Project Deliverable F:

Prototype I and Customer Feedback

GNG 1103 – Engineering Design

Faculty of Engineering

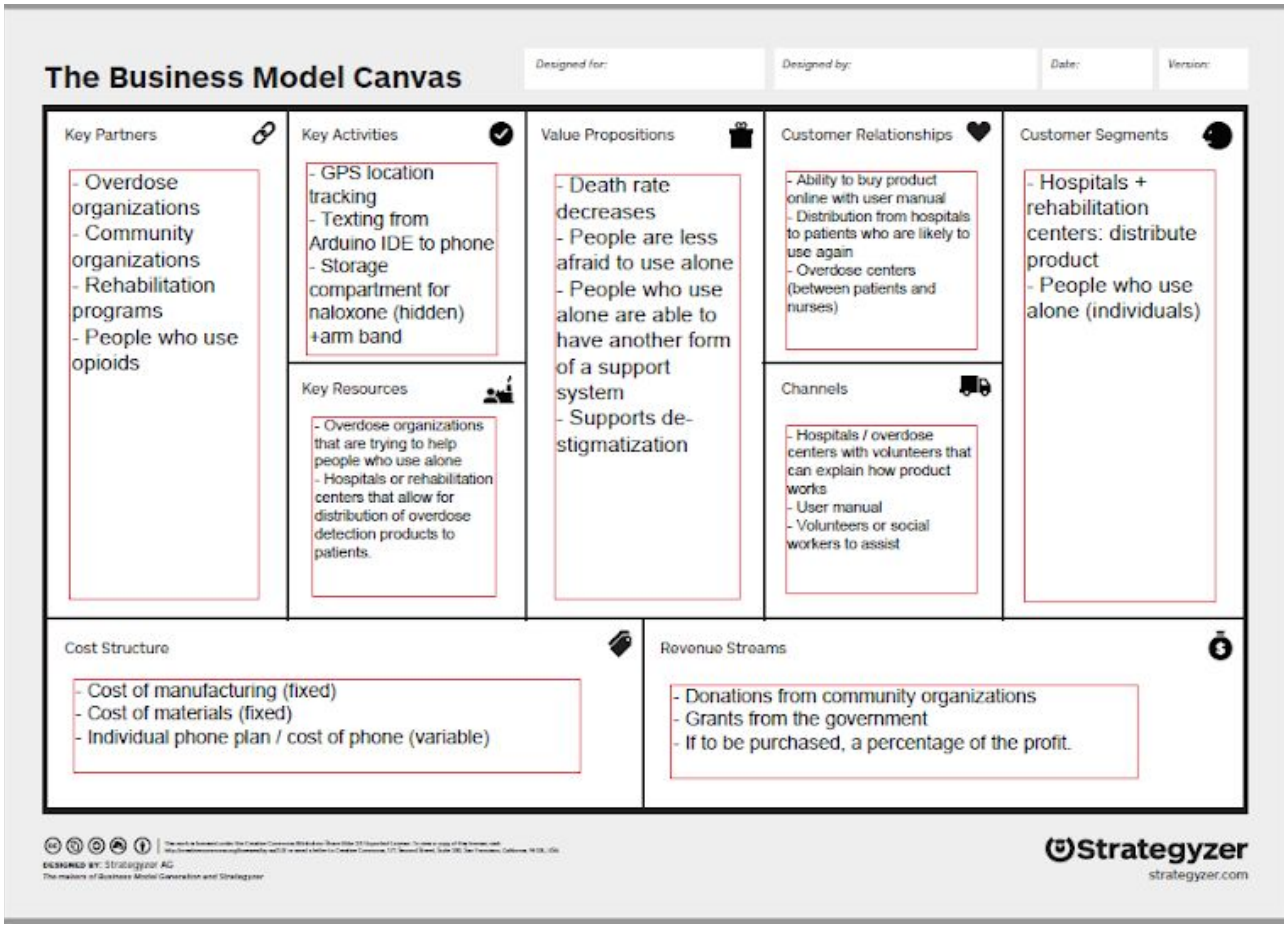
University of Ottawa

GROUP 2

INTRODUCTION

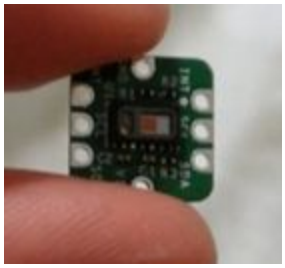
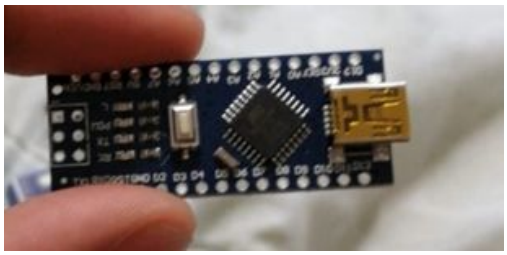
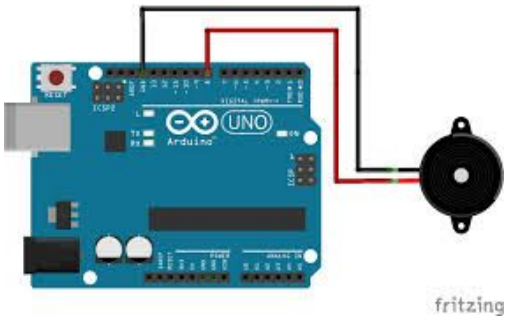
Following the completion of the project design plan in the previous deliverable, the initial testing and of our prototype. We began by taking the information we obtained from our initial client meeting along with our own conceptual designs; from these design criteria we were able to design, build and test an initial conceptual prototype. However due to the technical limitations of the prototype and due to a absence of our desired design materials, only three prototype tests are planned to be conducted within the following week. The only subsystem that we deemed testable in the first week of prototyping is our device's data input system, which consists of the oximeter and the arduino-nano. In addition to testing individual subsystems, we have also decided to test specific related to the non-functional factors of our device such as portability, durability and comfort. Because this is our first prototype many of the components are non-functioning and mainly shown as placeholders for future subsystems. Despite the first prototype being non-functional, we have begun to receive the necessary materials to begin building working subsystems. In order to implement these subsystems as efficiently and effectively as possible, we have been analysing the drawbacks of each subsystem and referring to our previous contingency plans. Ultimately, the following will be a presentation of our group's initial prototype which is intended to provide a physical proof-of concept towards the final design of our project.

