Faculté de génie
Faculty of Engineering

Project Deliverable D: **Conceptual Design**
GNG 1103 - Engineering Design

Overdose Detection Device

Submitted by
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Introduction

The goal of this deliverable is to combine the individual design ideas of each member of our team to come up with three final design ideas that will be presented to our client in order to obtain feedback.

In the past three to four weeks, we've been through the process of defining the problem we have to solve, establishing the needs our device has to fulfill and creating criteria our device has to have.

Our problem statement was the following: *The Sandy Hill Community Center wants a discreet and durable device for opioid users, that can detect an overdose and quickly alert medical professionals.*

We have established a list of needs with direct statements from Tali Cahill, our client, who is also a nurse at the Sandy Hill Community Center and works with opioid users which leads us to believe that her statements are credible and can be effectively used in order to establish the needs of our customers.

With those needs, we were able to create a list of design criteria and give these criteria a ranking of priority. After individually brainstorming and trying to figure out ideas that fulfill our design criteria, we were able to come up with three ideas each. These ideas are listed in this document and are supported by images or sketches. By benchmarking our own ideas and comparing them with the help of a point system, we will be able to decide which three ideas will be retained for our client presentation on Thursday February 13th.

In this document can be found a reminder of our needs identification, a reminder of our design criteria (with functional/non-functional requirements), as well as our individual ideas and finally, our three final picks for our client presentation.

Problem

After our client meeting with Tali Cahill, a nurse who works with opioid users at the Sandy Hill Community Center, our intentions for the project became clearer and we were able to put together a list of needs for our project users. The goal is to now translate these needs into design criteria that will be able to be applied to our prototypes/final product. We also have to establish our initial constraints, as well as some functional and non-functional requirements for our products. Lastly, we will evaluate the products that are already on the market or that have been made to set standards for our product and be able to overdo these existing products in terms of quality.

Initial Constraints

- Weight (lbs)
- Cost ($)
- Long battery life (lasts at least a day)
- Size (cm ⋅ cm ⋅ cm)
- Operating Conditions (°C and weather)
- Prototyping time

Requirements

Functional Requirements

- Efficiency (has to react in less than 1 minutes)
- Doesn't depend on someone other than the user
- Transportable
- Contacts help
- Accurately detects an overdose
- Can effectively read blood oxygen

Non-Functional Requirements

- Aesthetically pleasing
- Product life (years)
- Failsafe (cancelling function)
- Discreet
- Customizable

- Comfortable

Technical Specifications

- Price: 100$ CAD
- Dimensions: not decided yet but small (discreet)
- Durability: battery life for at least a whole day
- Production Time: approximately two months
- Reaction Time: under 30 seconds

Needs Identification

Customer Statement (exact words)	**Interpreted Need** (express specifically what the raw data implies)	**Importance** (1-5)
“You need both your hands to take drugs… No one wants to keep something on their finger”	The device cannot get in the way during common tasks	4
“Biggest use is in people who are using alone”	The device doesn’t depend on another person being there	5
“For people working in the trades, It can’t be too expensive”	Relatively cheap cost	4
“Has to do something where it saves them or calls someone in 3 minutes”	The device should react quick enough to get medical attention in time	5
“Should be fairly resistant to water and day to day wear”	Durable enough to wear in everyday activities	4
“Should be discrete... Not totally easily identifiable to other people”	Appears like daily wear	3
“I would love it to measure respiratory rate”	Measures respiratory rate	2
“There should be a way to say ‘this is a false alarm’ and if they were really overdosing they wouldn’t be able to override it”	The user should be able to overwrite a false alarm if it occurs	4
“Something people can customize”	Different designs and settings depending on certain lung diseases, etc.	2

“Naloxone gives them an immediate overdose (like a flu x100)... No one wants to have a naloxone”	Should administer naloxone if the person is overdosing	2
“More than a days battery life”	The device should be able to last throughout the day	5
“The easiest way is through pulse oximetry”	Use a pulse oximeter to measure blood-oxygen-level	5
“GPS may be a barrier”	Users may not want authorities to know their location	1

Conceptual Designs

Each team member has outlined three different ways to solve the problem.

