Project Deliverable G:

Prototype I and Customer Feedback

GNG 1103 – Engineering Design

Faculty of Engineering

University of Ottawa

GROUP 2

INTRODUCTION

Following the completion and testing of our first conceptual prototype in the previous deliverable, we are now ready to create our first functional prototype. Our second prototype will contain improvements in certain design criteria as well as new design features that were not incorporated within the first prototype. All of which was based upon the feedback we obtained from our second client meeting along with the results from our initial stage of prototype testing. For our second prototype, we chose to focus on making sure the main subsystems within the device are built and functioning properly. In correlation to our objectives, three prototype tests were planned to be conducted within the following week. The first addressed the data input system of our device, consisting of the Bluetooth module, the Arduino Nano and the oximeter. Another series of tests will be conducted regarding our device application, which will be used as the overall communication between the subsystems of the device. In addition to testing individual subsystems, we have also decided to direct multiple prototype tests towards specific non-functional factors of our device. This would include drawing and 3D printing a model of the device case using CAD software, then asking for feedback in regards to the aesthetics and comfort of the model from volunteers. Ultimately, by the end of our second prototype we would want to have a mid-fidelity, functioning prototype that is capable of receiving/collecting inputted information and converting it into the desired output.

MAIN OBJECTIVES OF SECOND PROTOTYPE / DESIGN PLAN II

Feasibility: This part of the prototype is the hardest to complete as it is composed of mainly coding. Therefore, in order to complete each task, each hardware component's coding section is separated. The final code will incorporate all hardware components (arduino, speaker, oximeter, bluetooth, phone). The feasibility of this plan is high as it follows "divide and conquer" so that each task can be done one at a time. So far, half of the coding is finished, which leaves for the coding for the bluetooth and phone and the assembly of all codes.

Analysing Critical Subsystems / Integration: Each system must be functioning properly in order for the entire prototype to work. How the integration works is:

The oximeter will detect oxygen levels at the wrist. Once levels drop below 80%, it will relay this message to the arduino which is monitoring. Then, the arduino will cause the speaker to begin beeping as an alarm. The arduino will also use the bluetooth module to send a text message from the user's phone to a loved one, explaining the situation of the overdose and direct them to call 911. Each hardware component must work in order for the prototype to function.

How to reduce risk / uncertainty: In order to reduce risk for the prototype, there must be sufficient time planned for testing each section of code, and especially for when the final code is created. The device itself must be tested in different situations (durability, water resistant, ease of use, if comfortable, functionality) in order to identify where

errors may occur and fix. The hardest component to add into the code will be the bluetooth, and if it does not function with the other components, wires will be added so that the arduino will directly receive data from the oximeter. This will only be done if there is absolutely no time left to fix the code.

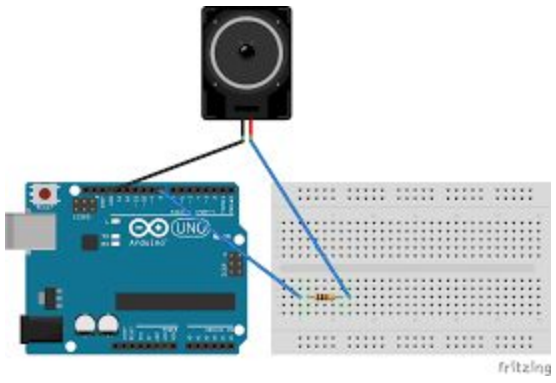
CLIENT FEEDBACK INCORPORATED INTO PROTOTYPE

