Deliverable E: Project Schedule and Cost

GNG 1103 Group 12C

Names:

Abdullah Abdulmajeed

Alyssa Wang

Antonia Zupu

David Konyer

Spencer Henry

Yomna Elsahili

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To: Prof. David Knox, Ms. Rani Damuluri, Mr. Saelameab Demilew

This report will showcase possible construction components of our LifeLine product and provide a prototype testing outline.

Introduction:

In this deliverable we will outline a plan to construct a combination of focused style prototypes to ensure that the final product looks and functions appropriately as intended. The first stage will examine the outer case of the device and other essential components like the oximeter. Subsequent stages will build on that until the final design is built with the requirements as shown in Table 1 below. We will also include an excel document with the list of materials needed to construct our prototypes and their costs so that we can manage our budget.

As discussed within our last deliverable, our finalized conceptual design will consist of a large wristband which will contain the central device on top with a small extension placed on the inner palm for measuring blood oxygen saturation levels. When the device detects signs of an overdose, it will send signals to a phone application that will confirm if the person is overdosing and then either proceed with getting help or leaving as a false alarm.

After further reflection, we realized that a major component of the design was forgotten, the battery and it's charging mechanism. This is a vital aspect of our device since the device should be worn daily and for extended periods of time since the time at which the person will use is unpredictable. Research has brought us to the conclusion that the lithium ion battery is the best choice because they are known to be compact and have persistent longevity. The battery should be able to sustain the functions of the device for at least a 24 hour period. Alongside the addition of the battery, we would like to implement a switch that controls the device. This would make sense because the device only needs to function when the person is using opioids and thus would be responsible for turning it on when necessary. This would be beneficial because it would conserve energy, thus reducing the risks associated with the battery not having a long enough life span.

Furthermore, initially we thought that we would have to be restricted to a premade phone application, like *Bluefruit*, due to its compatibility with the *Arduino Uno*. However, after further discussion we had come to the conclusion that creating an phone application on our own would be best for our device. This will allow us to design the app with customizable features and make the app more user friendly. Not to mention, the presentation of the app contributes significantly to how our client will perceive us, thus it is important that it accurately reflects the efforts of the team.

Task Prototypes:

Deliverable	Task	Testing Method	Design Criteria	Material Needs:	Group Member
Deliverable F: First Prototype	Schematic Circuit Diagram	-Logical	- Functionability	N/A	Abdullah
	Phone Application Set up	-Ease to Use*	-Functionability	App Inventor	Spencer Help from: David
	Visual Model of Exterior Device Frame (Velcro Option)	- Client Feedback	- Discreetness - Comfort - Invasiveness	-Drawing program	Antonia
	Visual Model of Exterior Device Frame (Elastic Option)	- Client Feedback	- Discreetness - Comfort - Invasiveness	-Drawing program	Alyssa
	Code Template	- Logical to follow	-Functionability	N/A	Yomna
Deliverable G: Second Prototype	Coding the alarm & response failsafe	- Response Trials -Testing oxygen saturation response time on phone with bluetooth module, performing breath holding and exercising tests.	-Discrete - Functionability	-Arduino Board -Wires -Bluetooth Module	Alyssa Help from: Yomna
	Oximeter Accuracy and Placement	-Oximetry accuracy test comparison to other products on the market. -Test accuracy of the oximeter at different locations(ear lobe, wrist, palm, finger)	-Accuracy of blood-oxygen level reading -Provides obscurity to shield the users from opioid stigma.	-MAX30100 Oximeter Chip. _Breadboard. -Arduino Uno Board. -Market Oximeter. -Connection Cables.	Abdullah Help from: David
	Bluetooth connection Works (Blood-oxygen level is sent to	- Response Trials	-Functionability	- None	David

	app)				
	Creating the main code	- Check if blood-oxygen readings are sent and displayed on app	-Functionability	-Phone application -Arduino Uno	Alyssa Help from: Yomna
	Interior Device Frame	- Scale - Bending - Customer Feedback	-Weight -Bulky -Durability/Strength	-3D Printing	Antonia Help from: Alyssa
	Exterior Device Frame (Refer to Figure 1.)	-Putting it on and moving around - Client Feedback	-Comfort -How much it moves -Durability -Discrepancy	- velcro -gorilla glue -fabric	Antonia Help from: Spencer
	Speed of Overdose detection	- Accuracy in readings during exercise and sleep	-Functionability		Abdullah & Spencer
Deliverable H: Third Prototype	Device Connection to App	- Response Trials	- Functionability	Device: -MAX30100 Oximeter Chip. _Breadboard. -Arduino Uno Board. -Market Oximeter. -Connection Cables. -Phone Application	Alyssa, Yomna & Abdullah

Table 1. Stages of prototype design and testing.