Tony's Ideas

1) A shoe that has all of the contents within the heel of the shoe. The pulse oximeter will be in the front of the shoe, and will attach to your pinky toe to ensure the light waves go through the skin. There will also be a zipper that will run along the front of the shoe and will allow for the oximeter to be attached. Underneath the heel will be a battery to run the device, that will also run the pulse oximeter, the circuit board, and the arduino. There will also be a GPS tracker that alerts authorities that a person is having an overdose, and will cost $110 CAD.

2) This device will be in the form of a wearable watch. The watch face will have a square face with a diameter of 55 millimeters, and a thickness of 6 millimeters. The watch will encapsulate the micro-arduino, battery and a prototyping board. It will have a lithium ion battery that will last up to 3 days without being charged, and will be able to be charged through a micro USB. There will also be a pulse oximeter that will be built to measure blood-oxygen levels. Another feature is the GPS tracker which will alert authorities when an overdose is happening. The

device will have an adjustable plastic wristband, and will cost approximately $150 CAD.

3) This device will be wrapped around your calf right below your knee. It will have a neoprene inner layer to ensure that it is comfortable on the skin with a velcro out layer to be adjustable and keep it in position. The unit will have dimensions of 8cm long, by 4cm wide, by 0.5cm thick. It will contain a charging port at the bottom of the device, that is connected to a tiny 5V battery. It will also have a pulse oximeter that will send a signal through your calf to a microcontroller, which will then send a signal through bluetooth to a module on a smartphone. It will cost approximately $95 CAD to a consumer and will have a battery life of 3 days on a full charge.

Benchmarking Designs

Point system: 3 = green 2 = yellow 1 = red

Design Criteria	Boot	Watch	Calf Unit
Waterproof and not easily broken	Yes	No	No
Can connect to apple and android phones	Yes	Yes	Yes
Costs less than $100	No	No	Yes
Not noticeable and does not interfere with everyday tasks	Yes	Partial	Yes
Detects overdose and does not go off when there is no overdose	Yes	Yes	Yes
Reacts to overdose within 1 minutes	Yes	Yes	Yes

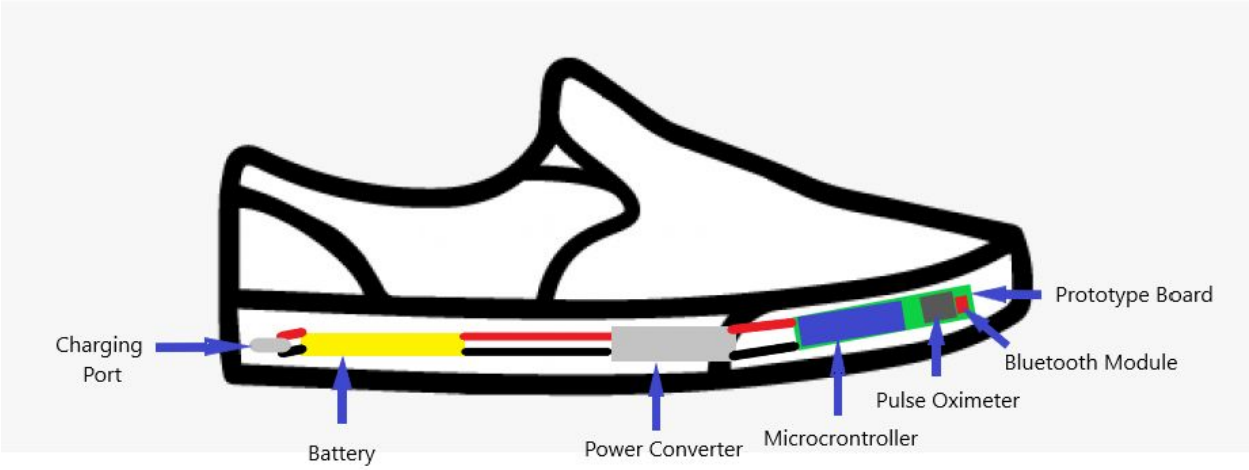
Updates information without prompt	Yes	Yes	Yes
Has cancelling option	No	No	No
Pleasing to the eye	Yes	Yes	No
Measures users respiratory rate	No	No	No
User can enter personal stats	No	Yes	No
Can last at least 24 hours	Yes	Yes	Yes
Constantly measures blood oxygen levels	Yes	Yes	Yes
Administers Naloxone	No	No	No
Sends GPS location of the user to authorities upon activation	Yes	Yes	No
Total Points	35	34	31

Therefore the best product through benchmarking designs is the boot, with the watch closely behind.

