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Faculté de génie
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Project Deliverable H: **Prototype III and Customer Feedback**
GNG 1103 - Engineering Design

Overdose Detection Device

Submitted by

GNG1103, Section C01, Group 3

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Introduction

This deliverable will outline the development and testing of our third prototype. It will also include summaries of the test results and feedback we got from previous prototypes which lead to the creation of our final product. This prototype incorporates all ideas discussed in previous deliverables including the pulse oximetry circuitry, the 3D printed shoe sole model, and the functional apple and android Bluetooth apps. The final product will combine all aspects of the design to make a fully functional product capable of reliably detecting an opioid overdose and alerting friends and family.

Since this prototype builds off of the previous two prototypes it includes all the necessary adjustments found through previous tests. The final circuit is made using an Arduino nano and wires are cut and stripped to make the electric component as compact as possible. Parts are also soldered to keep all parts secure and ensure a constant connection. The 3D printed sole has been customized to fit the electrical components exactly so that everything is held securely. It is also designed as thin as possible and modelled to fit inside an average shoe. The Apple and Android apps will measure blood oxygen level, heart rate and a GPS location. Users will be able to input contacts that they want and when an overdose is detected a text will be sent to those contacts.

Client feedback

During our last client meeting, it was imperative for us that we had to obtain some client feedback on our design idea. Tali mentioned to us that it was important for the sole to be comfortable for the client and that it continues to accurately read blood oxygen levels while the client is going about their daily life. She also mentioned the concern of the oximeter still displaying the blood oxygen levels accurately when the user is wearing socks. We would’ve made sure these concerns would’ve been taken care of in our testing.

Final Prototype Status Update

Due to the sudden closure of the CEED resources, our prototype remains unfinished. We were on track to complete our final prototype by March 20th. The outstanding tasks for our prototype included ensuring signals were sent from the bluetooth module to the phone, printing the final product using the 3D printer, and assembling all components. With use of the makerspace 3D printers, the sole and coverpiece for the sole was scheduled to be printed. Improvements included in this prototype were reducing weight and size of the sole, increasing arch support, reshaping of the sole to better fit in standard footwear and preventing unnecessary movement of the sole during use. The orientation of the components fitted inside the sole were adjusted based on assembly during prototype 2.

The changes made to the sole were:

- The space where the pulse oximeter sits was made smaller so that there was full contact with the persons toe
- The space where the wires connect to the pulse oximeter was made larger to account for the larger wires
- A lowered arch was made to ensure that the sole is comfortable and does not obstruct usual foot positioning
- A hole for the wiring was made on this arch

