GNG1103

Final Design Report

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Submitted by

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Abstract

This report is an outline of our entire three-month long project. From the first client meeting and the needs identification up to the design of the final prototypes and the work left to be done. Product specifications have been assigned through the help of benchmarking various designs which lead to each of our group members coming up with 3 conceptual designs. From there, the group went into the convergent stage of the ideation process which helped us determine one final idea to proceed with. From this point forward a project plan was established in order to achieve a realistic result by the deadline. Unfortunately due to covid 19 and the viral outbreak our team was not able to proceed with the development of our product and our third and final prototype was never finalized.

As for most projects, prototyping and testing took up the most time and resources, these were done on a weekly basis in order to see what to change to have a fully functioning project. Through the prototyping phase, a final solution emerged, a solution that satisfied most of the client's needs and passed through all phases of testing.

Finally, a conclusion and recommendation for future work can be read for anyone who'd like to improve our current design and take it even further as the capabilities and potential for such a design is limitless.

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List of Acronyms

Acronym	Definition
BPM	Beats per minute
EMS	Emergency services
BOL	Blood oxidation level
Max30100	Blood oxidation level sensor

1 Introduction

The point of this project is to create an opioid overdose detection device for users at risk of an overdose. Our group will be looking at creating a device that is discreet and will be able to detect an opioid related overdose in real time. This device will then send a signal to a loved one instructing them to contact EMS. This device will be used as a life saving tool against the opioid pandemic in the middle class of Canada. The target users will be middle aged men in the construction industry which make up a large percentage of opioid related deaths in Canada.

A problem exists for users in the construction industry to safely consume opioids without running the risk of having an overdose and not being able to detect it until it's too late. This problem has affected many people before and will continue to affect workers if a solution is not found. The plan is to create a comfortable device that will be worn by the user on a day to day basis. After we have fully identified all the needs of the client we have decided to prioritize them accordingly. The first priority is that the device has to be able to detect an overdose while it's happening and respond within 15 seconds. The second priority is that the device will have to be discreet and comfortable for the user to wear since this device will be used on a daily basis. The third and final priority of this device will be that it has the send information from the Max30100 sensor to the mobile application through the use of a bluetooth module. The application will then in the event of a drop in user's BOL or BPM send an emergency message to a loved one.

2 Need Identification and Product Specification Process

This section will go through the problem statement developed, the benchmarking process as well as the needs and target specifications identification.

2.1 Problem Statement

A need exists for opioid users to safely consume opioids without having the risk of overdosing through a portable device designed to activate EMS, effectively measure blood saturation while being cost effective

2.2 Need Identification

Scale:

1. Necessary
2. Important
3. Useful
4. Optional

Priority	Customer Needs	Specifications
1	Safety	Alerts paramedics/Police/family/caretaker
1	Safety	Measure oxygen saturation(under 90%)
2	Cost	Has a cost between 50-150$ (price of a cheap phone)
2	Safety	Measure respiratory rate
3	Device features	Possesses at least a day's worth of battery life
3	Device features	Discrete
4	Aesthetics	Aesthetically pleasing

Table 1 Need Identification and Priority

The needs were divided into functional and non-functional requirements. A list of constraints was then derived from these needs.

<u>Functional Requirements:</u>

- Real-time tracking of oxygen saturation percentage
- Real-time tracking of breaths per minute
- Alerts emergency services
- Bluetooth compatible
- Does not inhibit movement or control

Non-Functional Requirements:

- Aesthetically pleasing
- Discrete
- Customizability options
- Water resistant - Durable

Constraints:

1. Cost $
2. Durable
3. Beyond a days battery life

Specifications	Importance Factor Number	Benchmark#1: AK1980 Fitness Tracker	Benchmark#2: Innovo Deluxe Fingertip Pulse Oximeter
Safety	1	2	1
Cost	2	3	1
UI	3	1	2

Device features	4	1	2
Total:	NA	7	6

Importance Factor Number:

1 - Very Important, 4- Less Important

Scale for each product:

4-Very important, 1-Less important

Table 2 Benchmarking Process

Using the functional and non-functional requirements as well as the constraints, the benchmarked products helped make a table of target specifications. The goal was to achieve each one of these target specifications by the end of the design process.

Design Specifications	Relation (=,>,<)	Value	Units	Verification Method
Functional Requirements				
Alerts paramedics/Police /family/caretaker	=	Yes	N/A	Testing
Measure oxygen saturation	<	80	%	Testing
Let's the user know that they are having an overdose	=	Yes	N/A	Testing
Hands free	=	Yes	N/A	Testing
Non-Functional Requirements				
Aesthetically pleasing	=	Yes	N/A	User feedback

Discrete	=	Yes	N/A	Final Testing
Customizability options	=	User sensitivity to opioids	N/A	User feedback
Water resistant	=	Yes	N/A	Testing
Constraints				
Cost	<	100	$	Under final budget
Not too delicate(sturdy enough)	<	Averag e force	Newtons	Testing
Possesses at least a day's worth of battery life	=	Battery life	Time(hours)	Testing

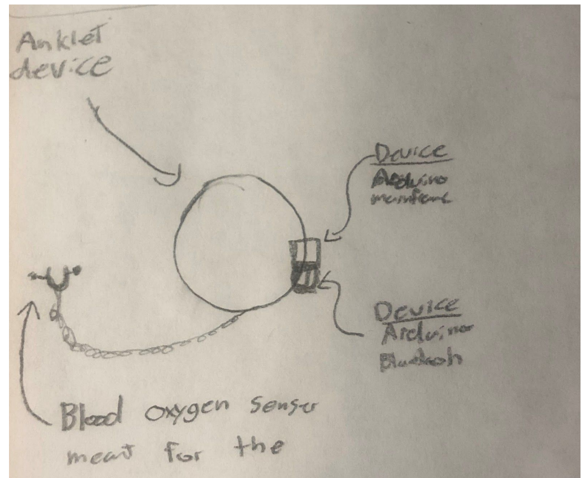
Table 3 Engineering Design Specifications

3 Conceptual Designs

After empathizing with the client through the first client meeting, our team continued onto the next step in the design process. This step is the ideation phase. The project deliverable D had as a goal to outline every step our team took to come up with our final solution for our device. Our team first started by generating 3 unique concepts each in the divergente phase of ideation. Our team then continued on to the next step of ideation which is the convergent phase. We came together and compared all of our ideas with an assigned chairman and notetaker. This was done by comparing each concept to our design criteria and classing them by levels of fulfillment. The final concept was then chosen as being the most efficient at meeting most, if not all design criteria.

3.1 Adam's Concepts

Figure 1 Anklet Device

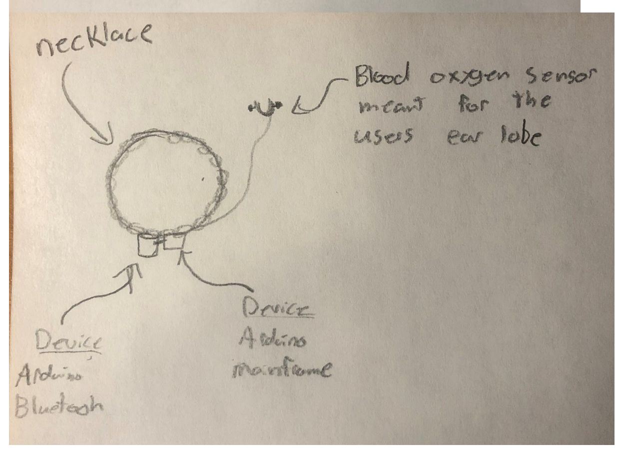


For this concept, the blood oxygen sensor will be attached to the user's toe, with the arduino compartment of the device attached to an anklet. This concept also includes bluetooth, and the capability to notify EMS

Pros: Discrete

Cons: Discomfort

Figure 2 Necklace Device

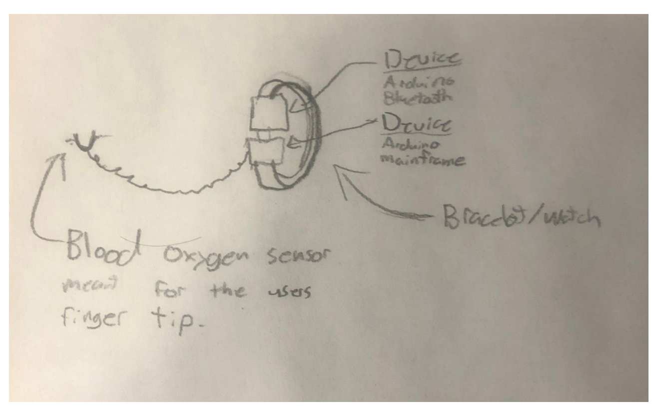


Similar to concept 1, concept 2, consists of a blood oxygen sensor attached to the user's ear lobe. As well as a necklace that supports the devices arduino compartments. This concept also includes bluetooth, and the capability to notify EMS.

