GNG1103

Deliverable E: Project Schedule and Cost

Opioid overdose prevention device

Submitted by

GNG 1103, Section C00, Group 1

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February 16th, 2020

University of Ottawa

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Introduction

The objective of this deliverable is to develop a structured project plan to make sure that our group is on track to developing three device prototypes on time. This plan will also allow us to properly plan out an estimated cost of components for each of the prototypes and final design. There are a total of three prototypes due from now until our design day. Our first prototype will be relatively cheap and will allow us to properly visualize what we want our product to look like. This prototype will also be used in the second client meeting held on february 13th in UOttawa's STEM building. We will try to find materials around the makerspace area and use all the free resources at hand to make a scale model which will serve as a shell for the arduino processing board and necessary parts. This prototypes main function will be to demonstrante to the user/client what the device will look like and will give them an idea of what day to day device interaction would look like. The second prototype will serve to test the functionality of the device. It will ensure all non-functional requirements can be met and that these aspects of the device are up to group standards. The third prototype will serve to test all functional requirements and will demonstrate how well all arduino parts/sensors will come together. This will also show us if the system will truly be capable of detecting someone's BPM and BOP (Blood oxidation level) through arduino sensors. It's main function will be to allow us to know where we are in the development stage of our prototyping to then be able to move forward with our final product and device testing.

In order to come up with a organized and structured project plan we will include a list of all tasks needed for each prototype. The project plan will also include the duration of each task to make sure we are not falling behind on our project plan and will include a list of members responsible for each task. We will also utilize Gantt charts to organize and set up our prototype plans. Project planning includes planning for project risks and allowing for a contingency plan. This will allow the project to stay on course while also taking into account the fact that each team member has a heavy workload. Finally, the step will break down all the different types of parts and components needed for each prototype. The final part will also present an estimated cost for each prototype and an overall estimated cost of our final design of the device. The goal of this final part will be to ensure we stay on budget between $100.

Project Plan

1). Tasks to Be Completed

Prototype 1 - Appearance

The first prototype focuses on a low fidelity/low cost model with the intention of mainly showing the client the concept to ensure it is a viable option to reduce the time wasted if the concept proves to be unsatisfactory. The model itself will be a simple physical model with materials that are at hand, as the main focus of the project revolves around how the device will be worn as per the problem statement shown in class “Not be intrusive or hard to use for the user.” (users must want to use the device consistently)[Lecture 1, p.g 13]. The model will also be used to test general functionality with hopes to rule out any abstract ideas that were not clear without a physical model during the ideate stage of our project.

The initial prototype focuses on a low fidelity/low cost model to show to the clients and to observe as a team to check general functionality. This is done to help validate the initial concept and reduce the uncertainty of future models. Essentially, it will provide the bare basic information to see if the current solution holds value as a product and avoid any critical flaws. It will include a simple physical model with basic materials and a simulated model in solidworks. The physical model will be used to help communicate the simulated model which will naturally be more accurate. Then comparaisons can be made between simulation and reality in the basic sense as both models lack comprehensibility. A focused prototype will be made as well in regards to a basic, non-functional Dashboard UI. This will help model the basic idea of the UI. Another low fidelity model will include the basic wiring for one SD card slot to check if it is possible to tell electronically if SD card is in place or not.

Task List for Prototype 1

Task	**Person assigned**	**Duration (Days)**
Buying and customizing Ankle brace	Adam	2
Buying velcro scraps	Zach	1
Mounting velcro to sock	Callum	
Design casing to be 3D printed	Tristan Brady	2
Install all parts together	Everyone	1

Buying List (Deadline: February 27th)

1. Compression sock/Ankle brace
2. Velcro straps
3. PLA filament

Prototype 2 - BlueTooth and App

The second prototype for this project focuses mainly on a medium fidelity/low cost model. The main focus for this model is to test/check the functionality as well as feasibility of the bluetooth and a barebones app. We will be also using prototype 1, after analysis from the results/feedback from the first client meeting to test the functionality of combining the two prototypes with the main focus of linking the arduino bluetooth to a cellular device, the app itself for this prototype will be to test if a signal can be sent from the arduino bluetooth chip to a phone to call a number (later the EMS number will be implemented). 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 hope is to have the BPM (beats per minute) and BOL (blood oxygen level) displayed on the app as well. The second prototype will mainly be focusing on testing the arduino set-up, through testing we hope to find the optimal combination of components in the most feasible way.

