UNIVERSITY OF OTTAWA – FACULTY OF ENGINEERING

ENGINEERING DESIGN

GNG1103

Project Deliverable H: Prototype III and Customer Feedback

Felipe Ortiz Figueiredo
Precious Eze
Tasha McDonnell
Cami Tiffin
Raphaelle Jean-Baptiste

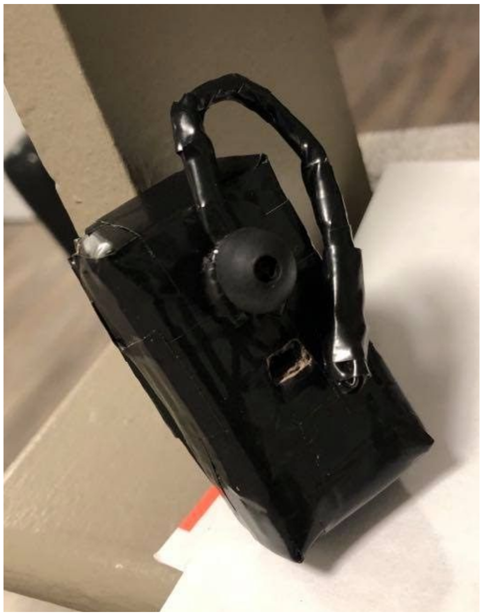
March 2020

1. Introduction

The opioid monitoring device that we have designed can greatly benefit society by saving thousands of people from overdosing on opioids. Thus far we have identified client needs, design criteria, created several conceptual designs, constructed a schedule for our product and completed our first and second prototype. The results from our second prototype allowed us to test the functionality of the oximeter sensor. We also were able to produce a functioning app and determine the user interface. Our second prototype also helped us to conclude that it would be better to use the ESP32 hardware instead of the arduino nano. This is because the ESP32 already has bluetooth whereas the arduino nano would need an added bluetooth module. Switching to the ESP32 simplified our hardware, saving us time and allowing it to be more compact so the device would be overall more discreet. In our second prototype we were also able to create a model of our earpiece casing in solidworks. Knowing which hardware components we were using allowed us to determine the dimensions of the casing. Our next step in ensuring we can produce a quality product is a third prototype. The objective of this prototype is to complete a fully functioning comprehensive prototype. In this prototype we will be primarily focusing on determining the accuracy of the oximeter readings, determining the effectiveness of the app and accuracy in sending location, and finally we will be 3D printing the casing and testing its ability to stay on the user's ear. We hope to receive constructive feedback from the client on our product and will try to implement her suggestions/modifications in any future work we pursue. Our third prototype will hopefully allow us to complete all the components to have a fully functioning model. By prototyping we can test different features of our device and improve them until we reach our desired criteria.

2. Prototype Description

In the previous prototypes, we determined the appearance of our earpiece. We also determined the hardware components and oximeter code outline. In the second prototype, we tested the functionality of the oximeter. Now for this comprehensive prototype, we have paired the oximeter with the app to have a functioning "finish product". We switched to the ESP32 hardware instead of the Arduino Nano. This decision resulted in a clean and more aesthetically pleasing design. In Addition, we used a web-service called IFTTT which makes it possible for the device to send a text message by just using a wi-fi connection which makes it possible for the device to send a text message by just using a wi-fi connection. After receiving feedback from Tali, we made sure the earbuds were adjustable so the device could remain steady during daily use. Unfortunately for the final product we did not get the opportunity to 3D print the final casing so we replaced it with a casing made of other material. We got all the sensors to work and the cellphone to connect and send the user's location to the device.



3. Test Objectives Description

3.1 Specific test objectives

For this final prototype our objective was to ensure that we have a functioning comprehensive product. Our goal was to implement all the different parts of the project into a whole for testing. Our goal was to ensure that the working product was comfortable, and accurately do it's predicted job. Despite having difficulty with the oximeter circuit, we were able to test the data outputted by the oximeter on several different ear lobes to test its accuracy. For this test we focused on the oximeter accuracy and consistent reading since we now have a functioning oximeter.We also planned to test the casing's structure. This included how well the casing will withstand our audience daily activities as well as different temperatures such as cold, warm ect.. In terms of the software we wanted to make certain that the all essential sections of the app. These tests would include making sure of the accuracy and effectiveness of the app's algorithm and logic.

3.2 What exactly is being learned or communicated with the prototype?

For our first prototype, our goal is to create a good foundation for our device so that in the upcoming weeks, we are able to focus on “less crucial aspects" of our design. For the second major prototype we were able to build the major component of our hardware and software. We want to make sure the main component of our application as well as our device work to the best of their ability under our time constraint. For this prototype we focus one the comprehensive working design. Early in the process of building this prototype, we learned that the measurements for the earpiece were not to scale and the earpiece was not taken into account so modifications were done. In this prototype, we also learn that our oximeter even though it was defective worked accurately under certain constraints.

3.3 Possible types of results?

Several possible results were possible when testing our design as a whole. As previously mentioned in our last document, we hoped for the ideal situation where the last major prototype would be that all our tests need little to no modification since we would be under a time constraint. Based on what has been observed the following are possible results:

- Casing cracks under the weather flunction
- App send accurate location to third party under given time
- Casing comfortable and stable
- Oximeter closes under too cold weather
- Oximeter sends accurate information to the app
- Parts too heavy to be carried for 24hr
-

3.4 How the results will be used to make decisions or select concepts

As Stated above there are many possible results that we could encounter that would result in different final decisions. If the earpiece casing cracks due to weather conditions (can be extremely cold in Canada) or if the material isn’t durable we will look into other materials for our casing; for instance, instead of using plastic we may decide rubber would be better. Another issue we could possibly have with the earpiece casing is it’s stability and comfortability. If the product is falling off the user’s ear or is not comfortable for the user we will have to modify our solidworks design to add extra support and possibly foam pieces for comfort. Another aspect we will have to look at when making the decisions is the accuracy of the oximeter. The safety of the user is the most important thing, if the oximeter readings are not consistent and accurate we will need to modify the code or look into different (more accurate) hardware options. If the app does not send an accurate location we would potentially add in another hardware piece that detects the GPS location of the user so that we can ensure its accuracy. Lastly, if the hardware is too heavy to be carried on the ear all day we would either move the device to another location of the body (finger, toe) and modify our casing or we would talk to the client about increasing our budget so that we could invest more money into the hardware and get smaller hardware components.