MAIN OBJECTIVES OF FIRST PROTOTYPE / DESIGN PLAN



OBJECTIVES
COMMUNICATING AND RECEIVING FEEDBACK FOR IDEAS
VERIFYING FEASIBILITY OF FIRST PROTOTYPE
ANALYSING CRITICAL SUBSYSTEMS / SYSTEM INTEGRATION /REDUCING RISK AND UNCERTAINTY
IDENTIFYING A STOPPING CRITERIA WHICH WILL ALLOW US TO END THE TESTING OF THE FIRST PROTOTYPE

PROOF OF CONCEPT (MATERIALS / SUB-SYSTEMS)

Material / Sub-System	Description
	Oximeter chip: this chip is small enough for the device to be discrete and still detect oxygen levels.
	Arduino nano: the arduino nano will control all aspects of the overdose detector and will be powered through batteries.
	Arm Band: a prototype of the armband that will hold a storage compartment for naloxone.
	Speaker: example of how the speaker will be hooked up to the arduino nano from https://www.arduino.cc/en/Tutorial/toneMelody

	Naloxone Storage Compartment: potentially as a smaller, more condensed spray bottle that is attached to the arm band. Bluetooth Device and Location GPS: as seen above, there is spacing provided for the devices as the specific models have not been bought yet.

ANALYSIS OF CRITICAL COMPONENTS /SUB-SYSTEMS

It is difficult to simulate the conditions of a real overdose in order to test the oximeter of our device. The only way to realistically accomplish this test would be to compromise someone's health and safety which isn't permitted. As such, we can only test it's sensitivity to noticeable changes of blood oxygen levels. To emulate a large change in oxygen level, we will ask the tester to exercise and increase their breathing rate. If the oximeter gives an accurate reading, when oxygen levels increase it is safe to assume it can do the same when oxygen levels drop.

