

**Conclusions/action items:**



## 2/2/26 - Client Meeting 1

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NOOR AWAD (nawad2@wisc.edu) - Feb 05, 2026, 7:26 PM CST

**Title:** Client Meeting Notes

**Date:** 2/2/26

**Content by:** Noor

**Present:** Group

**Goals:** Take detailed notes about sections of PDS I am writing, focusing on client requirements and differences between last semester's project and this one

**Content:**

- Cognitive element, if red they reach with one hand etc.
- Grade difficulty while still assisting the patient
- Too heavy, made 3d printed box
- Push of a button could switch the color from red to green
- Scanning activity could see a color
- Fiberoptic cable flash light onto a thin plastic disc
- Haptics where the patient touches it and gets some sort of feedback
- Button where you can randomize the colors
- 3 in in diameter is a good target, target can't be too small
- Telescoping rod was too heavy
- Set distance is fine, electronics should go at the end
- Need good balance in your hand
- Has to hold for about ten minutes, not too much strain on the arm
- Already have Bits - large screen tv that patient stands in front of, one program is a circle that pops up on the screen, problem is that its a single plane, whereas he likes the degrees of freedom for the dynamic balance
- Wants an auditory sound for feedback
- Budget - 500 dollars tentatively
- Prototype used every single day, each patient use is about 10-15 mins, will be wiped down between patients, cant absorb liquids.
- Wants something other than PVC for the rod, aircraft grade aluminum, kevlar tubing, should be fairly durable,
- If patients have light sensitivity, make sure that it is visible but not blinding
- PVC pipe with laminated construction paper is a goal weight
- Attachment failed between box 3d printed to the pipe
- In terms of testing, client is able to take to the hospital
- Functional reach test, without moving feet stand out. Need to include a ruler so we can do the functional reach, should be greater than 10 inches, Functional gait assessment, dynamic gait index,
- **Prioritizing the weight at the end**

**Conclusions/action items:**

Overall, the client is definitely focused on the weight of the design as a primary focus and an area of improvement. In addition, there are some good insights about tests he wants to do. This a good starting point for when we create designs, knowing that there is a weight requirement and there must be a ruler attached to the design.



## 2/6/26 - Team Meeting

---

NOOR AWAD (nawad2@wisc.edu) - Feb 06, 2026, 12:50 PM CST

**Title:** Team Meeting

**Date:** 2/6/26

**Content by:** Noor Awad

**Present:** Team

**Goals:** Divy up sections for design matrix

**Content:**

- A couple design ideas each
- Work on criteria for actual design,
- Be done with this thursday night, familiar with each person's work for the week
- Add note that electronics should stay the same, we will start looking into specifications for auditory feedback (is there a decibel to reach)
- Sensor research for auditory feedback, look into clicker
- Design matrix for audio feedback, three ideas: speaker, user/clinician, sensor with arduino

**Conclusions/action items:**

Work on design matrix, come up with individual designs, look into auditory feedback



## 2/13/26 - Team/Advisor Meeting

---

NOOR AWAD (nawad2@wisc.edu) - Feb 13, 2026, 12:45 PM CST

**Title:** Team and Advisor meeting

**Date:** 2/13/26

**Content by:** Noor Awad

**Present:** Group + Advisor

**Goals:** Present design matrix and take note of which sections I need to do for preliminary presentation.

**Content:**

Have slides done enough so we can get feedback

PVC matching the same size as the carbon fiber, measure a bunch and cut once of the carbon fiber so that we are not wasting costs.

Include old electronics, say pros and cons of previous design, etc.

Could talk to TEAM lab about drilling through carbon fiber, maybe cut a small piece and practice the drilling.

Look into whether this is documented RESEARCH THIS

ALSO HIGHLIGHT BOTTOM OF THE DESIGN MATRIX

Add total on the bottom of the design matrix

I will do PDS Section of presentation + present the auditory feedback matrix

**Conclusions/action items:**

Based on this meeting we will divvy up the presentation, include old designs, present these matrices as they are.



## 3/13/26 - Advisor/team meeting

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NOOR AWAD (nawad2@wisc.edu) - Mar 13, 2026, 12:33 PM CDT

**Title:** 3/13/26 Advisor Client meeting

**Date:** 3/13/26

**Content by:** Noor Awad

**Present:** Team + Advisor + TA

**Goals:** Document team/advisor meeting, any instructions for show and tell

**Content:**

Advisor:

- Try to update CAD
- focus on two good questions for show and tell
- Preliminary report feedback
- Update my protocol with Kat's digital pins for LED display
- Ask about colors / color blindness
- Red/green alternatives pitch
- Housing, need battery access
- Think about how we could adjust capacitive sensor threshold
- Figure out survey questions
- Circuitry assembly next week
- If we know weight, start figuring out the best way to configure the handle ( display, breadboard, arduino + some)
- Make sure everything in the appendix is referenced once
- Update PDS for final report - weights, colors, buttons can be changed the PDS
- Check presentation feedback

Team:

**Conclusions/action items:**



## BSAC Executive Meeting 2/6/26

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NOOR AWAD (nawad2@wisc.edu) - Feb 06, 2026, 11:42 AM CST

**Title:** BSAC Executing Meeting

**Date:** 2/6/26

**Content by:** Noor Awad

**Present:** BSAC Exec

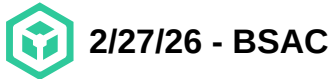
**Goals:** Come up with questions for faculty, introductions and plan for the semester

**Content:**

- Recapped training throughout the curriculum, canvas assignment coming soon
- Note on lab archives: Used in industry, importance of documentation
- Spreadsheet for training - do we know what you use to confirm completion
- Could integrate Zotero training
- BME 200 lecture
- Technical Writing (Reports)
- Discussion Topics for faculty
  - BME 200 Lecture
  - 201 - help decide track?
  - Introducing tracks earlier
- BME specific intro course as opposed to INTER EGR 170
- Course enrollment/track question
- Feedback on technical writing, next advisor meeting after could be about specifics in addition to canvas comments

**Conclusions/action items:**

Based on this exec meeting, I want to talk to my group and advisor about expectations for advisor meetings. Also check in with group about lab archives and training spreadsheet.



---

NOOR AWAD (nawad2@wisc.edu) - Feb 27, 2026, 12:39 PM CST

**Title:** BSAC Lecture

**Date:** 2/27/26

**Content by:** BSAC

**Present:** BSAC general

**Goals:** Follow up on questions from last week, discussion

**Content:**

- Talked about following up on feedback fruits
- More lecture topics
- Training coming up on 3/20

**Conclusions/action items:**

Based on this meeting, we continued discussing BME 200/201 and talked about how we could improve presentations and reports

**Title: BSAC Faculty Meeting****Date:** 3/13/26**Content by:** Noor Awad**Present:** BSAC and faculty**Goals:** Discuss with faculty about recent discussion topics**Content:**

- Training due 3/20
- Show and Tell next Friday, need to submit a call to action Wednesday
- For 201s
  - Power lecture is easier to fit into lecture than two lectures a week
  - Consultation and report for sample holder - trying to get it done as fast as possible, each design looks pretty similar. Told them to create a procedure and continue to research materials, not critical advice.
- Course enrollment
  - Pay attention to when each class is offered
- Show and Tell
  - Keep a list of questions when 402s come around, explain questions well, etc.
  - Don't treat this like a presentation, treat it as a collaboration with 402s
  - Write down feedback as you get it.

**Conclusions/action items:**

Based on this meeting, I got advice from seniors about how to best approach show and tell, and also have a record of some ongoing discussion topics for BSAC

## 2026/01/27 - Biological Applications

Freyja Heggeland - Jan 27, 2026, 4:22 PM CST

**Title:** Biological applications

**Date:** January 27th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Citation:** [1] A. Parton, P. Malhotra, and M. Husain, "Hemispatial neglect," *Journal of Neurology, Neurosurgery, and Psychiatry*, vol. 75, no. 1, p. 13, 2004, Available: <https://pmc.ncbi.nlm.nih.gov/articles/PMC1757480/>

**Content:**

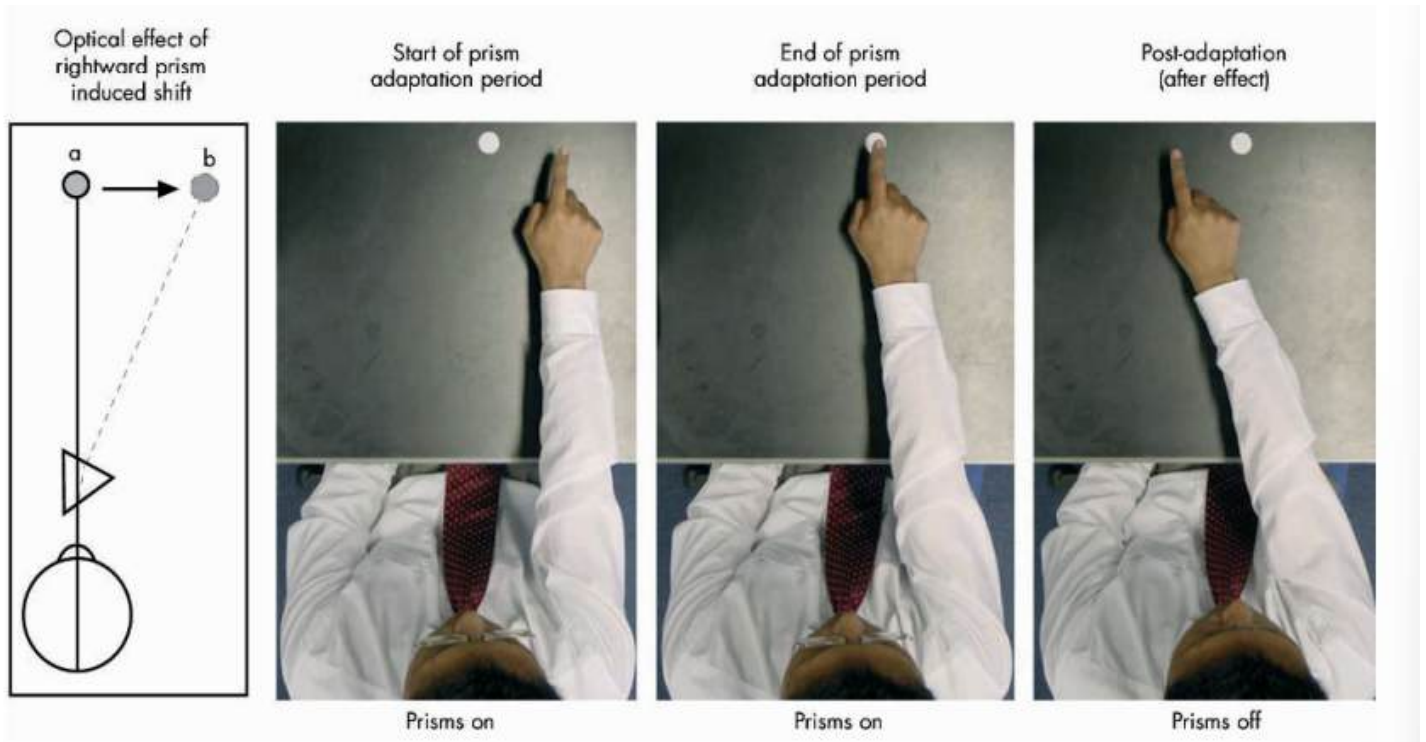
Hemispatial neglect syndrome is "characterized by reduced awareness of stimuli on one side of space, even though there may be no sensory loss. Although it is extremely common, it has proven to be a challenging condition to understand and to treat" [1].

The areas of the brain that are affected by this condition are the medial temporal areas. They are damaged in these patients in the parahippocampal region, which has strong connections with the parietal cortex. (research these areas of the brain and what basic motor functions they affect, see how this can be translated into further damage when under the intensity of a damaging stroke.)

Cortical and subcortical lesions were discovered in the brain of patients with this condition. The authors state that the damage in this region alone is not the reason for the hemispatial neglect. There may be more damage in the brain that could have been neglected when noticing these lesions [1].

Current treatments (as of 2004, when this was written) look into using eyeglasses that use the ipsilesional side of vision in each eye. This means that the glasses are designed to work better with the specific patients, as parts of their vision has been blocked out/removed. As far as I understand this condition, the patients can still "see" what is in front of them normally (their eyes still pick up color and shapes), but cannot process the images that they see, as if something is impeding the signal from the eyes to the brain. This sounds reasonable since the strokes that are associated with this condition are semi-frequent and potentially dangerous.

Image of the glasses' light refraction with before, during, and after simulations:



The "post-adaptation" image of this series shows the potential negative side-effects of the usage of these eyeglasses. It shows that the patient's eyes and brain may "learn" to display things that are further realigned from the initial visual intercept of the glasses.





## 2026/01/27 - Case Study of Patient with Hemispatial Neglect

Freyja Heggeland - Jan 27, 2026, 4:33 PM CST

**Title:** Case study of Hemispatial Neglect

**Date:** January 27th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Citation:** [1] T. Hoffman, "The man whose brain ignores one half of his world | Thom Hoffman," *The Guardian*, Nov. 23, 2012. Available: <https://www.theguardian.com/science/blog/2012/nov/23/man-brain-ignores-half-world>

**Content:**

"My old world finished (when I acquired this condition) and the new world started the same day" [1]. Alan Burgess had a stroke on November 5th, 2007 which led him to develop hemispatial neglect. His stroke damaged his parietal lobe. "The damage causes him to ignore people, sounds, and objects on his left (side)" [1].

The article shows that patients with hemispatial neglect are often unaware of their condition, and that the effects can just seem like the effects of growing older, with certain parts of the body starting to shut down. Pre-and post-stroke stimuli are also perceived very differently. A study performed by Dr. Malhotra of the Imperial College in London showed that motivation, such as a monetary reward, could be used in the rehabilitation of stroke patients to help them become more inclined to seek more treatment.

Image of a patient with hemispatial neglect showing that he can view a pencil when placed on his right side, but not on his left shown below. When he moves it towards his center and towards his left side, he becomes unable to perceive it. "Patients explain the disruption to their everyday lives caused by hemispatial neglect", seen in the video included in the source link [1].



**Conclusions/action items:**

- continue preliminary research and look into other designs
- begin drafting initial sketches
- meet with client to discuss needs and other design requirements



## 2026/01/27 - Global Effects of Research into Hemispatial Neglect and Current Treatments

Freyja Heggeland - Jan 27, 2026, 4:49 PM CST

**Title:** Global impacts

**Date:** January 27th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Citation:** [1] T. Brandt and M. Dieterich, "Central and Higher Cortical Vestibular Disorders," *Sciencedirect.com*, Sep. 09, 2020. <https://www.sciencedirect.com/science/article/pii/B9780128093245239126> (accessed Jan. 27, 2026).

[2] Science Direct, "Hemispatial Neglect - an overview | ScienceDirect Topics," *www.sciencedirect.com*, 2020. <https://www.sciencedirect.com/topics/neuroscience/hemispatial-neglect> (accessed Jan. 27, 2026).

### **Content:**

"Epidemiologically, approximately 3–5 million patients present with neglect annually after sustaining a stroke, and about one third of these patients experience a chronic form of the impairment persisting for more than a year post-onset" [1]. We are looking at around 1-1.5 million patients with chronic impairments, with an additional 3 million patients that experience a non-chronic form of the condition. Neglect is estimated to affect roughly 50% of all stroke survivors in the early stages.

Researchers have discovered that patients may fail to notice objects on the left side of a scene, ignore words on the left side of a page, or neglect food on the left side of a plate. They may dress or shave only one side of their body, which could lead to more assistance being necessary for their survival and wellbeing.

Cognitive and behavioral manifestations have also been noted to occur in patients, as patients may be unable to acknowledge, report, or make explicit use of information falling in the visual hemispace contralateral to the lesion [1]. Auditory issues are also prevalent, as some patients and their family members/caretakers noted the patients being unable to hear from a certain side, due to improperly processed information. Hearing aids have no current link of properly working with patients either, meaning existing measures need to be updated and reconfigured to assist the patients [2].

Some existing methods introduce stimulation-based therapy to the patient. ScienceDirect says "Non-invasive brain stimulation techniques such as repetitive Transcranial Magnetic Stimulation (rTMS) and transcranial Direct Current Stimulation (tDCS) are based on the concept of interhemispheric inhibition, aiming to reduce overactivation of the contralesional hemisphere or stimulate the lesioned hemisphere" [2]. Beneficial effects were demonstrated both at the sub-acute and chronic phases of strokes, so there is potential to see this treatment work in the future. However, this is a rather expensive solution, making it inaccessible for some patients.

### **Conclusions/action items:**

- continue preliminary research and look into other designs
- begin drafting initial sketches
- meet with client to discuss needs and other design requirements



## 2026/03/11 - Maximum Safe Range for Electrical Components

Freyja Heggeland - Mar 11, 2026, 1:42 PM CDT

**Title:** Electrical component safety measures

**Date:** March 11th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the safety guidelines for our project

**Citation:** .[1] R. M. Fish and L. A. Geddes, "Conduction of Electrical Current to and Through the Human Body: A Review," *Eplasty*, vol. 9, p. e44, Oct. 2009, Available: <https://pubmed.ncbi.nlm.nih.gov/articles/PMC2763825/>

[2] M. R. Zemaitis, L. A. Foris, R. A. Lopez, and M. R. Huecker, "Electrical Injuries," *Nih.gov*, Jul. 31, 2019. <https://www.ncbi.nlm.nih.gov/books/NBK448087/> (accessed Mar. 11, 2026).

### **Content:**

This should be a fairly low issue, but just in case, electronic components may cause shock or harm to either the user of the device or the patient in a therapy session.

This article explains how electrical current reaches and travels through the human body and how this process leads to injury. The authors review basic electrical principles and human physiology to describe why electrical accidents occur and how different conditions influence the severity of injury. They emphasize that electrical injury depends on several factors including voltage, current, resistance, duration of exposure, and the path the current takes through the body [1].

The article explains that electrical current can reach the body through several conductive environments such as air, water, the ground, or metal objects. When a person contacts a voltage source and another conductive surface, the body becomes part of the electrical circuit, as discussed frequently in BME 201 and 310. Current then flows through tissues according to the electrical resistance of different body components. Skin usually provides the greatest resistance, while internal tissues such as blood and muscle conduct electricity more easily because they need electrical pulses to function [1].

Skin resistance plays a major role in determining how much current enters the body. Dry skin may have high resistance, but moisture, large contact areas, or high voltage can significantly reduce this resistance. When voltage is high enough, the outer skin layer can break down electrically, allowing more current to pass into deeper tissues. Once this happens, the body's overall resistance decreases and the risk of severe injury increases [1]. When working in a physical therapy session, the patients' skin is more likely to be dryer than wetter, meaning this could be a factor in considering overall shock absorbance and resistance.

Finally, the review discusses how the path of current through the body influences injury patterns. For example, current traveling from hand to hand or hand to foot can pass through the chest and heart, increasing the risk of lethal outcomes. The authors conclude that understanding how electricity is conducted through the body helps clinicians interpret electrical accidents and anticipate possible medical complications following electrical exposure [1].

"Electrical injuries are a complex and potentially life-threatening form of trauma often associated with high morbidity and mortality. The severity of these injuries depends on factors such as the type of current, voltage, and the body's resistance. These injuries are a distinct and potentially life-threatening form of trauma resulting from low- or high-voltage exposure" [2].

"High skin resistance leads to greater energy dissipation at the skin surface, often resulting in cutaneous burns and reducing the amount of electrical energy that reaches internal tissues" [2]. We should not need to worry about this due to the low voltage (9V) being output at a low current (maximum ~50mA).

### **Conclusions/action items:**

- continue design drafting
- continue research
- organize team meeting



## 2026/01/23 - Dynamic Ranges for Balance

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Freyja Heggeland - Jan 23, 2026, 9:58 PM CST

**Title:** Dynamic Ranges for Balance

**Date:** January 23rd, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement. Also, this ended up having a lot of just self-brainstorming for ideas.

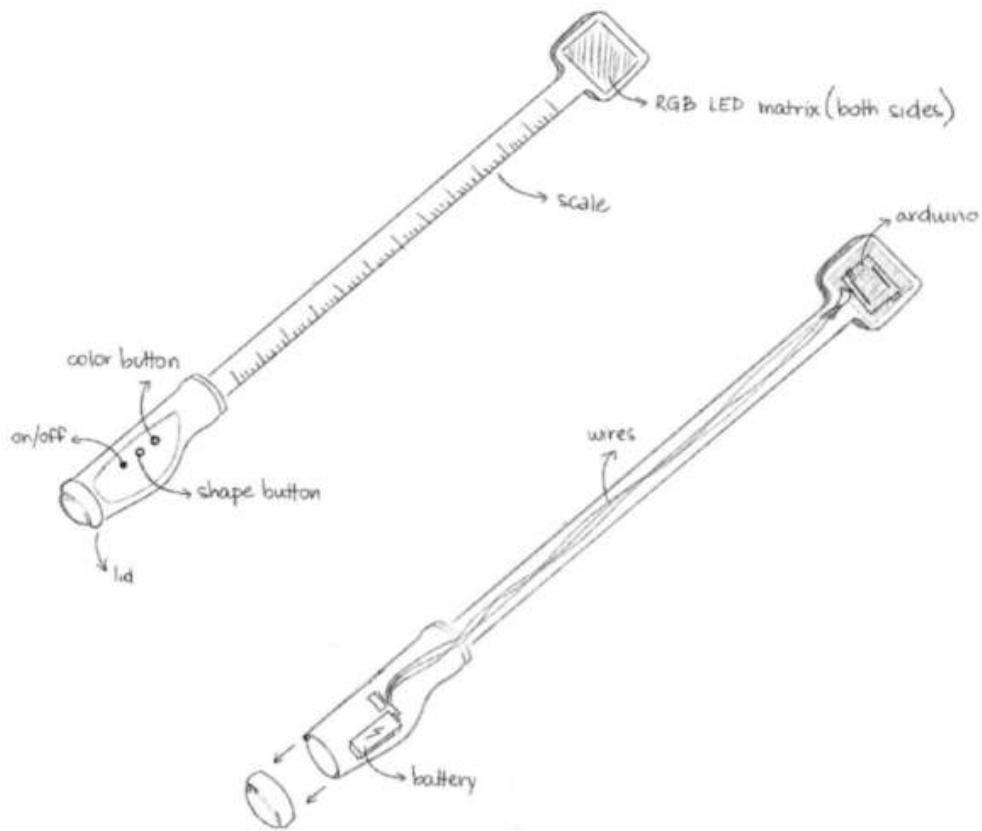
**Content:**

After being assigned the project, I started to look into the previous work, as this project has been worked on twice before. The first occurrence was completed in Fall 2023, the second in Fall 2024. Two doctors, both physical therapists, are mentioned throughout documentation in this Fall 2024 teams' deliverables. With one as the advisor and the other as the client, I'm not sure if the names were switched mistakenly at some point? (PDS mentions advisor as client, this is probably just a mistake.)

The Fall 2024 necessary components and design requirements are as follows: must help post-stroke patients improve balance and visual scanning in the case of "hemispatial neglect syndrome". Should contain a target for patients to reach & display different colors and shapes for visual scanning. My interpretation of this is a design that includes a staff/walking stick-like object that can help them regain their balance/keep a third point of contact with the ground, which is known to help existing balance changes with load bearing, standing objects. It should also have the ability to display (like a hologram? projector? maybe a dynamic system so there can be a tactile element to it where the user could try to feel the corners/edges of eg. a small, rough, plastic pyramid. Something akin to one of those blocks that toddlers have to put into the correct shaped hole. Maybe have something with a rough/bumpy surface for more of the tactile sensation [inclusivity of people that can't see as well and maybe couldn't make out an image. A color projector with different color lenses is a good idea though.]) TLDR: walking stick to help people with hemispatial neglect syndrome that can have some kind of interaction so they can test and examine their health after a stroke.

The device should be able to function for 8 hours a day, 5+ days a week, functioning for a year with "minimal" maintenance, aside from components with the electronics. Should last 3+ years in storage w/out a change in functionality or deteriorating. Waterproof design, used in indoor environments. Maximum 3 ft in length. Needs a display with a 3" diameter. <5 lbs, Most of these criteria are suggesting that this should be made of a solid, PVC or PLA like structure.