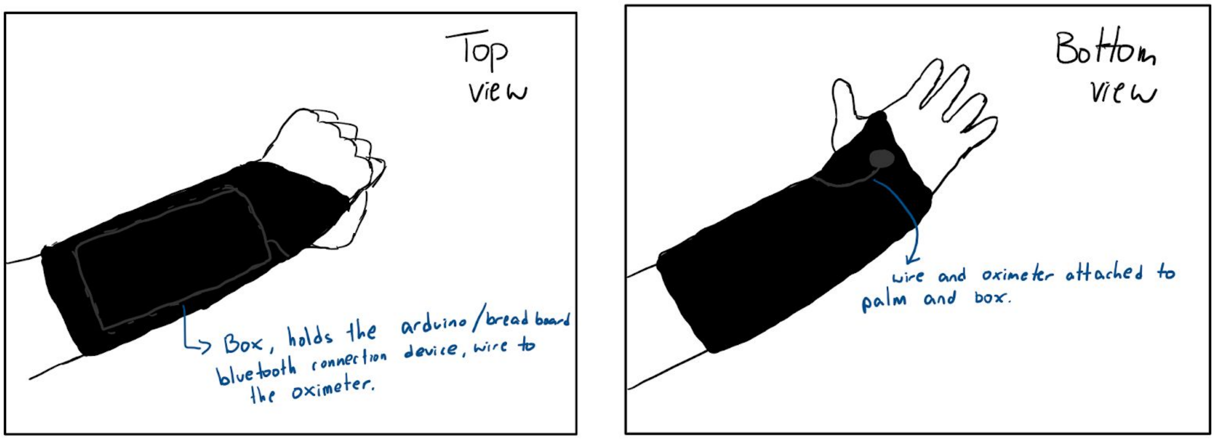


Figure 1. Device Frame Idea.

Testing Methods:

Throughout each prototype stage, there will be several test trials completed to ensure all aspects of our device are functional. For the first prototype, the tasks required will be very preliminary and will be improved based off of the feedback provided by the client. During the second prototype, the coding of the alarm and failsafe, and speed of overdose detection will be tested by conducting trials that will attempt to simulate a real overdosing scenario. This will be done by attaching the blood oxygen saturation device to someone undergoing vigorous exercise because one's oxygen levels typically lowers during physical activity due to less binding being able to occur between the oxygen and hemoglobin. This will also be tested while someone sleeps since blood oxygen levels typically drop during this activity too. Another task involves determining the accuracy of the oximeter. This will be done by testing the oximeter at different locations on the body, specifically the finger, palm, wrist, and ear. This will help us ensure that we pick the best placement for our device such that we minimize the risk of a false reading. This accuracy will also be reinforced by comparing the measured blood oxygen levels found by our device and a real oximeter. Moreover, the tasks focused on the connection and delivering of data from the device to the phone application will simply be tested by inspecting the functionality of the system. The interior of the device will be tested to ensure that it does not interfere with the daily life of the user. This means tests will be conducted involving movement of the arms to determine if the device is too bulky and restricts normal functions. Lastly, the exterior of the device consists of how the device will be worn. Since the user will be wearing it daily, how comfortable the exterior device is needs to be tested. This will be done by having someone wear the wristband for extended periods of time and monitoring how comfortable it is. Also, the exterior device needs to accomodate for a large range of sizes, thus we will test this by having multiple people with varying forearm sizes try the device on to ensure it fits.

Client Meeting Preparation:

We will present our prototypes for the exterior device frame and use the feedback the client gives as a basis for improvement. In the last meeting, the client emphasized that the subtleness of the device is her biggest concern, therefore we will have multiple prototypes for them to choose from or criticize.