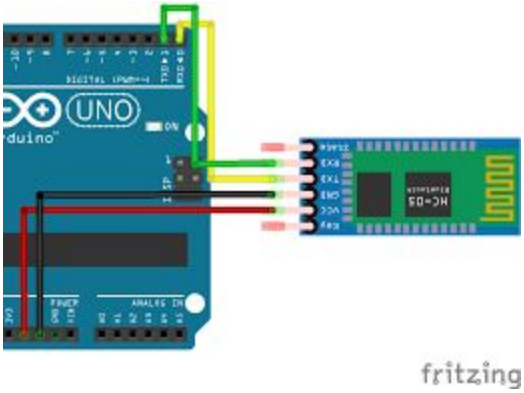
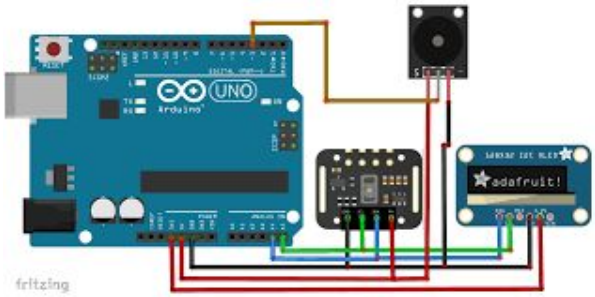
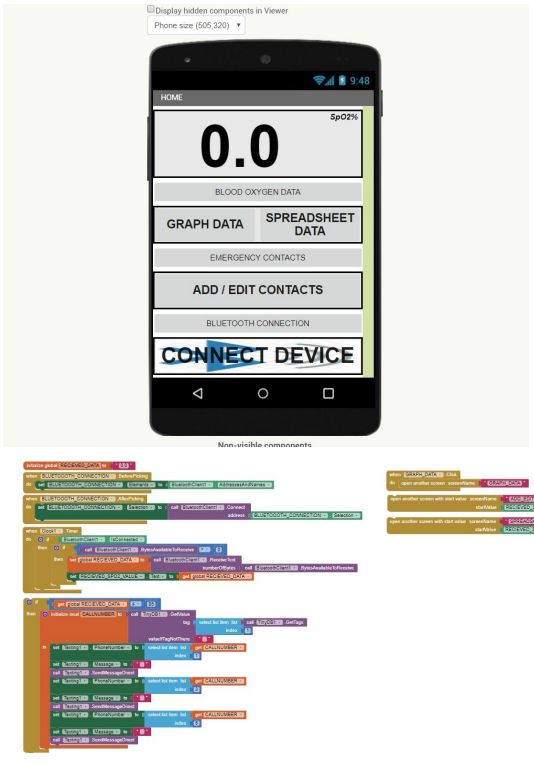
Client feedback was an integral part of our project when it came to adjusting and improving the design of our device. In the first client meeting we discovered two critical changes to our original concept design. They included how naloxone was not to be administered via a needle for precautionary/safety purposes and the computer program can not call the police. Currently, we have successfully integrated both of these criteria into our second prototype. We replaced our naloxone injection with naloxone nasal spray which would attach to the arm band and have administration instructions. For contacting emergency personnel; we set up a function in the device application program that texts the emergency contacts inputted by the user when the system detects an overdose.

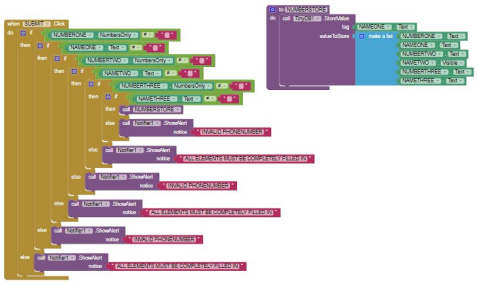
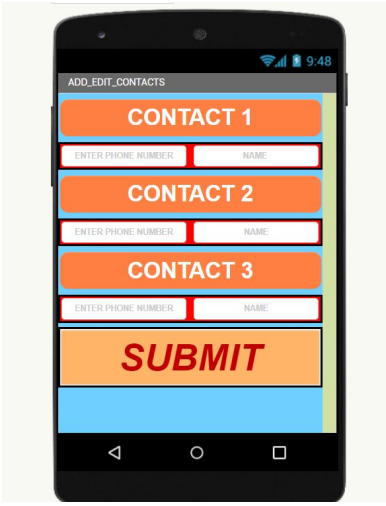
In the second meeting we had two goals; showcase our first edits and gain new feedback. The client was pleased with our initial changes and proceeded to give more feedback which we can now be incorporated into our second prototype. The main focus of the clients regarded the comfort and practicality of wearing the device as well as the battery life. To test this we will first need to develop a physical casing to house the hardware of the device. After creating the prototype we will have multiple

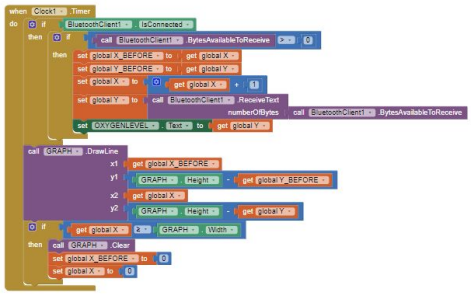
volunteers wear the device the whole day to make sure it is comfortable and discrete. Therefore we based most of our prototype testing plans this week on these criteria. Another important consideration for future prototypes is the battery life of the device. The clients stated that the the overdose detection device should have a long battery life and has to be rechargeable. As such, for our third prototype when we decide on the battery that is going to be incorporated within the device, we also need to ensure that the battery has enough power to last for one day under full use. Additionally, in preparation for our third prototype we are looking for a smaller naloxone bottle, a less bulky strap, and a more aesthetic oriented wrist component.