Task List for Prototype 2

Task	**Person assigned**	**Duration (Days)**
Assembly of Arduino UNO and bluetooth module with jumper wires	Tyler	1
Coding	Tristan / Adam	4
App programming and creation	Zach/ Callum	7
Integration of Parts and compression sock	Tristan	1
Bluetooth connection test	Everyone	2

Buying List (Deadline: March 6th)

1. Arduino UNO
2. Bluetooth w20
3. Jumper Wires
4. PLA Filament

Prototype 3

The focal point of the final prototype is to assess the performance of the incorporated aspects of our design while requiring a high value budget. We will use the first two prototypes to guide and ensure practicality of prototype 3, while using the feedback control system implemented with the response from the initial designs. This will minimize the wariness of future models as well as highlight the specific elements that need improvement. With the main goal of prototype 3 being product functionality, it will provide invaluable information on the progress of our system as well as establish a baseline for further development.

This prototype will include a bluetooth chip, along with the wiring, arduino uno and blood oxygen sensor. We've also added straps to securely hold the device to prevent sliding and discomfort. Prototype 3 will be able to show just how well the product will feel and perform, with performance and overall device effectiveness being our main concern. The hardware and core functionality can be tested many times throughout the design process, but this prototype will be pretty much exactly what our products will be like from a customer's point of view.

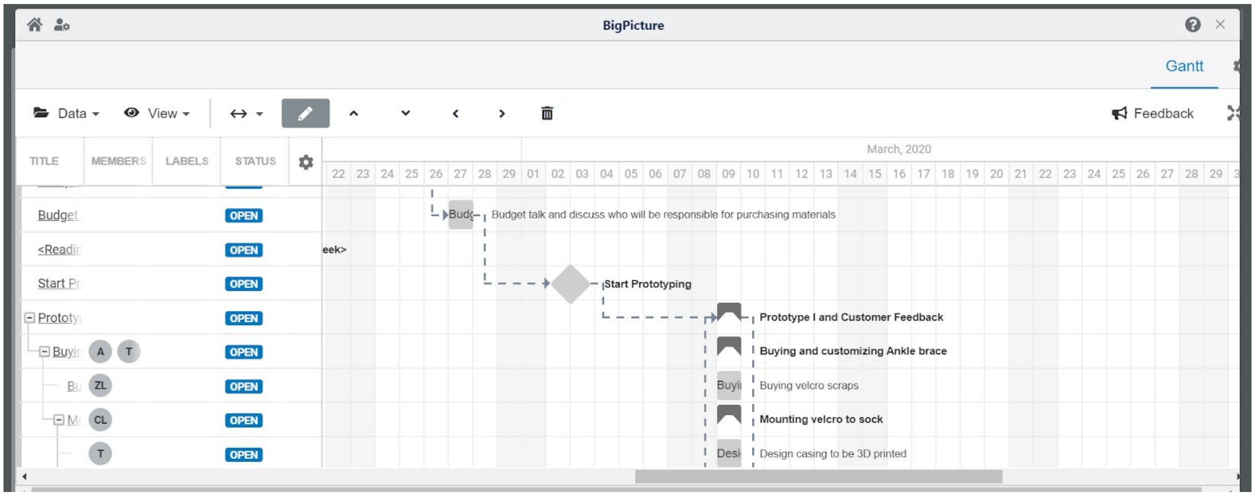
Task List for Prototype 3

Task	**Person assigned**	**Duration (Days)**
Assembly of Arduino UNO and Oximetry sensor with jumper wires	Tyler	1
Coding	Tristan / Adam	4
Integration of Parts and compression sock	Zach	1
Sensor functionality testing	Everyone	2
Assembly and aesthetic design	Zach/ Callum	2

Buying List (Deadline:March 20th)

1. MAX30100 Heart Rate & Oximetry sensor
2. Arduino UNO
3. Jumper Wires
4. PLA Filament

2). Gantt Diagram



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Budget talk and discuss who will be responsible for purchasing materials