3.5 Criteria for test success or failure

Hardware:

- Good Physical state of the device after testing
- High level of comfort
- High Firmness on the user's ear
- The sensors provide a good accuracy
- Great hardware communication, the sensors communicate well with the ESP32
- Pleasing aesthetics

Software

- No appearance of bugs on the app
- The text message pursue user's location with high accuracy
- App connects to the ESP32 and remain connected to the device until turned off
- The text is sent to the right person

3.6 What is going on and how it is being done

The type of prototype we are doing is a comprehensive prototype; our goal is to implement all of the product attributes and test the integration of the different components we have been working on. The reason that we are doing this type of prototype is because it allows us the opportunity to thoroughly test our product. Completing a comprehensive prototype will be more expensive and take more time but it will allow us to reduce uncertainty about the functionality of our device and allow us to determine how all the components fit together. In this comprehensive prototype we are integrating all our critical subsystems and testing our fully functioning product. Our comprehensive prototype is a fully functional and accurate oximeter sensor, an app that locates the user and sends a text alert immediately to a third party and a 3D printed earpiece case that will hold all the hardware components.

3.7 Testing Process

At this final stage of the project, we wrap up the knowledge obtained from the last prototypes. In order to save time, the initial plan was not to repeat past tests that we already know the results of but, with the limitations of team members being distant we could not perform new tests. Therefore, at this stage, we can only look back on the last variables and perform the same tests in order to confirm our current knowledge. At section 6.3 we wrote the testing process if we had a perfect scenario, without the social distancing.

3.8 Information being measured

- Level of comfort/how long it can be worn
- Accuracy of oximeter sensor
- How quickly text and location of the user is sent
- Weight of the device
- Size of the device
- Battery life

3.9 Information being observed and how is it being recorded

As declared before we could not make new observations because we did not perform new tests. At the final of this derivable(Section 6.3) we wrote the information being observed if we had a normal scenario, without the social distance of team members.

3.10 What materials are required and what is the approximate estimated cost?

3.10.1 Bill of Materials

MATERIALS	COST(Taxes not included)
Bluetooth (HC05)	$11
ESP Chip Board	$3
Oximeter (MAX 30100)	$24
3mm Red Led	$0.03
1KΩ Resistor	$0.15

Push Button	$0.60
Battery (5V):	$23
Solidworks earpiece case	$0, To be built on Solidworks and 3D printed at the University.

Table 2. *Bills of Materials*

3.10.2 Estimated Cost

Total Estimated Cost of materials = $61.78

3.11 Work to be done

Focusing on the accuracy of overdose detection and GPS location, and feasibility of the product for user's day-to-day lives was an important step in order to successfully complete a full-functioning final prototype. Planning the tests and how we would analyze the results helped to determine what features of the device needed to or could be improved. Because of the COVID-19 outbreak, a big step in our design process for this prototype was determining how we could effectively complete our tasks. This included brainstorming new ideas, and checking in to make sure everyone was able to complete their tasks under the circumstances. We also continually referred back to our problem statement to compare it to our current design. This allowed us to determine what could be improved and tweaked on the final design to make sure we were giving the client the most fulfilling solution.

4. Prototype Test Plan

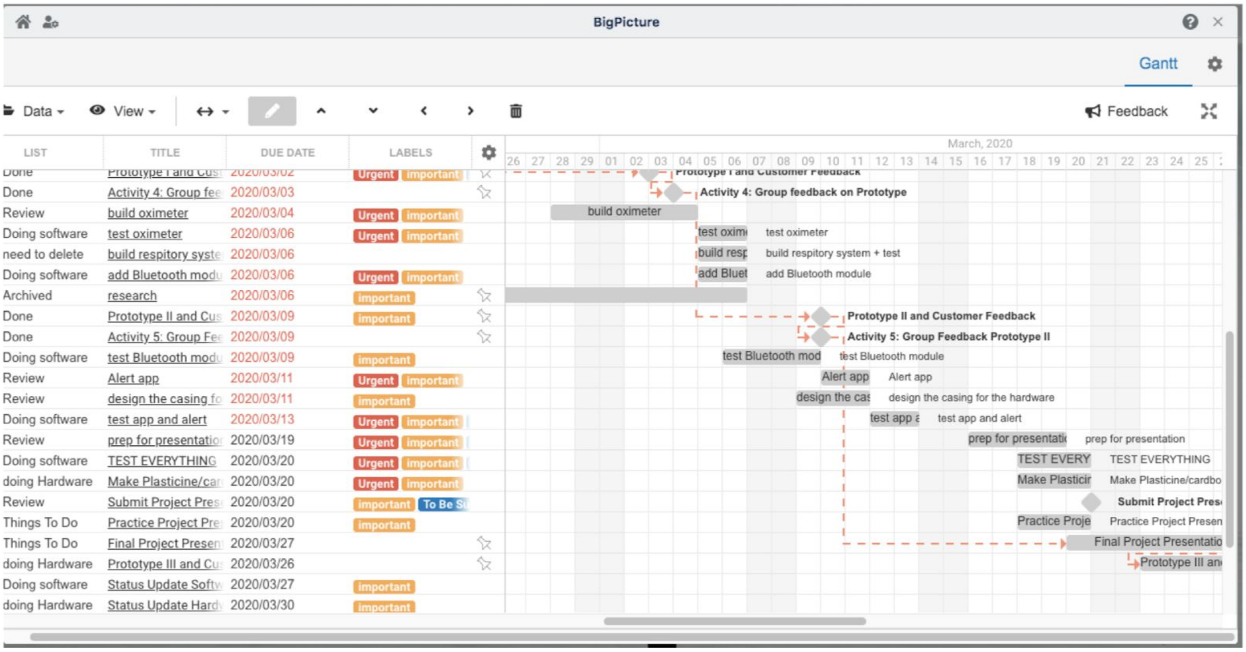
4.1 How long will the test take and what are the dependencies

To analyze our final prototype we would need to complete a series of outlined analysis. Based on the goals for the final prototyping and testing, which include an accurate oximeter and bluetooth module, a functional application and a durable and steady device casing; there are other tasks that would be required. These task are the dependencies for our final prototype test and they include :-