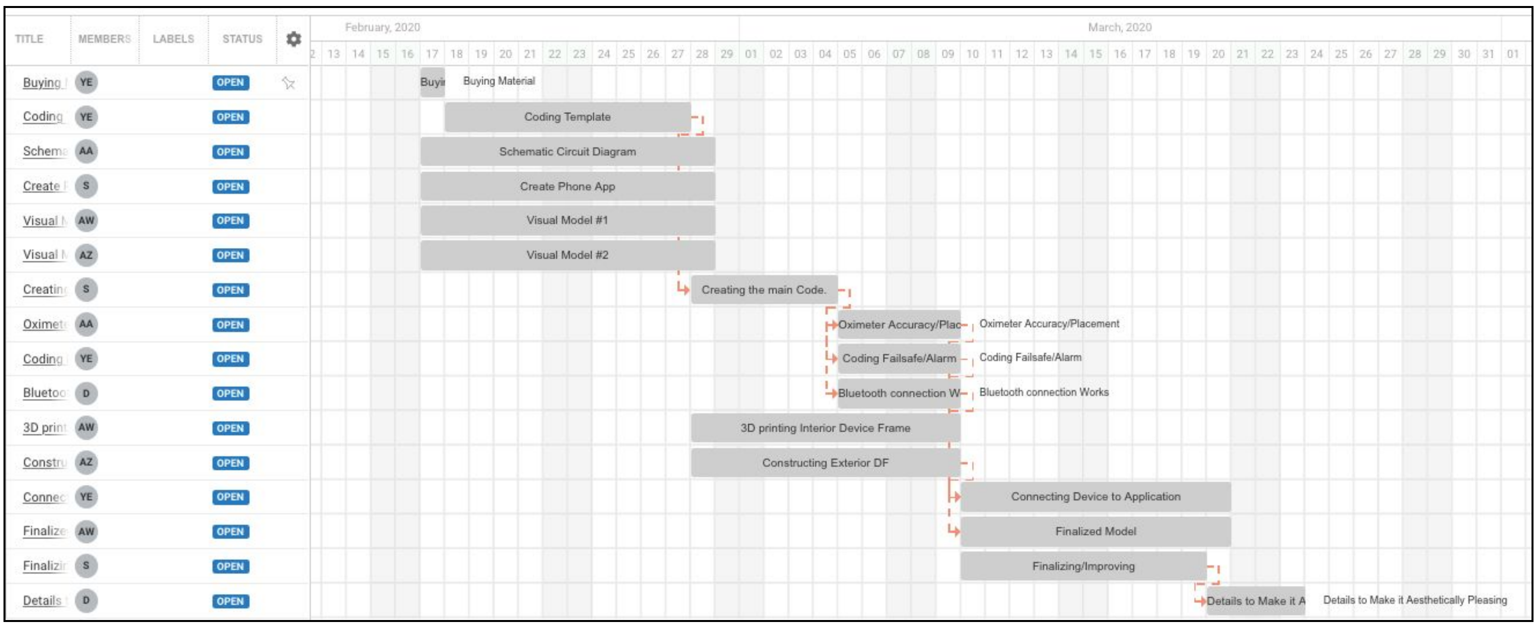
Schedule:

Task	***Duration***	***Group Member In Charge***	***Due Date***
Buying/Collecting materials	Once this deliverable is done, getting all the materials to begin building and testing our prototypes	Yomna	February 17th
Schematic Circuit Diagram	February 17th - March 1st	Abdullah	March 1st
Coding Template	February 24th - March 1st	Yomna	March 1st
Creating Phone Application	February 24th - March 1st	Spencer Help from Antonia	March 1st
Visual Model of Exterior Device Frame (Velcro Option)	February 24th - March 1st	Antonia	March 1st
Visual Model of Exterior Device Frame (Elastic Option)	February 24th - March 1st	Alyssa	March 1st
Creating the Main Code	March 1st - March 5th	Spencer Help from Abdullah and Yomna	March 5th
Oximeter Accuracy and Placement	March 5th - March 8th	Abdullah	March 8th
Bluetooth connection Works	February 24th - March 8th	David	March 8th
3D printing the interior case	3D printing training on February 27th. March 1st - March 8th	Alyssa Help from David	March 8th
Constructing the Exterior Device Frame	March 1st-March 8th	Antonia	March 8th

		Help from Spencer	
Coding failsafe alarm	March 5th - March 8th	Yomna Help from Spencer	March 8th
Finalized exterior device model -connecting the oximeter and exterior shell	March 8th -March 22nd	Alyssa Help from: Antonia, Abdullah	March 22nd
Connecting the device to the application	March 8th - March 22nd	Yomna	March 22nd
Finalizing and improving	March 8th - March 22nd	Spencer	March 22nd
Last minute details to make it aesthetically pleasing	March 9th - March 22nd	David	March 22nd

Table 2. Task Schedule.

Gantt Chart:



Project Risks:

The main risk with our prototypes is an aspect of our device malfunctioning causing us to change our conceptual design. When testing our oximeter, there are risks regarding the accuracy of its placement. If having it on the palm of the hand doesn't give as accurate readings as the finger placement does, then we will need to reconstruct our design concept and move the whole device to a different part of the body. Changing the location changes the device frame, which may result in us having to purchase more materials and allocating more time in adjusting to the new design. This would cause major delays within our schedule since other aspects of our design, exterior frame and functionality of the syncing of data between the device and phone, are dependent on the functionality of the oximeter. Thus, they cannot be started until the oximeter is successfully working. In order to mitigate the risk of this occurring, we will be testing the device in multiple different locations and under different conditions to ensure the consistency of our results. We will also be adding a switch to control when the device is on and off. This will be beneficial since it will ensure that false readings are not found due to certain conditions such as during exercise, sleep, and in cold temperatures (may lead to vasoconstriction in the blood).