The preliminary presentation surrounded a few main components. For the design matrices, choices were made between shaft materials, display screen designs, and handle designs. These appear to be the main dynamic components of the design.



^ previous iteration of the preliminary design, looks interesting, I might start drafting something like this later.

#### Conclusions/action items:

Preliminary work is useful to look at, mostly because it's a great way to learn how other people took a shot at a project like this.

- continue preliminary research and look into other designs
- begin drafting initial sketches

# 2026/01/27 - Existing Designs to treat Hemispatial Neglect

Freyja Heggeland - Jan 27, 2026, 5:03 PM CST

**Title:** Existing designs to treat hemispatial neglect

**Date:** January 27th, 2026

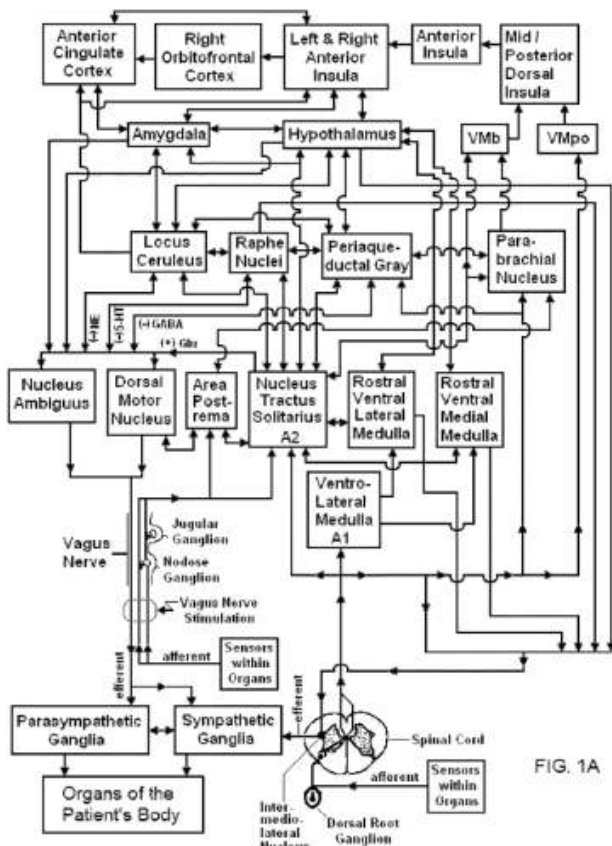
**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Citation:** [1] B. Simon and J. Errico, "US10537728B2 - Vagal nerve stimulation to avert or treat stroke or transient ischemic attack - Google Patents," Jul. 29, 2013 Accessed: Jan. 27, 2026. [Online]. Available: [https://patents.google.com/patent/US10537728B2/en?q=\(hemispatial+neglect\)&oq=hemispatial+neglect](https://patents.google.com/patent/US10537728B2/en?q=(hemispatial+neglect)&oq=hemispatial+neglect)

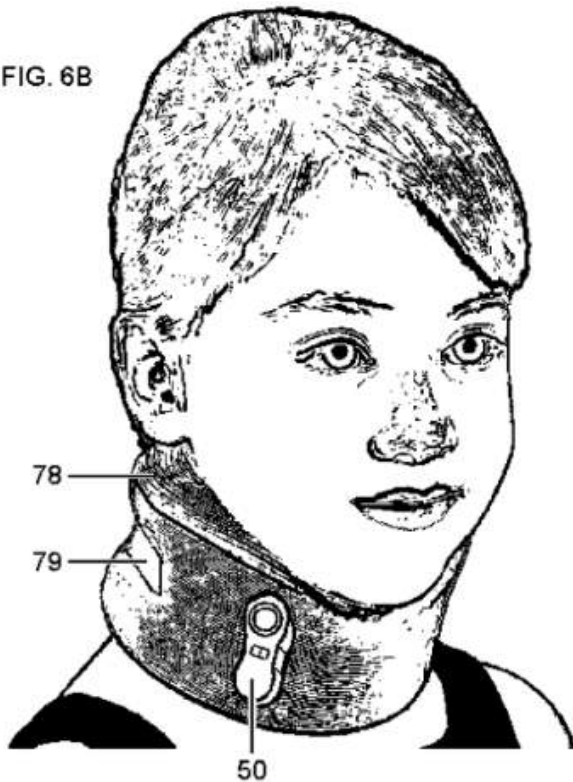
**Content:**



The above figure shows the flow chart diagram of signals between the brain's many functions [1].

The device appears to be an addition to a neck-wrap-like clothing that surrounds the neck and has a small device on the front-right side, as seen below [1].

FIG. 6B



"A transient ischemic attack (TIA) is also caused by ultrasonography. If carotid stenosis is identified, cerebral ischemia in the brain, spinal cord or retina. TIAs share the arteriography may be done. Treatment is aimed at prevent same underlying etiology as ischemic strokes and producing further TIAs and especially at preventing a stroke" [1]. This shows the depth of symptoms that can occur within the patients and how we can prepare for them with our design. The other implications of this is to complicate our design with new features that could potentially treat some of these symptoms, especially as some of these are more deadly than others.

**Conclusions/action items:**

- continue preliminary research and look into more biological components
- begin drafting initial sketches
- meet with client to discuss needs and other design requirements





## 2026/01/29 - Movement Assistance Device - Gait Mimic Chassis for Patient Treatment

Freyja Heggeland - Jan 29, 2026, 3:06 PM CST

**Title:** Existing designs to treat post-stroke patient

**Date:** January 29th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Citation:** [1] M. Goldfarb and S. Murray, "Movement Assist Device," Jun. 17, 2013 Accessed: Jan. 29, 2026. [Online]. Available: <https://patents.google.com/patent/ES2773853T3/en>

**Content:**

(Note, this entire PDF is in Spanish and I have not taken/spoken Spanish in well over 3 years, so I'm interpreting/translating to the best of my ability)

This device works with multiple measurements taken from the patient's legs, waist, torso, etc. (seen below in Fig. 1) and molds a robotic/mechanical exoskeleton around the patient's body (see fig. 2).

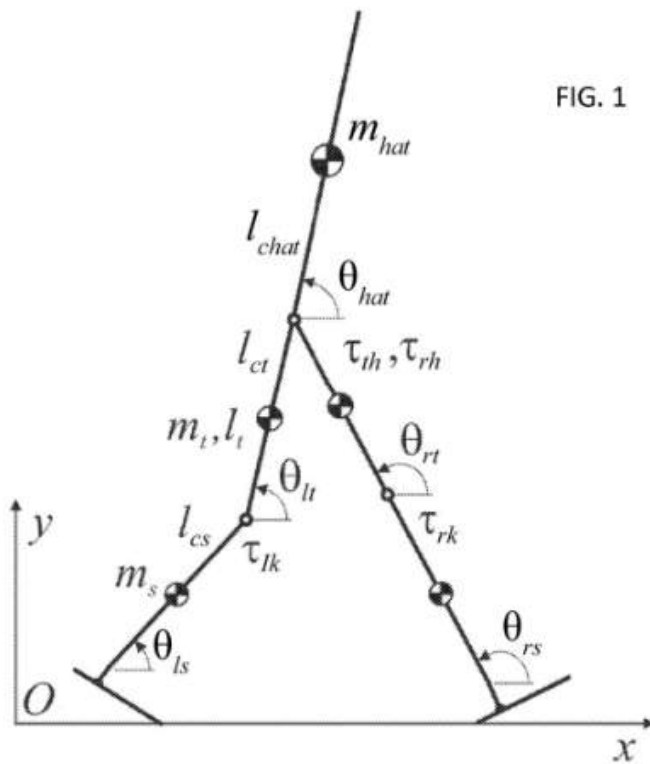
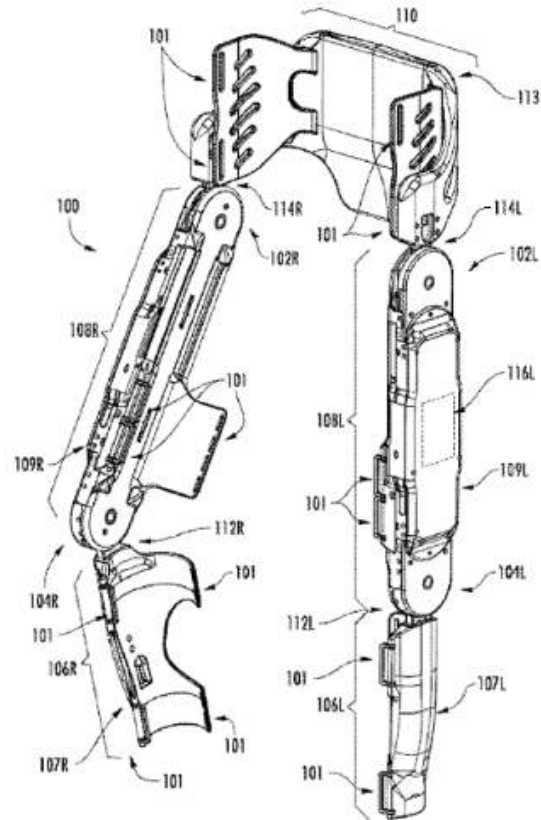


FIG. 1



This appears to be a chassis-like device capable of holding the patient's legs in a stable position and enabling them to walk properly. More figures in the diagram show detailed schematics of the joint pieces for the knee and hip connections.

Image below: person wearing this chassis design:



The above image shows how this device can be a complete structure when working with a patient. The following data from this document shows graphical summaries of testing, based on factors such as the length of the design, the amount of help the patient needed, and the time it took to equip/unequip the chassis.

**Conclusions/action items:**

- continue preliminary research and look into more biological components
- begin drafting initial sketches
- meet with client to discuss needs and other design requirements



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**Título: Dispositivo de asistencia al movimiento**

<p><b>Publ. en:</b> 15.06.2012 US 201301490200 P</p> <p><b>Fecha de publicación y entrada en vigor de la solicitud de la patente:</b> 15.07.2009</p>	<p><b>Inventor:</b> KARDEHLIT LUB VERGITY (100.0%) 300 Kipling Rd., 2021 West Elm Avenue Madison, Tennessee 37203, EE.UU.</p> <p><b>Inventor(es):</b> KOLPANG, MICHAEL y KARDEHLIT, SPENCER</p> <p><b>Agencia Representadora:</b> ELZABETHA S.L.P.</p>
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2 773 853 T3

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**ES2773853T3pdf.pdf (3.34 MB)**

# 2026/02/04 - Versatile Walking Cane Patent

Freyja Heggeland - Feb 04, 2026, 5:36 PM CST

**Title:** Versatile Walking Cane Patent

**Date:** February 4th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

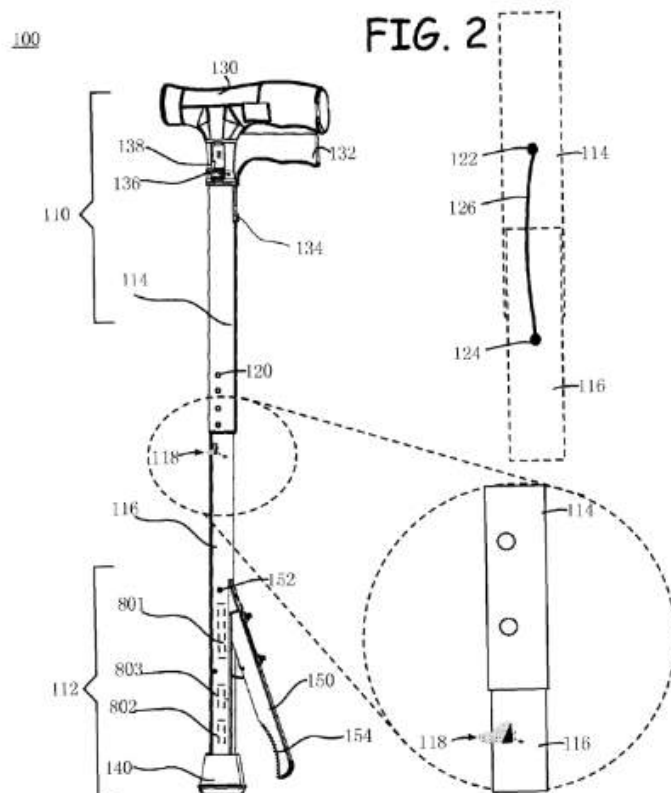
**Citation:** [1] R. Moreau, "US9277794B2 - Versatile walking cane - Google Patents," Jan. 16, 2015 Accessed: Feb. 04, 2026. [Online]. Available: <https://patents.google.com/patent/US9277794B2/en>

**Content:**

Patent US9277794B2 discloses a multi-functional walking cane designed to assist users in mobility and handling small objects and performing auxiliary tasks. The invention recognizes that traditional canes primarily serve as support devices and proposes a cane that integrates additional capabilities such as grabbing objects, adaptability in length, and potential accessory integration [1].

The core structure of the cane includes two main telescoping shafts, which slide relative to each other to adjust the cane's length. A locking mechanism fixes the shafts at the desired length for the user's comfort. This adjustability makes the device versatile for users of different heights or for varying tasks where different lengths are useful [1].

A standout feature of the invention is a jaw-grip mechanism integrated near the cane's lower end. This hinged grip operates through a trigger on the handle: when the trigger is actuated, a linked string or mechanism causes the jaw to open or close. When not in use for gripping, the jaw-grip retracts into a slot in the cane's shaft so it doesn't interfere with walking support. This allows the cane to function both as a walking aid and a simple retrieving tool [1]. We would not mimic this section of the device, but it allows us to look at having a button towards the top of the item that affects something at the bottom. See the figure below for button labeling and claw visualization.



Beyond the trigger/jaw mechanism, the patent describes various optional enhancements. For example, the cane may include one or multiple illumination sources that light the path ahead or the position of the jaw-grip, aiding in low-light conditions. Other embodiments mention a shoehorn





## 2026/02/04 - Folding Walking Cane with Adjustable Length

Freyja Heggeland - Feb 04, 2026, 8:45 PM CST

**Title:** Folding Walking Cane Patent

**Date:** February 4th, 2026

**Content by:** Freyja Heggeland

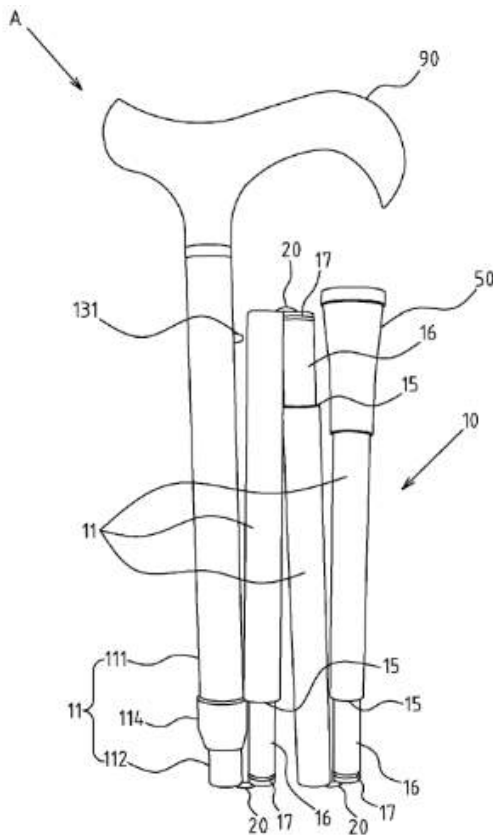
**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Citation:** [1] M.-H. Lee, "Foldable walking stick with adjustable length and a shock-proofing mechanism - Google Patents," Feb. 12, 2009  
 Accessed: Feb. 05, 2026. [Online]. Available: <https://patents.google.com/patent/US20100200032A1/en>

**Content:**

This could add a more compact aspect to our device, but I'm not sure how it would adapt with the electronics.



The patent US20100200032A1 describes an invention of a foldable walking stick that can support a user while also offering adjustable length and a shock-proofing mechanism [1]. It explains that traditional walking sticks or canes often lack stability and comfort when extended or folded, and the flexible locating pin and other components in this design aim to improve performance compared to earlier designs [1].

The core structure of the invention consists of a rod holder containing two or more interconnected rods and a handle fixed at the top of the stick [1]. Each rod is divided into a first and a second rod section, with the second section able to move relative to the first to allow adjustment of the overall length of the walking stick [1]. A flexible pulling rope extends through parts of the rods to facilitate folding and unfolding of the stick for storage and use [1].

To lock the stick at a chosen length, the second rod section includes a flexible locating pin that fits into one of several locating holes along the first rod section [1]. This locating pin has a tapered shape that improves the locking engagement and stability when the stick is extended [1]. An O-ring assists in creating a tighter fit and reducing unwanted motion between the rod sections [1].

Within the hollow interior of the rods, the patent describes a shock-proofing mechanism that helps absorb impacts and reduce vibrations during use [1]. One embodiment includes a shock tube, a flexible member, and a shock lever that work together so that the stick can better cushion pressure exerted

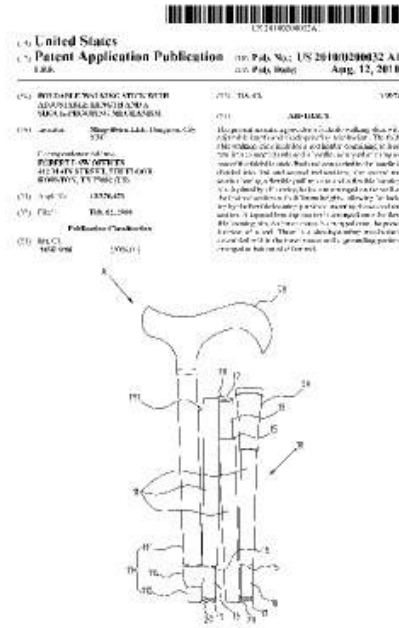
by the user's step [1]. This enhances comfort, especially for users walking on uneven surfaces for extended periods [1].

Additional details in the patent focus on improving ease of assembly, strength, and reliability of the walking stick while folded or unfolded [1]. Features such as elastic spacers and reducing heads are described to enhance stability and connection between sections of the rod [1]. The patent also outlines several variations and combinations of these structural elements to allow customization and improved performance depending on user needs [1].

**Conclusions/action items:**

- continue preliminary research and look into more biological components
- continue drafting sketches
- edit and submit PDS

Freyja Heggeland - Feb 04, 2026, 8:41 PM CST



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US20100200032A1.pdf (700 kB)



## 2026/02/05 - Rod Main Structure Component Analysis

Freyja Heggeland - Feb 05, 2026, 3:10 PM CST

**Title:** Rod Main Structure Component Analysis

**Date:** February 5th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Citations:** [1] S. Mirdehghan, "Carbon Fiber Properties - an overview | ScienceDirect Topics," *ScienceDirect*, 2021. <https://www.sciencedirect.com/topics/materials-science/carbon-fiber-properties> (accessed Feb. 05, 2026).

[2] X. Huang, "Fabrication and Properties of Carbon Fibers," *Materials*, vol. 2, no. 4, pp. 2369–2403, Dec. 2009, doi: <https://doi.org/10.3390/ma2042369>.

### **Content:**

"High tensile strength and modulus, low density, electrical conductivity, and excellent dimensional stability, making them suitable for applications" [1].

"The two most important precursors in the carbon fiber industry are polyacrylonitrile (PAN) and mesophase pitch (MP)" [2].

Carbon fibers are engineered materials made mostly of elemental carbon where the atoms are bonded together in long crystalline formations aligned along the fiber axis. This structure gives carbon fiber an excellent strength-to-weight ratio with tensile strength and modulus values that can significantly exceed those of many metals, while maintaining a very low density in the range of about 1.6–2.0 g/cm<sup>3</sup>. They are produced from precursors such as polyacrylonitrile (PAN) or mesophase pitch, with production involving stabilization, carbonization, and heat treatment at high temperatures to develop the graphitic crystalline structure that underlies their mechanical performance. The specific properties of the resulting fibers depend on the choice of precursor and processing conditions, with different grades available that emphasize high strength or high modulus depending on the end use [1][2].

Carbon fibers exhibit a combination of light weight and high mechanical performance that makes them highly desirable for structural applications where reducing mass is critical. Their high tensile strength and stiffness make them well suited as reinforcements in composite materials that are used in aerospace, automotive, civil engineering, defense, and sporting goods sectors. In these applications, carbon fiber composites can dramatically improve load-bearing capabilities while reducing weight compared to traditional materials like steel or aluminum. In addition to mechanical advantages, carbon fibers have good chemical resistance, low thermal expansion, and useful electrical conductivity, which can be tailored through processing and purification to suit varied applications [1][2].

Carbon fibers also have drawbacks that limit their use in some contexts. One key disadvantage is cost. The complex manufacturing process and the expense of precursors such as PAN contribute to a high price per kilogram compared with alternative fibers such as glass or aramid. This cost barrier has historically restricted wider adoption in mass-market industries like mainstream automotive manufacturing where cost sensitivity is high. In addition, carbon fibers are brittle relative to metals and other fiber types, meaning they can fail in a brittle manner under certain loading conditions and are less able to absorb energy from impacts without cracking [1][2].

Another limitation of carbon fibers stems from anisotropy in their properties. The strength and stiffness are extremely high along the fiber axis but much lower in the transverse direction. This means that the design of carbon fiber composites must carefully consider fiber orientation to align strength with load paths. Composite parts also require a matrix material, often a polymer resin, to bind fibers and transfer loads; the performance of the composite depends on the fiber-matrix interface as well as the fibers themselves. Furthermore, while carbon fibers resist many chemical environments at room temperature, they are susceptible to oxidation at elevated temperatures, which can degrade properties if the material is not properly protected [1].

Ongoing research highlighted in the open-access review reflects efforts to expand the use of carbon fibers by reducing production cost and enhancing mechanical properties. Alternative precursor materials such as lignin or polyethylene are under investigation to lower the cost of carbon fiber manufacture while still achieving competitive performance. Optimizing the microstructure and processing parameters continues to be a focus to improve tensile and compressive strengths and expand potential applications. The balance of mechanical and physical properties with challenges in cost and manufacturing underscores the material's niche in high-performance applications and the continued interest in evolving its capabilities [2].

I believe this is a strong contender for our choice of rod material, as its properties are highly valuable in the context of our design.

Note for labarchives format: the first file is currently inaccessible for some reason, I am actively looking for a fix but the link from the citation above may need to be used for now. I believe the ScienceDirect website is currently under maintenance.

**Conclusions/action items:**

- continue preliminary research and look into more biological components
- continue drafting sketches
- edit and submit and upload PDS

Freyja Heggeland - Feb 05, 2026, 3:09 PM CST

Materials 2009, 2, 2369–2403; doi:10.3390/ma2042369

 **materials**  
ISSN 1996-1044  
www.mdpi.com/journal/materials

Review

### Fabrication and Properties of Carbon Fibers

Xiaosong Huang

Chemical Sciences & Materials Systems Laboratory, General Motors Research & Development Center, Mail Code 400-106-710, 30500 Mound Road, Warren, MI 48090-9055, USA;  
E-Mail: xiaosong.huang@gm.com; Tel.: +1-516-956-0826; Fax: +1-516-956-0636

Received: 30 October 2008; in revised form: 3 December 2008 / Accepted: 14 December 2008 / Published: 16 December 2008

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**Abstract:** This paper reviews the research and development activities conducted over the past few decades on carbon fibers. The two most important precursors in the carbon fiber industry are polyacrylonitrile (PAN) and mesophase pitch (MP). The structure and composition of the precursor affect the properties of the resultant carbon fibers significantly. Although the essential processes for carbon fiber production are similar, different precursors require different processing conditions in order to achieve improved performance. The research efforts on process optimization are discussed in this review. The review also attempts to cover the research on other precursor materials developed mainly for the purpose of cost reduction.