Brendan's Ideas

1) This detection device is built into the sole of a shoe. A charging port located at the heel of the shoe provides power to the rechargeable battery. From the battery, electricity is passed through the converter to give the microcontroller the necessary input voltage. The microcontroller is controlling a pulse oximeter. The pulse oximeter sends light rays into the user's toe in order to measure the

oxygen content in their blood. The microcontroller uses that information to determine if the user is overdosing. At this point, a signal is sent from a bluetooth module to an app on the users phone. The app will give the user the option of saying it was a false alarm. If the user either confirms an overdose or does not respond to the app, emergency services will be contacted. The cost of this device will be 85$.



2) This device is worn on the user's wrist. Inside of the watch is the microcontroller that operates the pulse oximeter located on the underside of the wrist. It is connected through the strap of the watch to remain discreet. Since the pulse oximeter is located on the wrist, the accuracy of the device is reduced. With a device this small, the battery life had to be cut back, lasting only twelve hours at a time. This device will cost 130$. The price is higher for this device to have smaller components that can be hidden easily.

3) This device has been built into an undershirt. There is a pocket on the inside of the shirt where the device is held. A microcontroller utilizes the heart rate and breathing rate of the user to determine an overdose. The device is equipped with a twenty four hour battery and a bluetooth transmitter synced with an app on the user's phone. This device costs 80$.

Benchmarking Designs

Point system: 3 = green 2 = yellow 1 = red

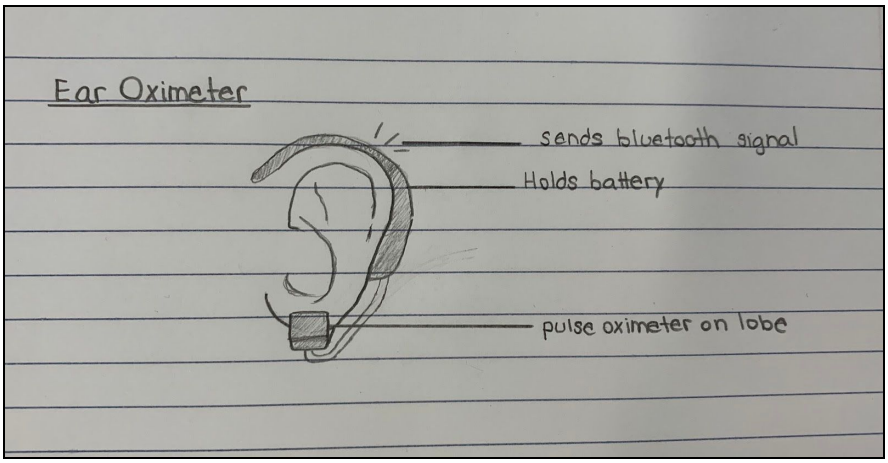
Design Criteria	Shoe	Watch	Shirt
Waterproof and not easily broken	Yes	Yes	No
Can connect to apple and android phones	Yes	No	Yes
Costs less than $100	Yes	No	Yes
Not noticeable and does not interfere with everyday tasks	Yes	Partial	Yes
Detects overdose and does not go off when there is no overdose	Yes	Partial	Partial
Reacts to overdose within 1 minutes	Yes	Yes	Yes
Updates information without prompt	Yes	Yes	Yes
Has cancelling option	Yes	No	Yes

Pleasing to the eye	Yes	Yes	No
Measures users respiratory rate	No	No	Yes
User can enter personal stats	Yes	No	Yes
Can last at least 24 hours	Yes	No	Yes
Constantly measures blood oxygen levels	Yes	Yes	No
Administers Naloxone	No	No	No
Sends GPS location of the user to authorities upon activation	Yes	No	Yes
Total Points	41	27	36