Pros: Accurate blood oxygen level detection.

Cons: Not very discrete, discomfort

Figure 3 Watch/Bracelet Device



For the third concept, the overdose detection method will be the blood oxygen level. This device has the blood oxygen sensor attached to the user's finger tip, the arduino comportements are attached to a bracelet. This concept also includes bluetooth, and the capability to notify EMS.

Pros: Accurate blood oxygen level detection

Cons: Interferes with users capability to use opioids

3.2 Tristan's Concepts

Figure 4 Watch concept

This concept is a bluetooth ring sensor that would connect to a portable display screen attached to a watch. The idea is that the discreet ring would have a BOL(blood oxidation level) sensor embedded inside it and it would constantly read your BOL and simultaneously send the information to the portable watch to be read by the user.

Pros: Discreet and very portable

Cons: Very hard to make and would be expensive.

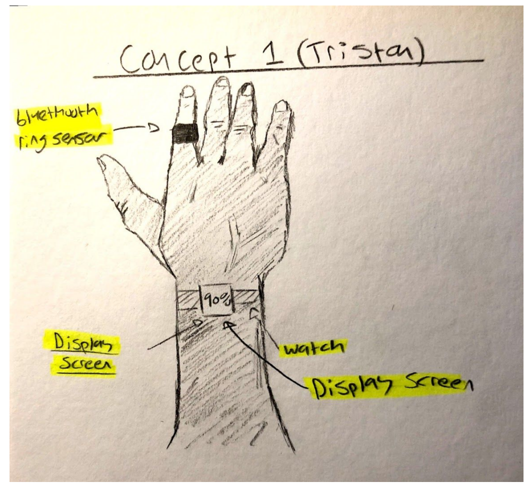


Figure 5 Earing/Phone

This concept would be designed to look like a portable insulin pump. The large device would read the persons BPM while reading a signal from an exterior sensor which would read the person's BOL. This device would display this information, while also acting as the main body of concept. The users contacts, sensor sensitivity and battery life would all be controlled via this phone size device.

Pros: Effective and a one stop shop

Cons: Bulky and expensive.

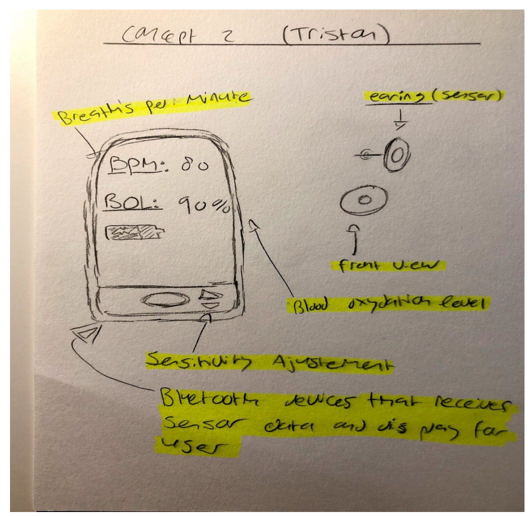
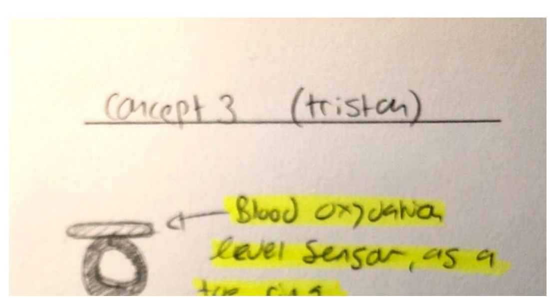


Figure 6 Ring concept

This concept would be designed to be as cost effective and discreet as possible. The small sensor on the end of a ring which could be attached to a foot or



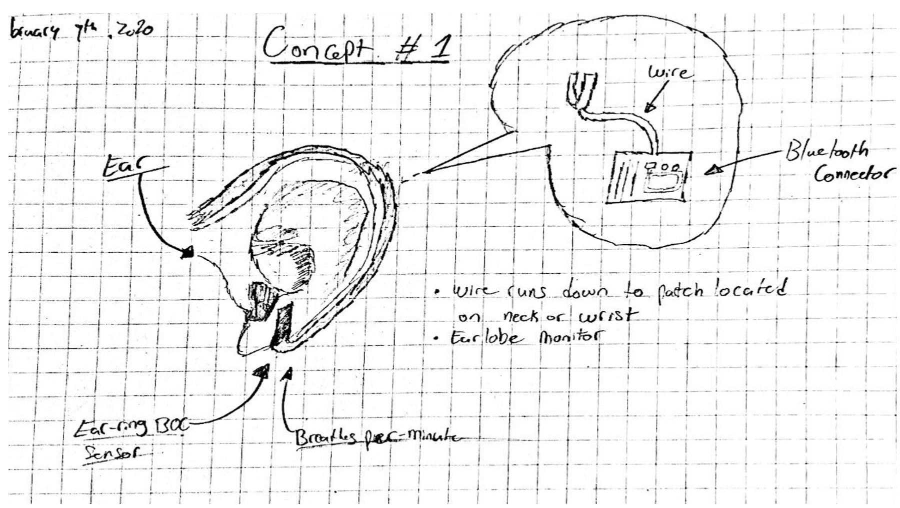
hand, would be used to measure a person's BOL and send this information via bluetooth to the person's phone.
This information would be displayed using a team create app which would also be used to contact EMS in the case of an overdose.

Pros: Cheap and effective

Cons: Time consuming to create an app, and could only calculate your BOL.

3.3 Zach's Concept

Figure 7 Ear-lobe Monitor



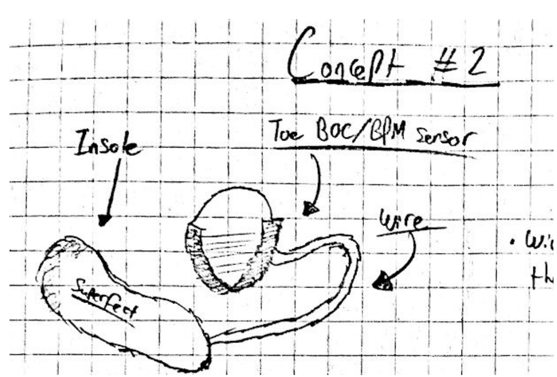
This idea uses a "clip-on" on attachment to measure blood oxygen levels and respiratory rates through the ear-lobe cartilage. To better manage feel and look, the wire will wrap around the outside of the ear, leading to a bluetooth device to connect through a mobile phone.