**Keywords:** carbon fiber; composite; light weighting; high strength; high modulus

---

#### 1. Introduction

Carbon fiber is defined as a fiber containing at least 92 wt% carbon, while the fiber containing at least 99 wt% carbon is usually called a graphite fiber [1]. Carbon fibers generally have excellent tensile properties, low densities, high thermal and chemical stabilities in the absence of oxidizing agents, good thermal and electrical conductivities, and excellent creep resistance. They have been extensively used in composites in the form of woven textiles, prepreg, continuous fibers, roving, and chopped fibers. The composite parts can be produced through filament winding, tape winding, pultrusion, compression molding, vacuum bagging, liquid molding, and injection molding.

In recent years, the carbon fiber industry has been growing steadily to meet the demand from different industries such as aerospace (aircraft and space systems), military, turbine blades,

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carbonfiber2.pdf (414 kB)



## 2026/02/08 - Rod Main Structure Component Analysis - Part 2

Freyja Heggeland - Feb 08, 2026, 5:00 PM CST

**Title:** Rod Main Structure Component Analysis but I'm doing this again with different materials

**Date:** February 8th, 2026

**Content by:** Freyja Heggeland

**Present:** self



**Goals:** learn more about the scope of our project and understand the problem statement. Complete design matrices and decide on materials with the team.

**Citations:** [1] "Common Design Mistakes in Aluminum," *Lincolnelectric.com*, 2024. <https://www.lincolnelectric.com/en/welding-and-cutting-resource-center/welding-how-tos/common-design-mistakes-in-aluminum> (accessed Feb. 08, 2026).

[2] D. Hwang and K. H. Cho, "Usability test for a cane-combined weight support feedback device," *Technology and Health Care*, vol. 32, no. 6, pp. 4257–4265, Jul. 2024, doi: <https://doi.org/10.3233/thc-240056>.

### Content:

Aluminum alloys are a valid option for a material choice [1].

- Al-Zn alloys allow for strong overall structure but can be overbearing when considering weight and the patient's perception of the weight.
- The image below shows the dynamic ranges for tensile strength of different available material choices, those being Al-Si, Al-Cu, and Al-Mg [1].
- 
- This article focusses on the welding strength and capabilities of materials when considering welding, so it is not as relevant to our project as it could be, but it still shows us the relative strengths of each material chosen.
- Al-Cu alloys may be of little interest to us due to their low corrosion resistance and highly conductive components, which are both undesirable characteristics due to their capabilities of harming the patient or user of the device [1].
- "Al-Zn-Mg-Cu alloys that are often used in aerospace fabrication, and are supplied in the form of sheet, plate, forgings, and bar, as well as extrusions" [1]. I thought this was interesting due to the multiple components of the alloy present and the extremely high tensile strength, but this material is undesirable for our design due to its susceptibility to heavy corrosion [1].
- 
- The above image shows the tensile yield strength of 4 different materials when considering their tempers and cold work in welding applications. This is not directly relevant to our project but it can be useful to understand the points at which these materials begin to fail and how much pressure they can withstand before yielding [1].

### Article 2:

- This article focusses more on gait, which is a more prevalent issue for our design's characteristics [2].
- "Various efforts have been made to enable physical therapists to quantitatively assess patients undergoing rehabilitation of cane-assisted gait and improve the method by which patients can self-rate the level of weight support" [2]. This is the exact criteria our client wanted us to investigate with our research into this project. I believe this will be extremely valuable for our overall research and understanding of the design parameters.
- This study does have an immediate flaw, being all patients included in the study were male and this device is meant to be usable for everyone involved.



- Shown above: cane model with counterbalance device at the end of the rod that measures sway and deviation from steady position [2]. "A pressure sensor measures the level of weight support for the cane in kilograms, and the information is transmitted to a smartphone app for display" [2].
- "A gait-assistive device is used to enhance independent mobility and minimize fall accidents and injuries to prevent dysfunction and reduce treatment costs" [2]. This device is extremely similar to what we will be constructing, tempted to put this entry into competing designs.
- The bulk of the dissatisfaction of this device came from its weight, being made of an aluminum alloy, meaning this is valuable information for our device's construction.

#### Conclusions/action items:

- continue preliminary research and look into more biological components
- continue drafting sketches
- complete our design matrices



## 2026/02/22 - Carbon Fiber Tube Model Option

---

Freyja Heggeland - Feb 22, 2026, 4:20 PM CST

**Title:** Carbon fiber tube model

**Date:** February 22nd, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Link:**

<https://www.amazon.com/Pultruded-Customizable-Lightweight-Robotics-4x3x1000MM/dp/B0DJJTX3SQ?th=1>

**Content:**

The amazon link above leads to a carbon fiber rod. 1 meter long, 8 mm outer diameter, 7 mm inner diameter, which is nearly perfect for our project. It is slightly long, but that's better than being too short.



We may be able to use the excess length for a different part of this device's construction? I'm not sure, I'll check with the group.

I think this is a strong contender for a final prototype design (after we build it with PVC first)

**Conclusions/action items:**

- complete our preliminary report
- continue material research and ordering
- these tubes will help us construct this device



## 2026/03/04 - Carbon Fiber Tube Specific Weave

---

Freyja Heggeland - Mar 04, 2026, 12:52 PM CST

**Title:** Carbon fiber tube weave specifics

**Date:** March 4th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Links:** <https://dragonplate.com/carbon-fiber-101-understanding-weaves-and-fabrics?srsltid=AfmBOorqCVbsCYOZH9g4KU4SnqbHo89ZFciNqZqTH5aKvpKzvXdzW4rx> [1]

<https://ru.rgcarbonfiber.com/resources/choosing-the-right-carbon-fiber-weave.html> [2]

<https://www.elevatedmaterials.com/carbon-fiber-weaves-what-they-are-and-why-to-use-them/> [3]

**Content:**

Summary of all 3:

Plain weave carbon fiber is characterized by a simple over-under pattern that provides high stability and resistance to fraying, making it ideal for flat surfaces and structural consistency [1, 2, 3]. Twill weave offers greater pliability for complex, contoured shapes due to its staggered fiber pattern, while also delivering a popular, aesthetic diagonal appearance [1, 2, 3]. Satin weaves and unidirectional materials provide specialized, high-performance options, with satin offering a smooth surface and unidirectional providing maximum strength in one direction [2, 3].

For engraving inch markers, plain weave is the best choice because its tight, stable, and symmetrical grid pattern prevents splintering and ensures precise, clean results.

I will be further researching materials that we can order of this specific weave.

**Conclusions/action items:**

- complete any other deliverables we have before the one in early april
- ORDER THE MATERIALS AND BEGIN DRAFTING
- these tubes will help us construct this device



## 2026/03/11 - Potential Handle Alternative

---

Freyja Heggeland - Mar 11, 2026, 2:06 PM CDT

**Title:** Handle alternative option

**Date:** March 11th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Links:** <https://www.amazon.com/Fenix-Smooth-Ribbed-Bicycle-Handlebar/dp/B07K5NF7J7>

**Content:**

This option could provide more "grip" to our design, making it easier to hold and use for our client [1].



These are made of rubber, meaning they can be held quite easily. Each has a total weight of around 0.4kg. This could be an option for our device. I will discuss with the group regarding this option to see if we would like to move forward with this.

We also need to work on protocol development, so this could be useful, as this part is already created and the manufacturer seems to be in a good business standing.

We also need to set up a call to action regarding the future of our project.

**Conclusions/action items:**

- complete any other deliverables we have before the one in early april
- begin drafting device
- this option could provide more "grip" to our design, making it easier to hold and use for our client



## 2026/02/02 - Initial Rod CAD Sketches

Freyja Heggeland - Feb 02, 2026, 3:41 PM CST

**Title:** CAD Sketches

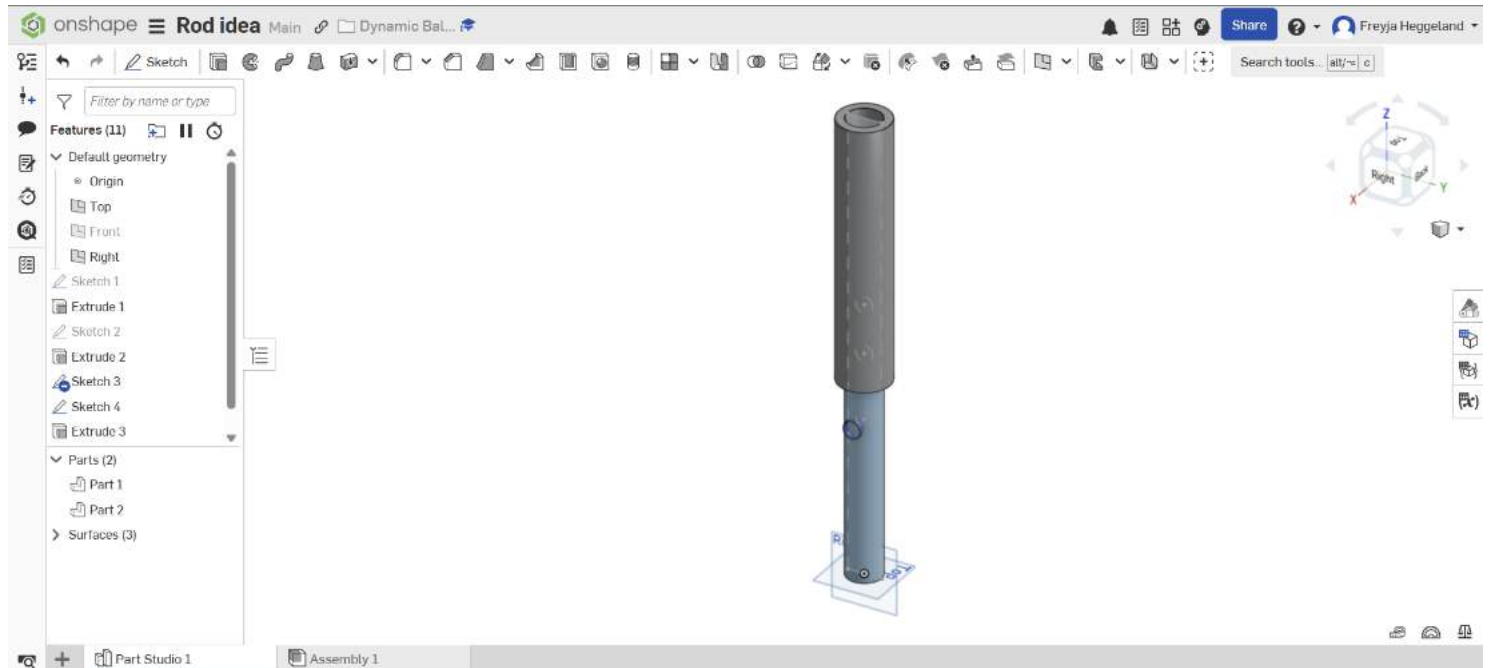
**Date:** February 2nd, 2026

**Content by:** Freyja Heggeland

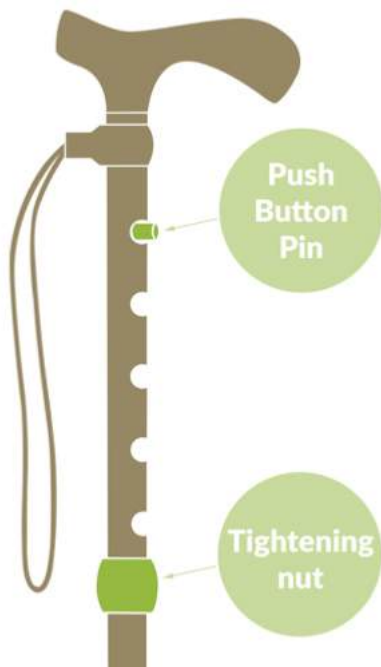
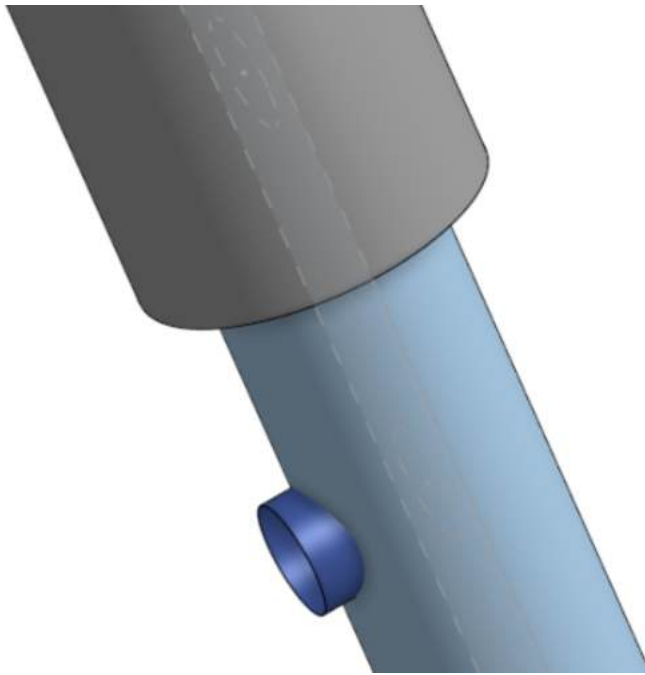
**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement. Get a better visual for our project.

**Content:**



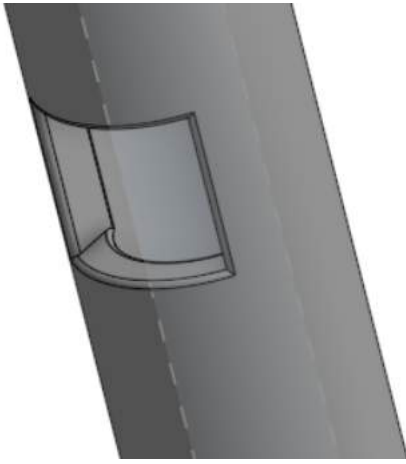
Rod components are made from two main cylindrical units. Taller section will be a sturdy, waterproof material that may weigh more than the bottom portion. Shorter section will have a rubber cap on the end of it for ease of use and tactile grounding when used with the patient. Rivets featured along bottom section (see below) are meant to signify a possible extension mechanism, similar to existing walking cane models, also seen below.



<-- "Bush button pin" inspiration from [stickandcaneshop.com](http://stickandcaneshop.com), also features handle model that I may develop in CAD in the future.

Clarification: the dark blue ring shown in the picture (2) above appears every 4.5" up the shaft of the smaller rod. There is a 1" indent for the outside of the circle that will allow for the button adjustment to be pressed, released, and moved.

For material choices, I believe that the best options are to go with a carbon fiber upper portion and a PVC or HDPE bottom portion that will attach to the rubber stopper at the end. For the development of a screen, I may initially print out a demo in the makerspace and either add to the design or cut out a 3"x3"x1" square with 1" depth.



So I added the 3"x3" square hole, removed the remaining portion of the rod that interfered with the square, filed the edges for sake of professional look, and allowed a space for the electronics to be added inside the larger rod.

More developments to come in future sketches, but for now, I rest.

<https://cad.onshape.com/documents/c649972329b1831f08b4adb6/w/c200c08bd5731e404ec51ce1e/b8f13d9de2fe73d3d56de02f?renderMode=0&uiState=698117d7d25fdbec88890807>

^ link to view current progress, I'm not sure if Onshape updates the files beyond when the link was created, we shall see.

**Conclusions/action items:**

- continue drafting sketches
- continue preliminary research and look into other designs
- continue brainstorming with the team



## 2026/02/11 - Continuing CAD Sketches for Alternative Design

---

Freyja Heggeland - Feb 12, 2026, 4:13 PM CST

**Title:** CAD Sketches

**Date:** February 11th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement. Get a better visual for our project.

**Content:**



In this 1/2 hour session, I added a box to the end for the screen location and also hollowed out the end rod so we could route wires through the device.

More details and developments to come in the future.

**Conclusions/action items:**

- continue drafting sketches
- continue preliminary research and look into other designs
- continue brainstorming with the team



## 2026/02/11 - Second Design for Matrix Sketches

Freyja Heggeland - Feb 11, 2026, 5:40 PM CST

**Title:** Design Sketches

**Date:** February 11th, 2026

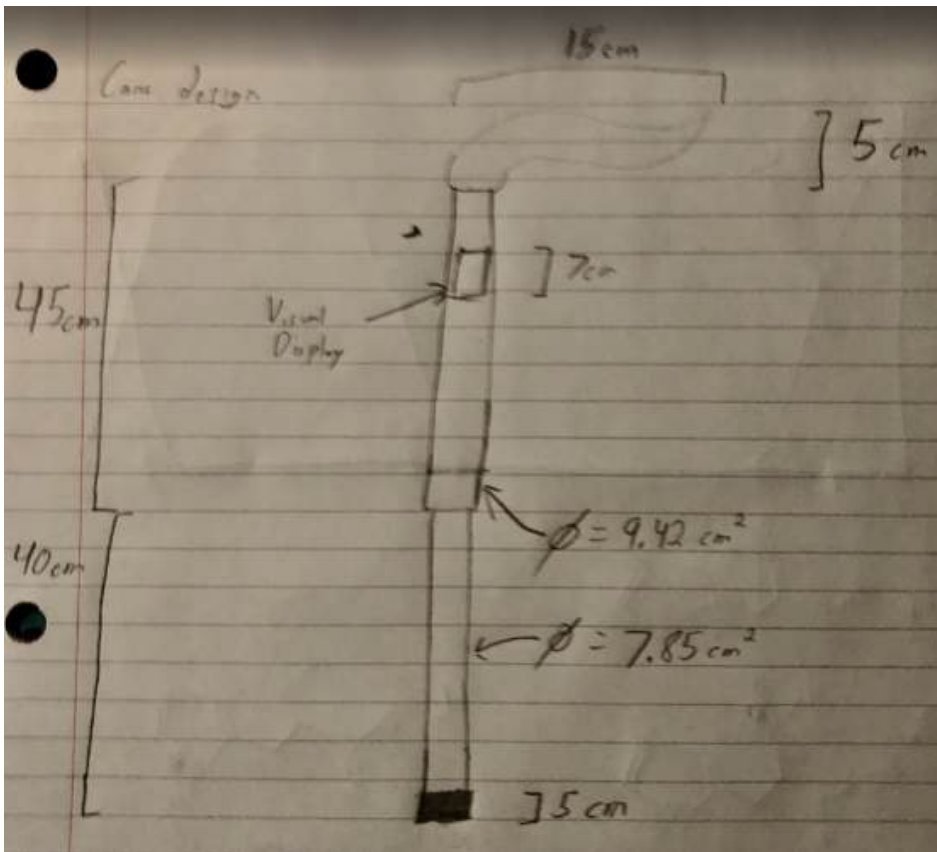
**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement. Get a better visual for our project.

**Content:**

I started drawing some sketches for our final design in the design matrix, as we currently have the final design from last year and the CAD model that I worked on last week. Sketches are shown below.



This design will be adapted in computer-based software before being exported for use in deliverables.

**Conclusions/action items:**

- continue drafting sketches
- develop preliminary presentation by next week
- continue brainstorming with the team



## 2026/03/11 - Tentative Arduino Code

---

Freyja Heggeland - Mar 11, 2026, 3:05 PM CDT

**Title:** Tentative Arduino Code (temporary, needs to be checked, verified and edited)

**Date:** March 11th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** properly run each electronic component in our design

**Content:**

Arduino code is attached below. This **\*\*\*SHOULD\*\*\*** work (I hope). I do not currently have the components to completely run all of this, so testing this code may be delayed.

**Conclusions/action items:**

- complete any other deliverables we have before the one in early april
- begin drafting device
- test code as soon as electronic components arrive

---

Freyja Heggeland - Mar 21, 2026, 11:43 PM CDT

```
#include <Adafruit_NeoPixel.h>
```

```
#define LED_PIN 7
```

```
#define NUM_LEDS 64
```

```
#define RANDOM_BUTTON 4
```

```
#define RG_BUTTON 5
```

```
#define CAP_SENSOR 2
```

```
#define SPEAKER A0
```

```
Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);
```

```
bool randomMode = false;
```

```
bool rgMode = false;
```

```
bool currentRG = false;
```

```
unsigned long lastUpdate = 0;
```

```
int updateInterval = 500;
```

```
void setup() {
```

```
    pinMode(RANDOM_BUTTON, INPUT_PULLUP);
```

```
    pinMode(RG_BUTTON, INPUT_PULLUP);
```

```
    pinMode(CAP_SENSOR, INPUT);
```

```
    pinMode(SPEAKER, OUTPUT);
```

```
    matrix.begin();
```

```
    matrix.show();
```

```
    randomSeed(analogRead(A1));
```

```
}
```

```
void loop() {
```

```
    checkButtons();
```

```
    checkSensor();
```

```
    updateMatrix();
```

```
}
```

```
void checkButtons() {
```

```
    if (digitalRead(RANDOM_BUTTON) == LOW) {
```

```
        randomMode = true;
```

```
        rgMode = false;
```

```
        delay(200);
```

```
}
```

```
if (digitalRead(RG_BUTTON) == LOW) {
```

```
    rgMode = true;
```

```
    randomMode = false;
```

```
    delay(200);
```

```
}
```

```
}
```

```
void checkSensor() {
```

```
    int sensorState = digitalRead(CAP_SENSOR);
```

```
    if (sensorState == HIGH) {
```

```
        tone(SPEAKER, 1200, 200);
```

```
    }
```

```
}
```

```
void updateMatrix() {
```

```
    if (millis() - lastUpdate < updateInterval) return;
```

```
    lastUpdate = millis();
```

```
    if (randomMode) {
```

```
        for (int i = 0; i < NUM_LEDS; i++) {
```

```
            int r = random(0,255);
```

```
int g = random(0,255);

int b = random(0,255);

matrix.setPixelColor(i, matrix.Color(r,g,b));

}

matrix.show();

}

if (rgMode) {

uint32_t color;

if (currentRG) {
color = matrix.Color(255,0,0);
} else {
color = matrix.Color(0,255,0);
}

for (int i = 0; i < NUM_LEDS; i++) {
matrix.setPixelColor(i, color);
}

matrix.show();

currentRG = !currentRG;
}
}
```



## 2026/03/22 - Revisiting Arduino Code with Feedback

Freyja Heggeland - Mar 23, 2026, 12:58 PM CDT

### Title: Revisiting arduino code with feedback

**Date:** March 22nd, 2026

**Content by:** Freyja

**Goals:** show other groups what we've done so far this semester.

### Content:

New content could be written on either ESP32 or raspberry pi, depends on team goals and weight distribution for the device. I believe the code pasted below should be adequate for the time being. Otherwise, we can rewrite this as needed.