Tara's Ideas

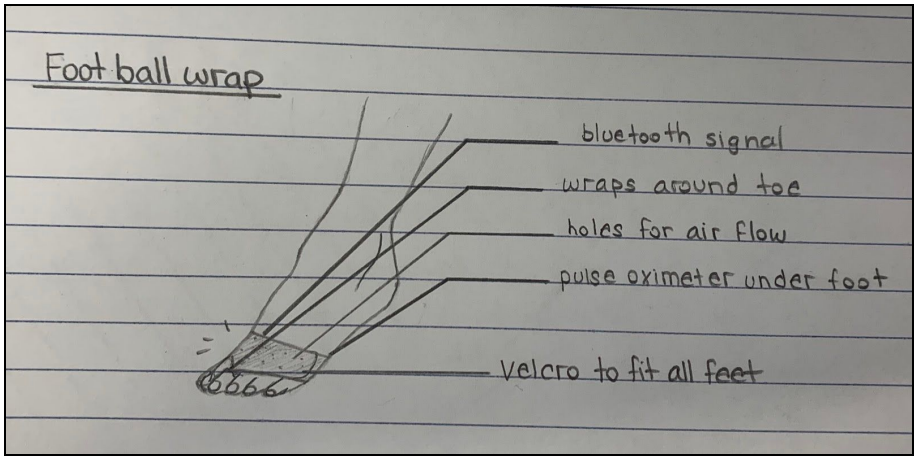
1) **Ear Oximeter**

The device clips to the ear lobe to measure oxygen saturation and heart rate. The device wraps around the top of the ear to hold it secure and holds a battery behind the ear which can last up to 5 days. The device resembles a hearing aid. It is made of a durable waterproof material. The upper ear portion and clip are attached by a loose wire. It is capable of sending a Bluetooth signal to a phone or other device to record vitals and gps location frequently and calls authorities within a minute of detected overdose. Total cost including the battery ($20), small GPS ($15), pulse oximeter ($40), ear hook ($15), and arduino and parts ($45) is around $135.



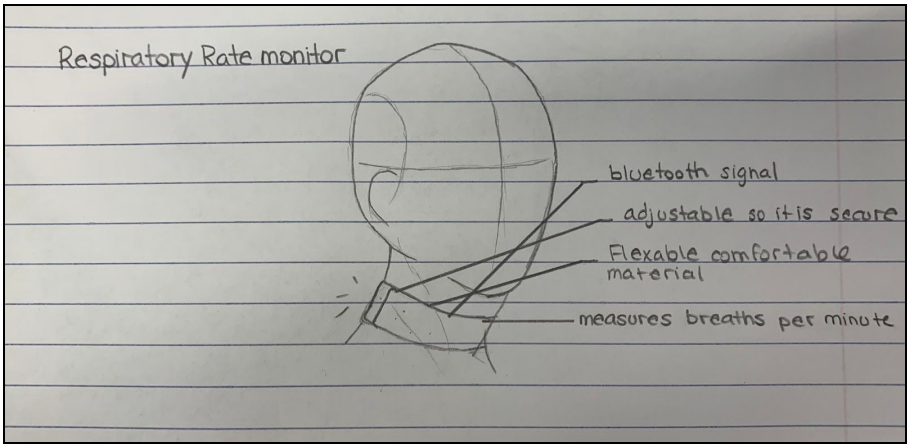
2) **Foot Ball Wrap**

This device is a piece of cloth with a built-in pulse oximeter that is wrapped around the foot. The cloth has holes to allow airflow and is a flexible comfortable material. The sole of the wrap has a device which measures pulse oximetry and the end of the cloth has velcro so it can fit every foot size. The device also attaches to one toe to prevent it from moving up and down the foot. A small battery is attached under the foot which can last one day. The device sends a bluetooth signal to a phone or other device to record vitals frequently and calls authorities within a minute of detected overdose. Total cost including the battery ($10), arduino and parts ($45), velcro ($10) and fabric ($15) is around $80.



3) Respiratory Rate Monitor

This device is used to measure respiratory rate. It is a band of fabric that wraps around the users neck and fastens on with velcro. The material is flexible with holes to allow airflow. A battery is stored behind the neck and can last two days. The device measured the users breaths per minute to detect the sign of an opioid overdose. The device can be hidden by wearing a turtleneck. It sends a bluetooth signal to a phone or other device to record vitals frequently and calls authorities within a minute of detected overdose. Total cost including the battery($15), arduino and parts ($50), velcro ($10) and fabric ($15) is around $90.