Pros: Discrete

Cons: Could easily fall/be ripped off

Figure 8 Toe-Insole Sensor

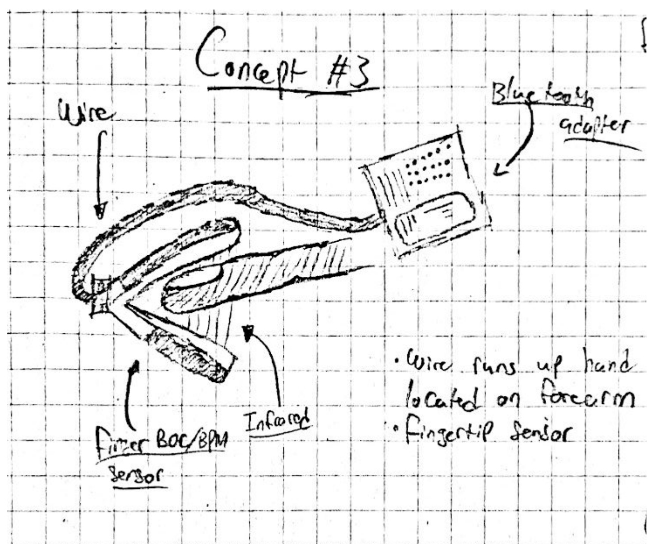
The toe-insole sensor monitors blood oxygen levels as well as breaths per minute through toe-cartilage.



This concept is very discrete and has a high durability, since its location is in the protected area between the sole and the shoe.

Pros: Discrete, Safe from Damage
Cons: Could be vulnerable to water damage

Figure 9 Fingertip Monitor



This last concept utilizes a common fingertip sensor to monitor the user's two main identification traits. It is linked to a forearm/bracelet bluetooth unit that can alert EMS and emergency contacts.

Pros: Cheap
Cons: Not discrete at all, Cannot use while doing activity

3.4 Callum's Concept's

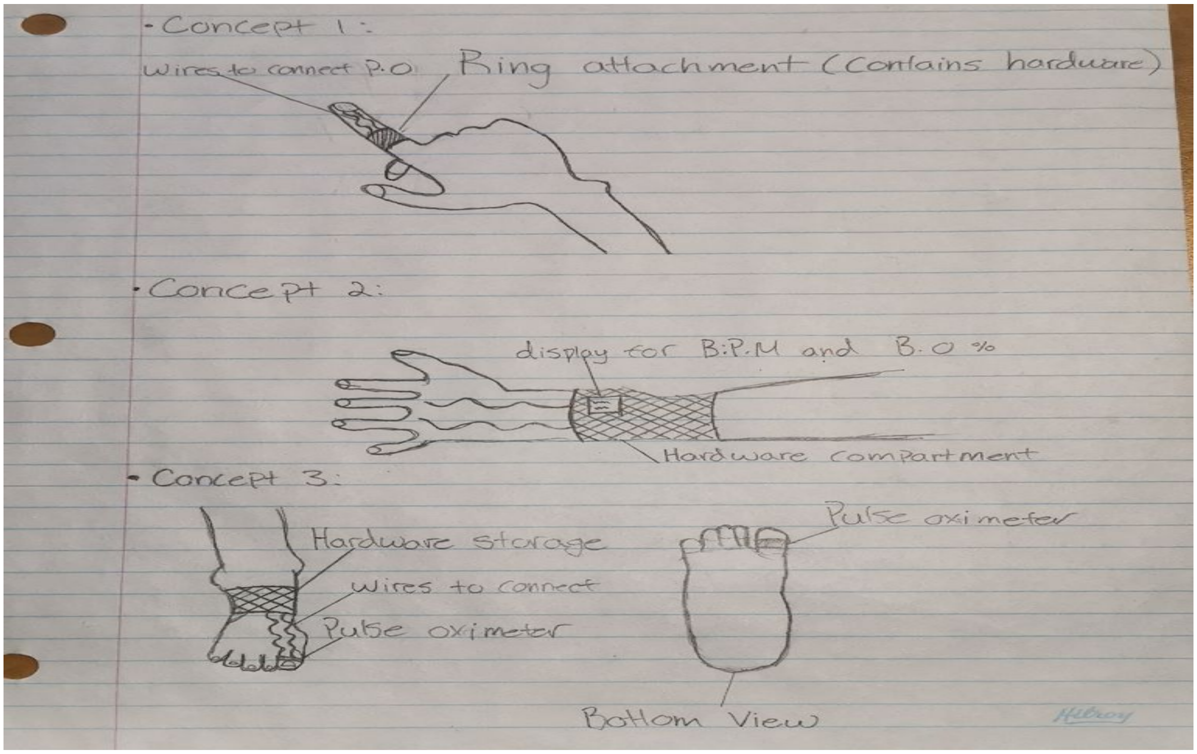


Figure 10 Ring

This concept is using the already known finger scanner to track blood oxygen level and heart rate, and converting it into a ring. While still being able to monitor the required levels it will also be less invasive than a module at the tip of one's finger.

Pros: less invasive,
Cons: too small for hardware(smaller battery)

Figure 11 Bracelet

This concept utilizes the aspect of the finger module without the invasiveness of the module itself. This concept would utilize a bracelet function that would house all the needed hardware(Battery, Blue-tooth adapter, pulse oximeter) with a wire connecting the sensor to the finger allowing for more mobility. In addition to a display that shows the percent oxygen level as well as heart rate

Pros: less invasive

Cons: bulky bracelet, would need to be an adjustable strap

Figure 12 Toe scanner

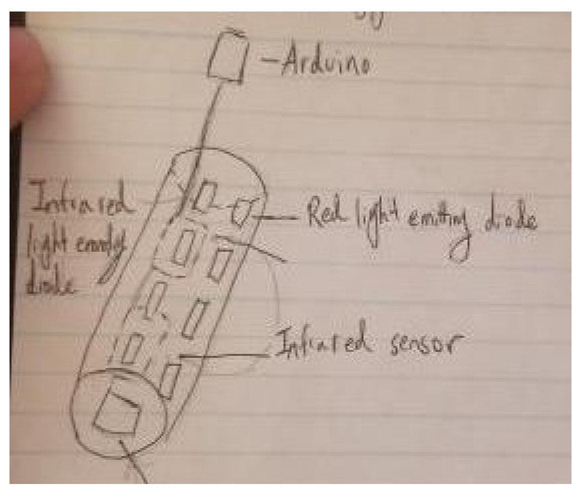
As the pulse oximeter can be used on a toe this eliminates the issues that come with having the pulse oximeter on the tip of the finger as most of the consumers would like complete free range of motion with their hands, this concept allows this free range of motion with no restriction to finger/hand motion. The design is more or less the sensor on the big toe of the user with the main bulk hardware being attached to the ankle which would house the needed specifications such as bluetooth to contact services and the battery.

Pros: free range of motion

Cons: requires space unless done barefoot, must be done seated

3.5 Tyler's Concepts

Figure 13 Arm Bracer style Blood Oxygen Reader



This design is designed to combat one of the biggest issues of every blood-oxygen monitor; in that the devices are usually intrusive and/or obstruct finger/ hand movement. With this device, the readings, display, and arduino/ bluetooth device will all be contained in a bracer housing that would be attached to the user's calves or forearm.

Pros: does not impair the user's hand/foot movement, very discrete.

Cons: The accuracy of the device might not be great, since the light penetrability through the arm/ leg is known to be difficult.

Figure 14 Forearm/calf with Finger/Toe Blood Oxygen

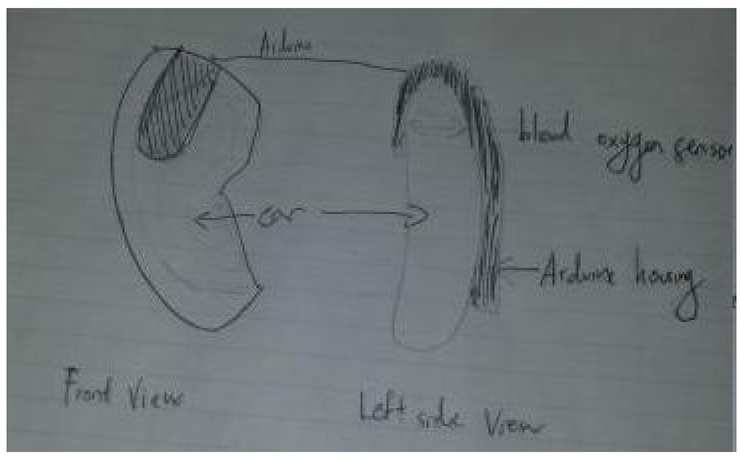
Sensor

This design will use a standard blood and oxygen sensor, but the Arduino and Bluetooth devices will be contained on the Forearm/calf.