At the client meeting we discovered that robotic or automated calls can not be sent to emergency lines. As a solution to this problem we have decided the next best option will be to connect the device to the phone which will send out a call to an emergency contact. The assumptions being made here are;

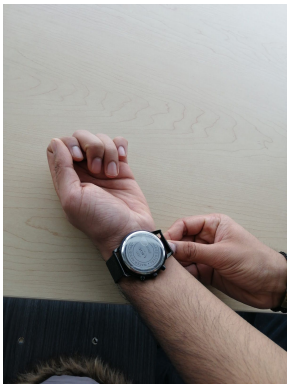
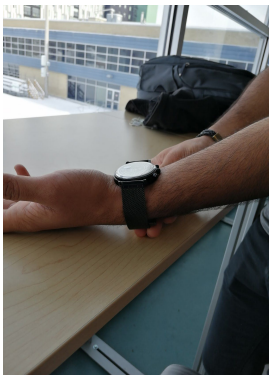
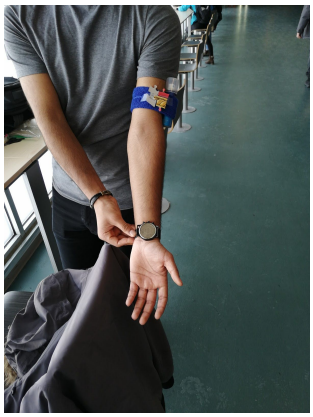
1. The phone battery is not dead and the patient has their phone in their pocket or near them

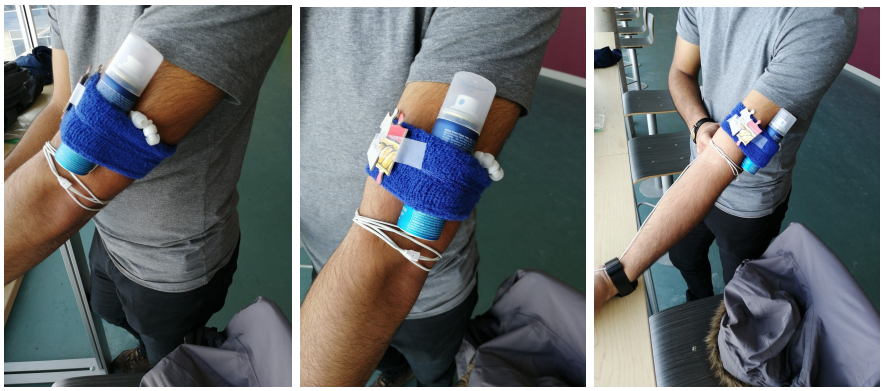
2. The emergency contact has their phone charged and are in a situation to see the call coming.

In everyday life there are a lot of times when calls are forwarded to voicemail because the person is busy or unavailable. To decrease the chances of this happening we want to design the caller program to not call one, but at least two or three contacts in a series of calls; in case the previous one isn't attended. The prototype for this program is not complicated and a pseudocode for the subsystem is already generated. In order to test the program, one group members phone will be used as the patients phone (sending out the calls) while 3 other group members use their phones as emergency contact numbers. In order for the program to work the program should cycle through all three contacts until one picks up and realizes the emergency.

One of the most challenging aspects of this design is to make it wireless. A device with wires running along someone's arm and into their pocket is unattractive, uncomfortable and can be a potential health hazard. In order to avoid this we need to make the device bluetooth compatible. This includes the wrist component connecting to the upper arm part and both of those to the patients phone. This would be tested when most of the device has already been programmed. We can send signals throughout all three components of the system and make sure all three connect with each other and can send and receive signals as well as apply their function.

PROTOTYPE 1: PHOTO REFERENCES

SUBSYSTEM / COMPONENT	PHOTO REFERENCE
OXIMETER WRIST VIEW	 
MAIN COMPARTMENT/ NALOXONE STORAGE UPPER ARM VIEW	
DEVICE FULL ARM VIEW	