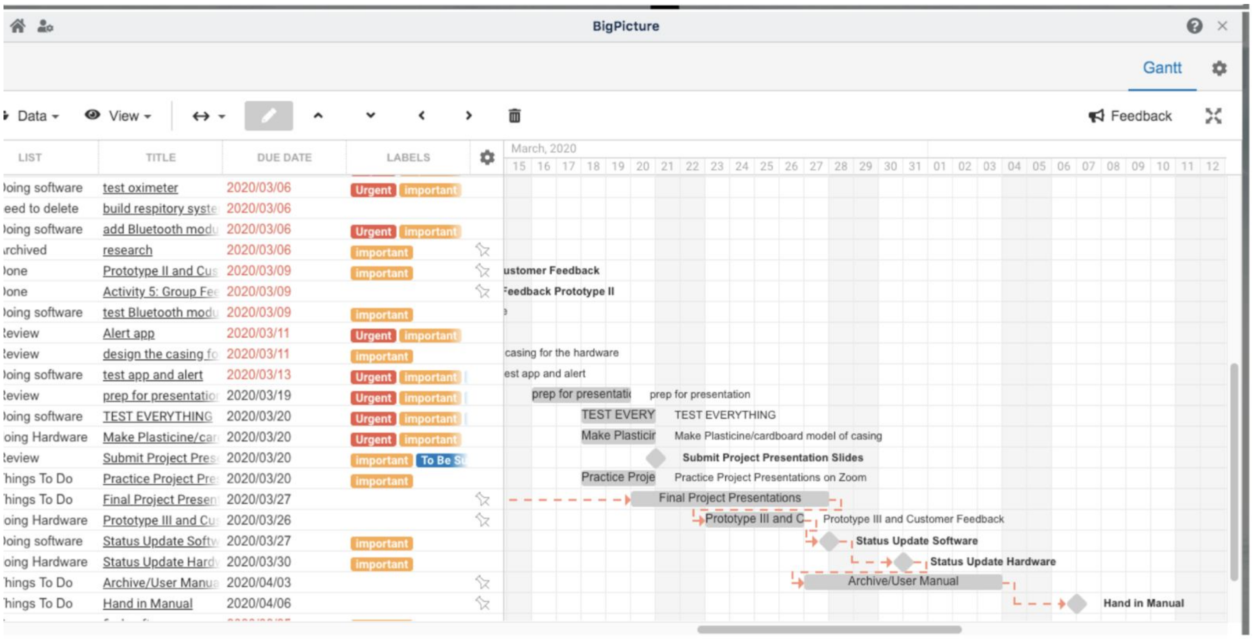
- Testing the bluetooth module

- Setting up the application alert system
- Design and print device casing for the hardware
- Battery calculation

Below is a figure showing a part of our general project gantt chart which includes these dependencies as subtask leading up to the milestones(Project presentation) and status update



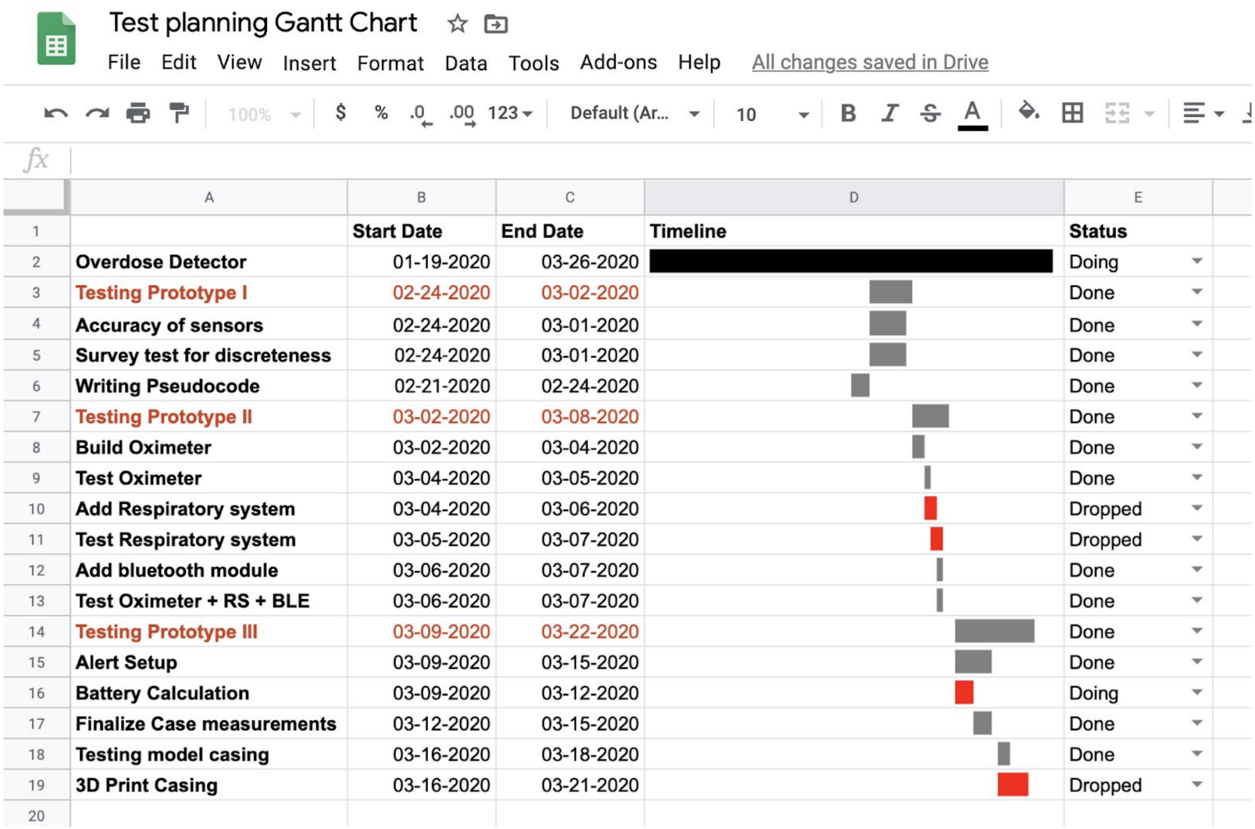
LIST	TITLE	DUE DATE	LABELS
Done	Prototype I and Cus	2020/03/02	Urgent important
Done	Activity 4: Group fee	2020/03/03	
Review	build oximeter	2020/03/04	Urgent important
Doing software	test oximeter	2020/03/06	Urgent important
need to delete	build respitory syste	2020/03/06	
Doing software	add Bluetooth modu	2020/03/06	Urgent important
Archived	research	2020/03/06	important
Done	Prototype II and Cus	2020/03/09	important
Done	Activity 5: Group Fee	2020/03/09	
Doing software	test Bluetooth modu	2020/03/09	important
Review	Alert app	2020/03/11	Urgent important
Review	design the casing fo	2020/03/11	important
Doing software	test app and alert	2020/03/13	Urgent important
Review	prep for presentatio	2020/03/19	Urgent important
Doing software	TEST EVERYTHING	2020/03/20	Urgent important
doing Hardware	Make Plasticine/car	2020/03/20	Urgent important
Review	Submit Project Pres	2020/03/20	important To Be Su
Things To Do	Practice Project Pre	2020/03/20	important
Things To Do	Final Project Presen	2020/03/27	
doing Hardware	Prototype III and Cu	2020/03/26	
Doing software	Status Update Softw	2020/03/27	important
doing Hardware	Status Update Hard	2020/03/30	important