Benchmarking Designs

Point system: 3 = green 2 = yellow 1 = red

Design Criteria	Ear Oximteter	Foot Ball Wrap	Respiratory Rate Monitor

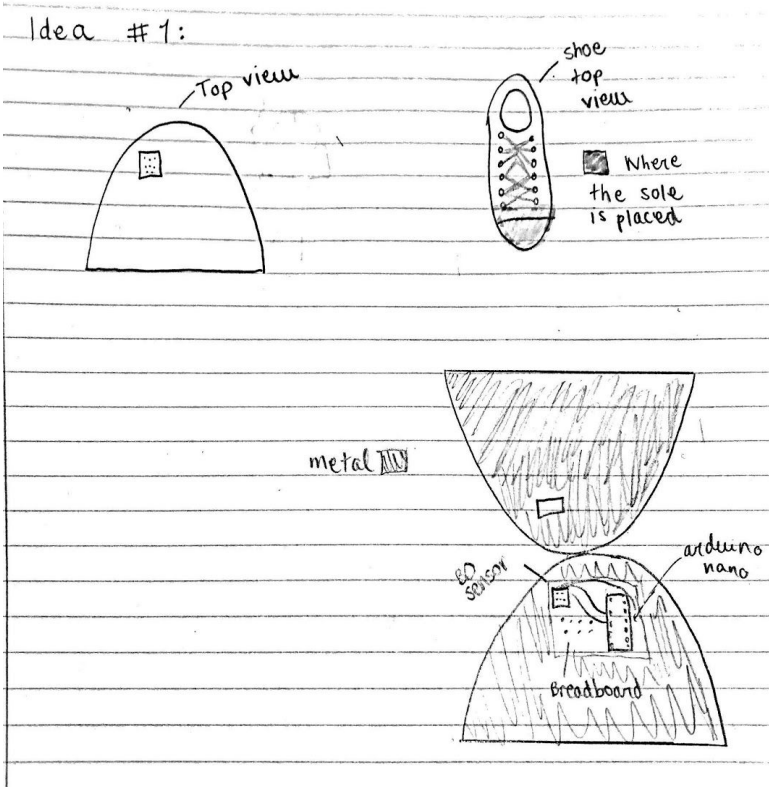
Waterproof and not easily broken	Yes made of waterproof plastic	No made of fabric	No made of fabric
Can connect to apple and android phones	Yes has bluetooth	Yes has bluetooth	Yes has bluetooth
Costs less than $100	No costs $135	Yes costs $80	Yes costs $90
Not noticeable and does not interfere with everyday tasks	Noticable if user has short hair	Hidden in shoe	Very noticeable if not covered and could be uncomfortable
Detects overdose and does not go off when there is no overdose	No	No	No
Reacts to overdose within 1 minutes	Yes	Yes	Yes
Updates information without prompt	Yes	Yes	Yes
Has cancelling option	No	No	No
Pleasing to the eye	No	Not seen	No
Measures users respiratory rate	No measures blood oxygen level	No measures blood oxygen level	Yes
User can enter personal stats	No	No	No
Can last at least 24 hours	Yes	Just 24h	Yes
Constantly measures blood oxygen levels	Yes	Yes	No measures respiratory rate
Administers Naloxone	No	No	No

Sends GPS location of the user to authorities upon activation	Yes	No	No
Total Points	**30**	**31**	**28**

Therefore the best product design is the Foot ball wrap

Heidi's Ideas

1. Sole Fragment Oximeter



This sole bit is made to be put in a shoe. It is only the top fragment of a sole so it can fit anyone's shoe. Near the big toe area, there is an incision in the sole material for the toe to be able to reach the blood oxygen sensor. On the inside of the sole, we can find the blood oxygen sensor, as well as the arduino nano microcontroller, a breadboard and a battery (not included in drawing) to power the arduino. The material of the sole is leather, but the sole is lined with metal to be able to resist

the force applied by the person who will walk with the sole in their shoe. The arduino would be programmed to send a bluetooth call signal to the opioid user's phone when the blood oxygen is lower than 90%. We would have to code this function, as well as the blood oxygen measurement function. The price would fit into our range, considering the fact that the leather material would be around 10$CAD, the arduino nano would be around 25$CAD and the sensor would be around 4-10$CAD. For the metal lining, we can use scrap material from the MTC in STEM. The breadboard and wires would be around 15$CAD and the battery would be around 10$CAD. Total cost would be around 65-70$CAD.