Figure 1- View of Sole

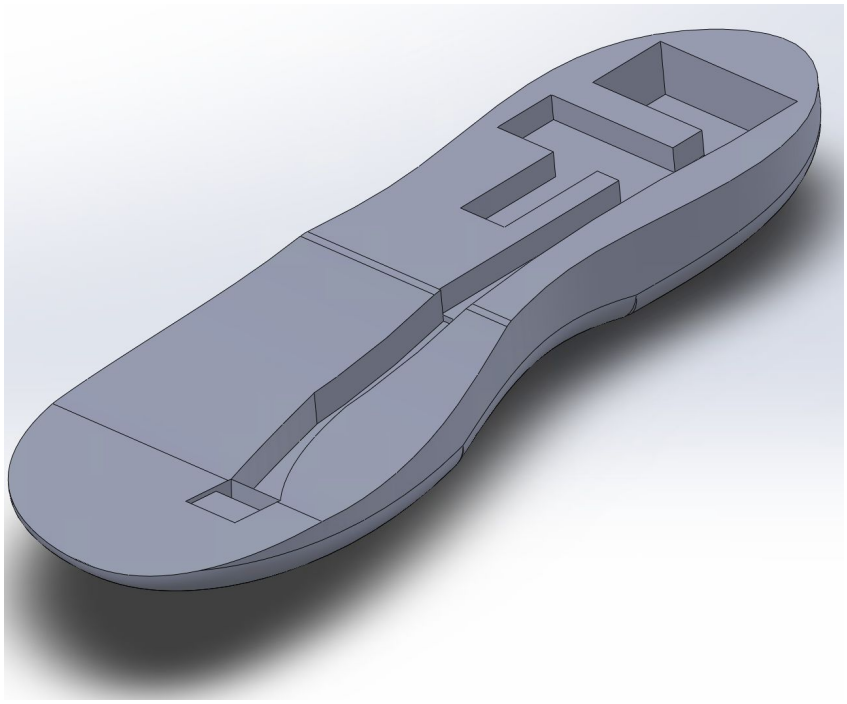


Figure 2- View of Sole 2

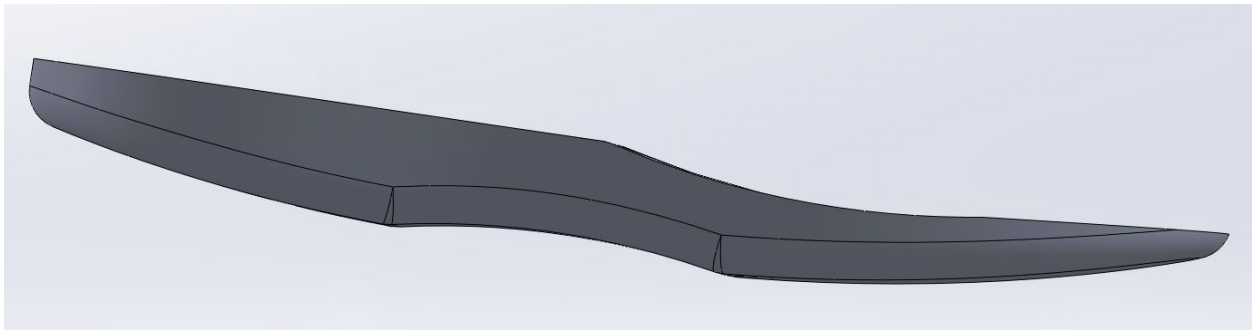


Figure 3- View of Sole 3