Suggestions from 402 students that relate to code:

- Maybe use an ESP32 instead of an Arduino
- Or a raspberry pi
- Add a time-gated portion for changing colors (set a while loop when the signal input is HIGH, add a counter, when counter gets to a certain point, do a new thing)

### Conclusions/action items:

- revisited code with feedback for ideally a better functioning device
- Continue physical modelling
- 3D print necessary portions

Freyja Heggeland - Mar 22, 2026, 12:45 AM CDT

Code below. Comments within to show what each portion does.

```
#include <Adafruit_NeoPixel.h>
#define LED_PIN 11
#define NUM_LEDS 64
#define BUTTON 7
#define RG_BUTTON 4
#define CAP_SENSOR 2
#define SPEAKER A0

Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);

bool randomMode = false;
bool rgMode = false;
bool currentRG = false;
bool powerOn = true;

unsigned long lastUpdate = 0;
int updateInterval = 500;
unsigned long lastCapTouch = 0;
uint32_t currentRandomColor;

unsigned long buttonPressTime = 0;
bool buttonActive = false;
bool holdTriggered = false;
```

```
void setup() {
  pinMode(BUTTON, INPUT_PULLUP);
  pinMode(RG_BUTTON, INPUT_PULLUP);
  pinMode(CAP_SENSOR, INPUT);
  pinMode(SPEAKER, OUTPUT);

  matrix.begin();
  matrix.setBrightness(191);
  matrix.show();
  randomSeed(analogRead(A1));
}

void loop() {
  checkButtons();
  if (powerOn) {
    checkSensor();
    updateMatrix();
  } else {
    matrix.clear();
    matrix.show();
    noTone(SPEAKER);
  }
}

void checkButtons() {
  if (digitalRead(BUTTON) == LOW && powerOn) {
    randomMode = true;
    rgMode = false;
    int choice = random(5);
    if (choice == 0) currentRandomColor = matrix.Color(255,0,0);
    if (choice == 1) currentRandomColor = matrix.Color(0,255,0);
    if (choice == 2) currentRandomColor = matrix.Color(0,0,255);
    if (choice == 3) currentRandomColor = matrix.Color(255,255,0);
    if (choice == 4) currentRandomColor = matrix.Color(128,0,128);
    delay(200);
  }

  // RG BUTTON LOGIC (Tap for color, Hold 3s for Power)
  int reading = digitalRead(RG_BUTTON);

  if (reading == LOW) {
    if (!buttonActive) {
      buttonActive = true;
      buttonPresTime = millis();
      holdTriggered = false;
    }

    // Check for 3-second hold
    if (millis() - buttonPresTime > 3000 && !holdTriggered) {
      powerOn = !powerOn;
      holdTriggered = true;
      // Quick beep to confirm power toggle
      tone(SPEAKER, 400, 100);
    }
  }
}
```

```
} else {
  if (buttonActive) {
    // If released before 3 seconds, treat as a tap
    if (millis() - buttonPressTime < 3000 && !holdTriggered && powerOn) {
      rgMode = true;
      randomMode = false;
      currentRG = !currentRG; // Immediate swap on tap
    }
    buttonActive = false;
  }
}

void checkSensor() {
  if (digitalRead(CAP_SENSOR) == HIGH) {
    lastCapTouch = millis();
    tone(SPEAKER, 1200);
  }
  if (millis() - lastCapTouch > 2000) {
    noTone(SPEAKER);
  }
}

void updateMatrix() {
  if (millis() - lastUpdate < updateInterval) return;
  lastUpdate = millis();

  if (randomMode) {
    for (int i = 0; i < NUM_LEDS; i++) matrix.setPixelColor(i, currentRandomColor);
    matrix.show();
  }

  if (rgMode) {
    uint32_t color = currentRG ? matrix.Color(255,0,0) : matrix.Color(0,255,0);
    for (int i = 0; i < NUM_LEDS; i++) matrix.setPixelColor(i, color);
    matrix.show();
  }
}
```



## 2026/03/23 - Arduino Code with Client Feedback

---

Freyja Heggeland - Mar 23, 2026, 12:59 PM CDT

**Title:** Revisiting arduino code with client feedback

**Date:** March 23rd, 2026

**Content by:** Freyja

**Goals:** redo the existing code with client feedback

**Content:**

Code pasted below. Client feedback listed:

- use red/blue instead of red/green to accommodate colorblindness
- 1 button function to switch between modes (click for red/blue switching, hold 3sec for random colors to flash with a 0.5sec delay (looked briefly into epileptic rate to assume the minimum rate we should include, suggested from NIH is maximum 3Hz so 0.5 sec delay should be fine.) Hold 5 seconds to turn off

**Conclusions/action items:**

- revisited code with feedback for ideally a better functioning device
- Continue physical modelling
- 3D print necessary portions

---

Freyja Heggeland - Mar 23, 2026, 1:27 PM CDT

```
#include <Adafruit_NeoPixel.h>

#define LED_PIN 11

#define NUM_LEDS 64

#define BUTTON 7

#define CAP_SENSOR 2

#define SPEAKER A0

Adafruit_NeoPixel matrix(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);

bool powerOn = true;

bool rbMode = true;    // false = red, true = blue

bool randomMode = false;

uint32_t currentColor;

unsigned long lastUpdate = 0;
```

```
const int updateInterval = 500;

unsigned long buttonPressTime = 0;

bool buttonActive = false;

bool holdTriggered = false;

unsigned long lastCapTouch = 0;

void setup() {

  pinMode(BUTTON, INPUT_PULLUP);

  pinMode(CAP_SENSOR, INPUT);

  pinMode(SPEAKER, OUTPUT);

  matrix.begin();

  matrix.setBrightness(191);

  matrix.show();

  randomSeed(analogRead(A1));

  currentColor = matrix.Color(255, 0, 0);
}
```

```
void loop() {

  checkButton();

  if (powerOn) {

    checkSensor();

    updateMatrix();

  } else {

    matrix.clear();

    matrix.show();
```

```
noTone(SPEAKER);

}

}

void checkButton() {

int reading = digitalRead(BUTTON);

if (reading == LOW) {

if (!buttonActive) {

buttonActive = true;

buttonPressTime = millis();

holdTriggered = false;

}

unsigned long heldTime = millis() - buttonPressTime;

// 5-second hold → toggle power

if (heldTime >= 5000 && !holdTriggered) {

powerOn = !powerOn;

randomMode = false;

holdTriggered = true;

tone(SPEAKER, 400, 100); // beep to confirm

}

// 3–5-second hold → random color mode

else if (heldTime >= 3000 && heldTime < 5000 && !holdTriggered) {

randomMode = true;

rbMode = false;

holdTriggered = true;

}
```

```
}

} else {

  if (buttonActive) {

    unsigned long heldTime = millis() - buttonPressTime;

    // Tap (<3s) → switch red/blue

    if (heldTime < 3000 && !holdTriggered && powerOn) {

      rbMode = true;

      randomMode = false;

      rbMode = !rbMode;

      currentColor = rbMode ? matrix.Color(0, 0, 255) : matrix.Color(255, 0, 0);

    }

    buttonActive = false;

  }

}

}

// Capacitive sensor

void checkSensor() {

  if (digitalRead(CAP_SENSOR) == HIGH) {

    lastCapTouch = millis();

    tone(SPEAKER, 1200);

  }

  if (millis() - lastCapTouch > 2000) {

    noTone(SPEAKER);

  }

}
```

```
// Update LED matrix

void updateMatrix() {

  if (millis() - lastUpdate < updateInterval) return;

  lastUpdate = millis();

  if (randomMode) {

    // Pick a new random color that is different from current

    uint32_t newColor;

    do {

      int choice = random(5);

      switch (choice) {

        case 0: newColor = matrix.Color(255, 0, 0); break;

        case 1: newColor = matrix.Color(0, 0, 255); break;

        case 2: newColor = matrix.Color(0, 255, 0); break;

        case 3: newColor = matrix.Color(255, 255, 0); break;

        case 4: newColor = matrix.Color(128, 0, 128); break;

      }

    } while (newColor == currentColor);

    currentColor = newColor;

  }

  // Fill matrix with current color

  for (int i = 0; i < NUM_LEDS; i++) {

    matrix.setPixelColor(i, currentColor);

  }

  matrix.show();

}
```


//open to feedback and edits from others if they're interested, have fun :3

**2026/01/28 - Freyja Heggeland - New Training - Disposal of Hazardous Chemicals**

Freyja Heggeland - Jan 28, 2026, 12:32 PM CST

**Title:** Training verification**Date:** January 28th, 2026**Content by:** Freyja Heggeland**Present:** self**Goals:** learn more about aspects of the COE and how we can learn more about different aspects of BME's reach**Content:**

**OVCR Training Information Lookup Tool**
**University of Wisconsin-Madison**



WISCONSIN  
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Freyja Heggeland has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	1/21/2025	1/21/2030
Chemical Safety: Cryogen Safety Training	Part 1 Final Quiz	1/26/2026	1/26/2031
Chemical Safety: The OSHA Lab Standard	Final Quiz	1/21/2025	
Community Research	HSR Optional Courses	9/9/2025	
Disposing of Hazardous Chemicals	Final Quiz	1/26/2026	1/26/2031
GCP Social and Behavioral Research Best Practices for Clinical Research	GCP ? Social and Behavioral Research Best Practices for Clinical Research	9/10/2025	9/10/2028
Good Clinical Practice for Drug/Device Researchers	Good Clinical Practice	9/11/2025	9/11/2028
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	9/9/2025	9/9/2028

Data Last Imported: 01/28/2026 12:24 PM

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**Conclusions/action items:**

- keep learning about new training protocols
- continue preliminary research and look into other designs
- begin drafting initial sketches



# 2026/02/25 - Freyja Heggeland - New Training - Biosafety 102: Bloodborne Pathogens

Freyja Heggeland - Feb 27, 2026, 10:25 AM CST

**Title:** Training verification

**Date:** February 25th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about aspects of the COE and how we can learn more about different aspects of BME's reach

**Content:**

See document below. This is what I submitted to canvas, shortly after completing the Bloodborne Pathogens training.

**Conclusions/action items:**

- keep learning about new training protocols
- continue preliminary report
- continue CAD sketches

Freyja Heggeland - Feb 25, 2026, 1:43 PM CST



[Download](#)

**BME\_Design\_301\_Training\_throughout\_the\_curriculum.pdf (160 kB)**

Freyja Heggeland - Feb 27, 2026, 10:32 AM CST



[Download](#)

**Screenshot\_2026-02-27\_103158.png (75.8 kB)**



## 2026/03/29 - Freyja Heggeland - Reformatted Training

Freyja Heggeland - Mar 29, 2026, 1:25 PM CDT

**Title:** Training verification

**Date:** March 29th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about aspects of the COE and how we can learn more about different aspects of BME's reach

**Content:**

See document below. This is what I submitted to canvas, shortly after completing the Bloodborne Pathogens training. (Note, this is a recompletion of the training completed on Feb 25th 2026 due to Canvas)

**Conclusions/action items:**

- keep learning about new training protocols
- continue preliminary report
- continue CAD sketches

Freyja Heggeland - Mar 29, 2026, 1:25 PM CDT

### OVCR Training Information Lookup Tool

University of Wisconsin-Madison



This certifies that Freyja Heggeland has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2026	2/25/2026	2/25/2027
Biosafety Required Training	Biosafety Required Training Quiz 2024	1/21/2025	1/21/2030
Chemical Safety: Cryogen Safety Training	Part 1 Final Quiz	1/26/2026	1/26/2031
Chemical Safety: The OSHA Lab Standard	Final Quiz	1/21/2025	
Community Research	HSR Optional Courses	9/9/2025	
Disposing of Hazardous Chemicals	Final Quiz	1/26/2026	1/26/2031
GCP Social and Behavioral Research Best Practices for Clinical Research	GCP? Social and Behavioral Research Best Practices for Clinical Research	9/10/2025	9/10/2028
Good Clinical Practice for Drug/Device Researchers	Good Clinical Practice	9/11/2025	9/11/2028
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	9/9/2025	9/9/2028

Freyja Heggeland - Mar 29, 2026, 1:33 PM CDT



**Freyja (MATTHEW)  
HEGGELAND**

ID Number: 908500531  
3

Eligibility: CoE  
Students

[Profile](#)

[Program Registrations](#)

[Bookings](#)

### My Memberships

Membership Type	Start Date	Expiry Date	Renew	Card Info
Machining	Tue, Aug 20 2024	Permanent	Not Renewable	N/A
Shop Tools	Tue, Aug 20 2024	Thu, Jan 2 3000	Not Renewable	N/A
Laser Cutter	Tue, Aug 20 2024	Thu, Jan 2 3000	Not Renewable	N/A
Lab Orientation	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable	N/A
Laser Cutter - Training Eligible	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable	N/A

**2026/02/08 and 2026/02/10 - Working on the Design Matrices - materials**

Freyja Heggeland - Feb 08, 2026, 5:06 PM CST

**Title:** Deliverable work

**Date:** February 8th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement. Get a better visual for our project.

**Content:**

I worked for around an hour looking at different material considerations and options for our design matrices that will be put into our preliminary presentation. The below screenshot shows the values, scoring, and strength of each criteria for the draft of our design material matrix.

freyja's input/design choices:	carbon fiber	weight CF score	aluminum ___ al	weighted AI alloy	material 3	material 3 weighted
weight (35)	5/5	35	3/5	21		
durability (35)	5/5	35	5/5	35		
cost (10)	1/5	2	3/5	6		
ease of engraving	2/5	4	4/5	8		
ease of fab (10)	3/5	6	4/5	8		
total (100)		82		78		

The aluminum alloy will likely be made with magnesium or cadmium for their corrosion resistant properties and tensile strength. The 3rd material will likely be stainless steel, or PVC. Stainless steel could be used for its strength, but it will be extremely heavy, so likely not a great idea. PVC could be useful as its lighter, but is less ideal to use because of its environmental impacts.

**Conclusions/action items:**

- continue drafting sketches
- continue preliminary research and look into other designs
- continue brainstorming new ideas and design criteria with the team

Freyja Heggeland - Feb 10, 2026, 1:47 PM CST

Continued on 2026/02/10, finished draft of material design matrix. See below.

freyja's input/design choices:	carbon fiber	weight CF score	aluminum ___ al	weighted AI alloy	PVC	material 3 weighted
weight (35)	5/5	35	2/5	14	3/5	21
durability (35)	5/5	35	5/5	35	4/5	28
cost (10)	1/5	2	3/5	6	5/5	10
ease of engraving	2/5	4	4/5	8	4/5	8
ease of fab (10)	3/5	6	4/5	8	5/5	10
total (100)		82		71		77

Continued like 30 minutes later, a much more polished and presentation-ready design.



more polished version:

choose whatever highlight color we want to run with

	carbon fiber	weight CF score	aluminum alloy	weighted Al alloy	PVC	PVC weighted
weight (35)	5/5	35	2/5	14	3/5	21
durability (35)	5/5	35	5/5	35	4/5	28
cost (10)	1/5	2	3/5	6	5/5	10
ease of engraving	2/5	4	4/5	8	4/5	8
ease of fab (10)	3/5	6	4/5	8	5/5	10
total (100)		82		71		77



# 2026/02/11 - Working on the Material Matrices - Discussing Criteria Weight

Freyja Heggeland - Feb 11, 2026, 11:15 AM CST

**Title:** Discussing Criteria Weight

**Date:** February 11th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement. Get a better visual for our project.

**Content:**

The design matrix draft is shown below.

	carbon fiber	weight CF score	aluminum alloy	weighted Al alloy	PVC	PVC weighted
weight (35)	5/5	35	2/5	14	3/5	21
durability (35)	5/5	35	5/5	35	4/5	28
cost (10)	1/5	2	3/5	6	5/5	10
ease of engraving	2/5	4	4/5	8	4/5	8
ease of fab (10)	3/5	6	4/5	8	5/5	10
total (100)		82		71		77

image source (left) <https://ikancorp.com/shop/rigs-matte-boxes-follow-focus/elements-rigs-rigs-matte-boxes-follow-focus-2/ik>  
<https://www.thyssenkrupp-materials-na.com/materials/aluminum/round>  
<https://formufit.com/products/1-2-in-f>

Links to image sources will be removed for the final draft. Note: Ease of Engraving is rated (10) points but cannot be shown due to the limitations of sheets. This will be changed for the preliminary presentation.

Criteria were chosen in this manner due to our clients specific requirements for the depths of this device. Weight interpretation is the most important aspect of this design and we want the patient to feel as little weight as physically possible. Durability is also extremely important, as this device is meant to last for a very long time and be in active use for the patient. Cost, ease of engraving, and ease of fabrication are all rated (10) points due to their lower importance for the project. Cost is lower due to our increased budget over past semesters. Ease of engraving should be relatively low effort for all materials due to our groups' access to the machining lab and Makerspace. Ease of fabrication also falls under this lower-ranked category due to our access to the machining spaces.

**Conclusions/action items:**

- continue drafting sketches
- continue preliminary research and look into other designs
- continue brainstorming new ideas and design criteria with the team

Freyja Heggeland - Feb 11, 2026, 12:19 PM CST

Edit from later in the day on 2026/02/11, I rearranged the values slightly by raising the "Weight" weight from 35 to 40 and reducing the "durability" weight from 35 to 30.

New matrix is shown below.




						
	carbon fiber	weight CF score	aluminum alloy	weighted AI alloy	PVC	PVC weighted
weight (40)	5/5	40	2/5	16	3/5	24
durability (30)	5/5	30	5/5	30	4/5	24
cost (10)	1/5	2	3/5	6	5/5	10
ease of engraving	2/5	4	4/5	8	4/5	8
ease of fab (10)	3/5	6	4/5	8	5/5	10
total (100)		82		68		76

image source (left) <https://ikancorp.com/shop/rigs-matte-boxes-follow-focus/elements-rigs-rigs-matte-boxes-follow-focus-2/>  
<https://www.thyssenkrupp-materials-na.com/materials/aluminum/round>  
<https://formufit.com/products/1-2-in>



## 2026/02/15 - Preliminary Presentation Work

---

Freyja Heggeland - Feb 15, 2026, 7:48 PM CST

**Title:** Working on the preliminary presentation slides

**Date:** February 15th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete and present a key component of our project.

**Content:**

I started today's work by copying over existing information from our PDS and design matrices to our presentation slides, taken from a copy of someone's slides from a previous year. We have adapted these new ones to house all of our matrices and design criteria, but this should run fairly normal as far as BME presentations go.

Also researched tensile strength, toughness, and rough cost estimates for each material. Sources found in presentation (may provide another link below to the source list of the ones I found).

Materials slides done, Design option slides to be continued either later tonight or tomorrow.

**Conclusions/action items:**

- begin constructing draft prototypes
- present our work with our team
- continue brainstorming new ideas and design criteria with the team

---

Freyja Heggeland - Feb 15, 2026, 7:48 PM CST

Bibliography for our materials slides - used for image links, cost estimates, toughness, moduli, etc.

This bibliography is a summary of sources, not in order of the slides, and will be reorganized at a later date for the sake of our preliminary presentation.

[1]Epsilon Composite, "The different grades of carbon fiber - Epsilon Composite," Epsilon Composite spécialisée dans la production de pièces et sous-ensembles en matériaux composites, 2025. <https://www.epsilon-composite.com/en/carbon-fiber-grades> (accessed Feb. 15, 2026).

[2]Ikan Materials, "Pair of 15mm Carbon Fiber Rods - 8" - Ikan," Ikan. [https://ikancorp.com/shop/rigs-matte-boxes-follow-focus/elements-rigs-rigs-matte-boxes-follow-focus-2/ikan-ele-15cfr8-p-pair-of-15mm-carbon-fiber-rods-8/?srsltid=AfmBOooWZYg0fvQHpc\\_a\\_IQmXovNofh5nhz8u4UIDdObvLY7bJUoT\\_7ex](https://ikancorp.com/shop/rigs-matte-boxes-follow-focus/elements-rigs-rigs-matte-boxes-follow-focus-2/ikan-ele-15cfr8-p-pair-of-15mm-carbon-fiber-rods-8/?srsltid=AfmBOooWZYg0fvQHpc_a_IQmXovNofh5nhz8u4UIDdObvLY7bJUoT_7ex) (accessed Feb. 15, 2026).

[3]K. Yang, J. Kang, and K. Numata, "Permalink Publication Date," Journal Nature communications, vol. 10, no. 1, Aug. 2019, doi: <https://doi.org/10.1038/s41467-019-11520-2>.

[4]SMITeam, "Carbon Fiber Cost: Factors That Influence The Most," SMI Composites, Nov. 10, 2020. <https://www.smicomposites.com/carbon-fiber-cost-factors-that-influence-the-most/>

[5]Simmal, "Understanding the Modulus of Elasticity of Aluminium | Simmal," Simmal, Sep. 26, 2025. <https://simmal.com/understanding-the-modulus-of-elasticity-of-aluminium/>

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- [7]O. Team, "Okon Recycling," Okon Recycling, Sep. 19, 2025. <https://www.okonrecycling.com/industrial-scrap-metal-recycling/steel-and-aluminum/waste-metal-prices/>
- [8]DirectIndustry, "aluminum alloy rod IMPOL D.O.O.," [DirectIndustry.com](https://www.directindustry.com/prod/impol-doo/product-192929-2036081.html), 2016. <https://www.directindustry.com/prod/impol-doo/product-192929-2036081.html> (accessed Feb. 15, 2026).
- [9]FORMUFIT, "1-1/2 in. Thinwall Furniture Grade PVC Pipe - White," FORMUFIT. [https://formufit.com/products/1-1-2-in-x-5-ft-furniture-grade-thinwall-pvc-pipe-2-pack?srsId=AfmBOoq1xEceEs0Iq84GobsVLEeFFfbDpF8LoFprApafsqfoB\\_Z0czbl](https://formufit.com/products/1-1-2-in-x-5-ft-furniture-grade-thinwall-pvc-pipe-2-pack?srsId=AfmBOoq1xEceEs0Iq84GobsVLEeFFfbDpF8LoFprApafsqfoB_Z0czbl) (accessed Feb. 15, 2026).
- [10]A. Rodolfo and V. M. John, "Application of fracture mechanics for the characterization of poly(vinyl chloride) pipes.," Journal of Vinyl and Additive Technology, vol. 27, no. 4, pp. 806–820, Jul. 2021, doi: <https://doi.org/10.1002/vnl.21852>.
- [11]PVC4PIPES, "The four main different PVC pipe categories," PVC4Pipes. <https://pvc4pipes.com/pvc-pipes/pvc-pipe-categories/> (accessed Feb. 15, 2026).
- [12]businessanalytiq, "PVC price index," businessanalytiq, Aug. 03, 2020. <https://businessanalytiq.com/procurementanalytics/index/pvc-price-index/>



## 2026/02/16 - Preliminary Presentation Work - Continued

Freyja Heggeland - Feb 16, 2026, 9:23 PM CST

**Title:** Working on the preliminary presentation slides

**Date:** February 16th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete and present a key component of our project.

**Content:**

Today I edited the final design slides to add our pictures and the descriptions of how each design differs.

Speaker: Freyja

# Design Options Considered

## Fixed Length Shaft

- Static length shaft
- Lightweight and mobile
- Switch allows for display

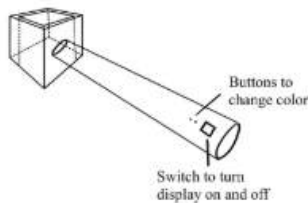


Figure X: Fixed Length Shaft

## Push Button Pin Shaft

- Allows for dynamic length
- Switch-controlled visual
- Lightweight and easily sterilized



Figure X: Push Button Pin Shaft

## Hands-Free Board

- Allows for hands-free use
- Allows work with other devices
- Less portable than others

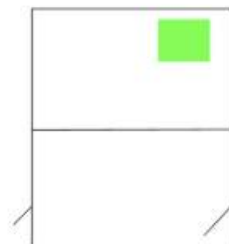


Figure X: Hands-Free Board

Current slide edited shown above, will be edited further with figure numbers when we are finalizing the presentation.

### Conclusions/action items:

- begin constructing draft prototypes
- present our work with our team
- continue brainstorming new ideas and design criteria with the team



## 2026/02/18 - Preliminary Presentation Work - Continued Again

Freyja Heggeland - Feb 18, 2026, 12:16 AM CST

**Title:** Working on the preliminary presentation slides

**Date:** February 18th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete and present a key component of our project.

**Content:**

Continued slide work and edited existing ones.

Speaker: Freyja

# Final Designs

- The Fixed-Length Shaft design
- Made of Carbon Fiber
- Bulk of weight centered at the handle
- Marked at every inch to measure reach

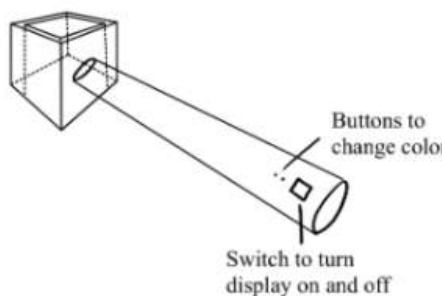



Figure X: The Fixed-Length Shaft Design

 DEPARTMENT OF  
**Biomedical Engineering**  
UNIVERSITY OF WISCONSIN-MADISON

19

**Conclusions/action items:**

- begin constructing draft prototypes
- present our work with our team
- continue brainstorming new ideas and design criteria with the team



## 2026/02/19 - Preliminary Presentation Work Finale

---

Freyja Heggeland - Feb 19, 2026, 10:45 PM CST

**Title:** Working on the preliminary presentation slides

**Date:** February 19th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete and present a key component of our project.