LIST	TITLE	DUE DATE	LABELS
oing software	test oximeter	2020/03/06	Urgent important
eed to delete	build respitory syste	2020/03/06	
oing software	add Bluetooth modu	2020/03/06	Urgent important
rchived	research	2020/03/06	important
one	Prototype II and Cus	2020/03/09	important
one	Activity 5: Group Fee	2020/03/09	
oing software	test Bluetooth modu	2020/03/09	important
eview	Alert app	2020/03/11	Urgent important
eview	design the casing fo	2020/03/11	important
oing software	test app and alert	2020/03/13	Urgent important
eview	prep for presentatio	2020/03/19	Urgent important
oing software	TEST EVERYTHING	2020/03/20	Urgent important
oing Hardware	Make Plasticine/car	2020/03/20	Urgent important
eview	Submit Project Pres	2020/03/20	important To Be Su
hings To Do	Practice Project Pre	2020/03/20	important
hings To Do	Final Project Presen	2020/03/27	
oing Hardware	Prototype III and Cu	2020/03/26	
oing software	Status Update Softw	2020/03/27	important
oing Hardware	Status Update Hard	2020/03/30	important
hings To Do	Archive/User Manua	2020/04/03	
hings To Do	Hand in Manual	2020/04/06	

4.2 Test planning Gantt chart

In order to organize and maintain tracking of our testing plan for the final prototype which would be representing the final design, we previously made a simplified gantt chart using google sheets. Now, we have modified the gantt chart(see below) to include the necessary subtasks for the testing of the final prototype. This as well includes the progress of the overall task(colored black), which takes into account the progress of subtasks. For the final prototype we would also be including subtasks that should be done before their due dates. However, due to the current situation changes have been made as some of the tasks can no longer be performed.



	Start Date	End Date	Timeline	Status
Overdose Detector	01-19-2020	03-26-2020	⬛	Doing
Testing Prototype I	02-24-2020	03-02-2020	⬛	Done
Accuracy of sensors	02-24-2020	03-01-2020	⬛	Done
Survey test for discreteness	02-24-2020	03-01-2020	⬛	Done
Writing Pseudocode	02-21-2020	02-24-2020	⬛	Done
Testing Prototype II	03-02-2020	03-08-2020	⬛	Done
Build Oximeter	03-02-2020	03-04-2020	⬛	Done
Test Oximeter	03-04-2020	03-05-2020	⬛	Done
Add Respiratory system	03-04-2020	03-06-2020	🟥	Dropped
Test Respiratory system	03-05-2020	03-07-2020	🟥	Dropped
Add bluetooth module	03-06-2020	03-07-2020	⬛	Done
Test Oximeter + RS + BLE	03-06-2020	03-07-2020	⬛	Done
Testing Prototype III	03-09-2020	03-22-2020	⬛	Done
Alert Setup	03-09-2020	03-15-2020	⬛	Done
Battery Calculation	03-09-2020	03-12-2020	🟥	Doing
Finalize Case measurements	03-12-2020	03-15-2020	⬛	Done
Testing model casing	03-16-2020	03-18-2020	⬛	Done
3D Print Casing	03-16-2020	03-21-2020	🟥	Dropped

As can be viewed from the image above, some of the tasks that could not be performed or were delayed are now expressed as dropped or expressed with a red timeline.

5. Analysis of Prototype

Final Prototype Status Update:

5.1 Document the final state of your prototype using as many sketches/diagrams/pictures and descriptions as required.

Unfortunately we were unable to fully complete our prototype due to COVID-19 facility closures and “social distancing”

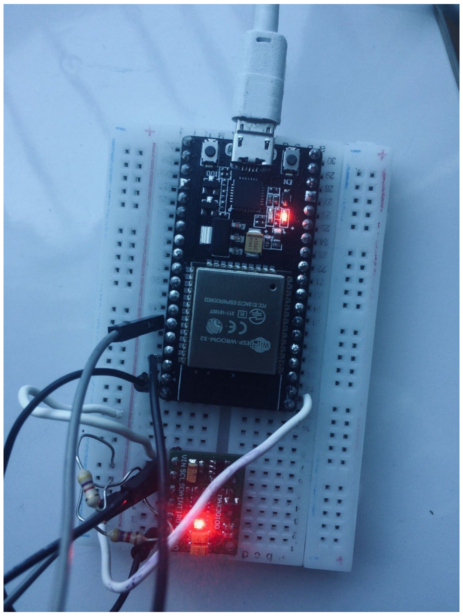
Hardware: We were able to complete a functioning oximeter sensor, we did not however have the ability to test its accuracy and reliability in measuring oxygen saturation because we had a faulty sensor.

Software: We had a functioning prototype of the app that connected to a user’s phone and was able to identify the user’s location. We were unable to send the text message alert and user location through the app due to social distancing. Since raphaelle had the working hardware components and Felipe had the working app we were unable to combine the two subsystems to simulate an overdose and ensure a text alert would be sent.

Casing: Due to facility closure we were unable to 3D print our solidworks model. Instead we tried to work around this by building another case from materials we could find. Unfortunately this did not allow us to determine the actual weight and comfort of our earpiece. We also were not able to test how secure the device would be to the ear because the weight and materials of the actual casing would be different in our final product. However, from the casing built from materials we were able to determine a good level of stability of the device.