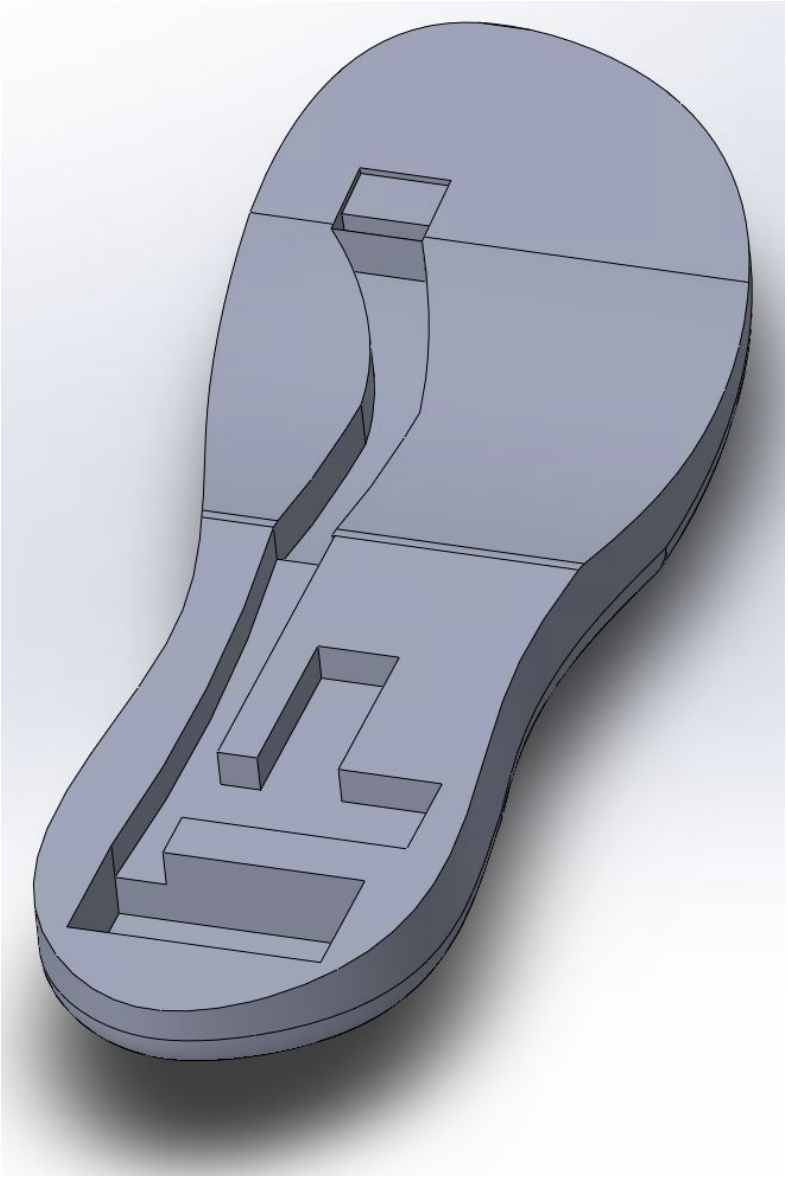


Figure 4- View of Sole 4

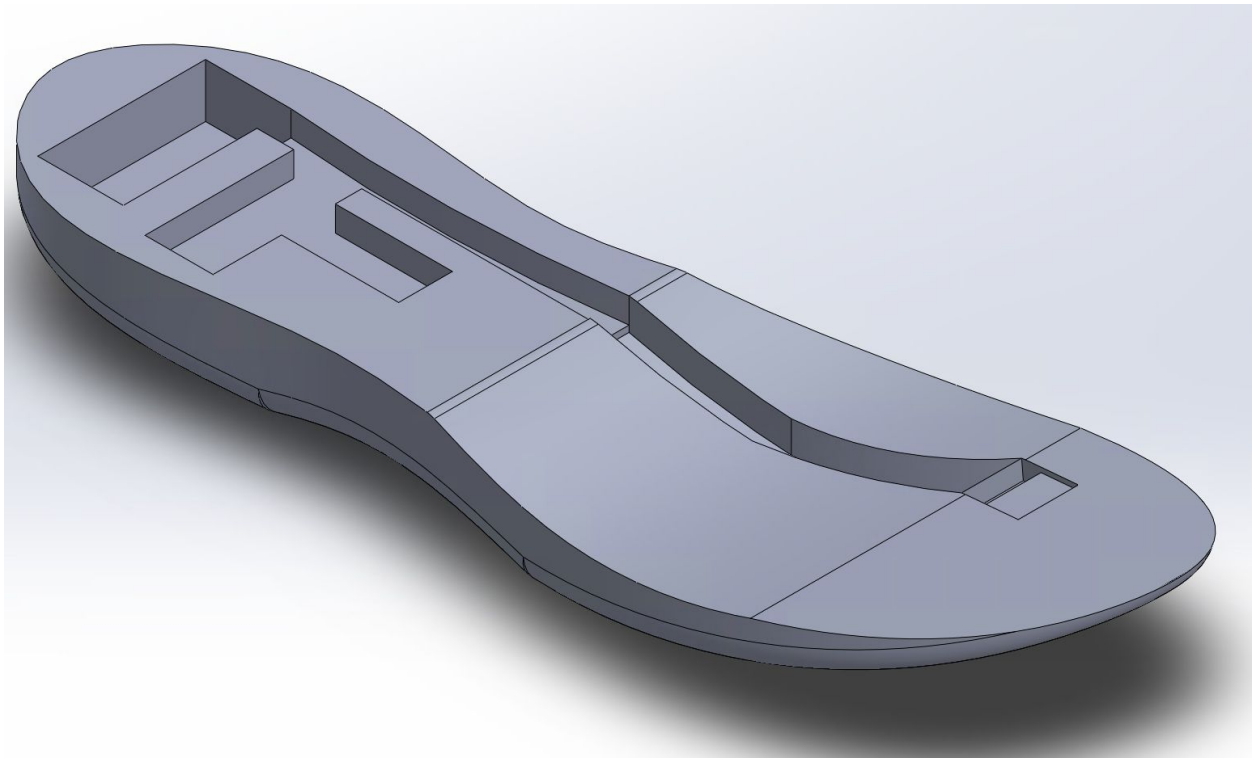
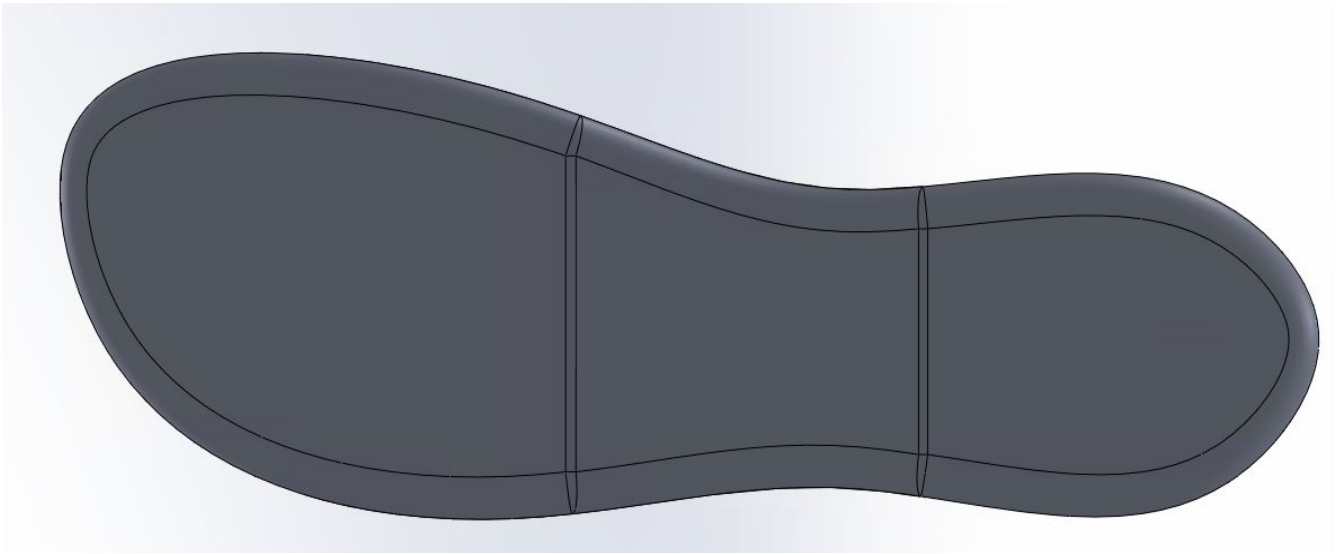