**Content:**

Finalized all sources, figure numbers, references page, and practiced my part for the presentation on 2/20/2026. Pics are found on our full pdf of the slideshow, found on the website and presented in 3355 E hall. [https://docs.google.com/presentation/d/1A8\\_TND00\\_OXWoRyg3x9Jtm9g9Zspm6z49Y5BRhbe7a8/edit?slide=id.g38458a86bc4\\_0\\_3#slide=id.g38458a86bc4\\_0\\_3](https://docs.google.com/presentation/d/1A8_TND00_OXWoRyg3x9Jtm9g9Zspm6z49Y5BRhbe7a8/edit?slide=id.g38458a86bc4_0_3#slide=id.g38458a86bc4_0_3)

**Conclusions/action items:**

- begin constructing draft prototypes
- present our work with our team
- continue brainstorming new ideas and design criteria with the team

# 2026/02/21 - Preliminary Report Work

Freyja Heggeland - Feb 21, 2026, 3:27 PM CST

**Title:** Working on the preliminary report

**Date:** February 21st, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete and present a key component of our project.

**Content:**

I'm mainly working on the preliminary design evaluation and fabrication sections.

Update from about an hour or two later: I worked on the preliminary design evaluation and completed most of it. We now have a solid draft of the preliminary design evaluation section. I've pasted what I worked on earlier below.

**Conclusions/action items:**

- begin constructing draft prototypes
- complete paper
- order materials

Freyja Heggeland - Feb 21, 2026, 3:28 PM CST

Raw text upload of the additions I made to the preliminary report document:

## *Preliminary Design Evaluation*

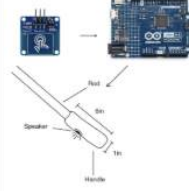
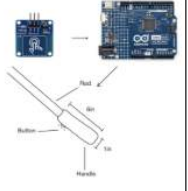
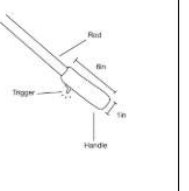
<i>Designs</i>		Design 1: Sensor-activated Speaker		Design 2: Sensor-Activated Button		Design 3: Manual Trigger	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (35)	3/5	21	4/5	28	4/5	28
2	Ease of Use (30)	5/5	30	5/5	30	3/5	18
3	Ease of Fabrication (20)	4/5	16	2/5	8	4/5	16
4	Sound Variability (10)	5/5	10	3/5	6	3/5	6
5	Cost (5)	3/5	3	3/5	3	5/5	5
Total:			80		75		74

Table X: Audio Design Matrix

**Criteria:**

*Weight (35):*

Weight is ranked as the most important criterion because excessive weight was a significant issue identified by the client in previous iterations of the device. Since the auditory feedback system is an additional feature being integrated into the existing design, it is essential that it does not increase the overall weight of the device by a large amount. The selected components must be lightweight and compact to ensure that the final prototype is lighter than previous versions.

*Ease of Use (30):*

Ease of use refers to the level of additional input required from the physician in order to activate or receive auditory feedback. The device should operate intuitively and integrate seamlessly into therapy sessions without requiring extra switches, buttons, or manual inputs. This ensures that the clinician can focus entirely on supporting and monitoring the patient rather than managing device controls. This criteria is weighted highly in order to prioritize patient safety and so as to not give extra work to the client.

*Ease of Fabrication (20):*

Ease of fabrication evaluates how complex it would be to integrate the auditory feedback system into the existing device architecture. This includes considerations such as modifying current circuitry, writing and debugging additional code, integrating new sensors or output components, such as a speaker, and producing any required 3D-printed housings or mounts.

*Sound Variability (10):*

Sound variability refers to the system’s ability to adjust volume or tone to accommodate different patient needs. For example, patients with hearing impairments may require higher volume levels or specific frequency ranges to perceive feedback effectively, that may be too loud for other patients. Additionally, varied sounds for positive or negative feedback can potentially improve patient outcomes. Although customizable auditory feedback would enhance usability and inclusivity, it is not essential for basic device functionality. Therefore, this criteria is weighted lower than core functional considerations such as weight and ease of use.

*Cost (5):*

Cost is assigned the lowest weight because the project does not have strict financial constraints. The client has provided a flexible budget, allowing design decisions to prioritize performance, reliability, and usability over price. Furthermore, the potential design options are expected to fall within a similar cost range, reducing the impact of cost differences on decision-making. Therefore, cost will likely not be a large determining factor.

<i>Designs</i>		Design 1: Carbon Fiber		Design 2: Aluminum Alloy		Design 3: PVC Tubing	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (40)	5/5	40	2/5	16	3/5	24
2	Durability (30)	5/5	30	5/5	30	4/5	24
3	Ease of Fabrication (15)	1/5	3	3/5	9	5/5	15
4	Ease of Engraving (10)	2/5	4	4/5	8	4/5	8
5	Cost (5)	3/5	3	4/5	4	5/5	5
<b>Total:</b>			80		67		76

Table X: Material Design Matrix

**Criteria:***Weight (40):*

Weight is ranked as the most important criteria because excessive weight was the primary concern raised by the client regarding the previous prototype. A reduction in weight is therefore critical to improving overall usability. The selected material must be as lightweight as possible while still meeting strength requirements. This will improve user comfort and reduce physical strain, particularly in a clinical setting where the device will be used repeatedly throughout the day. Additionally, lowering the weight contributes to patient safety by minimizing the risk of injury if the device is dropped or mishandled.

*Durability (30):*

Durability is ranked as the second most important criteria due to issues with structural failure in previous prototypes. The final design is expected to have a minimum life in service of one year with minimal maintenance. Therefore, the selected material must possess sufficient strength in order to not bend or break due to bending stresses from normal use. It should also demonstrate resistance to wear and impact from patients that can be encountered in a clinical environment. Ensuring durability will increase longevity and overall performance of the device.

*Ease of fabrication (15):*

Ease of fabrication is given a slightly lower weighting because the design requirements involve minimal complex manufacturing processes. The material will be purchased in tubular form, reducing the need for most fabricating techniques. Any additional fabrication such as cutting, drilling, or finishing will be carried out using tools available in the TEAMLab on campus. Although the fabrication process will be straightforward, the material should still be compatible with available tools and processes to ensure safe and accurate construction of the prototype.

*Ease of Engraving (10):*

Ease of engraving evaluates how effectively measurement markings can be permanently applied to the material. The final prototype must incorporate a clear and accurate measurement system so that the client can collect reliable data during functional reach tests. The material should allow for precise engraving, etching, or marking without compromising structural integrity. While this is an important feature for usability and data accuracy, it is not weighted as highly because alternative marking methods such as vinyl decals, adhesive scales, or stenciling can be used if direct engraving is outside of the scope of this project.

*Cost (5):*

Cost is assigned a lower weighting because performance characteristics such as weight and durability are of greater importance for this project. As only a single prototype will be manufactured, material cost does not significantly impact the overall design. Furthermore, the client has provided a flexible budget, allowing material selection to be guided primarily by functionality rather than price constraints. However, cost is still considered to ensure responsible purchasing choices and to maintain the potential for future scalability if additional units are to be made.

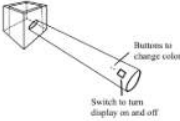

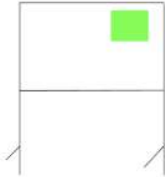
<i>Designs</i>		Design 1: Fixed Length Shaft		Design 2: Push Button Pin Shaft		Design 3: Hands Free Board	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (25)	4/5	20	4/5	20	5/5	20
2	Durability (25)	5/5	25	4/5	20	4/5	20
3	User Comfort (20)	4/5	16	4/5	16	3/5	12
4	Ease of Fabrication (15)	5/5	15	3/5	9	2/5	6
5	Safety (10)	5/5	10	4/5	8	4/5	8
6	Cost (5)	5/5	5	4/5	4	1/5	1
Total:			81		77		67

Table X: Final Design Choices Matrix

**Criteria:**

*Weight (25):*

Weight evaluates numerically and experimentally how heavy the final design will be perceived by the user. The product is intended to be in use while the client is physically supporting patients, so a manageable weight is a key factor in how easily this can be done. In addition, if the device is too heavy it might degrade faster or fail at attachments. Weight will be evaluated as better or worse than the previous design, which was deemed too heavy. If the device is too heavy and it hinders the client’s ability to support the patient, the patient could face a safety risk. Since weight impacts comfort, durability, and safety, it is given the highest weighting of the criteria.

*Durability (25):*

Durability refers to the device’s ability to withstand use for 8 hours a day 5 days a week. The device will be durable if it does not require frequent servicing. Durability also specifies that the attachments should be especially secure, since the previous designs have failed at the attachments. Durability can include the material strength and also the integrity of the design. If the device is not durable enough the device will be unsafe for the patient, so durability is very important for the chosen design.

*User Comfort (20):*

User comfort evaluates how easy it will be for the user to effectively use the final product. This includes how much the user’s hand needs to extend to change the color of the light displayed at the end of the device, the grip used to hold the device for extended periods of time, and the user’s confidence with using the final product for therapy. This criteria is important because this design has previously lacked comfortability for the user.

*Ease of Fabrication (15):*

Ease of fabrication describes the complexity of the design and evaluates how complicated the design would be to fabricate. This includes any 3D printing, machining, and circuitry. This criteria is important in order to determine if the proposed design would be able to be fabricated during the timeframe for this project and with the given resource constraints. However, this criteria is not the most important as there is only one prototype being fabricated opposed to multiple that need to be easily replicated.

*Safety (10):*

Safety describes the potential risk of injury due to sharp edges, exposed circuitry, etc. in order to choose a design that reduces the risk of injury for the user. This criteria is weighted low as all of the design ideas will have the circuitry safely enclosed and include rounded edges in order to avoid harming the user.

*Cost (5):*

Cost evaluates the expense for fabricating each design. This criteria is weighted the lowest because all of the designs have a similar complexity and will easily remain in the budget provided. The overall cost will ultimately be determined by the material chosen which will be evaluated in the material matrix.

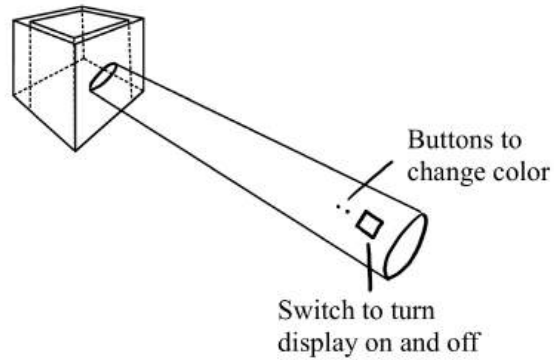


Figure X: Proposed Final Design

The proposed final design (shown above) combines aspects from each of the listed matrices. The fixed-length shaft is implemented as the bulk of the design, constructed with carbon fiber. This device will use a sensor activated speaker to perform a tactile, immediate response when a reach test is performed by the client in the physical therapy setting.



## 2026/02/22 - More Preliminary Report Work

---

Freyja Heggeland - Feb 22, 2026, 5:07 PM CST

**Title:** Working on the preliminary report

**Date:** February 22nd, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete a key component of our project and develop a model for our client.

**Content:**

Today I mostly worked with the fabrication section, doing the Materials subsection.

I also added figure captions to the CAD models in the "Fabrication" section.

We have not fully discussed the details of which electronic components we will be utilizing for this device, or at the very least, I am currently unaware of the specifics.

In total: I worked on the beginning of the fabrication section, added some captions to existing pictures, formatted some CAD images, and edited some of the existing text in the preliminary design evaluation and introduction sections.

**Conclusions/action items:**

- begin constructing draft prototypes
- complete paper
- order materials



## 2026/02/23 - More Preliminary Report Work - Background Research and Design Research Sections

Freyja Heggeland - Feb 23, 2026, 5:50 PM CST

**Title:** Working on the preliminary report

**Date:** February 23rd, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete a key component of our project and develop a model for our client.

**Content:**

Worked on background research section and design research section - both a part of the larger "Background" section.

Pasted raw text below, citations with [x] have links and will be labeled in the final product but are not here because I am lazy but I'm still keeping records.

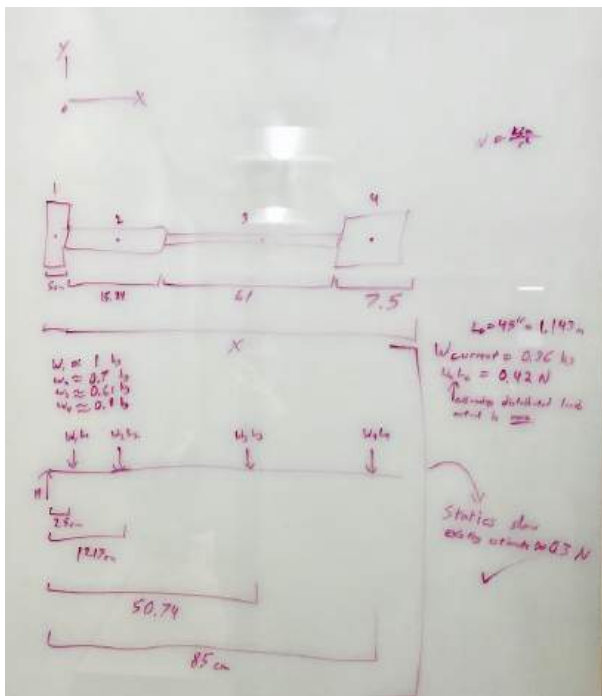
Edit from slightly later in the day: I'm also updating the "client information" tab

I also added more to the Fabrication Methods and figure captions in the fabrication section.

**Conclusions/action items:**

- begin constructing draft prototypes
- complete paper
- order materials

Freyja Heggeland - Feb 23, 2026, 5:42 PM CST



I did some static analysis for the design assuming the weight of each component is roughly (measured down) what is on the listing for each. I added extra weight to the counterweight, as our group will surely be doing this when we develop it.

Freyja Heggeland - Feb 23, 2026, 8:03 PM CST

Raw text of me editing the background research, design research, and client information sections (the spacing is also different due to the docs-labarchives transition not being as smooth as it could be):

### *A. Background Research*

The primary motivation for this type of rehabilitation therapy is treating post-stroke patients, specifically those suffering from Stroke Spatial Neglect Syndrome [x], which occurs in approximately 40% of stroke patients at some point during their lives post-stroke. Spatial Neglect is most often caused by damage to the base of the right cerebral hemisphere, causing the left-hemisphere to become more active and the right-hemisphere's effectiveness to fade, shifting the brain's overall attention toward their right eye and the images they receive from there [x]. This effect is typically associated with individuals who have experienced a right brain stroke (though left sphere neglect occurs as well) and lose awareness over what is happening with half their body. Patients suffering from this condition often have trouble balancing or moving around, as their brain amplifies the signaling received from one eye compared to the other, distorting the shape and size of objects along with their distance relative to it [x]. Due to these effects, this condition necessitates care in neurological rehabilitation hospitals that specialize in treating orthopedic and brain-related injuries. Many different kinds of stimuli need to be tested with patients to fully understand which regions of the brain are primarily affected by these post-stroke conditions. This device will test different kinds of stimuli, but cannot provide a full and complete diagnostic test. Still, it will attempt to reconcile as many as possible.

### *B. Design Research*

In addition to the above motivation for the project, it is also important that the device is easy to use in everyday uses. Physicians will be using this device in physical therapy applications, so the device needs to be mobile and able to freely move around while being used by the physician. The solution to this problem is in an ergonomic design that allows the physician to easily use the product without becoming fatigued and without having to move from their current position to assist the patient, should the patient lose their balance or fall. Considering that the client may have to use this device several times a day and for extended periods of time (more than one hour), the device should be lightweight, as not to cause any damage to the physicians' arm. This will factor into the weight distribution of the device, as the weight should be distributed more towards the user due to simple torque mechanics. Holding the device should be comfortable, which means the device's weight and the user's weight perception are the most important factors and will be set at a maximum of 5 N [x].

### *C. Client Information*

Mr. Daniel Kutschera is a physical therapist, specializing in neurological rehabilitation therapy for ThedaCare, an acute stroke clinic in Fitchburg, WI. His therapy specializes in stroke rehabilitation, specifically for patients suffering from Spatial Neglect Syndrome. The client provides guidelines that the device should be lightweight, ergonomic, and easy to use with easily identifiable shapes and colors.

Edit from a while after these edits were made but on the same day: I learned that these edits were in another group members section, so they have been deleted from the main document. I will keep them here for the sake of logging them, but they will not appear in the main paper.

---

Freyja Heggeland - Feb 23, 2026, 10:24 PM CST

New edits from later in the day for the Fabrication section:

## ***Fabrication***

The Dynamic Balance Device is designed to be lightweight, durable, and comfortable for both the therapist and patient. This includes selecting materials that fulfill these requirements, but can still protect the embedded electronics and keep the device intact. The main section of the device will be constructed of a carbon fiber tube, thus protecting the interior electric components and wiring from friction and or impact. Carbon fiber was chosen for this material due to its low density of  $1.7\text{g/cm}^3$  [x]. The material for the handle will also be constructed of carbon fiber. Previous iterations of this device worked with the 3D printer plastic polyurethane, but this is where the previous design failed under loading. The exterior portions of the handle and display components will also be constructed with carbon fiber for its lightweight aspects and extremely high tensile strength of roughly 5,000 MPa [x].

The major electronic components will be an Arduino UNO board, a battery to power the Arduino, a rectangular LED board to display colors on, and various wires for connection points for the above electrical components [x]. The audio feedback portion of

this device will be wired to the Arduino and powered through the same system.

#### *A. Methods*

The chassis of the device will be constructed with a 61cm long, 0.8cm external diameter, 0.7cm internal diameter tube. On one end of the tube, there will be a 7.5cm by 7.3cm by 2.5cm hollow rectangular prism attached to the tube with a hole near the connection point for wiring capabilities. The end of the carbon fiber tube will be attached to the center of one of the 2.5cm by 7.3cm faces, where the hole will be located. This is where the display will be labeled. One of the 7.5cm by 7.3cm faces will be removed and replaced with the display, allowing for easier access to the display.

The opposite opening end of the carbon fiber tube will be attached to the handle section, a 15.24cm long by 1cm outer diameter rod. This component will house two buttons that can turn the display at the end of the rod on or off. The counterweight will be connected to the opposite end of the handle and will function to manage the existing weight of the device, allowing the physician to more easily maintain the device in an upward position.

The electronic components of the device will be powered by a battery connected to an Arduino UNO, which will provide the proper signals to the circuitry. An LED board will be attached to the device in the rectangular box at the end of the tube. This LED will be attached with a display screen to properly show all colors that it can take on from the Arduino board. The wires that connect the buttons and the Arduino, display and battery will be run through the center of the carbon fiber tube. The speaker unit for the audio feedback will also be connected in this section.

---

Freyja Heggeland - Feb 23, 2026, 11:24 PM CST

Further note from even later, I am updating the preliminary design evaluation section. I will include the full transcript below when I am finished.

Edit and text from around an hour or so later, I redid the entire section:

### ***Preliminary Design Evaluation***

Design matrices are a tool used by the design team to determine which preliminary design is the best match for the client's criteria. The team broke their design up into three separate matrices: audio sensor, material for the shaft, and design for the shaft. Each matrix consists of their own criteria that applies to the specific portion's requirements of the total design. Each criteria were selected based on the client's requirements and the existing knowledge possessed by the design team.

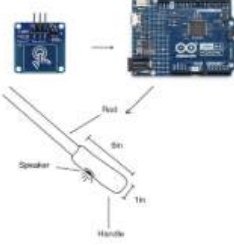
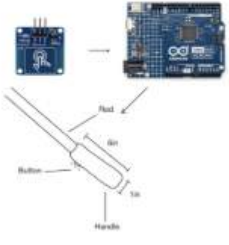
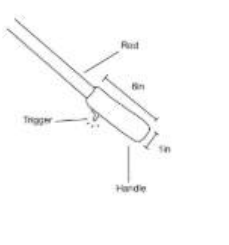
<i>Designs</i>		Design 1: Sensor-activated Speaker		Design 2: Sensor-Activated Button		Design 3: Manual Trigger	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (35)	3/5	21	4/5	28	4/5	28
2	Ease of Use (30)	5/5	30	5/5	30	3/5	18
3	Ease of Fabrication (20)	4/5	16	2/5	8	4/5	16
4	Sound Variability (10)	5/5	10	3/5	6	3/5	6
5	Cost (5)	3/5	3	3/5	3	5/5	5
Total:			80		75		74

Table X: Audio Design Matrix

This table is split into five main categories, each with different weight regarding the importance of each in the overall design choice. Weight is ranked as the most important criterion because excessive weight was a significant issue identified by the client in previous iterations of the device. Since the auditory feedback system is an additional feature being integrated into the existing design, it is essential that it does not increase the overall weight of the device by a large amount. The selected components must be lightweight and compact to ensure that the final prototype is lighter than previous versions. Ease of use refers to the level of additional input required from the physician in order to activate or receive auditory feedback. The device should operate intuitively and integrate seamlessly into therapy sessions without requiring extra switches, buttons, or manual inputs. This ensures that the clinician can focus entirely on supporting and monitoring the patient rather than managing device controls. This criteria is weighted highly in order to prioritize patient safety and so as to not give extra work to the client. Ease of fabrication evaluates how complex it would be to integrate the auditory feedback system into the existing device architecture. This includes considerations such as modifying current circuitry, writing and debugging additional code, integrating new sensors or output components, such as a speaker, and producing any required 3D-printed housings or mounts. Sound variability refers to the system’s ability to adjust volume or tone to accommodate different patient needs. For example, patients with hearing impairments may require higher volume levels or specific frequency ranges to perceive feedback effectively, that may be too loud for other patients. Additionally, varied sounds for positive or negative feedback can potentially improve patient outcomes. Although customizable auditory feedback would enhance usability and inclusivity, it is not essential for basic device functionality. Therefore, this criteria is weighted lower than core functional considerations such as weight and ease of use. Cost is assigned the lowest weight because the project does not have strict financial constraints. The client has provided a flexible budget, allowing design decisions to prioritize performance, reliability, and usability over price. Furthermore, the potential design options are expected to fall within a similar cost range, reducing the impact of cost differences on decision-making. Therefore, cost will likely not be a large determining factor.

The design matrix uses the criteria above to determine the best design. For weight, both the sensor activated button and manual trigger scored the highest due to the lower amount of components. For ease of use, both the sensor activated speaker and the sensor activated button scored the highest due to the sensor-based, automatic activation. For ease of fabrication, the sensor activated speaker and manual trigger scored the highest due to the addition of new parts into the device. For sound variability, the sensor activated speaker scored the highest due to its availability with other sound modules. For cost, the manual trigger scored the highest, due to the lack of as many electronic components as the other designs.

<i>Designs</i>		Design 1: Carbon Fiber		Design 2: Aluminum Alloy		Design 3: PVC Tubing	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (40)	5/5	40	2/5	16	3/5	24
2	Durability (30)	5/5	30	5/5	30	4/5	24
3	Ease of Fabrication (15)	1/5	3	3/5	9	5/5	15
4	Ease of Engraving (10)	2/5	4	4/5	8	4/5	8
5	Cost (5)	3/5	3	4/5	4	5/5	5
Total:			80		67		76

Table X: Material Design Matrix

This table is split into five main categories, each with different weight regarding the importance of each in the overall design choice. Weight is ranked as the most important criteria because excessive weight was the primary concern raised by the client regarding the previous prototype. A reduction in weight is therefore critical to improving overall usability. The selected material must be as lightweight as possible while still meeting strength requirements. This will improve user comfort and reduce physical strain, particularly in a clinical setting where the device will be used repeatedly throughout the day. Additionally, lowering the weight contributes to patient safety by minimizing the risk of injury if the device is dropped or mishandled. Durability is ranked as the second most important criteria due to issues with structural failure in previous prototypes. The final design is expected to have a minimum life in service of one year with minimal maintenance. Therefore, the selected material must possess sufficient strength in order to not bend or break due to bending stresses from normal use. It should also demonstrate resistance to wear and impact from patients that can be encountered in a clinical environment. Ensuring durability will increase longevity and overall performance of the device. Ease of fabrication is given a slightly lower weighting because the design requirements involve minimal complex manufacturing processes. The material will be purchased in tubular form, reducing the need for most fabricating techniques. Any additional fabrication such as cutting, drilling, or finishing will be carried out using tools available in the TEAMLab on campus. Although the fabrication process will be straightforward, the material should still be compatible with available tools and processes to ensure safe and accurate construction of the prototype. Ease of engraving evaluates how effectively measurement markings can be permanently applied to the material. The final prototype must incorporate a clear and accurate measurement system so that the client can collect reliable data during functional reach tests. The material should allow for precise engraving, etching, or marking without compromising structural integrity. While this is an important feature for usability and data accuracy, it is not weighted as highly because alternative marking methods such as vinyl decals, adhesive scales, or stenciling can be used if direct engraving is outside of the scope of this project. Cost is assigned a lower weighting because performance characteristics such as weight and durability are of greater importance for this project. As only a single prototype will be manufactured, material cost does not significantly impact the overall design. Furthermore, the client has provided a flexible budget, allowing material selection to be guided primarily by functionality rather than price constraints. However, cost is still considered to ensure responsible purchasing choices and to maintain the potential for future scalability if additional units are to be made.