2. Phone case oximeter

In this design the oximeter device system would be inserted into a card holder phone case. The layout of the technical aspect of the device (ie. arduino nano, blood oxygen sensor, etc.) would be the same as the previous design. The only difference is that it is held into a phone case. The user would have to hold their finger at the back of their phone while injecting so the sensor could measure their blood oxygen. The price range would be around 80-85$CAD considering the fact that the phone case would be around 20$CAD. The only issue with this device would possibly be the accessibility, since not

everyone has a phone, or a phone big enough for this case. This product would also monopolize the user's hand while injecting, which can lead the user to maybe not want to use this device.

3. Glove oximeter.

This third design is a glove and has a built-in oximeter on one of the fingers . This device does not use an arduino to function. Instead, the built-in oximeter has its own functioning bluetooth system and can be connected to an app on the user's phone. It can send a notification if the blood oxygen levels get under 90%. The cost of this device is around 250$CAD, since we would have to get an oximeter that can connect to an app (around 230$CAD) and a good pair of gloves (20$CAD).

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Benchmarking Designs

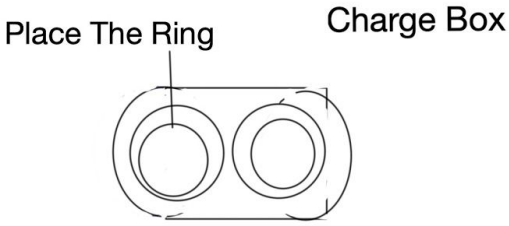
Point system: 3 = green 2 = yellow 1 = red

Design Criteria	Sole	Phone Case	Glove
Waterproof and not easily broken	Solid because of metal lining	Relatively resistant if phone is handled with caution	Less resistant since glove is made out of soft material
Can connect to apple and android phones	Yes	Yes	Yes
Costs less than $100	Yes	Yes	No
Not noticeable and does not interfere with everyday tasks	Yes	More or less	No
Detects overdose and does not go off when there is no overdose	Yes	Yes	Yes
Reacts to overdose within 1 minutes	Yes	Yes	Yes

Updates information without prompt	Yes	Yes	Yes
Has cancelling option	No	No	No
Pleasing to the eye	Yes	Yes	No
Measures users respiratory rate	No	No	No
User can enter personal stats	No	No	No
Can last at least 24 hours	Yes	Yes	No
Constantly measures blood oxygen levels	**Yes**	**Yes**	**Yes**
Administers Naloxone	**No**	**No**	**No**
Sends GPS location of the user to authorities upon activation	**No**	**No**	**No**
Total Points	**30**	**28**	**15**

Yuhui's Ideas

1. Ring Oximeter



The device loops around any finger and is as light as a ring. The battery and pulse oximeter are placed in the ring ring. The battery can be used for half a day because it is small. The ring is equipped with a portable charging case and can hold two rings. The size of the palm of the charging box can be charged at any time until the charge box runs out of power. It is made of durable waterproof material. It can send a Bluetooth signal to a phone or other device, dial the emergency sos help number on the phone when an emergency occurs, and use the phone's GPS system to send out location information. Bluetooth signal hosting ($ 15), pulse oximeter ($ 40), arduino and parts ($ 35) Ring material ($ 10) Charging case material ($ 20) Charging case battery and earphone battery ($ 50) Total cost is about $ 170 .

2. Mask Respiratory Detector

This device is used to measure the breathing rate. This is a mask-shaped device. The material is a flexible fiber with air holes large enough to allow air to circulate. The battery is placed in the center of the mask, and the device can be used to measure the user's breathing rate per minute to detect abnormal breathing rates. It will send a Bluetooth signal to the mobile phone or other devices. When an accident occurs, it will trigger the SOS alarm function of the mobile phone and use the GPS positioning of the mobile phone to send a signal. The device includes a battery ($ 15), an arduino and Bluetooth connector ($ 45), a mask ($ 8) and a breath monitor, and ($ 40) the total cost is about $ 108.