Figure 5- View of Sole 5

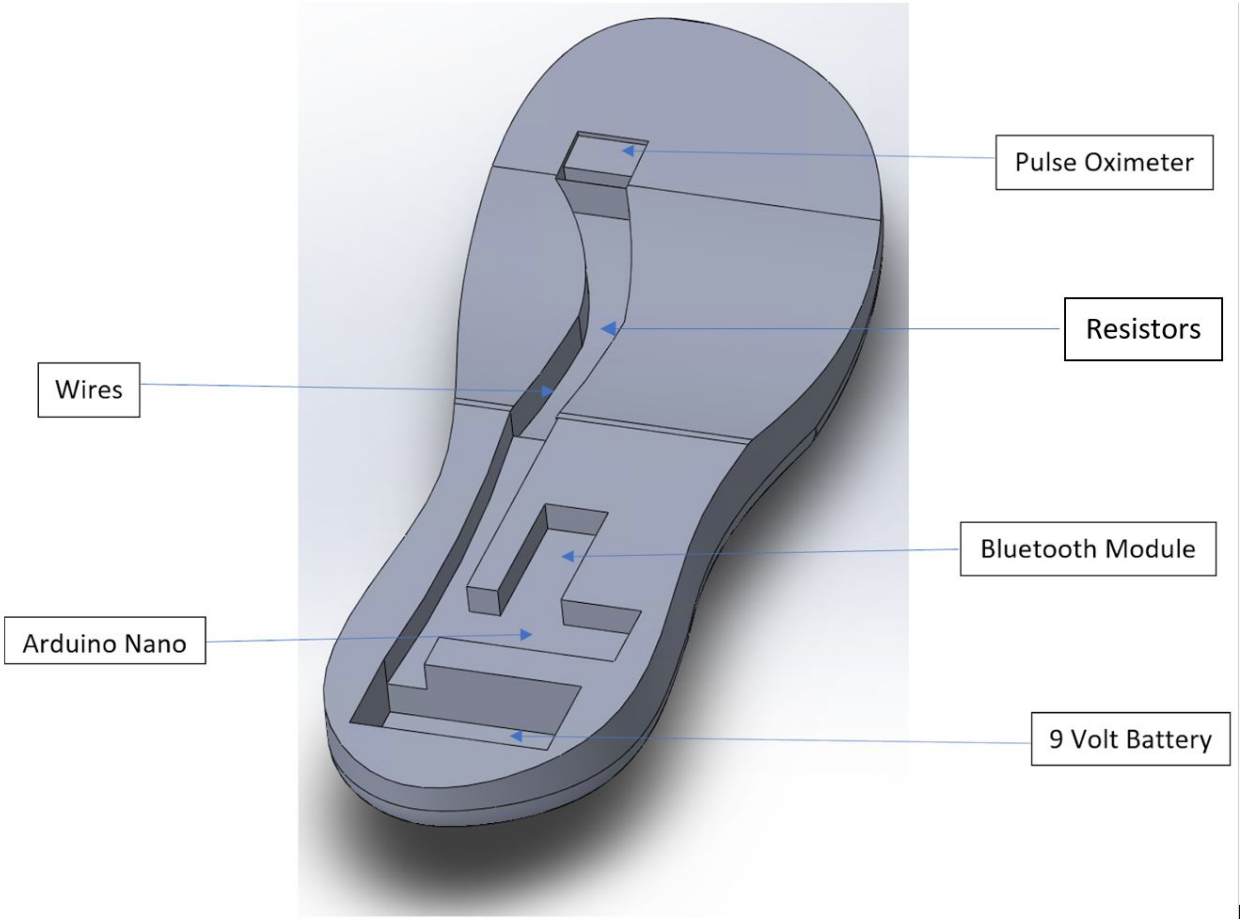


Data shows that approximately 11 people die each day from opioid overdoses, and 94% of overdoses in Canada are accidental. As a result, we designed a device to detect an opioid overdose in real time and alert an emergency contact to reach for help. We were in the process of creating a shoe sole that has a pulse oximeter that measures blood-oxygen levels and heart rate, which are key indicators of an overdose when low.