Pros: The simplicity of the concept will mean it will be easy and cheap to manufacture. This concept will allow the user to select which kind of sensor they want to use since different models of sensors will be compatible with the device.

Cons: since the sensors will be attached to the finger/toe, the device will interfere with user hand/feet accessibility.

Figure 15 Ear Clip



This concept will utilize the thin cartilage area where redlight and infrared light can pass through the skin easily. Ideally the bluetooth and arduino can be housed all in one piece behind the ear. This concept will allow the user full zero obstructions to their hands and other body areas, with the entire device being functional from behind the ear

Pros: Discrete, and non-intrusive to the user.

Cons: The weight and design of the device will be difficult to manufacture.

Since the device will be housed behind the ear, there will not be a detailed user interface on the device itself.

4 Project Plan, Execution, Tracking & Bill of Materials

This portion will touch on the numerous jobs our team needed to carry out in order to advance with further development with our device. The first step was to designate tasks and responsibilities, as well as create a Ghant chart to monitor the progress of each individuals' duties. We then determined what the main risks were in respects to our project plan and formed a contingency plan to prepare for unexpected hiccups in our progression. The last step was to estimate the cost of the components we would need to finish our device and also stay below our $100 budget.

4.1 Tasks and Assignments

4.1.1 Creation of Mobile Application

This task was assigned to Callum. He will be in charge of creating the mobile application that the users will be interacting with. This task time is estimated at around 5-7 days. The reason the estimated time for this task is so big is because creating the application - along with the complete physical model - is one of the biggest, most important parts of our device. The app creator that is used for this task is called MIT app inventor, which is a simple, straightforward application that makes creating a personalized app much easier. Despite this advantage, it is still difficult and time consuming to fully create a functional app.

4.1.2 Creation Physical Models and Prototypes

This task was assigned to Tristan and Zach. Tristan is in charge of designing our component housing in solidworks, as well as co-assembling all parts to complete prototypes with Zach. This consists of testing, soldering, and many other physical tasks to complete the models. The duration of these collective tasks is evaluated to be over the course of several weeks. The reason being that this is incorporating prototypes and our final design, which runs almost the whole duration of our device conception. More specifically, designing the box on solidworks and creating should collectively take around 1-2 days.

4.1.3 Arduino Code

This task was given to Adam and Tyler. They are in charge of finding existing code as well as familiarizing themselves with arduino code to fully code our device and make it operational. This part is easily one of the most important of our device since the entire functionality depends on the code to work. This is of importance due to the problem statement shown in class from the first lecture "The device should send a signal to a third party (e.g. loved ones or paramedics) to alert them if something is wrong." (Lecture 1, p.g. 13) In addition to this, further along the project timeline the goal is to have the BPM and BOL displayed on the app as well. This means that the code for the BOL sensor and bluetooth module must be functional to then send a signal to the application. To say, the code for our device is the base of our overdose detection as well as the first step in emergency contacting. The estimated time for coding our device is hard to tell, but it should take roughly a week or two since none of the members of our team are familiar with arduino code. Getting help from our TAs and others familiar with this code will be crucial to complete this task.

4.2 Risks and Contingencies

When working on a big project such as this one, with many different sections and deadlines, it is crucial to be aware of all the possible risks that follow. In order to be prepared for these risks, a contingency plan is made to manage the risk when they present themselves. With all of us being full time students, with busy schedules between all our other courses. A lack of time could be an issue going forward with the project. Solutions have been prepared if this problem arises; the plan is to either drop non essential parts of the project to save on time. Another option is to simplify some of the more complicated aspects of the project, such as, some of the more complicated parts of coding could be simplified. These solutions are good to have, to be prepared if a problem ever arose. Another problem that could possibly present itself during the completion of this project could be a lack of experience and knowledge with the more technical parts of the project. With all of us being first year students, with little knowledge in programming in arduino. Difficulty with programming could become an issue. In preparation for this, if obstacles with the coding begin to arise, we will seek help almost immediately, in order to resolve the issue as soon as possible. With programming being such a large portion of our project, it is crucial to stay up to date and to not get complacent with the work.

4.3 Cost Estimation

The core concept of our design consists of 2 elements; the electronic element, and the human mounting element. From the prototypes, the design of the product is composed mostly of parts that would be available from the uOttawa Maker store, and the components that need assembly will be purchased through the internet. The items that we are planning to purchase from the internet are the MAX30100 Heart Rate & Oximetry sensor, and the Compression socks. Other areas/components that we will need to purchase are jumper cables, velcro straps, batteries and clips to secure the different modules of our device. Also, we will need to spend a small portion of our budget on a sheet of acrylic to laser cut our component housing. In short, the bulk of our budget should be spent on the sensors and electrical modules for our device, since all the other parts can be acquired for free and/or cost a very small portion of our budget.

Table 4 Cost Estimation

ID	Description	Vendor	Qty	Cost
1	PLA Filament[1]	uOttawa Maker Store		free
2	Jumper Wires	uOttawa Maker Store	30	$3.00
3	MAX30100 Heart Rate & Oximetry sensor	Banggood.com	3	$14.02
4	Arduino Nano	uOttawa Maker Store	1	$22.99
5	Compression socks	Amazon.ca	12	$22.99
6	USB Cable	uOttawa Maker Store	1	$2.77
8	Velcro tape	Amazon.ca	16feet	$10.99
9	9V battery Battery Clip Connector Cable	Amazon.ca	2	$8.99
10	Bluetooth HC-06	Banggood.com	1	$4.41

Note 1: These prices before HST.
Note 2: Shipping cost for the Oximetry sensor and bluetooth sensor is 4.24$.

Total sum at the uOttawa Maker Store with tax and shipping:	CAD $ 34.40
Total price of all materials purchased online and shipping:	CAD $61.41
Total Sum of Material Costs:	**CAD $ 103.07**

Price for a single unit

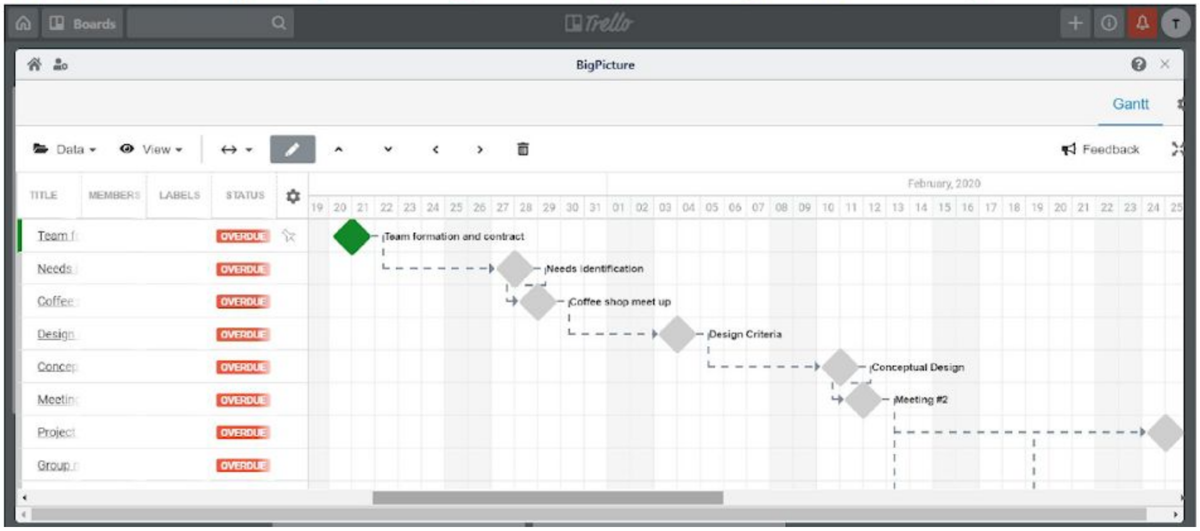
($14.01/3) + ($3/ 3) + $22.99 + (22.99/12) + $2.77 + ($10.99/16) + ($8.99/2) + $4.41 = $42.95