This design matrix also uses the criteria above to determine the best design. For weight, carbon fiber scored the highest, due to its low relative density. For durability, carbon fiber and aluminum alloy scored the highest due to their high tensile strength. For ease of fabrication, the PVC tubing scored the highest, due to how it can be worked on with multiple CNC machines. For ease of engraving, aluminum alloy and PVC tubing scored the highest due to the compatibility they have with mills. For cost, the PVC tubing scored the highest, due to its availability and price per gram.

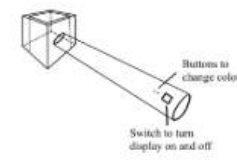

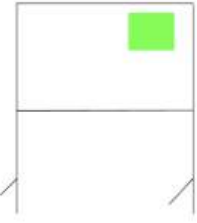
Designs		Design 1: Fixed Length Shaft		Design 2: Push Button Pin Shaft		Design 3: Hands Free Board	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Weight (25)	4/5	20	4/5	20	5/5	20
2	Durability (25)	5/5	25	4/5	20	4/5	20
3	User Comfort (20)	4/5	16	4/5	16	3/5	12
4	Ease of Fabrication (15)	5/5	15	3/5	9	2/5	6
5	Safety (10)	5/5	10	4/5	8	4/5	8
6	Cost (5)	5/5	5	4/5	4	1/5	1
Total:			81		77		67

Table X: Final Design Choices Matrix

This table is split into six main categories, each with different weights regarding how well they match the client’s requirements. Weight evaluates numerically and experimentally how heavy the final design will be perceived by the user. The product is intended to be in use while the client is physically supporting patients, so a manageable weight is a key factor in how easily this can be done. In addition, if the device is too heavy it might degrade faster or fail at attachments. Weight will be evaluated as better or worse than the previous design, which was deemed too heavy. If the device is too heavy and it hinders the client’s ability to support the patient, the patient could face a safety risk. Since weight impacts comfort, durability, and safety, it is given the highest weighting of the criteria. Durability refers to the device’s ability to withstand use for 8 hours a day 5 days a week. The device will be durable if it does not require frequent servicing. Durability also specifies that the attachments should be especially secure, since the previous designs have failed at the attachments. Durability can include the material strength and also the integrity of the design. If the device is not durable enough the device will be unsafe for the patient, so durability is very important for the chosen design. User comfort evaluates how easy it will be for the user to effectively use the final product. This includes how much the user’s hand needs to extend to change the color of the light displayed at the end of the device, the grip used to hold the device for extended periods of time, and the user’s confidence with using the final product for therapy. This criteria is important because this design has previously lacked comfortability for the user. Ease of fabrication describes the complexity of the design and evaluates how complicated the design would be to fabricate. This includes any 3D printing, machining, and circuitry. This criteria is important in order to determine if the proposed design would be able to be fabricated during the timeframe for this project and with the given resource constraints. However, this criteria is not the most important as there is only one prototype being fabricated opposed to multiple that need to be easily replicated. Safety describes the potential risk of injury due to sharp edges, exposed circuitry, etc. in order to choose a design that reduces the risk of injury for the user. This criteria is weighted low as all of the design ideas will have the circuitry safely enclosed and include rounded edges in order to avoid harming the user. Cost evaluates the expense for fabricating each design. This criteria is weighted the lowest because all of the designs have a similar complexity and will easily remain in the budget provided. The overall cost will ultimately be determined by the material chosen which will be evaluated in the material matrix.

Regarding weight, the hands-free board scored the highest, due to the physician not needing to hold the board up during its usage. For durability, the fixed length shaft scored the highest due to a lower amount of openings compared to the push button pin shaft. For user comfort, the fixed length shaft and push button pin shaft scored the highest due to their maneuverability and weight

dispersion. For ease of fabrication, the fixed length shaft scored the highest, due to the singular main piece that holds up the bulk of the material. It removes steps that would be necessary with either other design. For safety, the fixed length shaft scored the highest due to how the physician can use and hold it, along with how it doesn't need to have a button where things could possibly get stuck. For cost, the fixed length shaft scored the highest due to needing fewer mechanical components.

### ***Proposed Final Design***

The proposed final design combines aspects from each of the listed matrices. The fixed-length shaft is implemented as the bulk of the design, constructed with carbon fiber. The handle will contain an internal compartment for storage of the power source, as well as buttons to turn the display on and off and change the colors of the display. The sensor activated speaker will be implemented in the box at the end of the carbon fiber tubing. This device will use a sensor activated speaker to perform a tactile, immediate response when a reach test is performed by the client in the physical therapy setting. The LED component will also be kept in this end portion, allowing for different colors to be displayed. The LED will be compatible with an Arduino microcontroller that will allow for simple commands to be transmitted. Overall, the device will prioritize maintaining a light weight, being ergonomic, stable, affordable, and easy to use, being ideal for clinical and therapeutic settings that perform visual and balance training with patients.

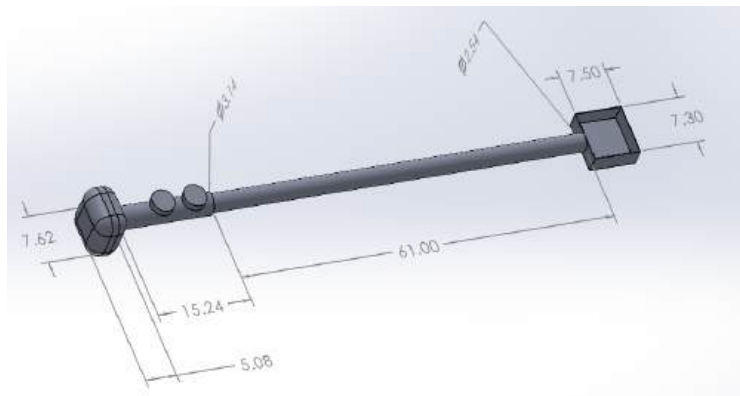


Figure X: Proposed Final Design



# 2026/02/24 - Preliminary Report Work - Finalizing and Appendices

Freyja Heggeland - Feb 24, 2026, 3:31 PM CST

**Title:** Working on the preliminary report

**Date:** February 24th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete and present a key component of our project.

**Content:**

Today, I worked on Appendices B and C of our matrix (expense spreadsheet and electronic flow diagram, respectively)

Pasted below

Materials have not yet been ordered, but the group consensus will be reached soon and our client and advisor will be notified of these decisions.

Less edits today than in the past 3 days but we're coming to a close on the project, so we should be good.

**Conclusions/action items:**

- begin constructing draft prototypes
- complete paper
- order materials

Freyja Heggeland - Feb 24, 2026, 3:30 PM CST

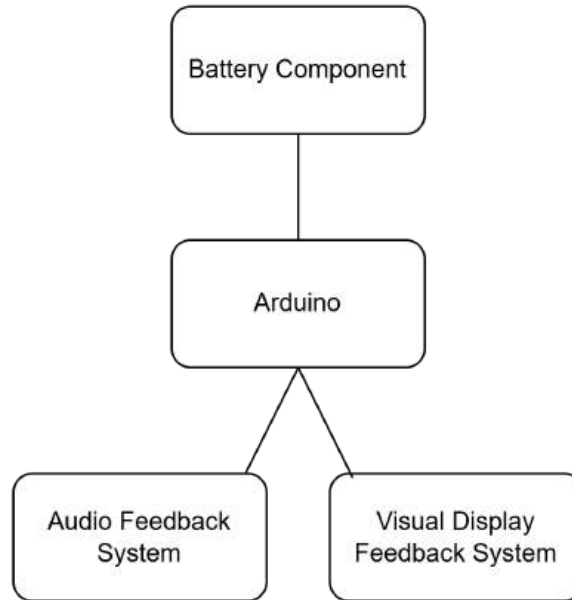
## Appendix B: Expense Spreadsheet

Materials have not yet been purchased, however these are the materials that will be purchased when the project moves forward in its present state. More items will be added to this list over time, due to acquiring more materials from the University of Wisconsin-Madison's TEAMLab and other online vendors when needed.

Item	Description	Manufacturer	Mft Pt#	Vendor	Vendor Cat#	Date	QTY	Cost Each	Total	Link
<b>Structural Materials</b>										
Carbon Fiber Tub	1m long, 8mm o	CHZDPP		Amazon	B0DJJTX35Q	2/22/2026	1	\$54.25	\$54.25	<a href="https://www.am">https://www.am</a>
									\$0.00	
									\$0.00	
									\$0.00	
<b>Electronic Components</b>										
Arduino Uno Rev	Arduino	Arduino	A000066	Arduino	7630049200050	2/23/2026	1	\$27.60	\$27.60	<a href="https://store-us">https://store-us</a>
									\$0.00	
									\$0.00	
									\$0.00	
									<b>TOTAL:</b>	<b>\$81.85</b>
									<b>Budget:</b>	<b>\$418.15</b>

Table X: Expense spreadsheet, showing existing expenses, materials, total amount spent, and the remaining budget.

## Appendix C: Electronic Flow Chart Diagram



Flow Chart Diagram: Shows the electrical components between the battery, Arduino, visual feedback, and audio feedback systems.

Freyja Heggeland - Feb 24, 2026, 4:12 PM CST

Note from later, I worked more on the expense spreadsheet and formatted the one in our report to be more compact and professional. Shown below.

Item	Description	Manufac turer	Mft Pt#	Vendor	Vendor Cat#	Date	QTY	Cost Each	Total	Link
<b>Structural Materials</b>										
Carbon Fiber Tube	1m long, 8mm outer diameter, 7mm inner diameter carbon fiber tubing	CHZDPP	B0DJJTX3S Q	Amazon	B0DJJTX3S Q	2/22/2026	1	\$54.25	\$54.25	<a href="#">Amazon.com</a>
<b>Electronic Components</b>										
Arduino Uno Rev3	Arduino microcontroller	Arduino	A000066	Arduino	76300492 00050	2/23/2026	1	\$27.60	\$27.60	<a href="#">ArduinoStore.com</a>
								<b>TOTAL:</b>	<b>\$81.85</b>	
								<b>Remaining Budget:</b>	<b>\$418.15</b>	

Freyja Heggeland - Feb 24, 2026, 11:47 PM CST

Update from very late in the day; I added a small portion to the existing preliminary design section. This was roughly 3-4 sentences at the end of the existing content present.

"This design extends from the base fixed-length shaft by adding new sections to extend and maintain the length of the device. This aspect of the design can make it more accessible for some users. The visual display fits into the box on the lower end, similarly to the fixed-length shaft. The control buttons are also placed similarly to the fixed-length design."



## 2026/02/22 - Reworking the PDS Based on Feedback

Freyja Heggeland - Feb 22, 2026, 6:33 PM CST

**Title:** Reworking the PDS

**Date:** February 22nd, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** Complete a key component of our project and develop a model for our client.

**Content:**

I worked on editing our old PDS for the development in our product design.

**Conclusions/action items:**

- begin constructing draft prototypes
- complete paper
- order materials

Freyja Heggeland - Feb 23, 2026, 5:03 PM CST



**Dynamic Balance Device**  
*Product Design Specifications*

BME 301  
Lab 304  
February 22, 2026

Client: Mr. Daniel Kutschera  
Advisor: Professor Okunog  
University of Wisconsin-Madison  
Department of Biomedical Engineering

Team:  
Katherine Sured (Team Leader)  
Thomas Koh (Communicator)  
Noor Anad (BSAC)  
Freyja Heggeland (BWIO and BFAO)

[Download](#)

**Dynamic\_Balance\_Device\_PDS\_Feb\_22\_.pdf (226 kB)**



## 2026/03/18 and 2026/03/19 - Constructing circuit with team and Material Sourcing

Freyja Heggeland - Mar 18, 2026, 3:34 PM CDT

**Title:** Circuit constructs

**Date:** March 18th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** Construct circuit and have it ready for show and tell later this week

**Content:**

3D printed portion will be remade

Carbon fiber rod was reordered due to existing one having a thin outer diameter.

Inner diameter of old rod was ok, but not ideal.

Outer diameter was way too thin. New rod outer diameter is 20mm, inner diameter is 18mm, length is 1000mm or 1m.

New rod will allow for better wire connections.

Kat and I purchased a 9V battery from the TEAMLab.

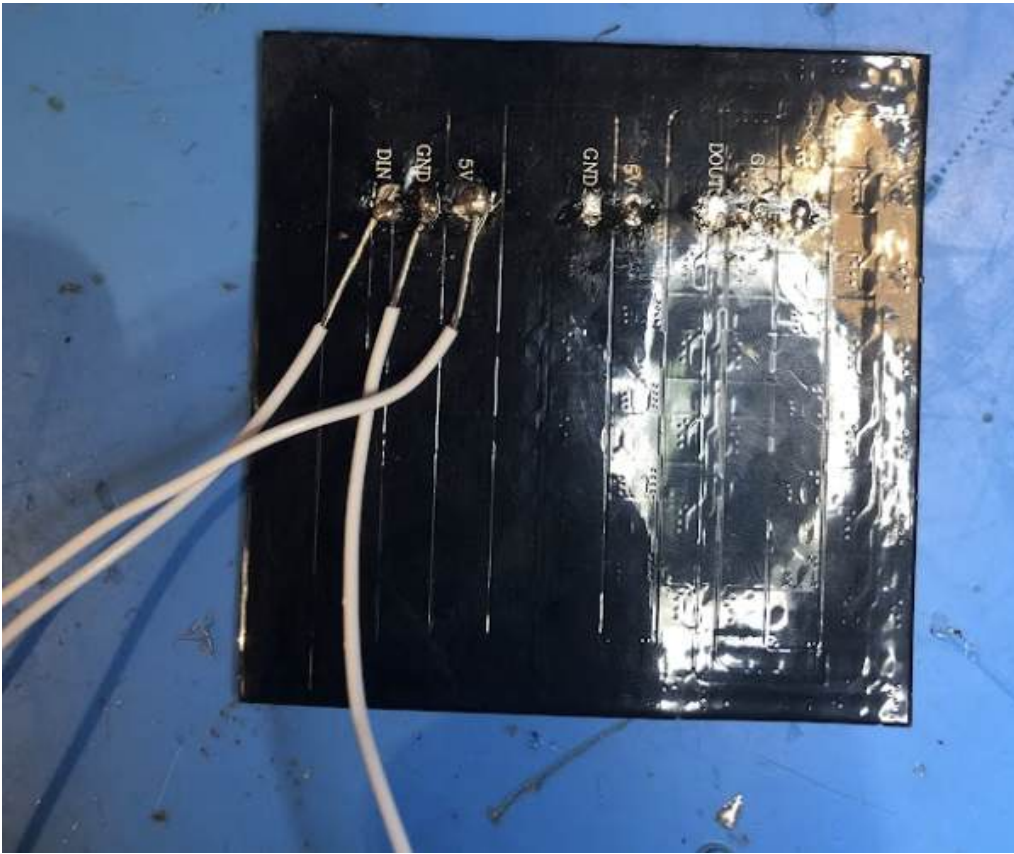
I worked on unsoldering the existing portion of the old model for the LED board.

Pictures will be added below.



All 8 of these nodes had previous connections that have now been removed.

We are now soldering wires to these connection points with our wires, as opposed to the other ones from the last iteration of the project.



Wires are now connected

This took like an hour

**Conclusions/action items:**

- continue building our prototypes for show and tell
- construct 3D chassis portion
- We constructed our circuit and worked on electrical logistics

---

Freyja Heggeland - Mar 19, 2026, 2:42 PM CDT

Note from 2026/03/19 but a relevant update:

Later in the day on 2026/03/18, I sourced new materials from the Engineering Centers Building on the UW Madison Campus. This included a 9V battery and a small metal rod with rough dimensions: 15cm long, 2.5cm outer diameter, 2cm inner diameter

Both of these components were placed into the team's locker and will be used in future prototype work.



## 2026/04/03 - Executive Summary Draft start

Freyja Heggeland - Apr 03, 2026, 3:31 PM CDT

**Title:** Executive Summary Draft beginning

**Date:** April 3rd, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** Write tong award assignment

**Content:**

Work pasted below:

Executive Summary: Tong BME Design Award, BME 301

### Dynamic Balance Device

Freyja Heggeland, Noor Awad, Katherine Sattel, Therese Kalt

Advisor: Professor Monica Ohnsorg

Client: Mr. Daniel Kutschera

Stroke patients are at an increased risk for developing Spatial Neglect Syndrome, resulting in a lack of understanding the representation of space and impaired spatial attention [4]. Specifically, about 30% of patients that have suffered from stroke experience Spatial Neglect Syndrome and patients that have had damage to the right hemisphere of the brain are at an even greater risk [1]. Spatial Neglect Syndrome often results in an increased risk for falling due to difficulty balancing that can significantly slow down the recovery process. An estimated 30% of patients who have suffered from stroke experience spatial neglect syndrome or lose vestibular sense, leading to falls that set back their recoveries. Therefore, it is important that clinicians have devices that help patients practice balance and retrain neural networks so they can complete daily activities such as walking independently. One study suggests that the total costs of the associated physical therapy can range from \$4,800 to upwards of \$10,000 [2].

Existing devices don't allow the clinician to easily assist the patient because they are too heavy, or are not complex enough to effectively improve balance. The goal of this project is to design a lightweight device that allows the patient to practice scanning and complete a functional reaching test using an electronic component. As opposed to the previous design of an aluminum pipe with an LED, this device will be multifunctional and durable for convenient use.

Problem statement/existing methods

Design and improvements over existing methods

Testing

Marketability

(example paper pasted below)

sources are on other document, anything not added here is not yet relevant

**Conclusions/action items:**

- continue building our prototypes
- construct 3D chassis portion

- I started the executive summary



## 2026/04/06 - Continued Executive Summary Draft

---

Freyja Heggeland - Apr 06, 2026, 12:26 PM CDT

**Title:** Executive Summary Draft more from last time

**Date:** April 6th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** Write tong award assignment

**Content:**

Work pasted below:

"This design improves upon existing methods by being more ergonomic and stable to hold in the user's hand. It also has multifunctionality and accessibility with the color changing LEDs and automatic speaker function, allowing colorblind and hard of seeing patients to gain more from the therapy, respectively. With around 1 in 12 men and 1 in 200 women having some variation of colorblindness, this is a necessary accommodation for universal design considerations [x]."

More will be added to this later today, likely in other entries or continued from this, where this line will be deleted.

**Conclusions/action items:**

- continue building our prototypes
- construct 3D chassis portion
- I started the executive summary



## 2026/04/07 - Continued Executive Summary Draft

---

Freyja Heggeland - Apr 07, 2026, 3:11 PM CDT

**Title:** Executive Summary Draft even more from last time

**Date:** April 7th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** Write tong award assignment

**Content:**

Work pasted below: (not all of this is mine, but I revised the existing section and added everything past the sentence ending in "effectively improve balance"

" **Marketability**

One study suggests that the total costs of the associated physical therapy can range from \$4,800 to upwards of \$10,000 [x]. Existing devices do not allow the clinician to easily assist the patient because they are too heavy or are not complex enough to effectively improve balance. Some existing devices, such as the Bioness Integrated Therapy System™ allow for the patient to reach out to show their progress with an interactive touch screen [x]. This design, while effective, costs around \$50,000 per unit, meaning some hospitals or clinics may be unable to purchase such a large device. It also does not allow for the therapist to directly assist with the therapy while holding the patient, thus the Dynamic Balance Device is a promising development for physical therapy use for patients with spatial neglect."

**Conclusions/action items:**

- continue building our prototypes
- construct 3D chassis portion
- I continued the executive summary



## 2026/04/13 - Updating Executive Summary with Feedback

---

Freyja Heggeland - Apr 13, 2026, 4:26 PM CDT

**Title:** Executive Summary Feedback yay

**Date:** April 13th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** Write tong award assignment and make it better than before

**Content:**

Added all comments from both advisor and TA suggestions

renamed file to fit requirements

Reworked "testing" section: (seen below)

This full prototype will be tested by surveying other biomedical students, gauging their ability to wield, manipulate, and use the device to its intended function. A marking will be placed on a wall and the duration of holding the device will be measured. Additionally, participants will be surveyed after holding and manipulating an earlier model of this design in comparison to this prototype. Their responses will be quantified and normalized based on body measurements, to ensure accurate data collection. The carbon fiber rod will be tested in 3-point bending to ensure that it can withstand strong forces being applied to the end of the rod and resist deformation.

more changes to come, all comments will be addressed and the summary will be rewritten

**Conclusions/action items:**

- continue building our prototypes
- construct 3D chassis portion
- I updated the executive summary for when it's due (not fully sure when)



## 2026/04/15 - Updating Executive Summary with Feedback again

---

Freyja Heggeland - Apr 15, 2026, 12:00 PM CDT

**Title:** Executive Summary Feedback yay

**Date:** April 15th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** Write tong award assignment and make it better than before

**Content:**

Rewrote sources, as we had them in IEEE format instead of the in-text writing that was desired by the requirements

I rewrote the entire thing to fit all of both our advisor and TA's requirements for our summary

Shown below

Executive Summary: Tong BME Design Award, BME 301

### Dynamic Balance Device

Freyja Heggeland, Noor Awad, Katherine Sattel, Therese Kalt

Advisor: Professor Monica Ohnsorg

Client: Mr. Daniel Kutschera

According to the American Stroke Association, stroke patients are at an increased risk for developing spatial neglect syndrome, a neurological condition that decreases spatial awareness, depth perception, and balance. Currently, the client performs this therapy by assisting the patient directly and moving a yardstick with a colored piece of paper on the end, indicating which hand the patient is intended to use to reach out and touch the paper. This method is currently inefficient due to a lack of dynamic visual and audio feedback. Existing biomedical designs were also too difficult to hold for extended periods of time. Therefore, it is important that clinicians have access to devices that help patients practice balance and retrain neural networks so they can complete daily activities such as walking independently.

This design, a continuing biomedical design project, improves upon existing methods by developing a more ergonomic design that is easier for the user to hold for extended periods of time. With the electronics placed on the user's arm and more weight in the handle, the device is much more lightweight. It also has multifunctionality and accessibility through the use of color changing LEDs and sensor-activated speaker integration, allowing colorblind patients and those with limited sight to have more effective therapy options.

This full prototype will be tested by surveying biomedical students, gauging their ability to wield, manipulate, and use the device to its intended function. A marking will be placed on a wall and the duration of holding the device will be measured. Additionally, participants will be surveyed after holding and manipulating an earlier model of this design in comparison to this prototype. Their responses will be quantified and normalized based on body measurements, to ensure accurate data collection. The carbon fiber rod will be tested in 3-point bending to ensure that it can withstand strong forces being applied to the end of the rod and resist deformation.

According to A. R. Riestra et al., the total costs of the associated physical therapy can be upwards of \$10,000. Existing devices do not allow the clinician to directly assist the patient because they are too heavy or are not complex enough to effectively improve balance. Some existing devices, such as the Bioness Integrated Therapy System™ allow for the patient to perform activities with an interactive touch screen. This design, while effective, costs around \$50,000 per unit, meaning some hospitals or clinics may be unable to afford this option. The affordability of this device is a key difference that makes the dynamic balance device more versatile and will allow the 7 million Americans living with stroke complications the opportunity to regain independence. Thus, the dynamic balance device is a promising development for physical therapy with patients in order to reduce the risk of spatial neglect.