The components required to complete this design are:

- 3D printed sole
- Pulse oximeter
- Bluetooth module
- Wires
- Arduino nano
- Resistors
- Rechargeable batteries

Figure 6- Components of Sole



App during Prototype 3

Our app during prototype three had improved majorly compared to previous prototypes. The user interface was redone to be visually pleasing and easy to use. On the app you can connect to the bluetooth device simply by clicking two buttons. It features GPS location, which is refreshed every thirty seconds to remain accurate. There is an emergency contact list in which you can add or remove people. When the device detects an overdose, the app is set up to send a text to every emergency contact. As well, the phone will begin to vibrate and the sound of someone saying breathe will be repeated as an attempt to regain the user's consciousness. Unfortunately, we were not able to make a failsafe notification, mainly because app inventor is not compatible with every part of the operating system. If we were using android studio, it would take time but we would be able to create a proper failsafe.

https://www.youtube.com/watch?v=F8UVEhile0Q

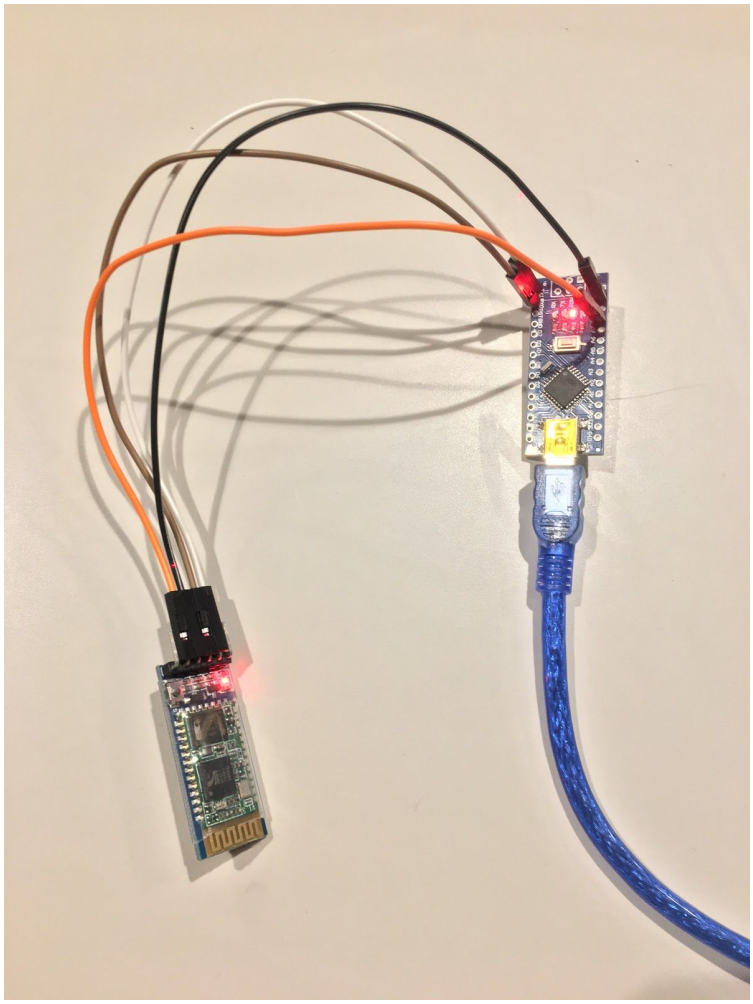
Purpose of Prototype

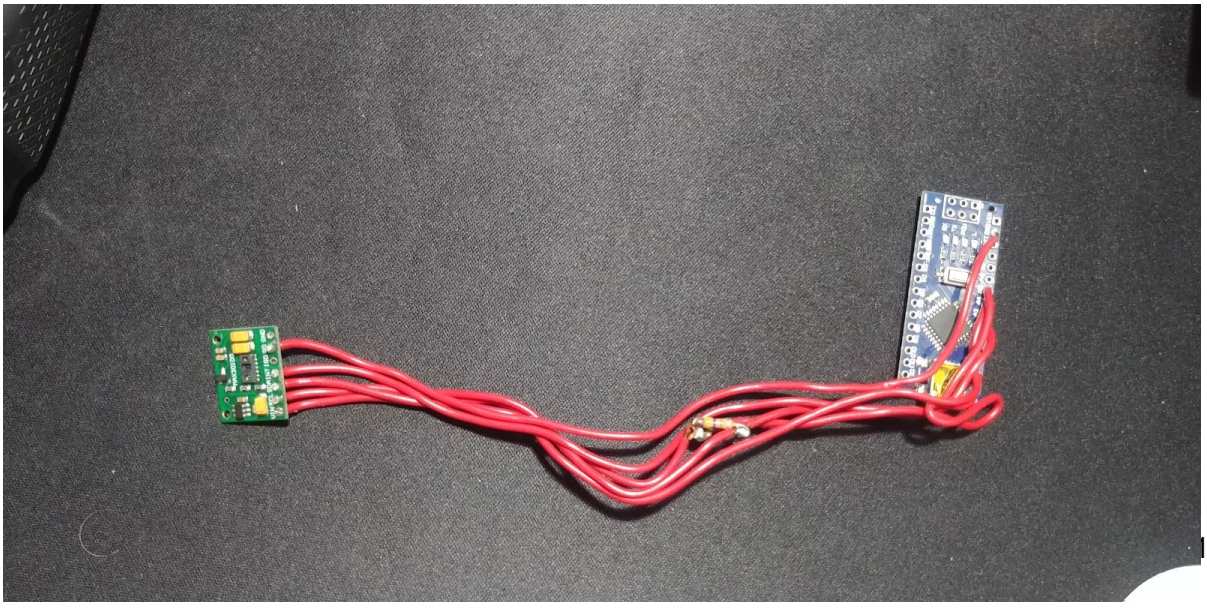
The purpose of our project is derived from our problem statement, to create a discreet and durable device for opioid users, that can detect an overdose quickly and alert medical professionals. After receiving information informing us that emergency services couldn't be contacted directly, our problem statement was revised to have the device contact a loved one or friend if opioid overdose occurs. Based on these changes, the purpose of our final prototype was to monitor blood-oxygen levels and heart rate through a shoe insole, to detect whether a person is experiencing an opioid overdose.

