Thermohelm:

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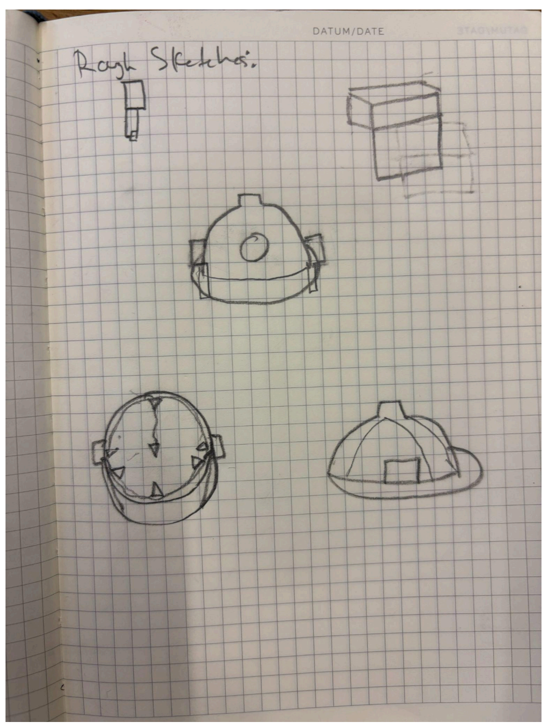
Documentation:

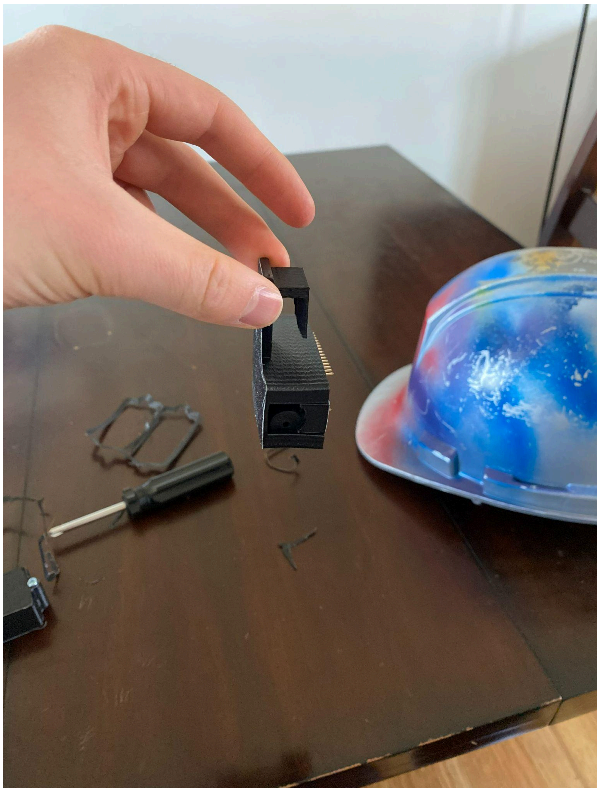
Brainstorming and Function:

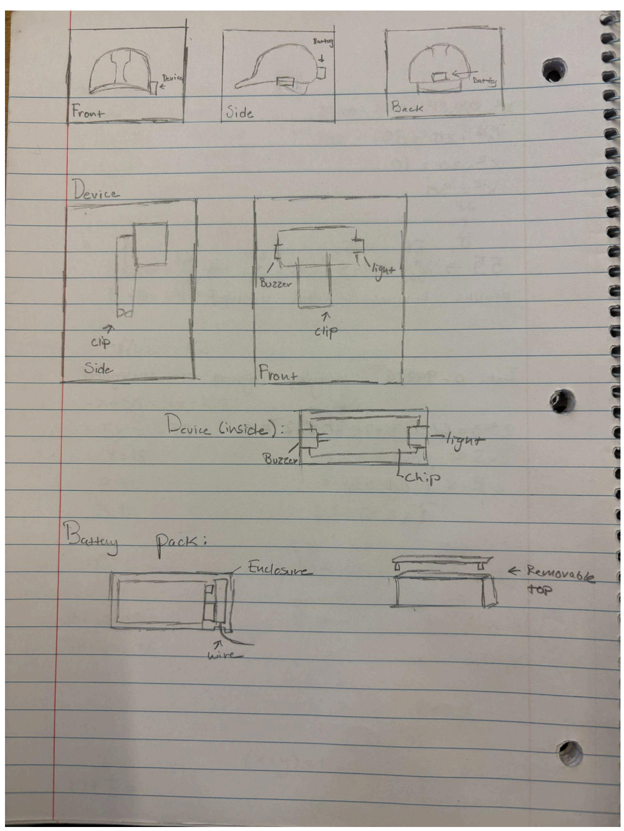
- For the instructions in this project, our group decided to go with safety solutions for a more practical use. Our idea started with creating some sort of monitor that senses temperature to know if someone is overheating or reaching the threshold of a heat stroke.
- The most practical use case we came up with was for construction workers and manual labourers. We decided to use a construction helmet to create a built-in temperature detecting system that can alert construction workers through an LED and a Buzzer as two sensory indicators.
- We used 2 10K Thermistors to detect around 2 specific areas of the head to get an average of the user's head temperature. With those averages, we would then have our code alert the user through the LED and Buzzer that they are overheating.
- We then created our rough sketches based on the helmet we had acquired and our basic understanding of our Thermistor sensors.