Below are pictures of the final state of our prototype:

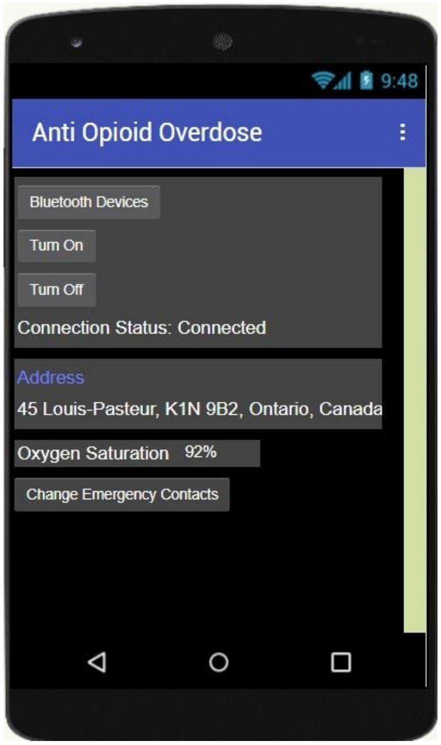
Working Oximeter sensor



Basic Code for Text Alert (has not actually been tested)

```
#include <Adafruit_BluefruitLE_UART.h>

void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:
 if (sensorValue < 90) {
  char message [40];
  char value [12];
  itoa(sensorValue, value, 10); //covert integer to character
  strcpy(message, "The user is overdosing! Administer naloxone. oxygen saturation is ");
  strcat(message,value);//sends characters to Bluefruit
  Serial.print("[Send]");
  Serial.println(message);

 }
}
```

Working App



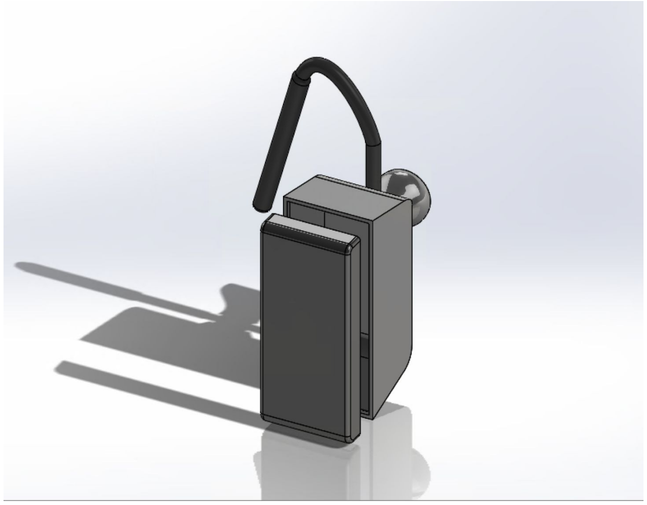
Connection Status: Connected

Address

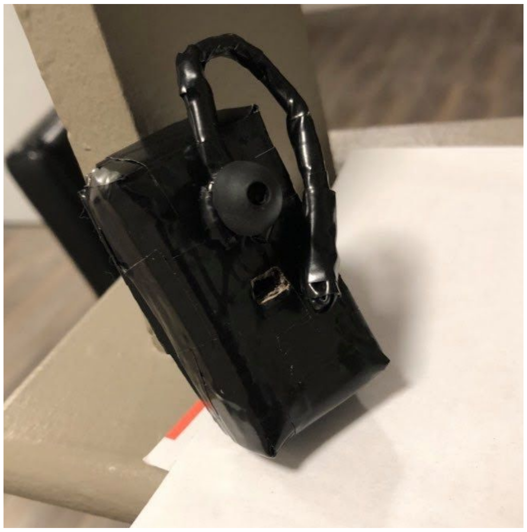
45 Louis-Pasteur, K1N 9B2, Ontario, Canada

Oxygen Saturation 92%

Solidwork Casing (to be 3D printed)



Updated Casing From Materials Around the House (to test earbuds and better determine stability, made because we couldn't 3D print)



5.2 Explain the purpose and function of your final prototype.

With the increasing number of opioid users today, and the fatal death associated with them, we were asked to build a non-intrusive affordable device to help control the effect of the epidemic. The team's goal was to create an efficient device which could detect and call a third party for assistance in less than 3 mins. After numerous months of researching, planning, and testing we built an earpiece that accurately measures a person's heart rate and oxygen saturation and alerts, which has the location of the user to third party when the levels are too low. This earpiece is accompanied with an app which connects via bluetooth with the device and gives the location of the user when needed. In addition, with the help of the IFTTT free web service, we made it possible for the user phone to send an automatic emergency text message using a wifi connection provided by the earpiece. Finally the earpiece is encased in a comfortable material with a silica gel ear cap so it can be worn throughout the day. This product, even though it is still in its prototype stage, was found suitable, durable and aesthetically pleasing for our users, which are mostly men in the trade (not excluding women).

5.3 Describe how your client would interact with your final prototype.

Upon purchase of the product, the client will receive the device, and a user manual. The user manual will outline proper use of the device in order for accurate functioning of the blood oxygen concentration reading, and any other features. The user must set up the app on their phone and connect it to the device in order for their recorded data to be displayed on the screen. The user must input their information (for example, their emergency contact). This will also connect the user's device to the 'get-help' features, including sending a message and the GPS location to third party responders. After preparing the battery, the user will attach the device by placing the earbud in their ear, and the arm around the back of their ear. This provides security so the device will not fall off. The device stays put on the user's ear until the battery charge is low, where the user must take it off to replace the battery. The user can choose to wear the device all the time, or just during the period where they are planning to use opioids.

5.4. link to a YouTube videos showing your prototype in action.

App: https://www.youtube.com/watch?v=qUyEzbhzJag ("Get Address" button added in order to show that the app can get the user's location)

Hardware: https://youtu.be/Yrgbb11B9UQ (accuracy of oximetry shown using serial monitor using finger. Earlobe wasn't shown because of demonstration would not be possible)

5.5 Results obtained in completed test and analysis with respect to earlier developed target specifications

	Design Specification	Expected	Verification Method	Actual
	Functional requirements			
1	Percentage error	<= 5%	Test oximeter	Incomplete testing
2	Monitoring Time	= 10 seconds	Test oximeter	10 seconds
3	Battery Life	>= 1 day	Test device	Incomplete testing
4	GPS tracking accuracy	<= 10 meter	Test app	10 meters