**Conclusions/action items:**

- continue building our prototypes
- construct 3D chassis portion
- I updated the executive summary for when it's due (not fully sure when)



## 2026/04/26 - Final Report revisions and rearranging

---

Freyja Heggeland - Apr 26, 2026, 7:42 PM CDT

**Title:** Final report

**Date:** April 26th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** Write final report

**Content:**

I updated my sections of the preliminary report to better fit feedback and the requirements of the final report. I changed around the sections within both the preliminary design and evaluation sections. I also suggested some changes to be made regarding our preliminary designs, as one of the main considerations did not come to fruition. I also rewrote some of the existing captions around the preliminary design evaluation to better fit their true intention in the report.

**Conclusions/action items:**

- continue constructing final report
- finish the semester strong



## 2026/04/28 - Final Report revisions, adding appendices

---

Freyja Heggeland - Apr 29, 2026, 12:04 AM CDT

**Title:** Final report

**Date:** April 28th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** Write final report

**Content:**

I mainly added the appendices, those being the PDS, expense sheet, arduino code, and other works found at the end of our report. I would paste those here, but there is so much text, that I think that labarchives would stop me due to some character limit. See rest of notebook for all of these ^^ things. Or just look at the final report, do what you want, idc. I also added the testing form from our fatigue testing/qualitative testing. The protocol and data were both included. Total time ~2hours.

**Conclusions/action items:**

- continue constructing final report
- finish the semester strong



## 2026/01/28 - BME 301 Lecture 1

---

Freyja Heggeland - Jan 28, 2026, 2:09 PM CST

**Title:** BME 301 Lec 1

**Date:** January 28, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Content:**

AI/Chatbots are not accurate and should not be used in an academic sense because they frequently make up information and sources, making their claims completely invalid and baseless.

Books are very useful and can be found in the library database found via the university bookstore.

We can use the "find it" button on the library database to find essential information for our project

Look for key-words to find better terms when searching for primary sources.

Zotero is a very useful citation manager - install this ASAP.

Organizing bibliographies is annoying and tedious, citation managers can do this for us.

The "ask a librarian" button/option/logo is extremely useful in finding sources as it is run by real people. Runs until around 10pm.

Switch enrollment if you have not yet done so.

Our group is planning to meet later today, so ideally we have a picture up on our website by EOD.

**Conclusions/action items:**

- we learned a lot about the power of library databases and how we can use them to learn more about our projects.
- continue preliminary research and look into other designs
- begin drafting initial sketches



## 2026/02/04 - BME 301 Lecture 2

---

Freyja Heggeland - Feb 04, 2026, 1:36 PM CST

**Title:** BME 301 Lec 2

**Date:** February 4th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Content:**

We learned about the depths of BME design and how we can get further into the job market surrounding relevant positions.

Most of us are still looking for positions unfortunately

I am one of them :(.

**Conclusions/action items:**

- we learned about job listings and how we can become more involved in the professional regards of BME design.
- continue preliminary research and look into other designs
- continue drafting sketches in CAD



## 2026/02/11 - BME 301 Lecture 3

---

Freyja Heggeland - Feb 11, 2026, 1:46 PM CST

**Title:** BME 301 Lec 3

**Date:** February 11th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Content:**

Discussing interviews today

Presentation tips:

- No hanging bullets
- top left bullet should be aligned on each slide.
- Be consistent with font style and type.
- Design ideas should be presented in the same order throughout the talk
- 6 words/line, 6 lines/slide and 1 minute per slide.
- Have statistics and be important
- Don't talk down to the audience (why would we do this)
- be enthusiastic
- Talk to the audience (more applicable during the poster presentations)
- Hit the highlights of the design matrix. Talk about most important criteria first and label/highlight each. (See work from literally like an hour ago)
- Max like 2-3 bullets at a time, other ideas can just go to other slides.
- 95% of this is just formatting.
- Figure captions: "Figure X. [what it is/what it's measuring] as a function of [independent variable or feature or something] demonstrating \_\_\_\_\_."
- CAD Drawings. Use of CAD images should only be single images with labels pointing to important parts. MAYBE include measurements. DO NOT include the isometric/front/top/whatever views because nobody gives a gaf.
- Type all labels and use computer generated arrows when pointing at things. Draw them in photoshop after sketching them on paper.
- Graph all data! (this is not relevant yet). Can show average +/- standard dev. Use comparable axes if applicable.
- We can use exploded views for things where stuff is well labeled and every component is shown. Block diagrams are also good, shows actual design, more useful for software or fluid/heating elements.

We are in 3355 E Hall on Feb 20th for our preliminary presentation.

**Conclusions/action items:**

- we learned about interviews and how we can become more involved in the professional regards of BME design.
- continue preliminary research and look into other designs
- continue drafting sketches in CAD



## 2026/02/18 - BME 301 Lecture 4

---

Freyja Heggeland - Feb 18, 2026, 2:03 PM CST

**Title:** BME 301 Lec 4

**Date:** February 18th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Content:**

Discussing our presentation on Friday and how we can be more prepared for it, also discussing our presentation drafts and peer reviewing them.

We are sitting with our teammates.

Project builder (include a LIVE LINK to the prelim presentation). Embedded videos (not applicable) need to be viewable across the UW database. Then, include a pdf of the presentation for grading. AND UPLOAD IT AGAIN in canvas.

Trade our presentations with someone else.

**Conclusions/action items:**

- we learned about how we can edit our presentation to be better and more succinct
- continue preliminary research and look into other designs
- continue drafting sketches in CAD



## 2026/02/25 - BME 301 Lecture 5

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Freyja Heggeland - Feb 25, 2026, 1:46 PM CST

**Title:** BME 301 Lec 5

**Date:** February 25th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the scope of our project and understand the problem statement.

**Content:**

Sitting with our groups

Noor is sick iirc

Feedback fruits part 1 due tonight

Diversity in engineering design:

- Including multiple perspectives in each decision
- Including people from different backgrounds, both in their engineering work and in a social/political/geographical sense
- Keeping an open mind for everyone that could be involved with your groups' creation
- 7 main components of universal design
- 

**Conclusions/action items:**

- finish and submit preliminary report
- continue preliminary research and look into other designs
- continue sketching in CAD



## 2026/02/25: Universal Design as a Group

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Freyja Heggeland - Feb 25, 2026, 1:58 PM CST

**Title:** Engineering Ethics

**Date:** February 25th, 2026

**Content by:** Freyja H.

**Present:** Freyja, Kat, Therese

**Goals:** learn more about universal design and make our device more accessible

**Content:**

Our design is built to improve:

Weight/ergonomics - making the design more accessible to different physicians

Addressing and being usable by other body types and forms - see above

Adding auditory feedback for hard of seeing patients - addition of feedback for the patient

Physically intuitive - design has buttons that will be labeled for ease of access. Labels will be etched so they can be felt as well. Also physically intuitive due to the etched ruler on the side of the central tube.

We address many of the 7 main principles with our design's functional attributes.

How can we improve?

Make our sensor more receptive, maybe a larger range of audio signals

**Conclusions/action items:**

We learned more about making our design more accessible and more ethical for different people.



## 2026/03/04: Library Session 2

---

Freyja Heggeland - Mar 04, 2026, 1:58 PM CST

**Title:** Library session 2

**Date:** March 4th, 2026

**Content by:** Freyja H.

**Present:** self, Kat, Therese, Noor

**Goals:** learn more about universal design and make our device more accessible

**Content:**

We are discussing patents, standards, and other resources for our design.

We have standards at the libraries - we did a quiz on this that was due right before this.

check TechStreet Enterprise for titles and use the Request a Standard form whenever we need to and we want a printed version - actually don't do this, this is an older slideshow

market research guides are also quite useful. 3 good ones: data axle reference solutions, IBISWorld industry reports, proquest one business

^ good to look at for larger scale economic information

articles are best found at the proquest one business source.

We will be writing executive summaries for the awards (at some point, Dr. Puccinelli stepped in at this point, I didn't fully get it)

Patents: (and the idea of prior art)

Prior art is a very large scale subject. Anyone who even applied for a patent counts as existing work in "prior art"

our patents need to be distinguished from other existing designs and prior art.

Squirrel feeder thing mentioned

Fat squirrels

Don't use commas in the [lens.org](https://lens.org) search feature. "6474260" for example

Recoiling action wildlife feeder - idk if this is supposed to be this way but this patent expired in 2002.

Strategies for our patent research:

- Use keywords

- Use asterisks to encompass more designs

- Use clarification codes

Use filters for more recent patents

Use synonyms of important words to find more examples.

Using the CPC engine where terminology doesn't get in the way as much

Patent examiners look for usefulness, novelty, and non-obviousness.

Claims start with a preamble, then a transition, then an antecedent basis.

Claims are different - even though they can be similar.

The two patents listed in class, 6474260 and 10010051 are both quite similar, but the language differs between the two. One is specified to work with squirrels, while the other uses the phrase "wildlife."

The inventors of the later patent worked around the initial claims of the first patent by not mentioning the animals' consumption as a part of the device. The first indicates it is purely a feeder, while the other is a "bungee apparatus".

You cannot patent something like this, BUT, you can market something because all of these patents are expired. You just can't claim that it's YOUR invention.

Group by "simple family" for better overall results

We can also search by classification and citation.

### **Conclusions/action items:**

We learned more about online resources and legal stuff.

We will keep working on ordering materials and gathering a composite list of materials to order.



## 2026/03/06 - BME 301 Tong Lecture

---

Freyja Heggeland - Mar 06, 2026, 1:08 PM CST

**Title:** Tong lecture

**Date:** March 6th, 2026

**Content by:** Freyja H

**Present:** all BME students

**Goals:** learn more about the BME design process and what an alum has to offer to all of us

**Content:**

Required for EVERYBODY

Justin Williams, PhD

Lots of degrees

TIME Magazine mentioned

Peter Tong was a huge influence and supporter of the BME department

"I want people to walk by and see bones being broken."

Today, talking about nervous stimulation and neuroengineering

Star Wars is getting talked about, specifically the end of E5 with the robot arm.

Erm actually

South Dakota has low population and there's not a whole lot going on there.

He ran track in college

Entrepreneurship is important and he's a self-starter.

Some other company bought their company to shut it down because they were a competitor.

Animal experiments performed on a larger scale after reclamation of the company.

Hydrogels were suggested for the design of the thin film electrodes

Greys anatomy

Large clinical need

Spinal cord injuries are somewhat frequent

**Conclusions/action items:**

- order materials
- organize team meeting
- meet with instructor after tong lecture



## 2026/03/11 - BME 301 Protocol development

---

Freyja Heggeland - Mar 11, 2026, 1:56 PM CDT

**Title:** Protocol development

**Date:** March 11th, 2026

**Content by:** Freyja H

**Present:** all BME students

**Goals:** learn more about the BME design process and what an alum has to offer to all of us

**Content:**

We should consider using leftover materials for the prototype drafts - less expensive and better for faster use

We should test our electronic components beforehand - some of our electrical components will be arriving in a few days.

I am currently doing research on any electronic issues that we may face when patients/clients touch the electrical components.

ALL materials we use should be very well documented. This should be in labarchives, docs, drive, etc. Any and all are good and appropriate.

We need to ensure that all materials and machines used need to be documented. All 3D printer settings must be documented and the 3D printer model must be documented, for example.

If things are printed as one piece, separate for a full and complete diagram to label each part.

We should have labels and sketches for each component to show how it fits into the whole picture.

For testing, (we should already be thinking about testing components, I am) we should have an n of at VERY least 3.

It is best we fail early, not at the end of the semester.

Now time to develop a protocol.

**Conclusions/action items:**

- construct draft device
- organize team meeting
- perform research



## 2026/03/18 - BME 301 Brevity in Communication - Lecture 9

Freyja Heggeland - Mar 18, 2026, 1:44 PM CDT

**Title: Brevity in communication**

**Date:** March 18th, 2026

**Content by:** Freyja H

**Present:** all BME students

**Goals:** learn more about how we can improve our BME project

**Content:**

Show and tell is this Friday

Engineering expo is on April 17th/18th and we can volunteer for - comes with free stuff

Oral:

1 minute show and tell, 5 minutes for a presentation to the judges.

Written:

executive summary, abstracts, reports

Elevator pitch: effectively communicate ideas in around 1 minute, less is ideal

Capture the attention of the people that we want to leave a good impression

How do we prepare this? Know the audience. We won't always know this (for reference, actual elevators) but these are our peers.

They will be interested in our project because they have to be for the class period

Rehearse this but it doesn't want to come off as a script. Keep a few main points in mind but don't have this like super rehearsed

Attention grabber, introduction, value proposition, benefits, call to action

Highlight key aspects

For value proposition, target the customer, demonstrate what we have and don't waste time on unnecessary background. Good for other projects and applications, not as strong for this instance.

Call to action assignment is due next Wednesday

Tong award example: introduction, "we developed this to do \_\_\_\_" "there is not a device to do \_\_\_\_\_, existing designs fail because of \_\_\_\_" "it's estimated that \_\_\_\_\_ people could use this device and it would have a \_\_\_\_ market in the current field."

Describe how our design is novel compared to existing models. People care about how we are working with our design specifications and how we need to mold the device around these aspects.

Project builder --> award selection --> upload executive summary (DUE AT THE END OF SPRING BREAK)

Do:

- maintain eye contact, confidence, excitement
- tailor pitch to different audiences
- keep it concise and straightforward

Don't:

- overwhelm with unnecessary details
- forget to listen to the audience
- sound rehearsed or robotic

Executive summaries:

- Elevator pitch but in a 1 page document (submit later in the semester, Thursday after spring break)
- provides concise overview of a longer document
- Captures attention
- Conveys key info
- Lets people make decisions quickly

Abstract lets the reader know if they want to actually read the paper or not. 150-300 words. Usually around 250. ALWAYS WRITE LAST!!!!

General structure: similar to report. Background, objective, methods, results, discussion, conclusion, future work if applicable, etc.

Try to keep reports <100 pages.

IEEE formatting obvs, don't explain the obvious, provide details REQUIRED to fully reproduce the final design and test it accordingly.

Avoid conversational text. Remove redundancies, etc.

DO

NOT

EVER

EVER

NEVER

EVER

USE RAW DATA IN A REPORT

Proofread the document obvs

BE BRIEF!!!!!!!!!!

We're gonna do the Tong award.

**Conclusions/action items:**

- construct draft device
- organize team meeting
- perform research



## 2026/03/25 - Ethics in Engineering and Applications

Freyja Heggeland - Mar 25, 2026, 1:55 PM CDT

**Title:** Ethics in engineering

**Date:** March 25th, 2026

**Content by:** Freyja H

**Present:** all BME students

**Goals:** learn more about how we can incorporate ethics into our design

**Content:**

We have to work on the executive summary over the next week + break, due 4/9

Ethics come from universal design considerations and should be integrated into every design that's ever built.

Ethics come from considering others and making sure many people can use the device.

Ethics is important and people should care more about ethical standpoints.

Ethical tests:

Harm test, publicity test, reversibility test, universality test, respect for persons test, utilitarian test, social justice test

We worked on the ethical testing document as a team.

- In your design teams, identify components (at least 2) of your design that could face ethical dilemmas or have an ethical dimension (for example, safety is often a trade-off).
- 1. Our design could not be accessible for colorblind patients as the screen uses red and green colors.
- 2. **The design may not be accessible for therapists that cannot properly hold it up throughout the whole therapy session.**
- Consider the appropriate language in ABET Outcome 4: an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- 1. **Done**
- Read through BME code of ethics: <https://www.bmes.org/bmes2023-policies>
- Review the [Code of Ethics for Engineers and Ethical decision-making system](#)
- Type up your answers and add to the case study answers (Q 1-4 above) – upload to Canvas. Copy and paste your design-specific ethics responses into your design notebook.
  - What components of your design have ethical dimensions (be specific and list at least 2)?
    - The display component of the design- not everyone can differentiate between certain colors
    - The weight of the entire design may be too much for the therapist to use
  - How will your team address the ethical dimensions? (What is your action plan?)
    - For each component:

- We could make the device have a red and blue screen to accommodate for patients with red/green colorblindness
  
- We could lower the perceived weight even further and add an additional support so it could maybe support itself.

**Conclusions/action items:**

- construct draft device
- organize team meeting
- update code as requested and needed



## 2026/04/08 - Engineering Judgment

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Freyja Heggeland - Apr 08, 2026, 1:52 PM CDT

**Title: Engineering Judgment**

**Date:** April 8th, 2026

**Content by:** Freyja H

**Present:** all BME 301 students

**Goals:** Be more judgmental in engineering practices and design

**Content:**

Filled out a google form

The process of making informed decisions, often in situations where there isn't a clear-cut answer or a specific code for the solution.

1.3 million.

Sun = 1394684 km diameter

earth = 12742 km diameter

ratio

ABET mentioned - agency that reviews the program and expects all engineers to be able to use engineering judgment to draw conclusions

Learn how to have engineering judgment by experience working with problems and various scenarios

Talking and learning as a team on evaluation in BME curriculum and design.

**Conclusions/action items:**

- construct draft device
- organize team meeting
- update code as requested and needed



## 2026/04/15 - Poster Presentations

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Freyja Heggeland - Apr 15, 2026, 1:53 PM CDT

**Title:** Engineering Poster Presentations

**Date:** April 15th, 2026

**Content by:** Freyja H

**Present:** all BME 301 students

**Goals:** Understand the requirements for our posters and build them accordingly

**Content:**

Necessary details:

Where to print? See website. Library system works. Clib/steenbock are the same price. Ask if they cut off white space, ask what size they can print. Make sure the poster file type is compatible with the printer that we're using.

Displaying images/graphs/whatever is the same as our preliminary presentation. Use feedback and intuition from those lectures.

Legible text, not microprint, useful figures that have captions. Have a clear introduction and background.

Have consistent formatting, good flow of information, no raw data,

Bad parts of a poster: no figure descriptions, raw data, inconsistent font size, single hanging bullets

To do:

- Read requirements
- include relevant and correct contact info!
- have titles and subtitles that actually mean something!
- Colorful, relevant, high resolution pictures.
- Avoid clashing and dark colors
- Caption every figure and include all necessary parts of a caption.

Context of use and workflow:

- Start with user and setting
- Place into a larger system
- Use color/grouping to organize what belongs together
- Use labels with minimal text
- Keep it high-level and understandable

Flow charts should be color coded and organized, max steps of like 10

**Conclusions/action items:**

- continue final fabrication
- update 3D models and build final prototype
- update code as requested and needed



## 2026/04/22 - Poster Review and Feedback

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Freyja Heggeland - Apr 22, 2026, 1:48 PM CDT

**Title:** Engineering Poster Feedback Peer Review

**Date:** April 22th, 2026

**Content by:** Freyja H

**Present:** all BME 301 students

**Goals:** Understand the requirements for our posters and build them accordingly

**Content:**

We discussed our existing work with other BME students and gave feedback on each others' posters

We got good feedback regarding our poster and I will be editing it later today with said feedback

**Conclusions/action items:**

- continue final fabrication
- update 3D models as necessary and test
- update code as requested and needed



## 2026/01/30 - First Advisor Meeting

---

Freyja Heggeland - Jan 30, 2026, 12:07 PM CST

**Title:** first advisor meeting

**Date:** January 30th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** understand and comprehend our project's goals and problem statement

**Content:**

Light/"airy materials" that still accomplish their goal.

We are presenting our lab notebooks

Discussing talking points during meeting - brainstorming/write a list of questions beforehand

"aspects you liked about the previous design, what we can do to improve on it"

**Conclusions/action items:**

- continue biological research
- continue team meetings
- continue finding questions for our clients



## 2026/02/06 - Second Advisor Meeting

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Freyja Heggeland - Feb 06, 2026, 12:27 PM CST

**Title:** second advisor meeting

**Date:** February 6th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** understand and comprehend our project's goals and problem statement

**Content:**

Discussed client meeting that we had earlier this week - getting more details from the client soon (we hope, we are in communications)

Use the 7 question model (strongly disagree to strongly agree scale)

MTS testing on our materials

We have access to MSTM standards through UW's database. Ask the library if we can't access them.

Carbon fiber rod depends on internal structure and stability.

Failure point of the last design was the interface section, fell off and was only suspended by its wiring.

Dr. O wants us to put like literally everything we do in this notebook, so do that.

**Conclusions/action items:**

- continue biological research
- continue team meetings
- continue finding questions for our clients



## 2026/02/13 - BPAG Meeting - Required Meeting

---

Freyja Heggeland - Feb 13, 2026, 12:24 PM CST

**Title:** BPAG meeting

**Date:** February 13th, 2026

**Content by:** Freyja H

**Present:** self and other groups' BPAG members

**Goals:** understand and comprehend our project's goals and how we can finance each component of the design

**Content:**

Biomedical Purchasing and Accounting Group

Get our client to purchase for us is ideal. Us paying then getting reimbursed is NOT ideal. (Mostly because I'm broke and I have 2 jobs)

We need to get our expenses approved prior to purchase.

We also need to keep track of all of our purchases, our receipts should be in our notebook. Email confirmation, Amazon expenses, etc.

All expenses should be kept in our progress reports and notebooks with time stamps.

3 kinds of faculty: Dr (not BME), BME, or community member.

"Do you want us to use UW funds for this project?" If no, simple. If yes, need to go through UW's purchasing rules. If the client pays, they need to go through the ShopUW+ system, Makerspaces, Team lab, etc.

Late resort: they can use their company card for a tax exemption. Us buying things personally is the LAST RESORT.

IF we have to buy stuff ourselves, we need to get reimbursed within 90 days or lose the money.

ShopUW+: client NEEDS to be the one that orders from here. Includes companies like Fisher, Promega, Grainger, Staples, DELL, Apple, Fastenal, SIGMA-ALDRICH, eppendorf, Newark, etc.

Shipping address: if we're ordering on UW funds, we can send them to:

**John Puccinelli, Dynamic Balance Device, 1550 Engineering Drive, Room 1080 ECB, Madison, WI, 53706-1609.**

This will send stuff to the blue room.

Small electronics can be purchased from the makerspace. BMEDesign has a \$50 total per team. Can exceed if needed. All team members can use this budget.

If we exceed the \$50 limit, there IS a method for more funding through the makerspace, but I doubt this will become relevant.

ECB is the same. "There's a room down there, full of STUFF."

ONLY THE BPAG WILL BE REIMBURSED. In case any of my team is looking at this, I'll Venmo you back, dw.

Invoices need to be shown for reimbursement.

Work with the hospital support staff if needed.

Nonreimbursable expenses:

- Our notebook
- Our poster is like \$50

That's it. Total for the two of these is ~\$75.

Have a good spreadsheet for this.

HAVE OUR CLIENT BUY THINGS FOR US. THIS WILL MAKE IT EASIER.

**Conclusions/action items:**

- continue biological research
- continue organizing team meetings
- continue developing presentation



## 2026/02/20 - BME 301 Preliminary Presentations

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Freyja Heggeland - Feb 20, 2026, 12:31 PM CST

**Title:** Prelim presentations

**Date:** February 20th, 2026

**Content by:** Freyja H

**Present:** self and team members and other groups from Dr. Williams' and Dr. Ohnsorg's lab sections.

**Goals:** understand and comprehend our project's goals and how we can finance each component of the design

**Content:**

Presentation day!

We are going 2nd. (12:20 time slot)

We did ok. :3

I stuttered a bit but tbh im not super worried about it. We were a bit under time (?).

**Conclusions/action items:**

- continue biological research
- continue organizing team meetings
- continue developing preliminary paper



## 2026/03/06 - Meeting After Tong Lecture

---

Freyja Heggeland - Mar 06, 2026, 1:16 PM CST

**Title:** post-tong lecture

**Date:** March 6th, 2026

**Content by:** Freyja H

**Present:** self and team members and other groups from Dr. Williams' and Dr. Ohnsorg's lab sections.

**Goals:** understand and comprehend our project's goals and how we can finance each component of the design

**Content:**

Cheap electronics may not be best

We can take apart the old prototypes

We will also be taking electronics from the blue room in ECB

**Conclusions/action items:**

- start building
- work with teammates to order materials
- We met and got a good summary of where we currently are with the project.