Function of Prototype

Using a pulse oximeter placed beneath the big toe (due to highest blood flow), the final prototype will take readings of the patient's blood oxygen levels. The pulse oximeter readings are sent to the arduino, which then transmits the signal to the bluetooth module. The bluetooth module will then send the readings to the users phone, which are displayed in the installed smartphone app. If the application senses the blood-oxygen levels to be below 85%, a text sent to the emergency list of contacts of the user will be sent displaying the location of the person who is overdosing. A voice

memo telling the drug user to breathe will start playing and the phone will start vibrating to give the overdoser a stimulus.





Client Interaction

For use of the prototype, the sole is to be placed at the bottom of the shoe and the user is to place their big toe on top of the sensor. They would then pair the bluetooth module and their phone to ensure the application is able to get readings from the sensor. The user can then do any daily activities and the prototype will function as long as they keep contact with the oximeter. The signals will constantly be sent to the app and it will alert loved ones when they are in need. A beneficial feature of the app is that it allows the user to input, add, and remove contacts at any time.

Planned Execution Under Normal Conditions

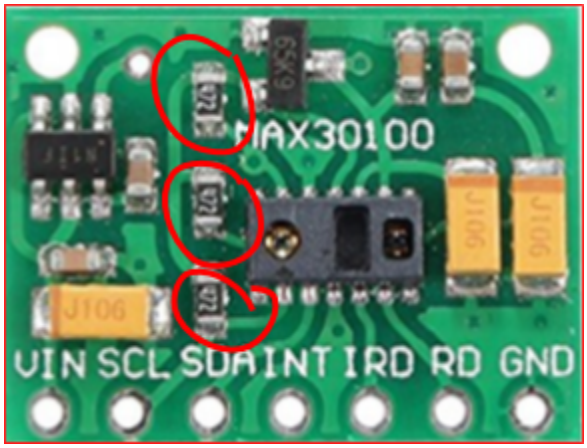
Because of the COVID-19 outbreak, it was impossible for us to complete our final prototype. Circumstances like the MakerSpace closing as well as the incitement of social distancing made it very difficult for us to continue to move forward with our assigned tasks that would lead to the completion of our third prototype.

While most of our subsystems have been successful following the testing that was done before the virus outbreak, we have been unsuccessful getting our blood oxygen sensor to work properly.

As we know from research and from information our client has disclosed during our first client meeting, it is possible to detect an opioid overdose through blood oxygen levels or respiratory rate. Having access to blood oxygen sensors that are easily compatible with microcontrollers (Arduino, RaspberryPi, etc.), it was clear for us that an oximeter was going to be a part of our final design.

After following many tutorials about the wiring between the Arduino Nano and the MAX30100 blood oxygen sensor, we still couldn't get any signals of the oximeter working. After doing some research, we learnt that the oximeter we were using had a design problem and wasn't compatible with the voltage from the Arduino Nano. According to our research, one of the ways this issue could be fixed is to solder off the resistors that are on the oximeter board.

Figure 7 - Removed Resistors on MAX 30100



Even though we learnt through some presentations that this method was successful for some of the teams, it unfortunately wasn't for us. After communicating with our Project Manager about what was the next step we could take, we decided to order a new oximeter, identical to the one we had previously acquired, because we thought that we had burnt out our old one due to the high level of voltage it was put through when using the Arduino.