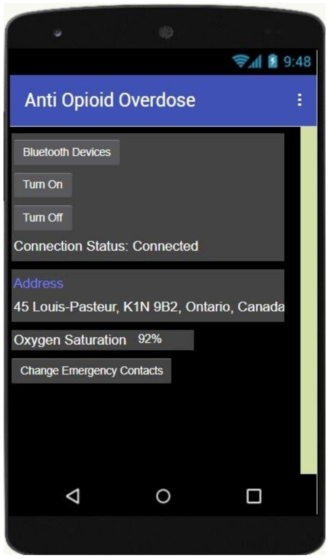
5	Customizable	= yes	Test	yes
6	Override System	= yes	Test app	no
7	Accurately detects overdose	= yes	Test oximeter	yes
8	Non-invasive	= yes	n/a	yes
	Constraints			
1	Size	< 65 x 30 x 15 mm	Measure size	60 x 28 x 12 mm
2	Weight	< 10 g	Weigh device	Incomplete
3	cost	< $100	Calculate price	$61.78
	Non-Functional Requirements			
1	Discreet	= yes	Survey	yes
2	Location of application	= convenient	Wear on user	convenient

5.6 Analysis : Accuracy of Oximeter and Bluetooth Module

Understanding the main purpose of this project, has always led us to placing this factor at a high priority level. It is very important that the oximeter generates accurate results and avoid fluctuating as the failure to do this would lead to the complete failure to achieve our goal. Considering the aim to save lives, if the oximeter fails to give the right values at the right time, we would end up in a situation where a user’s life would be at risk. Also, with having the device being discreet as one of our design criteria, it is important that the device doesn’t send out a false alarm as a result of a fluctuating oximeter. To test for the accuracy, the oximeter would be continuously tested from various positions and angles to ensure that it would also report constant and accurate reading. This analysis stage would be marked as complete once the oximeter can read and send constant values over a 24 hour period without fluctuating.

5.7 Analysis : Functionality of the Application

Recalling that another important criteria was that the device is designed to communicate with the user’s loved one in the case of an overdose. It is required that the application is efficient in such a way that it receives the information of an emergency and immediately sends out the user’s location with a message disclosing an overdose event. The test for the functionality would include checking that the app correctly receives the user's current status, obtains an accurate reading of the user's location and can send an emergency alert to the saved emergency contact. For the application to be concluded as done it should have passed all the aforementioned checks in testing.



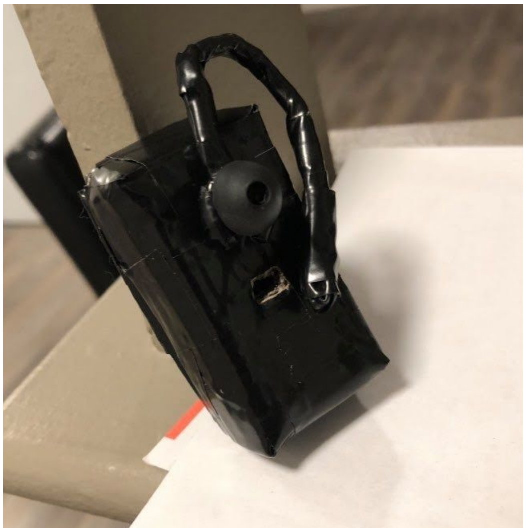
Connection Status: Connected

Address
45 Louis-Pasteur, K1N 9B2, Ontario, Canada

Oxygen Saturation 92%

5.8 Analysis : Durability and Stability of the Device Casing

This stage of design analysis considers a key question asked during the client feedback after the prototype II presentation which was "would the device be stable and not fall off?" . Given that the overall functionality of the device has been observed to have a high dependence on its casing, we have included certain testing measures for the device case. The first of which would be having someone wear the device prototype through the day while carrying out various activities from jogging to laying down to confirm that device does not easily move out of place. The prototype used here would be made to have similar weight to the expected final design and this helps carry out a check for another beneficial test which is ensuring that the device would not hinder daily activities. For the second important factor, durability, to be tested the plan was to have a 3D printed prototype worn while carrying out activities. This would ensure that in a situation that the device is used by someone working in, for example a construction site, or if the device accidentally slips it would not easily be damaged. However, due to the current pandemic that led to the closure of facilities and also the delay in finalizing the size of the device, this second test was not conducted. Although, we were able to complete the first test using the prototype seen below and ensured that device would be stable, not easily fall off or move out of place.



6. Future Work

In future work (after ensuring functionality/accuracy) we have a few ideas we would like to implement to bring our product to the next level. We would like to use a hearing aid battery to power our device, this would allow it to last longer and be more compact/discreet. Ideally we could also make our product play music through the earpiece using bluetooth; this would make users want to wear the device more. We would add additional features to the app such as custom messages, the ability to see trends in oximeter readings and sending the help alert to more than one person. Finally we would make the device only turn on when the user isn't moving, since they will not be moving when they are close to overdosing, this will greatly save on battery life.

Planned Execution under Normal Conditions:

6.1 Description of every aspect of your final prototype that was not completed due to COVID-19 facility closures and "social distancing"

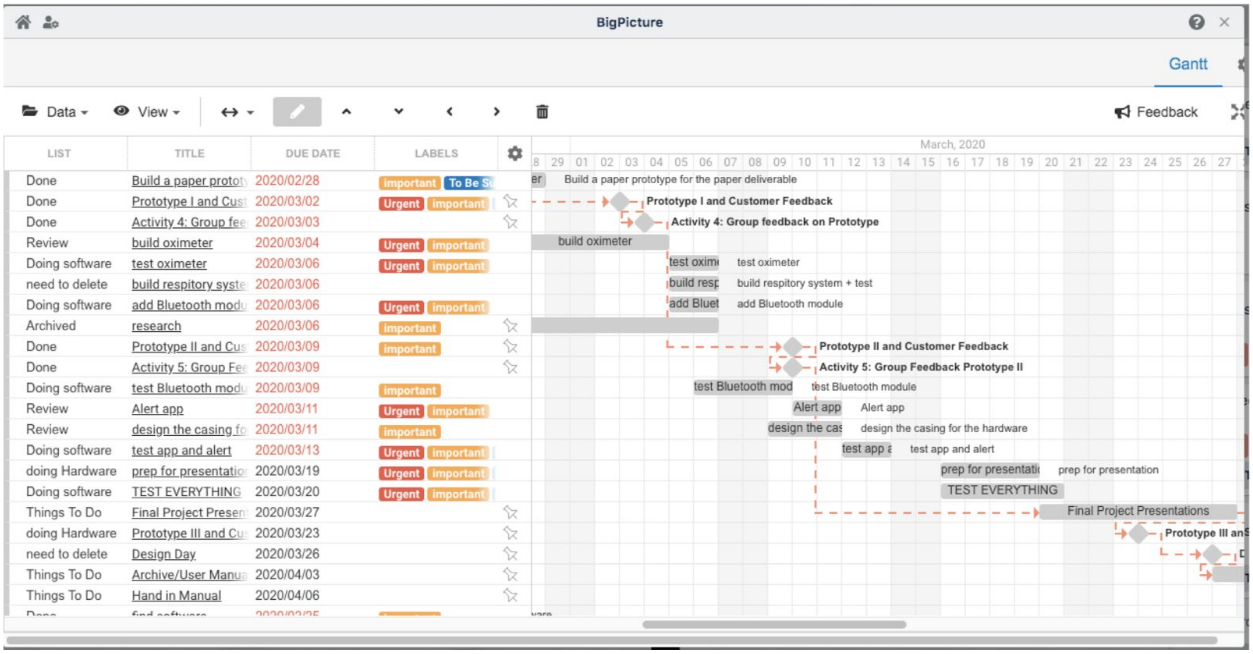
Unfortunately due to COVID-19 we were unable to complete all the tasks we had set out to accomplish. We could not 3D print our earpiece casing due to Makerspace closing. We were also unable to combine all of our critical subsystems because different group members had different components of our device (Raphaelle had the hardware, Felipe had the App and Precious had the casing) and we had to social distance ourselves so we could not join the components. Lastly we were unable to complete the pseudocode for the text alert to send to a third party.