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Start Prototyping

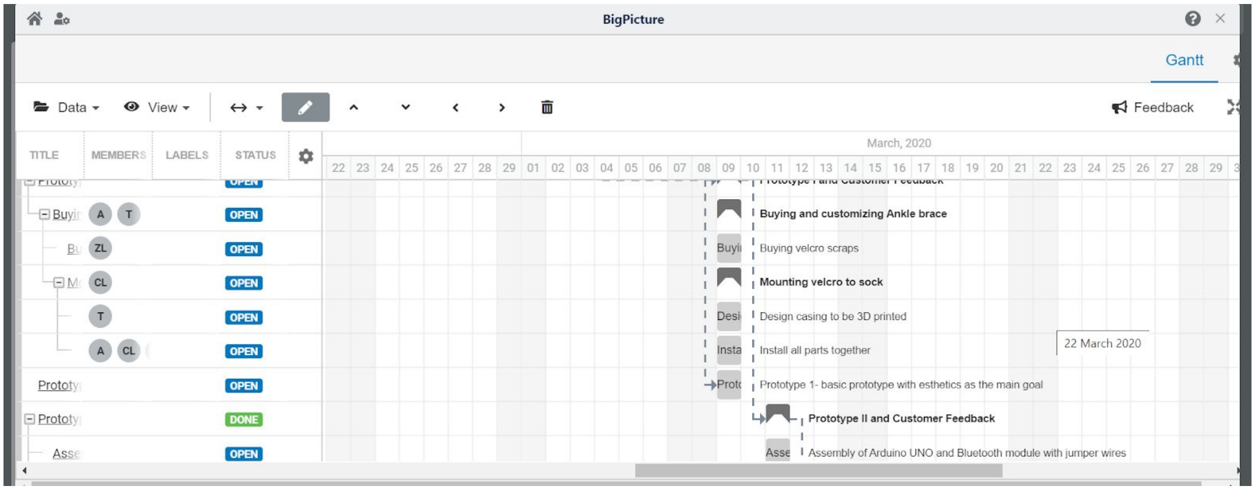
Prototype I and Customer Feedback

Buying and customizing Ankle brace

Buying velcro scraps

Mounting velcro to sock

Design casing to be 3D printed



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Buying and customizing Ankle brace

Buying velcro scraps

Mounting velcro to sock

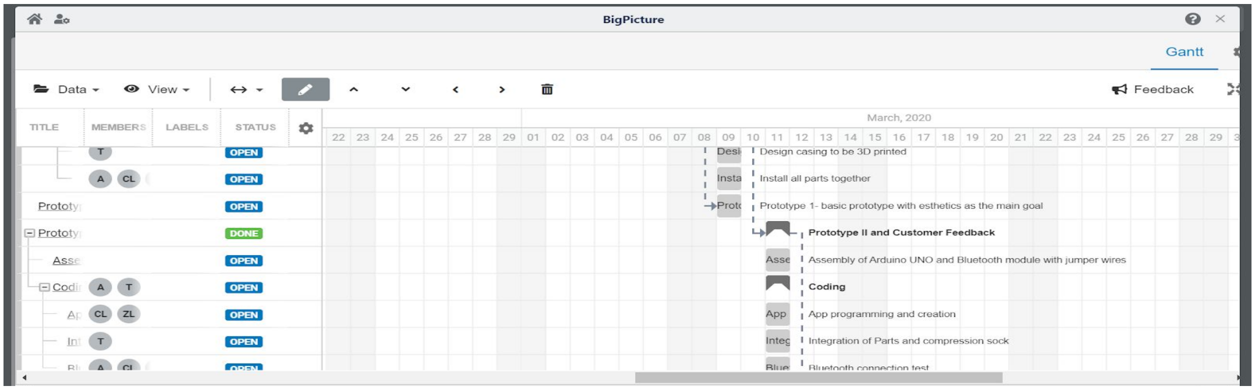
Design casing to be 3D printed

Install all parts together

Prototype 1- basic prototype with esthetics as the main goal

Prototype II and Customer Feedback

Assembly of Arduino UNO and Bluetooth module with jumper wires



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Design casing to be 3D printed