3. Glasses Oximeter

The device rests on the ear and clips on both sides of the head. The device is fixed around the head and the top of the ear, and the battery and Bluetooth transmitter are placed on the frame at the front of the ear. The device can work for 1 day. It is made of durable waterproof material. The oximeter pulse is placed in the gap between the ear and the head to measure the oxygen saturation. It can send a Bluetooth signal to the phone to frequently record vital signs and send location information to the authorities within one minute of detecting an overdose. The total cost including battery ($ 15), pulse oximeter ($ 40), glasses ($ 20), arduino and Bluetooth ($ 45) is about $ 130.

Benchmarking Designs

Point system: 3 = green 2 = yellow 1 = red

Design Criteria	Ring	Mask	Glasses
Waterproof and not easily broken	Yes, made of waterproof plastics	No, made of soft fabric	Yes, PVC and Metal
Can connect to apple and android phones	Yes	Yes	Yes
Costs less than $100	No	No	No
Not noticeable and does not interfere with everyday tasks	Yes	No	More or less
Detects overdose and does not go off when there is no overdose	Yes	Yes	Yes

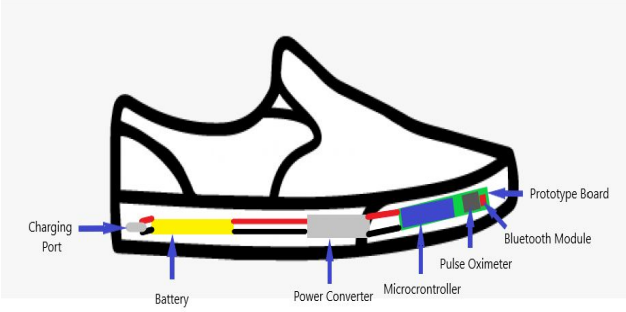
Reacts to overdose within 1 minutes	Yes	Yes	Yes
Updates information without prompt	Yes	Yes	Yes
Has cancelling option	No	No	No
Pleasing to the eye	No	No	Yes
Measures users respiratory rate	No	Yes	No
User can enter personal stats	No	No	No
Can last at least 24 hours	No	Yes	Yes
Constantly measures blood oxygen levels	**Yes**	**No**	**Yes**
Administers Naloxone	**No**	**No**	**No**
Sends GPS location of the user to authorities upon activation	**No**	**No**	**No**
Total Points	**32**	**29**	**32**

Top 3 Ideas

Based on the benchmarking design tables the three best designs were the shoe/boot, the watch, and the ear oximeter. These designs were decided upon through the benchmarking criteria as well as discussion amongst the group.

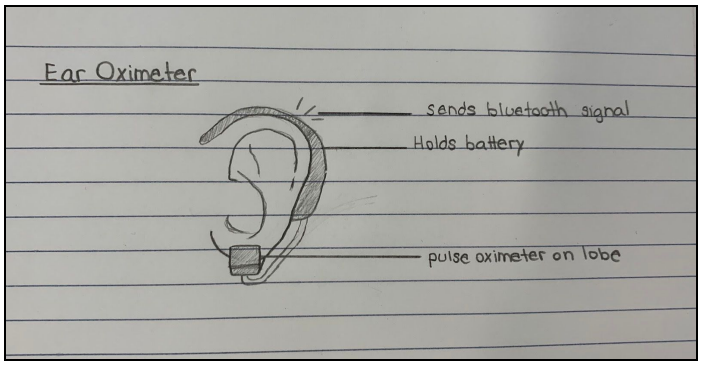
The most important criteria that was met by the designs were their durability in various weather conditions, low cost, discreteness, and ability to constantly measure blood oxygen levels.

Shoe/Boot



Watch

Ear Oximeter



Conclusion

By completing this deliverable we were able to determine the 3 best design concepts to meet the users needs. By keeping the problem statement in mind, we all created our own 3 ideas for different designs of the device, and gave thorough descriptions with visuals.

By using the established list of needs from our client we were able to brainstorm ideas and turn them into designs. Through discussion and benchmarking we were able to decide on the three best ideas as previously shown. These ideas will be presented to the client in the near future and we will obtain feedback on the designs.

Future Plans

As we progress further in this project, our designs will need to be broken down so we can determine the hardware and software required. In the upcoming weeks we'll be coming up with a more in-depth project plan and will be discussing with the TA and project manager a cost estimate for the device.
Once that has been completed, we will begin working on our first prototype to show to the client.