6.2 Step-by-step action plan that we would have followed if we had 1.5 weeks (March 16th to 26th) to complete our prototype as we would have under normal conditions. Gantt chart included.

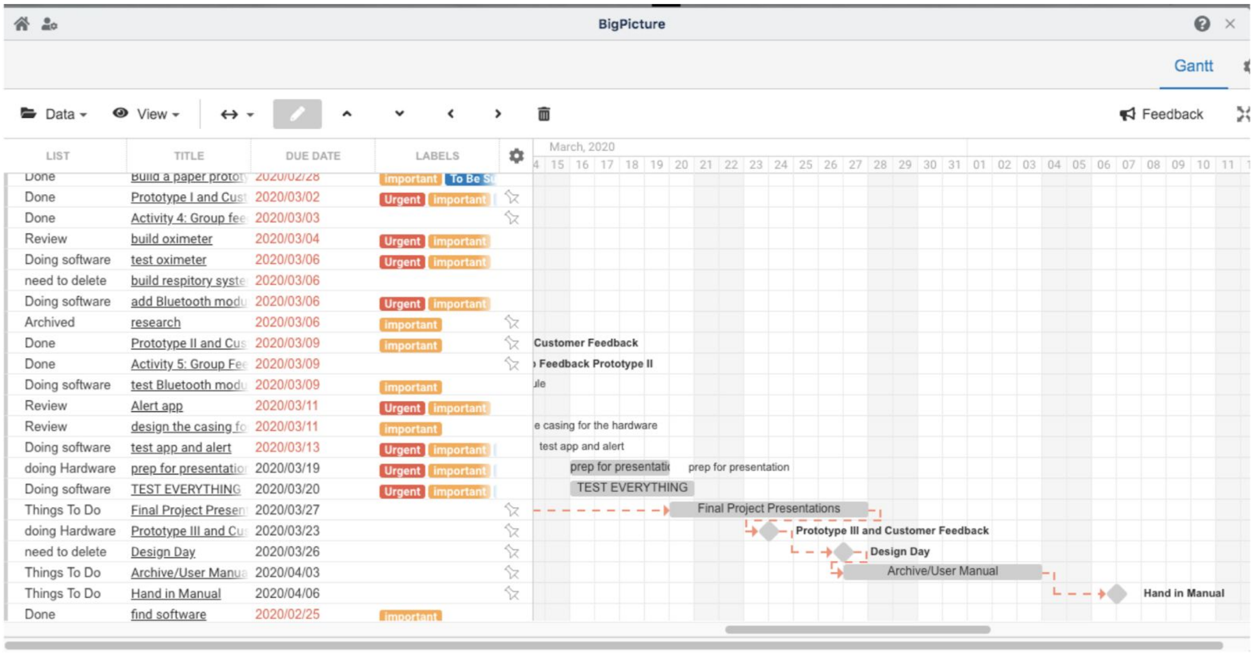
In the event that we had the time and facilities to complete our prototype and prepare for design day, we had outlined the next necessary steps that would have been taken. These steps and their scheduled dates would include:

- ➔ 3D printing of our prototype casing (March 16th - March 17th)
- ➔ Testing to ensure that the ear piece is comfortable and stable on the user’s ear (March 18th - full day)
- ➔ Completion of the last critical subsystem (text alert) (March 16th - March 19th)
- ➔ Battery Calculation and incorporation (March 16th - March 20th)
- ➔ Integration all the components to test the overall functionality and accuracy of the product (March 20th - March 22nd)
- ➔ Prepare Prototype for presentation (March 23th - March 25th)

Below are figures of our previous gantt chart (not indicating adjusted dates) which includes briefly the steps mentioned above, however as discussed in an earlier section of this document the gantt chart was updated to accommodate the current situation.



LIST	TITLE	DUE DATE	LABELS
Done	Build a paper protot	2020/02/28	important To Be S
Done	Prototype I and Cust	2020/03/02	Urgent important
Done	Activity 4: Group fee	2020/03/03	
Review	build oximeter	2020/03/04	Urgent important
Doing software	test oximeter	2020/03/06	Urgent important
need to delete	build respitory syste	2020/03/06	
Doing software	add Bluetooth modu	2020/03/06	Urgent important
Archived	research	2020/03/06	important
Done	Prototype II and Cus	2020/03/09	important
Done	Activity 5: Group Fee	2020/03/09	
Doing software	test Bluetooth modu	2020/03/09	important
Review	Alert app	2020/03/11	Urgent important
Review	design the casing fo	2020/03/11	important
Doing software	test app and alert	2020/03/13	Urgent important
doing Hardware	prep for presentatio	2020/03/19	Urgent important
Doing software	TEST EVERYTHING	2020/03/20	Urgent important
Things To Do	Final Project Presen	2020/03/27	
doing Hardware	Prototype III and Cu	2020/03/23	
need to delete	Design Day	2020/03/26	
Things To Do	Archive/User Manua	2020/04/03	
Things To Do	Hand in Manual	2020/04/06	