After our new oximeter arrived, we tried wiring it the same way we had the previous one wired but it still wouldn't work. During one of the labs, when we had access to a multimeter, we realized that some of the ports on the oximeter were wrongly labeled which is what caused us to have so much trouble with only getting it to turn on. We finally got the oximeter to give us a signal that it was successfully connected to the Arduino but when it came down to testing, as soon as we uploaded the MAX30100 code onto the Arduino, the oximeter started overheating. We did install a resistor with a capacity that we determined through calculations and the oximeter did stop overheating. However when we upload the code and open the serial monitor, the message "Initializing Pulse Oximeter" appears and we get no readings from the oximeter.

By the time we wanted to take measures to fix this problem, it was too late. We did order another oximeter but by the time we had gotten it, it was too late. We didn't have access to the resources we needed (like soldering iron and solder, or just help from our TA or PM). We nonetheless tried many combinations of wiring with our three new oximeters, we sent our code to our PM to get feedback on whether or not our code was right but despite everything we did, we couldn't get the oximeter to work.

Now, we do believe that our bluetooth module did establish a connection with our phones but since the oximeter didn't work, we couldn't make sure that the transfer of the oxygen levels data to the app was successful.

Due to the closing of MakerSpace and other design spaces, it was also impossible for us to 3D print our final shoe insole, since we don't have access to 3D printers outside of the spaces.

Steps taken

We believe that if the COVID-19 events wouldn't have happened, things would be different than what they are. Considering that our only problem concerning our third and final prototype was the functionality of our blood oxygen sensor, we think that the ten days we would've had before design day would've been enough to figure out how to get it working.

Here we have to consider the fact that we would've had access to MakerSpace, we could've solicited help from our Project Manager (which we can still do but she can't physically help us and take a look at our wiring, etc.) and most importantly, there wouldn't have been a certain delay in the communication between our members. Now, only one member has all the parts and it is hard to give that person ideas through virtual communication without getting a real life look at our electrical montage. We have different schedules (some of us work) and other occupations which means it is hard to stick to our weekly schedule meetings where we could help each other or ask other teams for their advice.

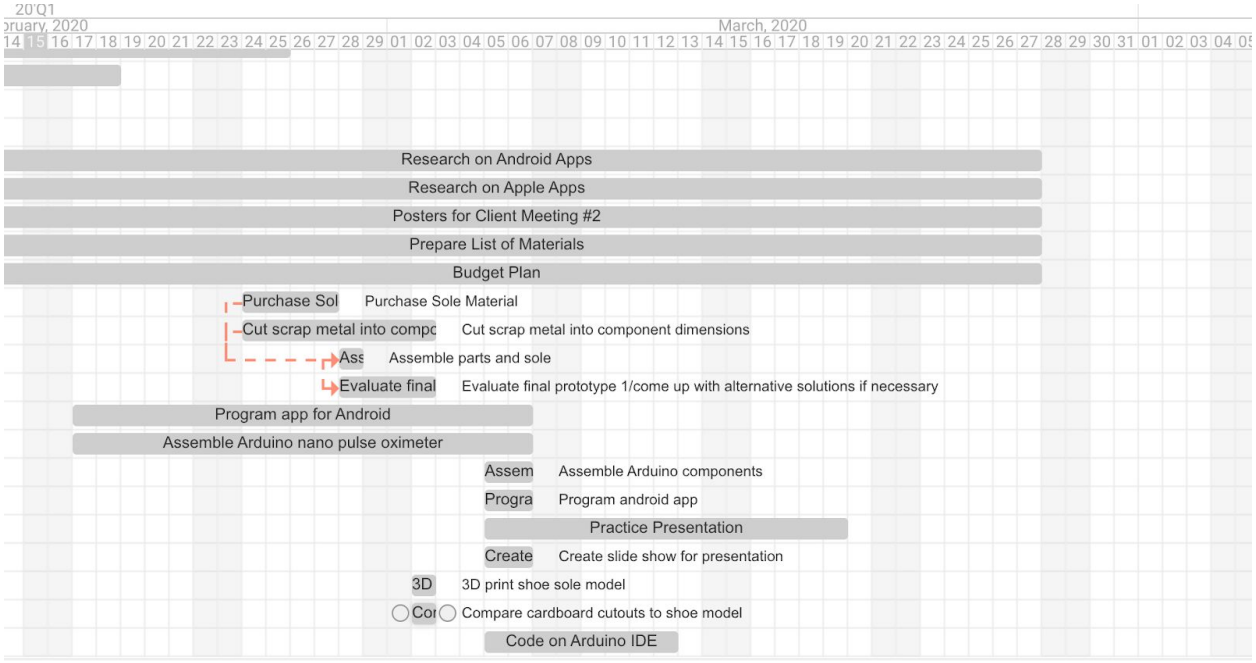
Table 1- Projected Task Outline

Task number	Task Description	Person(s) responsible	Date(s)	Dependency
1.	Schedule a meeting with Essraa concerning oximeter functionality	Tara	March 16th	-
2.	Order a different oximeter (be proactive)	Heidi	March 16th	-
3.	Wire new oximeter	Brendan	March 18th	Yes, with #2