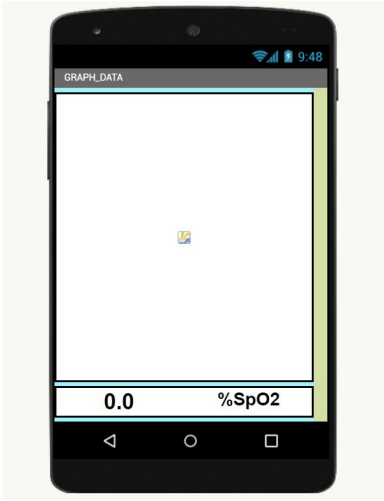
PROTOTYPE 2: PHOTO REFERENCES

	Example of how the speaker will be connected to the arduino. This speaker is used to create an alarm once oxygen levels are below 80%. All the speaker needs is the voltage source (arduino with ground and source), and a resistor. This makes this component the easiest to both wire and code.

	Example of the bluetooth module connected to the arduino board. This module will connect to the user's phone and will relay the text message to call emergency services.
	Example of how the Pulse Oximeter and heart rate monitor module is hooked up with an arduino uno board. The display screen will only be added as an extra feature given there is enough time leftover to also test it.
	An example of the display on a user's phone that displays oxygen levels. This allows the user to check oxygen levels when possible, and if a passerby or emergency responder checks the phone, they can also check it as well. This display also shows the button to add contacts for the user to add incase overdose occurs.

<table>
<tr>
<td> 

</td>
<td>This is the display on the phone where the user can add their contacts that the overdose detection device will contact incase overdose occurs.

It allows for 3 contacts which decreases the possibility that once the text is sent, the other person will be busy and not see it which increases the safety factor.</td>
</tr>
<tr>
<td>
 </td>
<td>Page displays a live graph showing the relationship between the time and blood oxygen level.</td>
</tr>
</table>

PROTOTYPE TEST PLAN

PROTOTYPING TEST PLAN WEEK #2		
Objectives		
Finish Coding Main Device Application Features	Criteria/Objectives	**Introduction:** Our application contains and acts as a communication channel among many of the key functional subsystems of our opioid overdose detection device. Such subsystems include GPS, Bluetooth, and emergency contact/SMS capabilities. Therefore it is crucial that the application is free of errors and working efficiently, as the functionality of other crucial subsystems will depend on it. **Test Objectives:** The app will be tested for its ability to receive inputted data from other functional subsystems and translate the data into the desired output. Specifically, we wanted to focus on testing the Emergency Contact SMS and GPS design criteria. If the app successfully produces it's intended output (SMS text: including the location of

		the device user, to a contact listed on the device user's phone), the application will pass the prototype test. For the individual components of the application, we will be testing and developing a variety of code which perform the same function. By doing so, we will be able to discover the most simple and efficient method of performing the desired tasks.
	Execution/Process	**Prototype Type:** Physical and comprehensive prototype that is functional and of medium-fidelity. The prototype will be focused on multiple aspects of the device application as well as the subsystems that depend on the application to function. Multiple tests will be conducted to simulate the process of transferring inputted data to the desired output of the device. **Test Process:** The main objective of the tests that will be conducted in this prototype will want to determine if a specific component of the device application functions properly. As such, the tests will not focus on measuring a specific variable. Observations regarding the successes and failures of each test will be recorded as a reference for future project development. Similarly, all code that will be used for the Arduino IDE and device application will also be documented. SMS/Emergency Contact: Two group members will be required to conduct this test. One group member will monitor the Arduino IDE, while the other member will simulate a user of the product and use the device application. The member monitoring the Arduino will manually change the blood oxygen value detected by the oximeter to <85% SPO2. While this is occuring, the other member using the

		device application will input a known phone number under the contact section in the application. If the app automatically sends a message to the inputted phone number when the blood oxygen is set <85% SPO2 the test will be considered successful. GPS: Similar to before, two group members will test this function; one monitoring the Arduino IDE while the other monitors the device application. The member monitoring the Arduino will manually change the blood oxygen value detected by the oximeter to <85% SPO2. While this is occuring, the other member using the device application will input a known phone number under the contact section in the application. If the app sends a message to the inputted phone number with accurate geographic components (longitude & latitude) the test will be considered successful. Bluetooth: This test can be conducted with one group member. The group member will use the device application to connect the application to the bluetooth module. If the application connects the test will be considered successful. **Stopping Criteria:** The testing for this prototype will conclude when all components of the device application are functioning as intended.
	Dependencies	We aim to finish the main functions of the device application by the end of the next week (March 15). Preferably these tests will be conducted in the beginning of the week (March 9-12) as further testing regarding the oximeters ability to transmit data is dependent on the device application functioning properly. All dependencies towards this