Install all parts together

Prototype 1- basic prototype with esthetics as the main goal

Prototype II and Customer Feedback

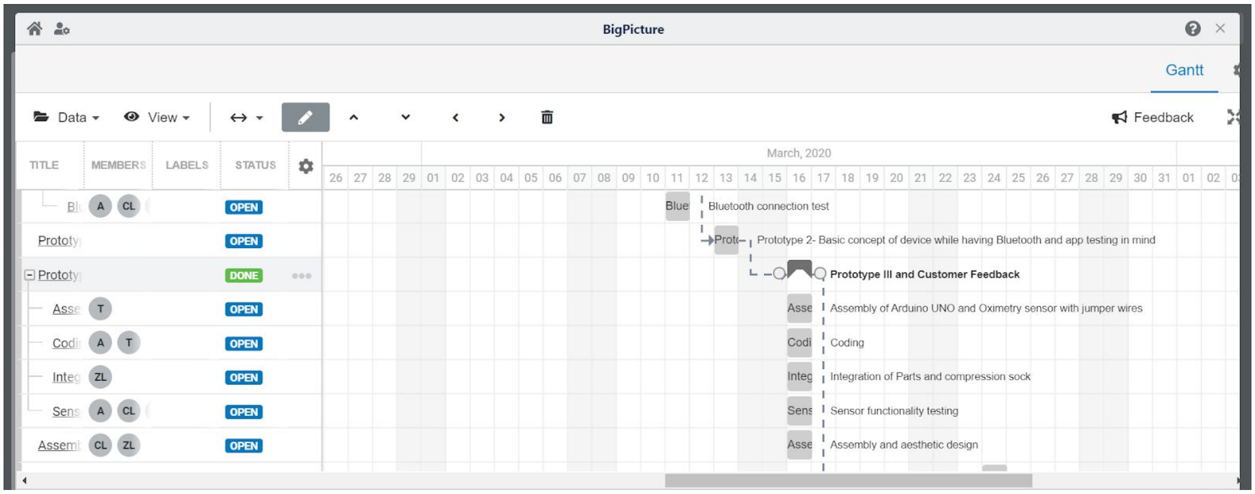
Assembly of Arduino UNO and Bluetooth module with jumper wires