LIST	TITLE	DUE DATE	LABELS
Done	Build a paper protot	2020/02/28	important To Be S
Done	Prototype I and Cust	2020/03/02	Urgent important
Done	Activity 4: Group fee	2020/03/03	
Review	build oximeter	2020/03/04	Urgent important
Doing software	test oximeter	2020/03/06	Urgent important
need to delete	build respitory syste	2020/03/06	
Doing software	add Bluetooth modu	2020/03/06	Urgent important
Archived	research	2020/03/06	important
Done	Prototype II and Cus	2020/03/09	important
Done	Activity 5: Group Fee	2020/03/09	
Doing software	test Bluetooth modu	2020/03/09	important
Review	Alert app	2020/03/11	Urgent important
Review	design the casing fo	2020/03/11	important
Doing software	test app and alert	2020/03/13	Urgent important
doing Hardware	prep for presentatio	2020/03/19	Urgent important
Doing software	TEST EVERYTHING	2020/03/20	Urgent important
Things To Do	Final Project Presen	2020/03/27	
doing Hardware	Prototype III and Cu	2020/03/23	
need to delete	Design Day	2020/03/26	
Things To Do	Archive/User Manua	2020/04/03	
Things To Do	Hand in Manual	2020/04/06	
Done	find software	2020/02/25	important

6.3 Systematic testing and analysis plan we would have followed to evaluate our prototype's performance compared to the target specifications

Information being observed

We performed important tests on the last derivables, such as ensuring all the sensors are being powered, the accuracy of the sensor and app functionalities. In order to save time we would not perform all these tests again instead, we would observe if all the parts function normally as it should. We would observe the first reaction of the user because we consider aesthetics a big factor for our device if the device is ugly people are not going to use it. We would also observe how the device feels and looks when it is being used. All this information is qualitative so we were going to listen to the people who are testing the device and make notes. We were going to test the device in different weathers, so we would observe its physical state after use. In terms of software, we would observe if the emergency text message is being sent to the right person and if the message pursues correct information, this information can be seen by observing the text inbox of the cellphone used in the testing.

Testing Process

Hardware

1. Firmness, comfort and feedback
   a)Place the device on someone.

b)Instruct the person different situations to be during the day, beside normal activities. Instructions such as laying down with all the 4 sides of the head, going up and down the stairs and jumping.
c)Let the person use the device for a whole day and later receive feedback. The feedback must contain the level of firmness, comfort and aesthetics.
d)Repeat the test with 4 other people. The weather must be different on each test.

2. Sensors
   a)On the arduino code editor, make every sensor output be printed on the serial monitor
   b)Place a finger on the sensor.
   c)Move your finger rapidly.
   d)Keep your finger on the sensor for about 1.5 minutes.
   e)On the arduino check if all the sensors are working and if the outputs are accurate.
   f)Repeat the test with 4 other people.

Software

1. App connects to the ESP32.
   a)Enable Bluetooth on a Cellphone.
   b)Connect the cellphone to the ESP32 on the Bluetooth connections tab on the cell phone.
   c)On the app and the code editor create a variable.
   d)Make the app send the variable values to the ESP32(for example 123).
   e)On the code Editor make the variable be printed.
   f)Run the app and the code written on the code editor.
   g)Check on the serial monitor if the value is printed.
   h)Repeat the test 3 times.

2. Correct information is being sent to the right person.
   a)On the app create a new contact to the emergency contact list.

b)On the code editor change the if statement that regulates the minimum oxygen saturation required to the text to be sent. Change the number for a regular oxygen saturation, such as 93%.

c)Place the device on someone and turn it on.

d)Check if a message is sent to the number added on the emergency contact list and see if the message put on the code editor appears. For example “Call for help! Mathew Andreas is having an opioid overdose at (address)”.

e)Check if the address given in the message corresponds to the address the person was at most 1 minute ago.

f)Test the procedure again with 4 other people in 4 different locations with 4 different phone numbers.

In order to record the final specifications we were going to copy the Need and Identification/Criteria table from the variables B and C and then we would fill it up with the values received from our final product testing.

7. Customer Feedback

Unfortunately we were unable to get final feedback from our client due to COVID-19. We did however alter our casing based on previous feedback to ensure the security of the earpiece to the user's ear. To do this we thickened the piece that would wrap around the ear and also added an adjustable earbud to fit different ear sizes of the user. If we were able to 3D print our earpiece the most important feedback we would be asking users for is: is it comfortable, is it light enough to remain on the ear all day and does it stay on the user's ear throughout daily activities? Our Client was very concerned that the user would not wear the device if it was not comfortable which would defeat the whole purpose of inventing our product. If we did not have so many issues with the functionality of our oximeter we would also have tested it more to determine its accuracy because we knew the client wanted to make sure our product could detect an overdose. Therefore, importance of accuracy and comfortability of the device were our biggest takeaways from our customer feedback and in the future completion of our product we would ensure we achieve this.

8. Conclusion

In order to understand how the final device would work, this final prototype combines all components into one comprehensive design. Throughout the development of the final functioning design, we referred back to our problem statement and compared it to our design to determine how effectively we reached our goals. This allowed us to analyze the entire design process, and be objective in understanding our successes and failures. Organization and communication was key in succeeding as an efficient team. In order to accomplish our goals and make use of our time effectively, we identified a series of tasks and assigned them to each team member. Meeting a couple of times each week ensured that we were always prepared for the next task. This also increased the involvement of each team member, kept everyone focused on the right task, and gave us more opportunities to share and debate new ideas. Frequently checking in made us accountable for completing our work, but also gave time for supporting each other if we were having difficulties along the way. We used Trello and our Gantt chart to identify dependencies and milestones, so everyone understood their tasks and any time constraints associated with them. We used our group chat mainly for planning purposes, such as when our next meeting would take place, but it also gave us a platform for asking quick questions to other team members if we were in need of another opinion. Throughout the whole design process, we were all good at taking responsibility and identifying what needed to be done, which helped us work effectively and thoroughly accomplish our goals. Throughout the development of this final prototype, we focused on ways we could consider client feedback to improve the quality of our design. Testing was an important step in order to fully understand how the device would have both positive and negative impacts on user's lives, and how we could fix any imperfections. Of course the COVID-19 situation caused some complications, but as a team we were able to overcome difficulties by committing to finish the project the best we could with the means we had available to us.

9. References

- Knox, David. "Lecture 11 - Giving and Receiving Feedback and Prototype Test Planning." Jan. 2020, Ottawa