Sketches and Research:

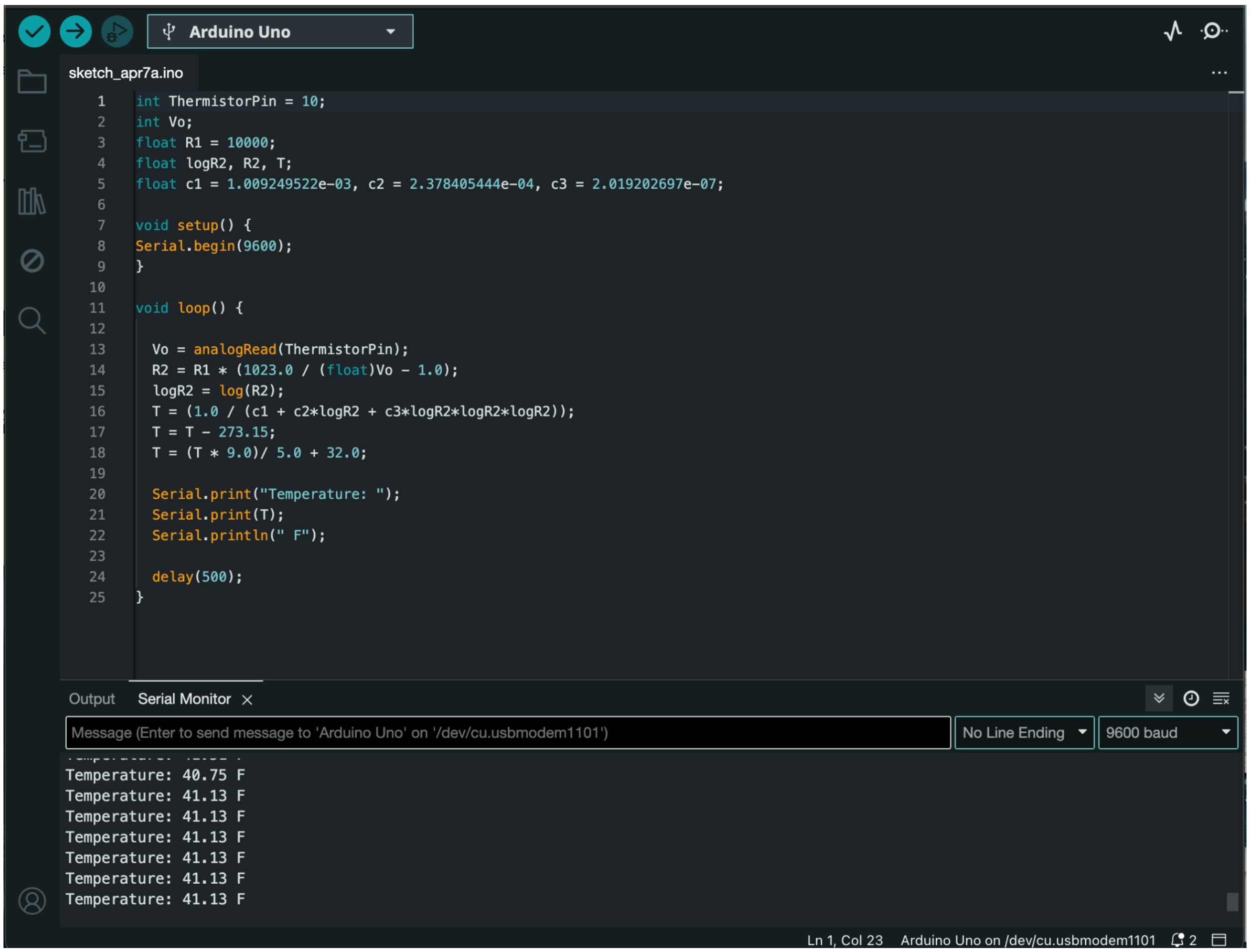
- We measured out the helmet dimensions and found that it is adjustable at a size 53-64 cm or 6 ⅝ - 8 head size. The rest of our measurements were rough estimates based on our sketches and the overall size of the helmet. We landed on having two 10K Thermistors around the helmet on the back and the vertex of the head.
- We gathered the hottest and coldest areas of the head from Sensitivity to cutaneous warm stimuli varies greatly in the human head. From this article, we found that two areas averaged for temperature of a human head would be on the vertex of the head, the hottest point, and the back of the head a consistent average temperature.
- We used the Steinhart-Hart Equation in our code to find the empirical relationship between the temperature and resistance of a thermistor with a negative coefficient. A, B, and C are coefficients that thatallow from the thermistor readings to find the temperature in Celsius. More information can be found here: Steinhart-Hart Equation.
- We found that for overheating and nearing heat stroke that the temperature of the user's head would be around 105-115 degrees, while anything over 115 degrees to 125 is extremely dangerous.
- Before getting into the 3D modeling, we measured the helmet insertions on each side. Our vision was that we would be able to 3D print insertions for the housing of our power supply and the Arduino Nano 33 IOT. We had each enclosure on each side of the helmet, and then the wires would hook up with the thermistors at the two points specified around the head.
- We measured out the enclosures and 3D modeled them to insert into one side of the helmet with the circuitboard, Buzzer, and LED. The other enclosure with the power source is located at the back of the helmet. Considerations were made to allow the Buzzer and LED to be sensed by the user and those around them when past a certain threshold of temperature, which is 105 degrees.
- With our research and sketches we modeled our 3D models and began printing them while we tested our circuit on a breadboard.