		prototype test are already accounted for.
Connect Oximeter to our Device App via Bluetooth	Criteria/Objectives	**Introduction:** After verifying the oximeter is capable of detecting the user's blood oxygen level, the next step in testing the effectiveness and reliability of the oximeter would be to successfully connect the oximeter to the device application via Bluetooth; thus allowing the oximeter to send the data it collects to the user's phone. As the oximeter is the source of input for the overall device, it is important that the oximeter functions properly. **Test Objectives:** The main objective of the test is to determine if the Bluetooth module is capable of sending inputted information to the device application in order to be processed further. Ultimately there are two possibilities that can occur during the testing process. In order for the tests to be considered successful, the Bluetooth module will have to send accurate information regarding the user's blood oxygen level and has to do so every second the device is operational. If the Bluetooth module is incapable of meeting these criteria, we will have to continue to modify the Bluetooth code until the program functions properly or deduce other methods of transferring primary data to the user's phone.
	Execution/Process	**Prototype Type:** **Test Process:** At least two group members are required for the testing of the oximeter, testing for the oximeter will be conducted . One group member will activate the oximeter through the Arduino IDE and the second group member will wear the prototype to begin screening for their blood oxygen level. The first group member will then connect their phone to the Bluetooth module and open the device application.

		On the homescreen of the application there will be a display featuring the readings of the oximeter. The first group member will then compare the data displayed on the device application and that of the Arduino IDE. In the application there is a function which allows the user to view the data of their blood oxygen level as a spreadsheet in relation to the time the data was collected. This will be compared to the Arduino IDE display, which also shows the blood oxygen level of the user to the time it was collected. Specifically, the accuracy of both blood oxygen level datasets as well as the delay time between the device application and the Arduino will be measured. **Stopping Criteria:**The testing for this prototype will conclude when the Bluetooth module is successfully able to continuously transmit primary data to the device application without failure.
	Dependencies	In order to conduct this test, a fully developed device application is required. Based on this criteria, testing for this prototype will most likely be conducted towards the end of the following week (March 9-15) . It is crucial that this prototype functions properly, as future tests which require primary data from the oximeter will be dependent on the this prototype being fully functional.
Printing / Testing CAD Model	Criteria/Objectives	**Introduction:** Our previous non-functional prototype offered a general overview of the design of our device, but it could not provide any accurate data regarding the comfort and aesthetics of the final product (as it was created using household items). Therefore, we will be designing and 3D-printing a case that is going to house the hardware of the device in order to obtain a better understanding of the aesthetics and comfort of our device.

		Test objectives: Our goal is to obtain primary feedback from initial testers and eventually produce a device that prioritizes user satisfaction. As such the success of the following tests will be based on the quantity and type (positive/negative) of feedback we receive from the primary testers. Throughout the testing process, users will be encouraged to share their opinions towards the design of the device case. All of which will be recorded as notes and will be further processed within future prototypes. Based on the feedback we receive from the primary tests, we will be able to alter the design of the device case in order to fix any issues suggested by the users.
	Execution/Process	**Prototype type:** Physical and focused prototype that is functional and of medium-fidelity. The prototype will be focused on testing a tangible device case, created using a variety of materials, that stores the necessary hardware for the device. **Test Process:** Testing for this prototype will be conducted in multiple steps. For the first step, a 3D printed CAD model will be created and used as the prototype. Volunteer testers will then be recruited to wear the prototype and give feedback through a survey consisting of ranking the prototypes ability to satisfy a non-functional requirement from 1-10. 10 being that the prototype satisfied their expectations and 1 being that the prototype needs improvement in that area. The testers will also be asked to provide their own comments towards one design feature they enjoyed and one design feature that needs improvement. Ultimately we will use the collected data to determine which aspects need to be modified for our next prototype.

		As the model is created out of a thin plastic we will only be able to receive feedback towards the overall aesthetics and discreteness of the design. The weight, comfort and durability qualities will be tested in future prototypes once we have decided on an overall design model for the device. **Stopping Criteria:** Testing for this device will end by the end of next week. Our goal is to ask at least 10 people to use and provide feedback towards the prototype.
	Dependencies	In order to initiate these tests a 3D printable CAD drawing is required. Based on our teams current progress, this model will be available before March 9th (3D Design printed) and initial test can be carried out all throughout the week until March 12th. However, because the primary objectives of the test revolve around non-functional elements of our design, the results are not immediately required. Even so, the results from the test will still be important as they will influence the direction of our device case in future prototypes.

CONCLUSION

In conclusion, this prototype is meant to be a feasible system as we are working with a low budget. It includes the testing of the many subsystems that are going to be implemented in the final product. Some examples are; the texting function, bluetooth communication, and most importantly the oximeter data collection.

As our team continues to stay organized, and finish tasks on time by using applications such as Trello, and WhatsApp, good progress is being made on the device each day. Time is the most important factor affecting our performance, and the new steps taken to combat it have helped us succeed not only on our deliverables, but also on the prototypes and our device.

With the completion of this stage of prototyping, in which a working prototype is created, we are ready to begin assembling and testing the device. In the next few weeks, we expect to create a fully functional opioid overdose detector, which includes the many components listed in this deliverable.