$42.95+ 42.95*0.15 = $49.40

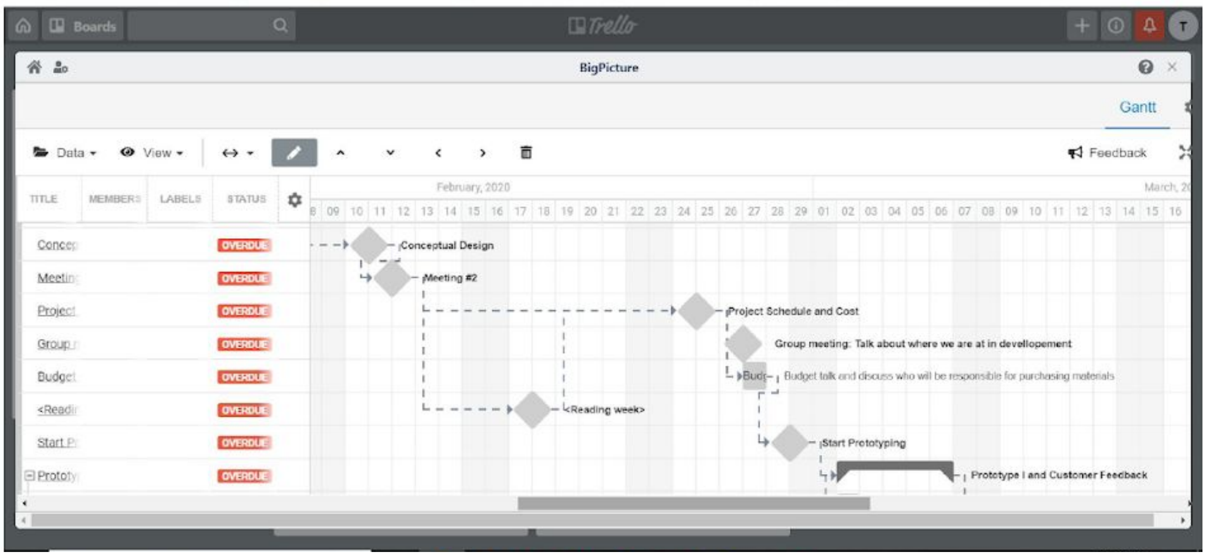
Unaccounted costs in the actual includes hinges, capacitors, acrylic casing to store the Narcan nasal spray, added an additional $20, rechargable. This ultimately brought our final price to $69.

4.4 Project Plan

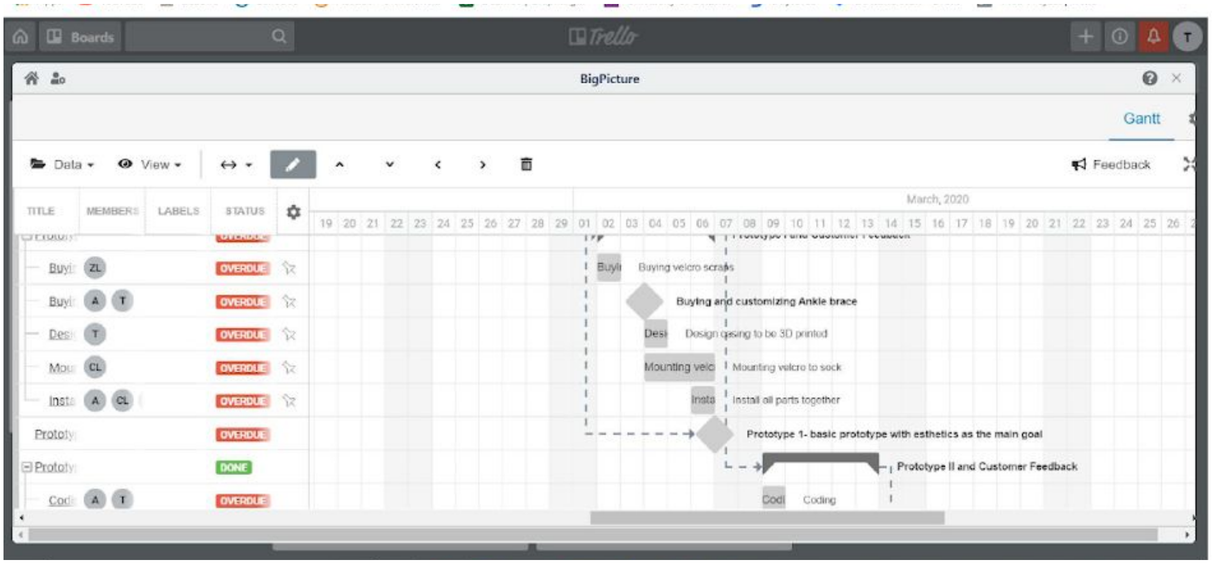
1



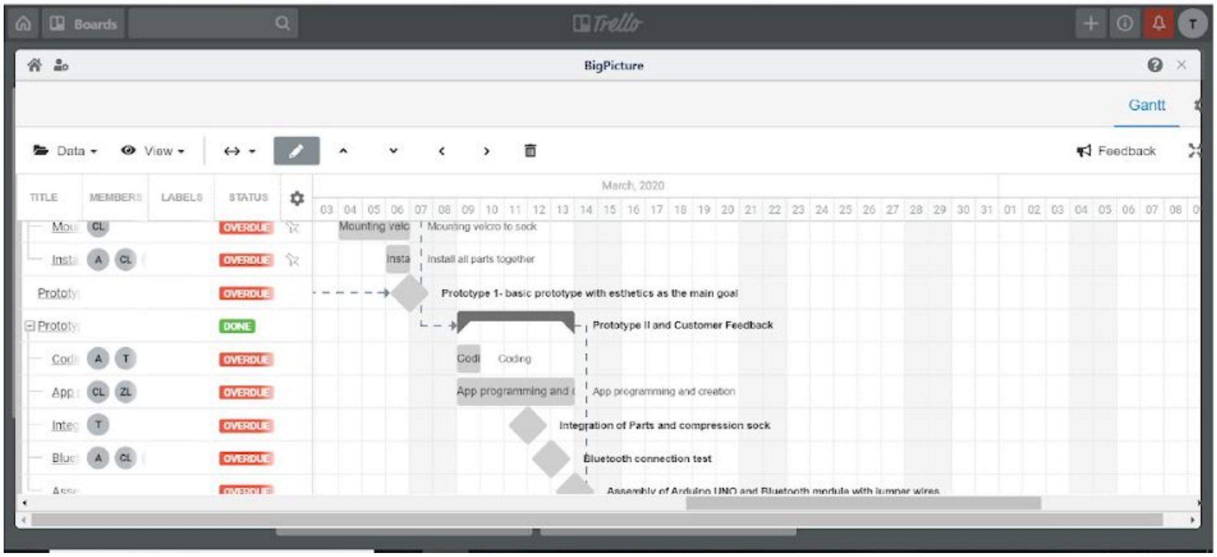
Boards
BigPicture
Gantt
Data
View
Feedback
TITLE
MEMBERS
LABELS
STATUS
February, 2020
Team formation and contract
Needs identification
Coffee shop meet up
Design Criteria
Conceptual Design
Meeting #2