CLIENT FEEDBACK INCORPORATED INTO PROTOTYPE

During our last client meeting, we received a lot of feedback, many of which we planned to implement and have added to our prototype. Previously, we had planned to make a naloxone injector. After the client meeting, we discovered that this option was too dangerous, as malfunctions could occur and possibly cause unnecessary injections. From this, we managed to create a new design for the naloxone compartment; a spray bottle which could be attached to the armband which could be used by people nearby in the case of an overdose. From the client meeting, as stated above, we also discovered that we cannot send emergency calls from a robot or a non-human operated machine. To solve this problem, we plan to make an emergency contact that would be called from the device in the case of an overdose. We have also taken into consideration their suggestions on making the device as discreet as possible by shaping the device into a watch as well as having an armband that can be hidden under clothing. Finally, our idea of connecting the ‘watch’ to the rest of the components on the armband using a wire turned out to have a flaw. As told by the clients, this would make it difficult for the users to use the opioids as the wire would hinder their usage. This was not ideal as wiring is much cheaper

than our newly incorporated idea of a bluetooth device. The bluetooth device would help transmit the information back and forth, while giving the device a clean and simplistic look. Some downsides of this implementation is that the device would be more expensive, and would require a longer battery life.

PROTOTYPE TEST PLAN

<table>
<tr><td colspan="3">PROTOTYPING TEST PLAN WEEK #1</td></tr>
<tr><td>Objective</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Oximeter Accuracy Under Blood Oxygen Fluctuations</td><td>Criteria / Objectives</td><td>Introduction:
The oximeter is one of the most important subsystems in the device for it triggers the activation of the main system when the user’s BOL drops below a certain oxygen threshold. In order to prevent any accidental activations of the device, having an accurate oximeter is important.

Test Objectives:
The oximeter is being tested on its ability to accurately read the BOL of the user under small levels of blood oxygen fluctuations. If the oximeter can accurately read blood oxygen levels to 0.1%SpO2, while identifying an accurate and stable BOL level for a long period of time, the test will be considered successful. Depending on the results, we might determine that our oximeter is unfit for our device and will have to replace it with another one that’s more reliable.</td></tr>
<tr><td>Execution / Process</td><td>Prototype Type: Physical and focused prototype that is functional and of medium fidelity. The tests will be focused only on the oximeter module; however, the results from the testing will affect the functionality of all the other subsystems in the device.

Testing Process:
The following test will be used to determine the accuracy and dependability of the oximeter. A minimum of two group members and the oximeter are required to conduct this test. The first group member will attach the oximeter to themself and let the oximeter begin to read their BOL, while this is occurring the second group member will record the BOL being presented by the oximeter onto an online spreadsheet every 5 seconds. After</td></tr>
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		5 minutes of repeating this process, the test will conclude and the recorded data will be compared to similar data from online sources for accuracy. Additionally the data will be screened for any outliers. If the BOL data is relatively stable with no major outliers and the primary data that was collected is similar to the data of another reliable source online, the test will be considered successful. **Stopping Criteria:** When the oximeter complies and successfully passes the criteria listed in the tests above.
	Dependencies	In order to test the oximeter, the device needs to first be connected to our arduino nano, which needs to run the correct code to activate the oximeter and allow it to begin detecting blood oxygen levels. Based on our group's current progress and the group Gannt chart, the tests will be initiated between the week of March 2nd to March 8th. Because the subsystem is responsible for the main input of the device, results from this test are essential for the performance of the device. Thus if an error does occur in the midst of testing it needs to be fixed immediately before product testing can continue.Especially since all other major subsystems within the device are dependent on the oximeter to function properly.
The Ability of the Device to Detect (Activate) When Blood Oxygen Levels Drop Below a Certain Threshold	Criteria	**Introduction:** As the oximeter is the subsystem that is obtaining primary data from the user (blood oxygen level), it is responsible for the activation of the overall device. Therefore it is crucial to ensure that the oximeter performs this task every time the user experiences an overdose. **Test Objectives:** The oximeter will be required to trigger the activation of all other subsystems of the device when a certain user blood oxygen level threshold is detected, if the device does not activate when the user's blood oxygen threshold is reached then the device failed to perform its main task. From the results of these tests, we can determine if the oximeter that we are going to implement into the final design is going to be reliable; if for example, the oximeter did not meet the criteria set our group we may have to replace it.
	Execution / Process	**Prototype Type:** Physical and focused prototype that is functional and of medium fidelity. The tests will be focused only on the oximeter module; however, the results from the testing will affect the functionality of all the other subsystems in the device. **Testing Process:** The following tests will measure the accuracy of the oximeter in large fluctuations of BOL as well as it's ability to send a signal to the users phone when BOL drops below the set oxygen threshold. In order to test the accuracy of the oximeter, we will