Front
Device
Side
Back
Battery
Device
Side
clip
Front
Buzzer
light
clip
Device (inside):
Buzzer
light
Chip
Battery Pack:
Enclosure
wire
Removable top

Filtered Data:

- We chose to filter our data through the Steinhart-Hart Equation and average out our 10K Thermistor temperature outputs.
- Our Serial Print outputs were filtered within our code to ensure the output is smooth and measured through the temperature outputs from the Thermistors in the Arduino program.
- Our code reads the thermistor pins and then takes them into the Steinhart-Hart Equation with various coefficients converted into Fahrenheit.
- This is seen in the Serial Monitor of temperature data, and is alerted when past a certain threshold to buzz and light up the LED.



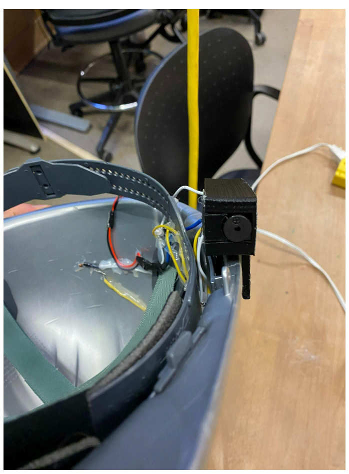
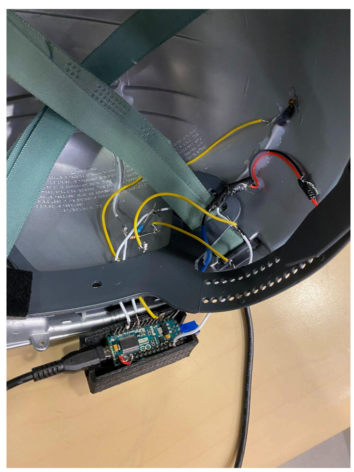
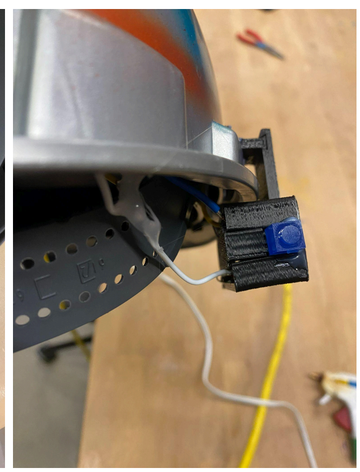
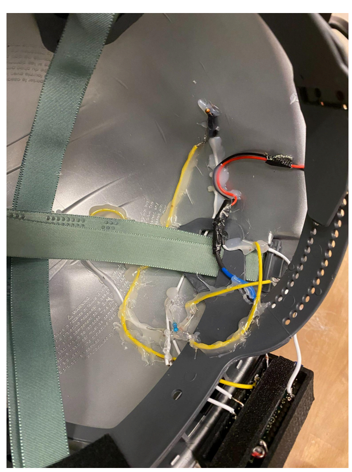

```
int ThermistorPin = 10;
int Vo;
float R1 = 10000;
float logR2, R2, T;
float c1 = 1.009249522e-03, c2 = 2.378405444e-04, c3 = 2.019202697e-07;

void setup() {
Serial.begin(9600);
}

void loop() {

  Vo = analogRead(ThermistorPin);
  R2 = R1 * (1023.0 / (float)Vo - 1.0);
  logR2 = log(R2);
  T = (1.0 / (c1 + c2*logR2 + c3*logR2*logR2*logR2));
  T = T - 273.15;
  T = (T * 9.0)/ 5.0 + 32.0;

  Serial.print("Temperature: ");
  Serial.print(T);
  Serial.println(" F");

  delay(500);
}
```