Boards
BigPicture
Gantt
Data
View
Feedback
TITLE
MEMBERS
LABELS
STATUS
February, 2020
Conceptual Design
Meeting #2
Project Schedule and Cost
Group meeting: Talk about where we are at in devellopement
Budget talk and discuss who will be responsible for purchasing materials
<Reading week>
Start Prototyping
Prototype I and Customer Feedback



Boards
BigPicture
Gantt
Data
View
Feedback
TITLE
MEMBERS
LABELS
STATUS
March, 2020
Buying velcro scraps
Buying and customizing Ankle brace
Design casing to be 3D printed
Mounting velcro to sock
Install all parts together
Prototype 1- basic prototype with esthetics as the main goal
Prototype II and Customer Feedback
Coding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Trello
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Gantt
Data
View
Feedback
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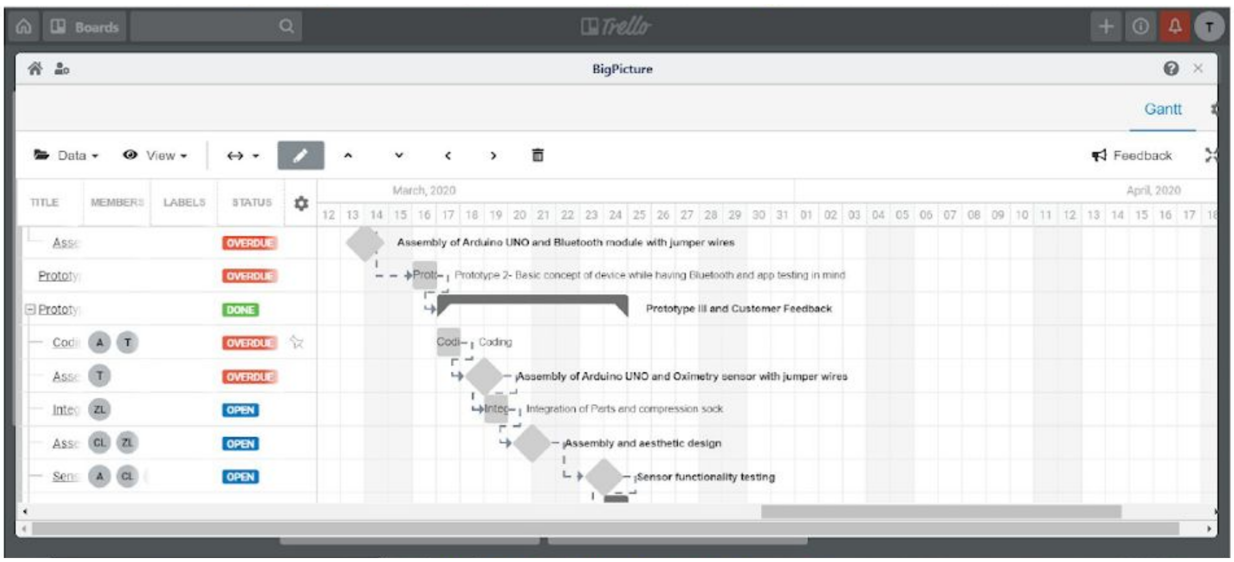
LABELS
STATUS
March, 2020
Prototype 1- basic prototype with esthetics as the main goal
Prototype II and Customer Feedback
Coding
App programming and creation
Integration of Parts and compression sock
Bluetooth connection test
Mounting velcro to sock
Install all parts together


Boards
Trello
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Gantt
Data
View
Feedback
TITLE
MEMBERS
LABELS
STATUS
March, 2020
April, 2020
Assembly of Arduino UNO and Bluetooth module with jumper wires
Prototype 2- Basic concept of device while having Bluetooth and app testing in mind
Prototype III and Customer Feedback
Coding
Assembly of Arduino UNO and Oximetry sensor with jumper wires
Integration of Parts and compression sock
Assembly and aesthetic design
Sensor functionality testing

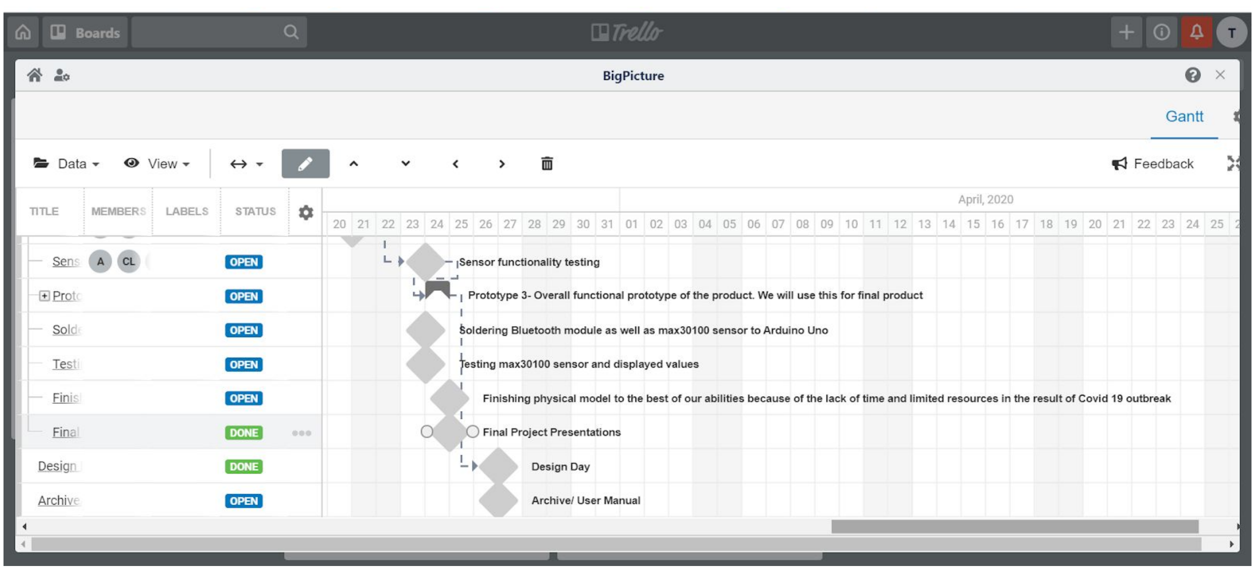

Boards
Trello
BigPicture
Gantt
Data
View
Feedback
TITLE
MEMBERS
LABELS
STATUS
April, 2020
Sensor functionality testing
Prototype 3- Overall functional prototype of the product. We will use this for final product
Soldering Bluetooth module as well as max30100 sensor to Arduino Uno
Testing max30100 sensor and displayed values
Finishing physical model to the best of our abilities because of the lack of time and limited resources in the result of Covid 19 outbreak
Final Project Presentations
Design Day
Archive/ User Manual

Figure 16 Project Plan Gantt Chart

5 Analysis

Based on the client needs that were obtained during the first client meeting, our group selected the top 3 designs and put them into a decision matrix as seen below in the table. This matrix works by outlining all the design criteria outlined in project deliverable C and each individual concept was given a score out of 5 for each criterion. Afterwards, the scores were added up to determine which designs best met the client's needs. The decision matrix helped narrow down the 3 individual concepts to only 1; each of which stood out from the rest.

5.1 Analysis of Concepts

Table 5 Decision Matrix

Selection Criteria	Option 1 Adam's Concept #1	Option 2 Tristan's Concept #3	Option 3 Zach's Concept #2	Option 4 Callum's Concept #3	Option 5 Tyler's Concept #2
Discreteness	4	4	5	4	2
Product Life	3	2	5	4	3
Cost	4	5	4	1	4
Notify EMS	4	4	4	4	4
Detection accuracy	4	4	5	4	4

5.2 Selecting a Concept

In order to pick the design that would best suit our criteria, each individuals' top design was put in and evaluated in a decision matrix found in Table 5. We discussed pros and cons in regard to feasibility, being a product that satisfies all the customers needs, while staying below our budget and requiring an appropriate amount of time and effort, along with resources available and the team's capability.