	with Arduino (if needed)			
4.	Finalize insole model in SolidWorks	Tony	March 16th-20th	-
5.	3D print insole	Tony	March 20th	Yes, with #4
6.	Finalize app features and coding (text, sound effect, GPS location)	Brendan	March 16th-20th	-
7.	Film and send Pitch Video	Brendan, Tony, Tara and Heidi	March 20th	-
8.	First round of testing (functionality)	Tara and Heidi	March 21st	Yes, with #1-2-3-6
9.	Second round of testing (non-functionality)	Bredan and Tony	March 21st	Yes, with #4-5
10.	Third round of testing (final prototype)	Tara, Heidi, Brendan and Tony	March 22nd-23rd	Yes, with #8-9
11.	Prepare slideshow for Design Day	Tony	March 24th	-
12.	Practice Pitch Presentation for Design Day	Tara, Heidi, Brendan and Tony	March 24th	-
13.	Design Day	Tara, Heidi, Brendan and Tony	March 26th	Yes, with #11-12

Here is a Gantt Chart that describes our tasks if the pandemic didn't happen:

Figure 8 - Gantt Chart



For Design Day, we planned on having an interactive set up. We were planning on paying the fee necessary to make our app available on Google Play store. Our visitors would have downloaded it and been able to test our device themselves by connecting our sole to their phones. We planned on having a small TV that displayed the different features and subsystems of our device to make our booth more visitor friendly. Most importantly, we were looking forward to discussing with people about our journey with our project and we were excited to hear about the other teams from different sections.

Testing

First round of testing:

Our first round of testing would've concerned the functional aspects of our device, ie. our oximeter and our bluetooth module.

For our oximeter, testing would have been simple: we would've tested it with our fingers and seen if the readings that appeared on the serial monitor are realistic (ie. around 90-100%). If it is the case and that the readings are consistent and correct (stops when the finger is taken off), then the testing for the oximeter would be complete and successful.

As for the bluetooth module, testing is very simple: if we are able to connect our bluetooth module to the app we created and have it display the blood oxygen level on the app (the data transfer is done through the code), and the app functions correctly and sends a text to the emergency contact list quickly when blood oxygen gets below 85% then testing is complete and successful.

Target Specifications accomplished with this round:

13	Blood-Oxygen Level	5	Constantly measures blood oxygen levels	-Must measure blood-oxygen-level to ensure the functionality of the device -Spo2%

6	Response Time	5	Reacts to overdose within 1 minutes	-Must respond quickly -seconds

15	GPS	4	Sends GPS location of the user to authorities upon activation	-Must send location for medical attention to reach them -Yes/No

Second round of testing

The second round of testing concerns the physical non-functional aspect of our device a.k.a the insole. Testing for the insole would be applying increasing forces on it to see if the material is resistant enough before already putting it in a shoe and walking around with it. If the insole resists the increasing forces, then we can test it in the shoe and try and walk around with it. If the sole resists the impact force of a body, then testing is completed and successful.

Target Specifications accomplished with this round:

1	Durable	3	Waterproof and not easily broken	-Has to hold up through everyday activities -Yes/No

4	Discreet	4	Not noticeable and does not interfere with everyday tasks	-Must not be bulky, or very noticeable -Device cannot get in the way during common tasks -Yes/No

Third round of testing

Third round of testing is about putting the non-functional aspects and functional aspects together. Testing will be walking around with the sole (electrical components included) and seeing if it still accurately reads blood oxygen through the toes. It's also about testing different socks to see how strong the infralight that reads blood oxygen levels is and determine if wearing socks with the device is still feasible. If all of the aforementioned features are working then we can say our prototype is complete and functioning.

5	Accurate	5	Detects overdose and does not go off when there is no overdose	-Must function when a person is having an overdose -Must not call for help when a person isn't having an overdose -Yes/No

7	Automated	3	Updates information without prompt	-Must update information to the app -Yes/No

Conclusion

Our final prototype design combines all aspects of previous models while incorporating changes we decided upon given our feedback. Sadly, due to the COVID-19 outbreak and the closing of Maker Space we were unable to finish our final prototype and perform the related tests. However, given our state before the outbreak, we believe under normal circumstances we would have completed our full product.

Due to the cancellation of design day we will be unable to present our product although presentations continue. From this prototype and the recent events we have learned the importance of staying on schedule and how to adapt to unforeseen circumstances.