		expose the oximeter to situations in which human blood oxygen levels normally increase/ decrease by a large amount. At least two group members and the oximeter are required for the following tests. For the first test, one group member will attach the oximeter to themself while the other group member monitors and records the data presented by the oximeter. The group member with the oximeter will run on a treadmill at 8km per for 10 minutes, while this is happening the second group member will monitor the BOL data being collected by the oximeter and paste the data onto a spreadsheet when the test concludes. For the second test, the group member with the oximeter will be required to fall asleep for 4 hours, while this is happening the other group member will monitor and record the BOL data being collected by the oximeter. A third test will also be conducted which simulates the conditions of an overdose. One group member will input a pre-coded Arduino program which forces the oximeter to believe the BOL of the user is below the blood oxygen threshold of 80% SpO2. If the oximeter registers this data properly it will send a signal to the user's phone via Bluetooth signalling the activation of the device. **Stopping Criteria:** When the oximeter passes all the tests and criteria listed above.
	Dependencies	In order to test the oximeter, the device needs to be connected to our arduino nano, which needs to run the correct code to activate the oximeter and allow it to begin detecting blood oxygen levels. Due to the importance of this test it will be initiated as soon as possible; based on current group progress this prototype test will be conducted between the week of March 2nd to March 8th. Because the oximeter subsystem is responsible for the main input of the device, results from this test are essential for the performance of the device. Thus if an error does occur in the midst of testing it needs to be fixed immediately before product testing can continue. Other major subsystems such as the Bluetooth module, GPS, speaker and are all dependent on the oximeter functioning properly.
Discreteness / Comfortability / Durability of Everyday Wear	Criteria / Objectives	**Introduction:** Although the appearance of the device does not affect the performance of the system, the device still has to remain practical for the user to wear. As such, a series of tests will be conducted which will be directed on obtaining user feedback towards the non-essential aspects of the device. **Test Objectives:** More specifically the weight, comfortability, and durability of the design will be targeted as the main aspects of these tests. We want to receive primary customer feedback from simulations in which our product would be used in everyday life. The testing will be considered successful if we do not receive any negative comments towards the certain aspect of our product being tested. From the user feedback, we can modify our device to

		meet the demands of the user and we can discover new aspects of improvement that may have not been discovered prior to user testing. More tests under this category will be added as the design progresses.
	Execution / Process	**Prototype Type:** This is a non functional prototype. A rough representation of the set up of the device. A low budget, low fidelity prototype made of household items. **Testing Process:** Testing will consist of multiple people of different body sizes wearing the device and providing feedback of how it feels. We would ask them questions about the size, the materials used, the discreteness, the weight, and other non functional attributes. For durability purposes, we would conduct a series of durability tests. Dropping the device from different heights and asses the damage. Also placing objects of various weights (backpack, shoes, a person sitting on it, etc.)on top of the device to see how well it does under different pressures, to see if components crack, bend, or stretch **Stopping Criteria:** We will continue to conduct these tests throughout our project design plan until the final project is created. The tests will conclude when we are satisfied with the results or when we do not have enough materials to build another prototype.
	Dependencies	No outstanding dependencies for this prototype, since it is our first one. it is only for the purpose of testing some non-functional requirements. Testing and assembly is just a matter of finding materials around the house to use in order to put the prototype together.

CONCLUSION

Our prototype gave us a visual estimate on how the final product will look. Being constructed from low budget items, the prototype was an inaccurate representation of the final product. This is especially evident in the arm band compartment portion of the device. Using a watch strap for the wrist apparatus proved to be aesthetically pleasing and comfortable for the user; so that will very likely be the direction we will take for the actual device. The arm band could definitely have been less cluttered, but this was due to the use of inaccurate sizing for

one of the components (naloxone nasal spray). The armband material was also an issue. For our prototype we used a cotton sweatband, but the material is too warm to be worn for an extended period of time. It was also too bulky and would be really difficult to wear under clothing. For that reason we will be leaning more towards a thinner, lighter material. This prototype provided us with significant information on how to construct our device so that it provides the most practical shape, size and weight for the satisfaction of the user.