5.2.1 Reasons for Selection

The criteria we used to determine the most practical design for our needs were the cost, discreteness, lifespan, detection efficiency and notification in case of an emergency. These were all established as critical needs by the client, and rightfully so, are the needs we based our selection on, as seen above in the selection matrix.

5.3 Final Concept

We mutually agreed that the ankle sock design was the choice for our needs. It can accurately monitor BOL from a user's Achilles tendon while being able to alert a mobile device that they may overdose. It is also cost-effective and satisfies most if not all of the customer's needs. The ankle is also a discreet, hideable place on the body, which is one of our most important needs. This design did meet the customer needs, except for the Bluetooth module not being programmed. The device proved to be a promising drug overdose monitor while being physically subtle.

5.4 Concept, Target Specifications, Benefits and Drawbacks

5.4.1 Target Specification and Requirements of the Final Concept

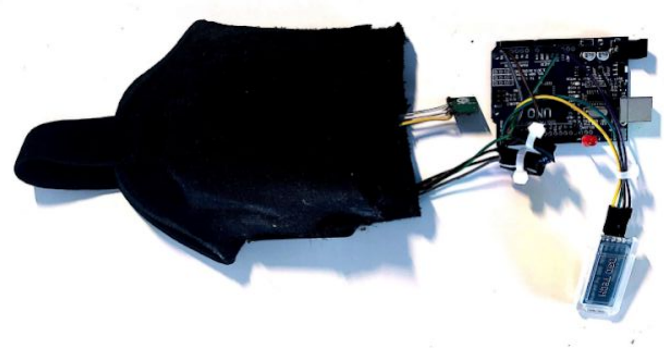
The target specifications and requirements/expectations for our design include being less than $100, a functional BOL detection device, bluetooth transmitter, mobile application and lastly a successful emergency contact notification.

5.4.2 Evaluation of the Final Concept Meeting Target Specifications and Requirements

The final concept should have an interactive application to monitor the device's function. At the moment, we do have a functional application that is able to receive signals from linked devices and perform various functions including contacting a preset phone number. It also includes extra features such as a note/log pad to record important user information.

The final concept should accurately detect BOL and recognize the percentage periodically. This specific attribute has been tested and we have confirmed that our device can successfully read a user's BOL and relay that information to an external device, such as a laptop.

The final concept should be discrete and durable. These characteristics have been met and are the main advantages our product delivers. It can fit comfortably under a pant leg and does not shift or move with users' mouvements. This is because our chosen body part to center our device around has a lot of potential to excel physically compared to other designs.



The final concept should relay information via bluetooth module to our mobile application. This attribute was not successfully completed due to lack of experience with arduino code and the covid-19 outbreak preventing our team from getting together and learning more about this foreign method of programming.

6 Prototyping, Testing and Customer Validation

In this section, we will be covering the prototyping phases as well as the testing phases. Including the test conducted at each prototype phase and the results and evaluation concluded once the testing was complete.

First we will go over our first prototype, then we will analyze and evaluate the results from the tests and finally, discuss the client's feedback and talk about how we planned the second prototype.

6.1 Prototype I

This part is separated into 3 main parts. The first being the description of the prototype and its features. The second being the test plan and its results. And finally the last part is the customer feedback received.

6.1.1 Prototype Descriptions

For the first prototype we created a physical model, with the goal to gain an understanding of the size and dimensions of the product and as well to gain customer feedback which we will be able to improve upon.

6.1.1.1 Compression sock

The first feature of the first prototype is the compression sock. The compression sock will be used as the overall mount of the product. The reason for picking a compression sock is because it is located in an area that is overall discret and also provides for easy BOL(blood oxidation level) and heart rate reading. It also is a comfortable way of having electrical components and parts for the project.

6.1.1.2 Velcro strips

The second feature of the first prototype is the use of velcro strips. The velcro strips will be used to mount and unmount the electrical casing to the compression sock. This will allow the user to easily wash the compression sock without having to make the casing waterproof. It will also allow for easy and effective mounting systems while being relatively cheap.

6.1.1.3 Rectangle wooden box

The third feature of the first prototype is the rectangle wooden box. It will be used as a casing for Arduino related parts and possibly will also store the battery source. We will utilize laser cut mdf from makerspace labs to make the first prototype out of cheap enough materials to maximize the overall project budget for the final prototype.

6.1.4 Testing and Analysis

This is the first test that will evaluate the comfort - the critical design aspect - of our product. This process will require us to make a prototype resembling the weight and proportions of our hardware box to properly assess the fit and functionality of our product. We will use feedback and data from different users to organize a prioritized table of what improvements need to be made. It will be key to get many different types of users to test our prototype in order to gain a variety of different preferences and needs that we will then be able to incorporate into our design. The possible areas of failure for this prototype could be either if users do not provide us with workable feedback or if we aren't able to implement the feedback into our design.

The procedure for this test is as follows:

Ask a variety of students and/or recovering users to try on our product (preferably people with some sort of affiliation to the university or our class)

1. We will introduce ourselves, give background information on our project and team. Ask open ended questions and listen actively.
2. Have them try on the sock and ask the following questions:
    a. Does the device stay in place while moving (i.e. does it twist, slide or rub)
    b. Does the device feel heavy or bulky? Does it impair mobility?
    c. How good does the product look? Does it fit under pants/shoes? (Scale of 1-10)
    d. Is the "one size fits all" concept feasible? Is the device too tight or loose?
    e. Get recommendations and feedback.

6.1.5 Customer Feedback

At the time of the first prototyping phase we had the chance to pitch our ideas to our client in the form of an in class presentation. We got a lot of positive feedback about our pitch and our first prototype, as well as recommendations and ideas to improve our design.

The client thought our problem statement was very clear and well written that expressed her needs well. The client clearly understood the goal of the first prototype as well as understood what we were going for as our first design. Their main comments about the design were the possibility of the device being a little too bulky as well as making sure the device could accurately read the user's blood oxidation level. A secondary comment we got from the presentation was that the client was worried the external casing for all the electrical components wouldn't be waterproof and therefore would affect the durability of the product. Going forward in the next prototype, one of the main goals will be to make a waterproof casing made out of acrylic sheet instead of mdf, therefore making it more water resistant. As for the device being too bulky the team is undergoing research on optimizing the dimensions of the electrical casing to ensure that all parts will properly fit while also allowing for extra space to fit the naloxone nasal spray. The dimensions will also keep the device as small as possible. Ideally, the client would like us to reduce dimensions, make the casing waterproof, allow space for naloxone nasal spray as well as display accurate and timely readings of the users BOL on their given smartphone.

Finally, it is important to the client that we complete a finished product. For that reason, they recommended we go for ideas that will maximize client needs and allow for a fully functional product that works and will serve as a life saving device in the case of extreme need. But the main goal is to complete a finished product.

6.2 Prototype II

From the customer feedback on prototype 1, some of the concerns brought about the design of the device included the device's bulkiness and the device's water resistance abilities.

Reduce dimensions: The goal for prototype 2 is to reduce the casing's thickness and width. After evaluating the leftover space on prototype 1 with all parts inside the casing, it was decided by the team to reduce the height of the box by at least 6mm or more. As for the width, further analysis will need to be done on space and dimensions but the general goal is to minimize the size of the physical box while maximizing space for parts.

Making the casing waterproof: The goal for prototype 2 is make the electronics' casing waterproof. The issue was brought up by the client because of the location of the device. Since our target audience are middle aged men in the construction industry who are regularly on the work site, the need for a waterproof casing is very important to note. The general public appreciates water resistance, so a waterproof casing will be keeping in trend with their other daily devices. This will be done using Acrylic laser cut sheets obtained from the maker store. This material was selected because acrylic sheets are much more waterproof than MDF and much more resistant to impact which makes the switch of materials a no brainer. Acrylic thermoplastics are an industry standard for everyday devices that see lots of human interaction.