## 2026/03/13 - Advisor Meeting

---

Freyja Heggeland - Mar 13, 2026, 12:28 PM CDT

**Title: Advisor Meeting**

**Date:** March 13th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** understand and comprehend our project's goals and how we can finance each component of the design

**Content:**

Start on the display side for updating CAD - Therese

We're doing notebook checks this week

Look for alternatives to RED and GREEN portions because colorblind patients exist and may perceive it all as brown. (Maybe add blue?)

We have a battery that can die. We should use something like the back of a flashlight (screws off but still looks professional, end of screwed off portion has springs that can push the battery into place and provide the proper voltage.

Figure out Survey Questions for when we begin to prototype.

Idea: somehow incorporate a "HOLD" feature for one of the buttons to add more functions with singular buttons. (Example: Hold for 2 seconds, device turns on. Hold for 5 seconds, device turns off. Press and immediately release to change color.)

**Conclusions/action items:**

- start building our prototypes for show and tell
- collect materials when they arrive
- We met with our advisor and learned more about where we want to continue with our project.



## 2026/03/20 - Show and Tell

Freyja Heggeland - Mar 20, 2026, 12:53 PM CDT

### Title: Show and Tell

**Date:** March 20th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** show other groups what we've done so far this semester.

### Content:

We displayed our work to other BME 301s and 402s.

I'm not sure if we're supposed to be taking notes right now

I'm gonna take notes for the group.

This is our design, the dynamic balance device.

- 12:05 pm - Report to the ECB atrium
- 12:10 pm - Interaction starts with 15 minute rotations
- 12:25 pm - First interaction ends (5 minutes to wrap up and seniors find a second group to interact with)
- 12:30 pm - Second interaction starts
- 12:45 pm - Second interaction ends (5 minutes to wrap up and seniors find a third group to interact with)
- 12:50 pm - Third and last interaction starts
- 1:05 pm - Third interaction ends, seniors may leave or find another group to talk to if desired
- 1:05 pm - 2:05 pm - Wrap up as teams, further interactions if needed, discuss the results from the event with your team and document it in the design notebook.

Suggestions from 402 students:

- Implement counterweight, could do something like a metal detector brace/sleeve
- Device (from 2 iterations ago) seems VERY bulky and does not need to be this way
- Maybe use an ESP32 instead of an Arduino
- Or a raspberry pi
- Counterweight like a fishing pole with the spool of fishing line (heavier portion near hand, rod very thin and lightweight)
- Look into attachments
- Add a time-gated portion for changing colors (set a while loop when the signal input is HIGH, add a counter, when counter gets to a certain point, do a new thing)
- Instead of the circuitry being in the handle, how difficult would it be to have it in a box that he can wear on his hip or something? Could have a cord running through the device.
- ^ like a fanny pack that has a cable connection to the device
- Rechargeable battery would be a good idea - may be more weight
- We should one of the patches that people wear when they're running to hold their phone but with the cables with the connection. The bulk of the weight could be located on the user's arm.
- Flexible breadboard?????????

### Conclusions/action items:

- We showed things and we told things.

- I took notes for the group.

- Update our CAD models and code as needed



## 2026/03/27 - Advisor Meeting March 27

---

Freyja Heggeland - Mar 27, 2026, 12:20 PM CDT

**Title:** Advisor meeting

**Date:** March 27th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** discuss feedback from last week and discuss further options with our advisor.

**Content:**

We discussed feedback from the show and tell session with Dr. Ohnsorg.

Our client likes the button being on the rod for ease of use. The on/off switch could be placed with the circuitry so its easier to keep on.

We got the sensors in and will be getting all materials by the end of the spring break week.

**Conclusions/action items:**

- I took notes for the group.
- Update our CAD models and code as needed
- Work on our executive summary



## 2026/04/10 - Advisor Meeting April 10th

---

Freyja Heggeland - Apr 10, 2026, 12:30 PM CDT

**Title: Advisor meeting**

**Date:** April 10th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** discuss feedback from last week and discuss further options with our advisor.

**Content:**

Executive summary coming in either this weekend or Monday

Next week meeting in ECB 3150. (Same time)

Use a cricket for etching the carbon fiber rod (abbreviating to CFR for rest of this doc)

Need more PPE for machining - may need to find someone else that can do this.

Maybe ask client about standards around the spatial neglect procedure vs other practices - maybe can get a price estimate? Idk??????????

Maybe look into musculoskeletal injuries from fatigue in physical therapists

<https://pmc.ncbi.nlm.nih.gov/articles/PMC11642160/> - link discussing this exact thing

Dr. P should be around for the engineering experience thing today, we may be able to do 3point testing today (?)

Off limits Monday evening and afternoon

Figures and data for the poster:

- stress/strain curve from MTS
- quantitative data from the qualitative survey - be intentional about how we design the controls - look up existing studies to see how they did data - probably on Elsevier? I have no idea. - Bar graphs are our friends - 2 axis graph would be good to have (time vs fatigue level) - as many quantitative metrics as possible.
- took colorblindness into account for
- Measure dB level of speaker, measure accuracy to trigger the sensor, compare to older groups' work - also a new CHEAP optimization for this device, improves therapeutic efficacy.

Figure out ideal poster layout thing and the ways we want to arrange it.

**Conclusions/action items:**

- I took notes for the group.
- Update our CAD models and code as needed
- Figure out ideal poster layout thing and the ways we want to arrange it.



## 2026/02/02 - First Client Meeting

---

Freyja Heggeland - Feb 02, 2026, 12:17 PM CST

**Title:** first client meeting notes

**Date:** February 2nd, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** understand and comprehend our project's goals and problem statement

**Content:**

Green = left, red = right (colors and hand coordination for stroke patients.)

Haptic at the end with some sort of feedback (reach out, they touch it, and then some reward or something) (maybe integrate a remote control color panel.) (see every cheap string light system on amazon that's like \$20)

Integrate multi-color light haptic system to the end.

Balanced in our hand, similar handle to a fishing rod. Lightweight with a counterbalance. Minimize the weight at the end.

They have a touch screen with circles that creates both a tactile and auditory stimulus. (Pops like a bubble when they touch the correct thing, error sound otherwise)

Auditory feedback is ideal but not required.

Budgeting and monetary use: \$500 budget, he can Venmo us back at the end of the semester or per item

Lightweight and waterproof materials, leaning towards carbon fiber or PVC/PLA rod for the bulk of the rod. Handle could have more of a grip to it.

Last year's model had a 3D printed portion that fell off after some use, either do a very heavy filament or avoid 3D print.

He has videos of patients using these items in the past, which would be incredibly helpful for us to analyze and learn from.

"Functional reach test" - patient (without moving) leans forward as far as they can. Add markings to the side of the rod to properly and accurately show how far the patient has reached down. Do this for MINIMUM 18", likely closer to the full length.

"Functional gait assessment" "dynamic gait test" - research these.

**Conclusions/action items:**

- continue biological research
- continue team meetings
- continue PDS development



## 2026/02/17 - Important Note from Client

---

Freyja Heggeland - Feb 17, 2026, 12:10 PM CST

**Title:** note from client

**Date:** February 17th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** understand and comprehend our project's goals and problem statement

**Content:**

Client details from the pickup (organized by Katherine, I cannot take credit for this):

- Full 3' design is unnecessary. He likes the idea of it being shorter, 24" should be the most that we need because it's being used as a reaching tool, with less importance on the functional cane aspect.
- Bulkier handle may be good to house the electronics. The bonus weight from this should be allocated from the rest of the handle if possible, as this would give us the greatest balance of weight distribution (I'm personally estimating that around 70% of the weight interpretation will be experienced in the hand.)

**Conclusions/action items:**

- Our design can and should be revised to meet new important requirements from our client.
- continue team meetings
- continue presentation development



## 2026/03/04 - Client Meeting - Discussing Materials and Ordering

---

Freyja Heggeland - Mar 04, 2026, 7:16 PM CST

**Title: discussing materials**

**Date:** March 4th, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** understand and comprehend our project's goals and problem statement

**Content:**

Started by discussing mechanisms and colors that we want to display on the LED board.

We want to ensure that our display is bright enough.

We also want to have adequate audio feedback.

He approves of our material choices and I'm going to be sending him the complete list of our order later tonight.

It is also a matter of timeliness.

He's insisting that I (or one of the other group members) make the purchases, then he can venmo them back after the semester is over.

Use the previous years' prototypes for parts and to learn about them.

**Conclusions/action items:**

- Our design can and should be revised to meet new important requirements from our client.
- continue team meetings
- begin prototyping before parts arrive



## 2026/03/23 - Client Meeting - Discussing 402's Feedback

---

Freyja Heggeland - Mar 23, 2026, 12:41 PM CDT

**Title:** discussing 402 feedback from last Friday's session

**Date:** March 23rd, 2026

**Content by:** Freyja H

**Present:** self and all of team

**Goals:** understand and comprehend our project's goals and problem statement

**Content:**

Discussing feedback from the 402 session from last Friday

We discussed the perceived weight reducer portion - having a brace around the upper arm that attaches to the device to help reduce weight.

Could also be a clip on thing to clip on to scrubs.

External connections/portions are totally ok with him. - Reduces user tension and stuff

Also to make it more streamlined - having 1 button and switching modes with a held function. Long press to go to random colors or something adjacent. As long as it is easy for the clinician, he is fine with it.

Also rechargeable battery option (likely USB-C port, can maybe work for like 4 hours before recharging? more run time = more weight so idk)

Electronic components COULD MAYBE be put on the wrist (his suggestion) but this does something similar to the scrubs clip-on thing we were discussing earlier.

Maybe different colors than red/green? Account for some colorblindness or something. We could add a "BLUE" setting

He currently uses red/green with the association of right/left hand respectively. Helps them remember associating things with each other

Some colorblind patients have come in the past, none have had issues with the current system.

We could make a double-tap setting to activate a mode that uses RED/BLUE instead of RED/GREEN to make it more accessible in the instance of someone with red/green colorblindness.

Actually we're just switching to red and blue period. Blue is now left hand association

Securing circuitry, a lot of people liked the idea of moving all of it behind/near the handle. It makes a LARGE difference in weight perception.

^ is a good indicator of our progress so far this semester. Better to have these options. He believes we're on track with it. I'll update the code after this meeting.

**Conclusions/action items:**

- Our design can and should be revised to meet new important requirements from our client.
- continue team meetings
- continue prototyping

---

Freyja Heggeland - Mar 23, 2026, 12:40 PM CDT

Summary:

Mechanical feedback:

- clip on device to attach to scrubs - counterweight
- Batteries/electronics good to include in either handle, near handle, or in counterweight
- rechargeable battery option (research materials)

**Electronic feedback:**

- use red/blue instead of red/green to accommodate colorblindness
- 1 button function to switch between modes (click for red/blue switching, hold 3sec for random colors to flash with a 0.5sec delay (looked briefly into epileptic rate to assume the minimum rate we should include, suggested from NIH is maximum 3Hz so 0.5 sec delay should be fine.) Hold 5 seconds to turn off



## 2026/02/06 - Meeting after Advisor Meeting Week 3

---

Freyja Heggeland - Feb 06, 2026, 12:59 PM CST

**Title:** Meetings!

**Date:** February 6th, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about our individual components of the design

**Content:**

Design a design matrix - submit as entries into labarchives.

Could do: material of the design, shape (last years, current model, other model), and electronic components (if last year's did not work sufficiently).

Auditory feedback could be another design matrix. (Click, beep, speaker, clicker triggered by the circuit.)

I am going to research materials with Katherine - steel, alloys, aluminum, carbon fiber, PVC, PLA,

add 1 design idea each, electronics should probably stay the same unless last year's. Find a sensor/switch.

**Conclusions/action items:**

- continue biological research
- continue preliminary research and look into other designs
- develop design matrices



## 2026/02/13 - Meeting after Advisor/BPAG Meeting Week 4

---

Freyja Heggeland - Feb 13, 2026, 12:40 PM CST

**Title:** Meetings!

**Date:** February 13th, 2026

**Content by:** Freyja Heggeland

**Present:** self and all of team

**Goals:** learn more about our individual components of the design

**Content:**

Start working on presentation over the weekend/later today

I will be out of commission tonight due to exam, but can start Saturday probably.

**Conclusions/action items:**

- continue drafting designs and CAD modeling
- develop our presentation
- develop our order



## 2026/02/27 - Meeting after Week 6 Meeting

---

Freyja Heggeland - Feb 27, 2026, 12:50 PM CST

**Title:** Meetings!

**Date:** February 27th, 2026

**Content by:** Freyja Heggeland

**Present:** self and all of team

**Goals:** learn more about our individual components of the design

**Content:**

We are discussing next week's goals for each of us, individually

I'm kind of surprised that the meeting didn't have more feedback for me.

We will be meeting next Wednesday at 2pm (after lecture) to discuss electronic components

We need:

- LED Board
- Speaker
- Arduino
- Motion sensor
- PVC with a 1" outer diameter
- research different filaments for our CAD (plz no PLA)
- research on carbon fiber - im doing this one
- Make deliverables more evident as to how our device is different from last years
- Reorganize design matrices so that our preliminary design is first, THEN material, THEN audio or audio then material

**Conclusions/action items:**

- Assist team with whatever they need help with.
- order materials
- decide on final materials to order



## 2026/04/10 - Group Meeting

---

Freyja Heggeland - Apr 10, 2026, 12:57 PM CDT

**Title:** Meetings!

**Date:** April 10th, 2026

**Content by:** Freyja Heggeland

**Present:** self and all of team

**Goals:** learn more about our individual components of the design

**Content:**

Summarized bulleted list below of key action items

Actionable Items:

- Circuitry needs to be soldered- Saturday (ideally 2 people)
- Speaker dimensions need to be measured- Saturday
- CAD file needs to be updated to fit speaker- Saturday
- Circuitry and code tested - Saturday (accuracy of touching the sensor and accuracy of buttons switching)
- Update and upload poster layout - prep for next Friday meeting (include pictures of MTS testing,
- Survey data summarized in either sheets/excel and matlab/something idk
- MTS testing- Wednesday after lecture (2 people)
- Make box with room for arduino nano, breadboard, and battery (this is for the armband thing) - tomorrow
- Update display portion to be more durable (add rectangles and cut them)- tomorrow
- Layer of electrical tape for exposed wires, brainstorm another layer- tomorrow
- Buy/borrow a roll of electrical tape at the Makerspace- tomorrow
- Talk to someone in the Makerspace about the Cricket- tomorrow
- Make the survey for qualitative data- tomorrow (freyja)
- Write fabrication protocols (write them while you're doing them)
- Write testing protocols (write them while you're doing them)
- Make poster outline - today
- Make final executive summary

**Conclusions/action items:**

Complete everything on the list above and do great on this project.



## 2026/04/11 - Group Meeting at U South/Wendt

---

Freyja Heggeland - Apr 11, 2026, 4:33 PM CDT

**Title:** Meetings and completing stuff from last meeting

**Date:** April 11th, 2026

**Content by:** Freyja Heggeland

**Present:** self and all of team

**Goals:** learn more about our individual components of the design

**Content:**

Arrived at like 10:30.

I met with Kat and Therese to complete the list of actionable items from our meeting after class on 4/10.

(Noor could not make the meeting due to external circumstances)

I updated the survey form questions to better fit a survey to meet our needs. I also simplified the responses so they can be easier to sort in either matlab or excel. I think this is an overall positive change to the testing protocol that we had previously.

[https://docs.google.com/forms/d/e/1FAIpQLSd3A79dlJpe5zix6pCuPhSksjfr\\_fmTCH-mJZsRNzyM0uUHrA/viewform](https://docs.google.com/forms/d/e/1FAIpQLSd3A79dlJpe5zix6pCuPhSksjfr_fmTCH-mJZsRNzyM0uUHrA/viewform) - link to form

I also started writing the fabrication protocols.

Moved to Wendt commons, starting new 3D print for our 3D printed section on the end of our device.

See document for progress completed today: <https://docs.google.com/document/d/11volHTmZBZYH5PrhDfEzdwfGhpQM8dJ98E1WuqmQ-Ss/edit?tab=t.0>

Screaming internally because we need to find a new capacitive sensor due to our current one having a range of about 5mm. We need one with (estimate) around 4" of range to activate our speaker. Currently asking my TA from BME 310 about borrowing an ultrasonic sensor for this instead. We might end up ordering this new sensor, tbh I'm not sure.

I also soldered some of the wires on our Fritzing diagram to help Kat with that progress.

Overall we got a lot done today and we made good (slightly subideal, but still solid) progress

**Conclusions/action items:**

Complete everything on the list from 4/10 and do great on this project.



## 2026/03/09 - Ordering Materials

Freyja Heggeland - Mar 09, 2026, 1

**Title:** Receipts from Kat's material orders

**Date:** March 9th, 2026

**Content by:** Freyja H

**Present:** self and Kat

**Goals:** order materials and construct device

**Content:**

Screenshot update of our financial page is below. Remainder of material will likely be

Item	Description	Manufacturer	Mft Pt#	Vendor	Vendor Cat#	Date	QTY	Cost Each	Total	Link	O
<b>Structural Materials</b>											
Carbon Fiber Tub	1m long, 8mm o	CHZDPP	B0DJJTX3SQ	Amazon	B0DJJTX3SQ	3/9/2026	1	\$57.23	\$57.23	<a href="https://www.am">https://www.am</a>	Y
									\$0.00		
									\$0.00		
									\$0.00		
<b>Electronic Components</b>											
Capacitive Touch	Sensor	Arduino	TTP223B	Ebay	TTP223B	3/9/2026	1	\$8.32	\$8.32	<a href="https://www.eb">https://www.eb</a>	Y
9v battery	Battery	Vetco Electronic	VUPN8981	Shopify	VUPN8981	3/9/2026	1	\$0.69	\$0.69	<a href="https://vetco.ne">https://vetco.ne</a>	Y
Tactile switch	Button	Vetco Electronic	TEA-5144	Shopify	TEA-5144	3/9/2026	2	\$0.89	\$1.78	<a href="https://vetco.ne">https://vetco.ne</a>	Y
Waterproof Swit	On/Off switch	Vetco Electronic	NTE-54-250W	Shopify	NTE-54-250W	3/9/2026	1	\$9.99	\$9.99	<a href="https://vetco.ne">https://vetco.ne</a>	Y
Speaker Module	Speaker	Vetco Electronic	VUPN6344	Shopify	VUPN6344	3/9/2026	2	\$4.21	\$16.21	<a href="https://vetco.ne">https://vetco.ne</a>	Y
								<b>TOTAL:</b>	<b>\$94.22</b>		
								<b>Budget:</b>	<b>\$405.78</b>		

**Conclusions/action items:**

- order materials
- organize team meeting
- begin drafting design with cheaper materials



# 2026/04/28 - Final Expense Sheet

Freyja Heggeland - Apr 28, 2026, 1:36 PM CDT

**Title:** Final expense sheet

**Date:** April 28th, 2026

**Content by:** Freyja H

**Present:** self

**Goals:** order materials and construct device

**Content:**

See attached pdf

**Conclusions/action items:**

- finish the semester

Freyja Heggeland - Apr 28, 2026, 1:36 PM CDT

Account	Description	Unit	Quantity	Unit Price	Total Price	Tax	Total	Link
Account 1	Description 1	Unit 1	Quantity 1	Unit Price 1	Total Price 1	Tax 1	Total 1	Link 1
Account 2	Description 2	Unit 2	Quantity 2	Unit Price 2	Total Price 2	Tax 2	Total 2	Link 2
Account 3	Description 3	Unit 3	Quantity 3	Unit Price 3	Total Price 3	Tax 3	Total 3	Link 3
Account 4	Description 4	Unit 4	Quantity 4	Unit Price 4	Total Price 4	Tax 4	Total 4	Link 4
Account 5	Description 5	Unit 5	Quantity 5	Unit Price 5	Total Price 5	Tax 5	Total 5	Link 5
Account 6	Description 6	Unit 6	Quantity 6	Unit Price 6	Total Price 6	Tax 6	Total 6	Link 6
Account 7	Description 7	Unit 7	Quantity 7	Unit Price 7	Total Price 7	Tax 7	Total 7	Link 7
Account 8	Description 8	Unit 8	Quantity 8	Unit Price 8	Total Price 8	Tax 8	Total 8	Link 8
Account 9	Description 9	Unit 9	Quantity 9	Unit Price 9	Total Price 9	Tax 9	Total 9	Link 9
Account 10	Description 10	Unit 10	Quantity 10	Unit Price 10	Total Price 10	Tax 10	Total 10	Link 10

[Download](#)

Dynamic\_Balance\_Device\_Expense\_Spreadsheet\_-\_Sheet1.pdf (48.5 kB)



## 2026/04/20 - MTS Testing on CF Rod

---

Freyja Heggeland - Apr 20, 2026, 5:13 PM CDT

**Title:** MTS Testing

**Date:** April 20, 2026

**Content by:** Freyja Heggeland

**Present:** self

**Goals:** learn more about the functionality and capabilities of our material

**Content:**

I (looked at the machine, it was scary, I do not currently know what I'm doing.) performed MTS testing on the remains of our carbon fiber rod. Length is approx 190mm

Due to my unfortunate lack of knowing what I'm doing, I will be joining Therese and Katherine tomorrow for this process. We will also likely be completing the qualitative testing during this time as well.

**Conclusions/action items:**

- finish poster
- deliver poster
- do good on award selection



## 2026/04/21 - Fatigue Testing

---

Freyja Heggeland - Apr 21, 2026, 6:37 PM CDT

**Title:** Fatigue Testing

**Date:** April 21, 2026

**Content by:** Freyja Heggeland

**Present:** self and all of team

**Goals:** learn more about the functionality and capabilities of our material

**Content:**

We completed fatigue testing for our device. We measured the things found HERE in THIS DOCUMENT: [https://docs.google.com/document/d/1mIDt8kqNQLExJ\\_mDHV19yrRUYuJ37z142wWiOwTqvHk/edit?tab=t.0](https://docs.google.com/document/d/1mIDt8kqNQLExJ_mDHV19yrRUYuJ37z142wWiOwTqvHk/edit?tab=t.0)

Work summary: This was going to be placed into a larger-scale meeting notes folder but this ended up being the first thing I was able to write down. I wrapped our wiring in electrical tape to have a more professional look and also to be more organized, after I took the existing marking electrical tape off. Kat painted our arm band to be completely black and to not show our electrical components. Noor worked on rewriting the code and reworking the Arduino. Therese had to leave early but gave good insights.

Testing protocol:

We tested on ourselves and each other.

We remade our speaker function after rewiring the rest of the electronic components. We were here for around 3 hours.

**Conclusions/action items:**

- finish poster
- deliver poster
- do good on award selection

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Freyja Heggeland - Apr 21, 2026, 6:00 PM CDT





## 2026/04/22 - Fatigue Testing and MTS Testing as a Group

---

Freyja Heggeland - Apr 22, 2026, 2:31 PM CDT

**Title:** Fatigue and MTS testing

**Date:** April 22, 2026

**Content by:** Freyja Heggeland

**Present:** self and all of team

**Goals:** learn more about the functionality and capabilities of our material

**Content:**

MTS Setup

We tested our fatigue levels on ourselves and other BME students

**Conclusions/action items:**

- finish poster
- deliver poster
- do good on award selection



## 2014/11/03-Entry guidelines

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John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

**Title:** Descriptive title (i.e. Client Meeting)

**Date:** 9/5/2016

**Content by:** The one person who wrote the content

**Present:** Names of those present if more than just you (not necessary for individual work)

**Goals:** Establish clear goals for all text entries (meetings, individual work, etc.).

**Content:**

Contains clear and organized notes (also includes any references used)

**Conclusions/action items:**

Recap only the most significant findings and/or action items resulting from the entry.



**Title:**

**Date:**

**Content by:**

**Present:**

**Goals:**

**Content:**

**Conclusions/action items:**