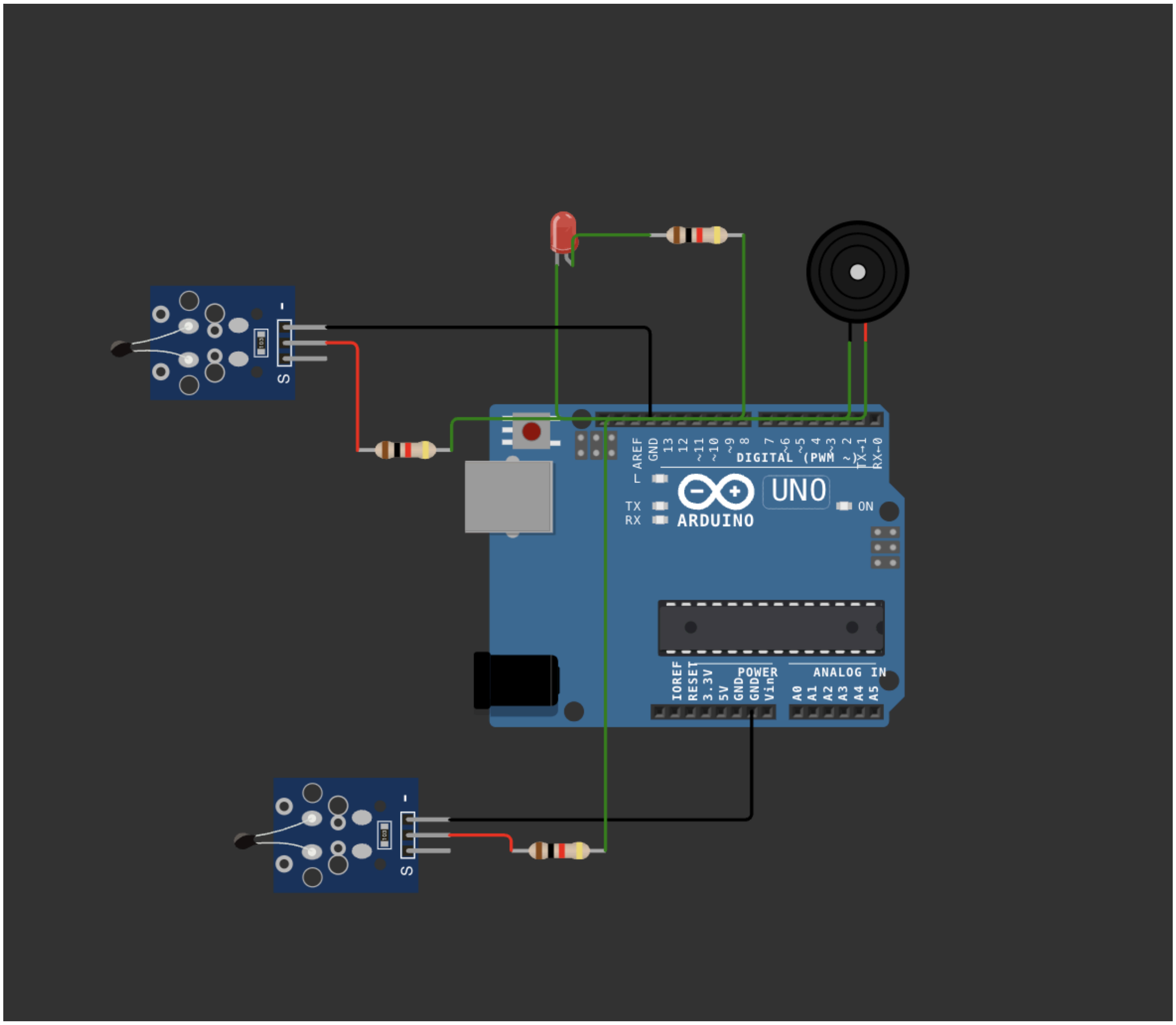
```
Temperature: 40.75 F
Temperature: 41.13 F
Temperature: 41.13 F
Temperature: 41.13 F
Temperature: 41.13 F
Temperature: 41.13 F
Temperature: 41.13 F
```

```
// SEVERE DANGER (stay on) - 115F ~= 46C
else if (averageTemp >= 115) {
  Serial.println("SEVERE DANGER!");
  // CONSTANT beeps and flashes of LED
  for (int i = 0; i < 6; i++) {
    digitalWrite(LED_PIN, HIGH);
    digitalWrite(BUZZER_PIN, HIGH);
    delay(250);
    digitalWrite(LED_PIN, LOW);
    digitalWrite(BUZZER_PIN, LOW);
    delay(250);
  }

  // Delay 0 seconds between readings af
}

// MODERATE DANGER (flash for 3 seconds) - 105F - 115F
if (averageTemp >= 105 && averageTemp < 115) {
  Serial.println("MODERATE DANGER!");
  digitalWrite(LED_PIN, HIGH); // LED stays ON

  // 5 beeps over 10 seconds (1s cycle)
  for (int i = 0; i < 5; i++) {
    digitalWrite(BUZZER_PIN, HIGH);
    delay(200);  // beep duration
    digitalWrite(BUZZER_PIN, LOW);
    delay(800);  // rest of the 1-second cycle
  }

  // Delay 30 seconds between readings after a MODERATE
  delay(30000);
}

float readThermistorFahrenheit(int pin) {
  int adcValue = analogRead(pin);
  float voltage = adcValue * (5.0 / 1023.0);
  float resistance = (5.0 - voltage) * seriesResistor / voltage;

  float steinhart;
  steinhart = resistance / nominalResistance;
  steinhart = log(steinhart);
  steinhart /= bCoefficient;
  steinhart += 1.0 / (nominalTemperature + 273.15);
  steinhart = 1.0 / steinhart;
  steinhart -= 273.15;

  // Convert to Fahrenheit
  return (steinhart * 9.0 / 5.0) + 32.0;
}
```

Power Solution:

- We decided to go with a 9-Volt battery because of a couple of reasons including the heat resistance of this battery, allowing for it to weather the conditions of construction work.
- The 9-Volt battery is easily accessible on a construction site making it practical for our use case.
- With our 9-Volt battery, it is also the perfect sizing as opposed to two double A's or other battery options.
- Lastly, the 9-Volt battery is durable and can withstand the harsh environment whereas a lithium-ion battery could overheat and explode, which is a major problem.
- It provides enough power for our Thermistor, LED, and Buzzer, making it the perfect option for our design.
- The 9-Volt battery is perfect for our design and ensures there is no wasted power within the circuit.