Moreover, risks may arise if we encounter problems with our code. If we cannot get the alarm to work, then our idea that would set us apart from the rest, would no longer be included into our design. As well, the phone application aspect of our device depends on a functional code that connects the main device to the user's phone. Issues relating to this would result in setbacks in our work since being able to contact help was a feature significant to our client. Thus, we would have to re-design our interactive application, which could also cause problems with our failsafe.

In addition, waiting for the materials to come in can lead to problems because any late shipments would result in us being unable to start the building process, thus causing delays within our schedule. To avoid this, we need to allocate the amount of time necessary for the materials to arrive in our schedule (gantt chart). We would also make each member responsible for a certain material to ensure that no miscommunication would result in missing or double ordering of parts.

A contingency plan was created by our team based on a list of possible risks and limitations. The greatest risk with our design is if the blood oxygen saturation monitor does not properly function in terms of both the purchased device and the program's code. If this were to occur, our best course of action is to consider backup pulse oximeter modules and adjusting to the change.

Materials & Costs:

Please refer to the attached excel spreadsheet for BOM.

Materials Needed:

- **MAX chip Pulse Oximeter:** A pulse oximeter chip that is compatible with arduino that measures blood-oxygen levels.
- **Arduino Nano:** A smaller version of the arduino board is needed in order for the device to stay small/light.
- **Bluetooth Module:** This is needed in order to connect the arduino device to the phone application in order for the GPS signal to be sent from the phone.

- **Velcro Strap:** The velcro strap is needed to hold our device in place on the arm of the user. The straps can help the user adjust the size and make it tighter or looser if needed.
- **Arm Tensor Fabric:** This material is the basic shell of our device. It is what all components will be attached to. We wanted a tensor fabric rather than any fabric so that it is tight and holds the pulse oximeter against the skin without it moving around no matter what the user is doing in their day to day activities. Tensor fabric is also very reliable as it is strong and thick so it is likely to survive a long time through average daily activities.
- **Wires:** Is needed to connect electrical components in our prototypes.
- **Battery:** The client stressed the importance of having a device that does not run out of battery quickly or needs to be recharged constantly. Therefore, we have decided on a 3.7 V battery and an electrical component that allows the battery to be recharged via a USB port (this component also logs data as an extra pro).
- **Breadboard:** This breadboard will be used for prototype one and two (as the team has not completed the soldering lab yet) to connect the components via wiring.

All the electrical components ordered are of the same voltage (3.7V)

When determining which material was the best choice, factors that were taken into consideration were cost, availability, quality, and reviews. Quality was one of the highest priorities because we needed to ensure that the materials we use are compatible with each other and suitable for its purpose (like being compact or comfortable). The quality of the product was verified by looking at the reviews to see if other customers were satisfied and to determine if the product is exactly how we expect to avoid problems in the future. Cost was also very important since we only have a $100 budget, thus we tried to find items that were cost efficient. Lastly, availability was considered since we have a busy schedule to uphold, thus most of our items were found on *Amazon* since we have *Amazon Prime*.

Conclusion:

In conclusion, the conceptual design was broken down into 3 stages which the execution of the design will occur in. Prototype 1 will consist of preliminary sketches in preparation of the physical prototype. Prototype 2 will be the first physical model built with cheap and simple materials to test the basic features of the device. Lastly, prototype 3 will be the finalized design where we add our last adjustments before presenting our device.

After outlining the steps, we were able to establish a materials list and the approximate cost for them. This outline is significant because it provides further insight on each aspect of the device, ensures the budget is maintained, and prioritizes, assigns, and determines the time required for each task. We determined the materials which would be used in preparation for building the physical prototypes. Realistically, we will face many challenges and problems during the construction of the device. Planning mitigation techniques and creating a contingency plan will help to minimize the amount of issues we encounter throughout the building process. Establishing more detailed steps and descriptions for each task has already led us to notice problems within the design like the missing battery aspect. Thus, the importance of finding mistakes like this early in the planning process is evident as it saved us from having to readjust our entire design to accommodate for the missing battery, as well as the negative impact it would have on our time and money. Ultimately, a thorough plan will ensure that all members are organized and prepared for any potential problems such that we are able to effectively execute the vision of our design.

Citations:

1. "Why does vasoconstriction happen?," *Healthline*. [Online]. Available: https://www.healthline.com/health/vasoconstriction
2. "Why a Pulse Oximeter is Important for High Endurance Athletes," *iHealth*. [Online]. Available: https://ihealthlabs.com/pulse-oximeter-important-high-endurance-athletes/