Planned Additions to the device:

A Naloxone nasal spray compartment and a functional Bluetooth connection from the sensor to a smartphone.

Space for naloxone nasal spray: The goal for prototype 2 was to allow for the space of a Nasal nasal spray. This decision was made by evaluating the pros and cons of having a nasal spray instead of the device calling EMS. The space needed for the nasal spray will come from the reduction of the electrical housing's overall dimensions.

Display BOL/Vitals values on their given smartphone: The main goal for prototype 2 is to successfully complete an intuitive working mobile application with features such as displaying sensor read values (O2Sat, etc), playing a pre rec-orded emergency message for anyone standing in the nearby surroundings as well as display the sensor value updates every minute or so while being very user friendly with a simple user interface. We aim to have two fully operational versions of this application for Android and iOS users.

Testing and Analysis.

This step includes physical testing of the new design, as well as technical evaluation of the application we have designed. For the physical part of the testing phase, we will wear prototype 2 for a prolonged period of time to know how comfortable it is. We wil-l pay particular attention to how the new straps and materials will perform as well as how the newly developed weight and dimensions affect the user. We will also test the water resistance by removing the hardware and performing drip testing, continuous stream testing, humidity and submersion testing. It is our hypothesis that there will be water that enters the box, but our goal is to minimize the amount that does get through. The last thing we will test for this prototype is the alert system we have created from the mobile application design process. We will connect our device to one of our smartphones and personally test the alert and sound system to measure time delay and overall function and performance of our software. The goal is to receive the notification in a timely manner; if this is not achieved the first time, we will use the collected data from testing and revisit our software and device design to achieve this goal through careful coding and engineering changes.

7 Final Solution

In this deliverable, we will be going through each of our prototyping phases (1, 2 and 3) which includes the tests conducted, the tests for each phase helped us to ensure our functional requirements were satisfied and that we were on the right track.

First, we will discuss the second prototype and analyze the key points of the testing: what worked, and what didn't work. We kept our prototypes for this phase very focused at the time exploring a component at a time, using the information gathered we were able to come closer to a final more desirable design.

Secondly, we will discuss the third prototype, mainly the changes from the initial and second prototype as well as how we tested the prototype and what we could conclude from the testing.

Finally, we will discuss and evaluate what the other teams thought of our project as well as describing the next steps needed to finalize the project.

7.1 Results from Prototype II

What Worked

From prototype II,

- Acrylic box:
    - Improvement to durability added a water resistant
- Cellular App:
    - Bluetooth functionality

What did not work

- Acrylic box:
    - Closing functionality
    - Rigid edges
- Cellular app:
  - Connection to device itself.

7.2 Prototype III

Summary:

Prototype three implemented many of the desired functional requirements for the project, it allowed us to test all of our ideas which includes: the rechargeable 4 AA batteries, the new naloxone compartment, a functioning blood oximetry sensor (The newly added resistors) and more flushed out app. And unfortunately due to Covid-19 prototype 3 included these aspects but not the bluetooth connection and app integration into our final design.

7.2 Parts description:

7.2.1.1 Cellular app

The app has a functional bluetooth component as well as additional screens were added that housed different functions and displays of data.

From prototype II, we fixed the code on the MIT app inventor as well as added additional buttons and screens to display data.

7.2.1.2 Max30100 Sensor

Adding the sensor to the arduino nano adding additional resistors to ensure the correct voltage was going to the sensor itself

7.2.1.3 Hc-06 bluetooth module

At-09, connects to the arduino uno board to send data

7.2.1.4 Acrylic casing

Minor adjustments were made from prototype 2

7.2.1.5 Narcan storage compartment

Compartment within the compression sock to store a narcan nasal spray.

7.2.1.6 Compression sock

The accessory that the casing sits in and narcan storage, in addition to what the user wears for the device to function.

7.2.1.7 Arduino Uno / Jumper wires

The arduino sensor is the main board that all the remaining hardware is stored on and connected via the jumper wires.

7.2.1.2 Max30100 Sensor

The blood oximetry sensor used to track the users percent blood oxygen levels in real time

7.2.1.5 4 AA rechargeable batteries

The power source the device uses

7.2.2 Testing and Results

Summary of test results:

Testing:

- Box Design
- Ergonomics and Comfort
- Waterproof and Durability
- Software

Results

- Durability ✓
- Comfort ✓
- Bluetooth ✗
- BOL sensor ✓

7.2.3 Customer Feedback

Unfortunately due to Covid-19 we were not able to receive any feedback.

8 Conclusions and Recommendations for Future Work

To summarize, the execution of the proposed project plan was successful. The product is almost fully functional, the device is able to read the users BOL with the pulse oximeter and arduino, as well as a phone application, however we've encountered difficulties with the bluetooth module. We currently have two separate parts to the device and we are missing the connection between them to have a fully functional device. Our device meets many of the user needs, such as discreteness.

This project has been a great experience to us, our group has been able to manage and follow our project plan, while respecting all due dates for deliverables, and being able to adapt to any challenges that presented itself. Throughout our project we were able to learn a lot, such as time management and to plan for contingencies.

For the future, the first step will be to finish the device and have it fully functional. The next steps would be to improve upon the device. There are multiple ways to improve upon the device, such as reducing the size.

9 Bibliography

- https://www.teachmemicro.com/max30100-arduino-heart-rate-sensor/
- https://www.instructables.com/id/A-Pulse-Oximeter-Device-for-Measurement-of-SPO2-a

n/
- https://how2electronics.com/blood-oxygen-heart-rate-monitor-max30100-arduino/#Blood_Oxygen_Heart_Rate_Monitor_with_MA
- https://www.festi.info/boxes.py/
- Bibliography

APPENDICES

APPENDIX I: User Manual

Main Features:

- Compression sock that can house the electrical component
- Electrical blood oxygen sensor, with bluetooth compartment
- Cellular phone app
- Rechargeable batteries
- Durable and water resistant

Product functions and maintenance:

For this specific product, no heavy maintenance is required. There are 3 main components to keep in mind in terms of the maintenance, firstly the batteries, the device won't work if there is no charge coming from the batteries therefore changes/recharging of batteries may be needed. Secondly the sock itself after continuous use will need to be cleaned, the box can be removed so that the fabric may be cleaned. Thirdly the blood oximetry sensor needs to be checked prior to see if it is reading values correctly.

The function of the product is to attach to the customer's ankle such that a sensor can take readings from their achilles tendon, The device is powered on with the batteries within the compartment. This powers the bluetooth and sensor of the device, The bluetooth connects to a cellular app which allows the phone to display the data read by the sensor, the apps functionality was also to send a distress message to a pre-made contact when low levels of blood oxygen are read by the sensor.

Health and Safety Guidelines

As a safety precaution, refrain from vigorous physical activity, in relation to the battery storage compartment. Make sure the device has a stable connection to the cellular app..

Troubleshooting

For troubleshooting there are 2 strains: hardware and software, on the software side which includes the app and bluetooth a quick restart of the app should remove any problem. For hardware if the device is not functioning it may need a replacement of batteries or some wires may need to be replugged in.

APPENDIX II: Design Files

- https://makerepo.com/AdamHowe/team-c1-never-close-to-an-overdose

The executable file of the project outlined in this report can be found under the name “Team C1 Never Close to an Overdose” in the MakerRepo repository. For this project, all our design files and deliverables can be found in makerRepo under the name project files. A description can also be found there that reads “Opioid overdose detection device. Our device will detect when the user is having an overdose, and through our app it will notify an emergency contact chosen by the user. The device is located at the users ankle, the pulse oximeter will read the users blood oxygen saturation level from the users achilles heel”