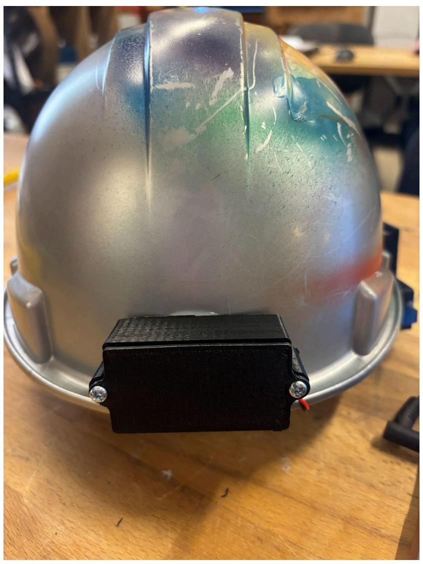
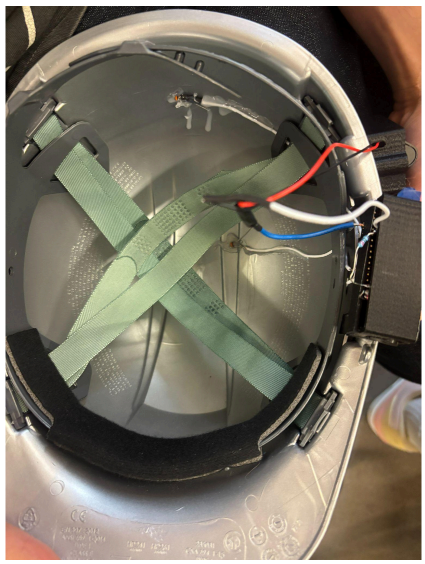
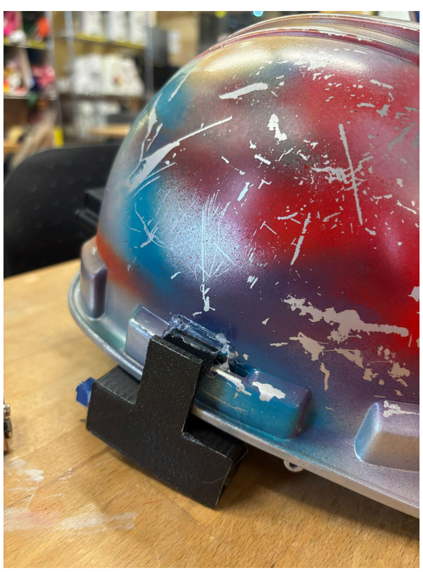
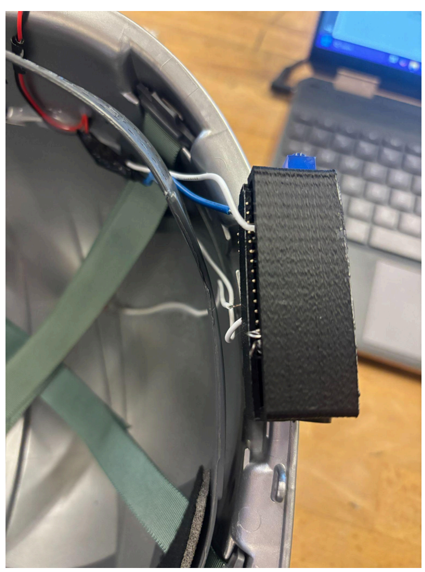







Math: 100 mA (MCU) + 10 mA (led) + 20 mA (buzzer) + 0.5*2 mA (2 thermistors) = 131 mA/hrs @ 5V

The Build:

- Lastly we put together all of our modeled parts, circuitry, and overall design into the helmet to test and finalize.
- We built our helmet after applying adhesive to our enclosures and soldering our full circuit. Carefully, we inserted our enclosures on each side for the power and circuit board. Ensuring that the LED and Buzzer were detectable by the user. Lastly, we put everything together into the helmet and ensured security through basic testing.
- Most of our build phase was just putting all of our components together within the relatively easy-to-fit helmet.

Demo and Process LED/Circuit Videos:

- https://drive.google.com/file/d/1j2QU1KxzPYbOIAzxgZDLNpewR8nauUDp/view?usp=sharing -PROCESS
- https://drive.google.com/file/d/1j2QU1KxzPYbOIAzxgZDLNpewR8nauUDp/view?usp=sharing -PROCESS LED
- https://drive.google.com/file/d/1eohRdtiv8r3zS23OTHBvzAkz2x3QEq9H/view?usp=sharing -PROCESS LED
- https://drive.google.com/file/d/1BXGpe034hNSgTNQsplqa3qbgKblYhYgt/view?usp=sharing - DEMO