Coding

App programming and creation

Integration of Parts and compression sock

Bluetooth connection test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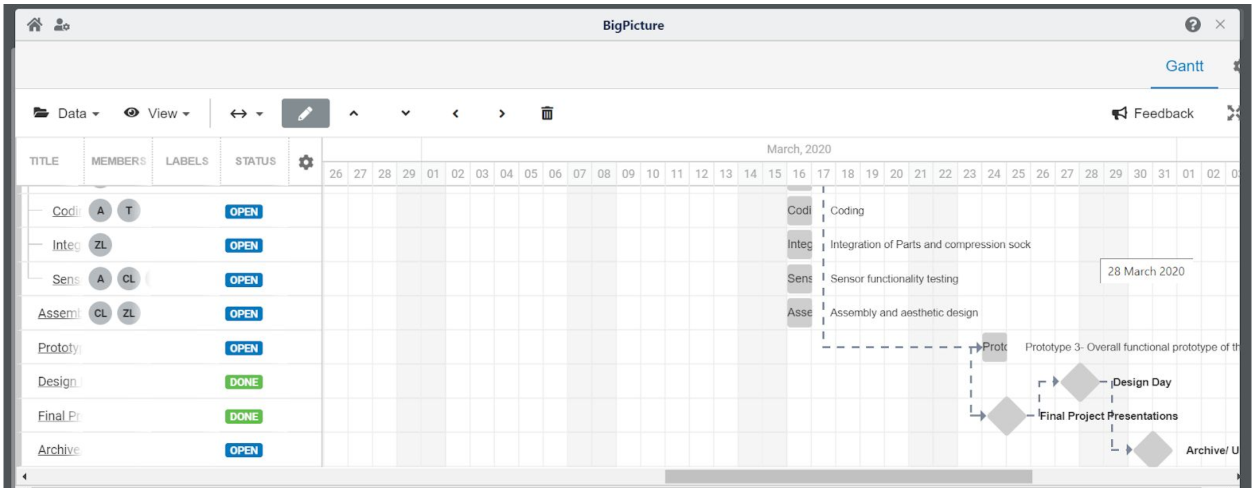
Blue Bluetooth connection test
Proto Prototype 2- Basic concept of device while having Bluetooth and app testing in mind
Prototype III and Customer Feedback
Asse Assembly of Arduino UNO and Oximetry sensor with jumper wires
Codi Coding
Integ Integration of Parts and compression sock
Sens Sensor functionality testing
Asse Assembly and aesthetic design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Sens Sensor functionality testing
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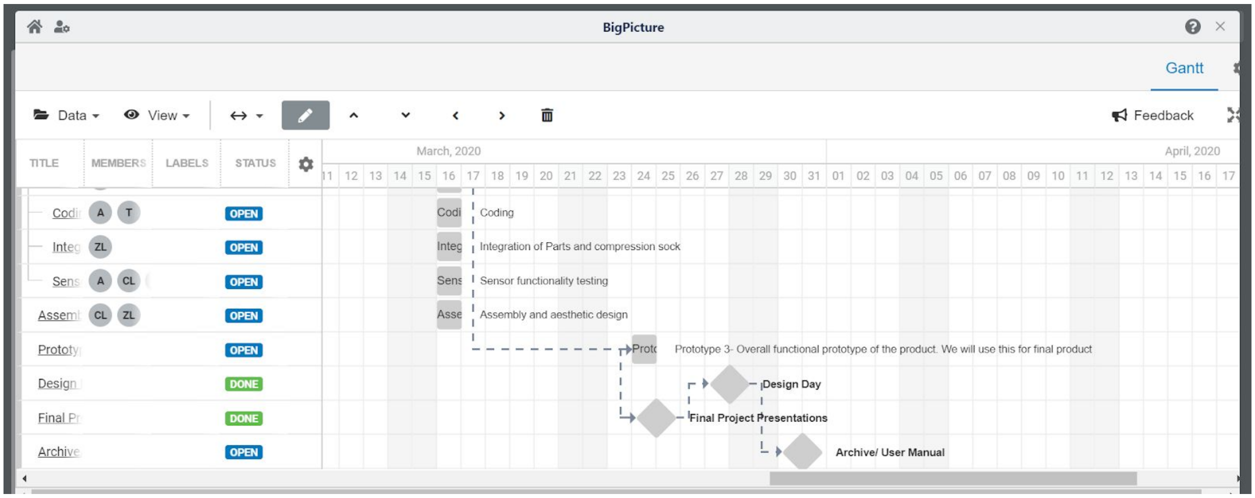
Design Day
Final Project Presentations
Archive/ U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Codi A T OPEN
Integ ZL OPEN
Sens A CL OPEN
Assem CL ZL OPEN
Prototy OPEN
Design DONE
Final Pr DONE
Archive OPEN
Codi Coding
Integ Integration of Parts and compression sock
Sens Sensor functionality testing
Asse Assembly and aesthetic design
Protc Prototype 3- Overall functional prototype of the product. We will use this for final product
Design Day
Final Project Presentations
Archive/ User Manual

3). Project Risks

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 come with such a large project. 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.

For the completion of this project we will need to order parts online, therefore there is always a risk of our parts not getting in on time, which could throw us off schedule. If this situation happens, we will have to find parts in stores that will accommodate our project, even if these parts are not ideal. Finally, our project is also very dependent on a couple computer programs, therefore the risk of computer malfunction becomes a risk. There is always a chance of the computer or software crashing, or an issue of saving your work. In preparation for this, we will be saving and backing up our work more frequently to prevent problems in relation to the many computer programs used.

Estimated Cost

The core concept of our design consists of 2 elements; the electronic element, and the human mounting element. As of the date of this report, the exact design is not finalized, but based on the prototypes, the device will guarantee to consist of less than 10 individual components. 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.

Bill of Materials

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**

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[1]

Price for 1

($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,compacitors, acrylic casing to store the Narcan nasal spray, added an aditional $20, rechargabl. This ultimatly brought our final price to $69

Discussion

The components with the highest cost are tied between the Arduino UNO processor and the Compression socks at $22.99 plus shipping. The Arduino UNO is said to be given to the groups for free, but it is still included for an accurate representation of the cost to manufacture our product. The components that could not be purchased straight from the university include the heart rate oximeter and the compression socks. Between the countless selections on the internet for compression socks, the brand our team went with is EULAY, as they have the highest sock to dollar ratio. EULAY gives us 6 pairs of graduated compression socks for the price of $22.99 and free one day shipping with Amazon prime. The only brand that comes close to EULAY is CAMBIVO who offers 2 pairs of compression socks for $17.99 with the one day shipping as well. CAMBIVO losses to EULAY in the numbers of choices for designs, and, sock to dollar ratio (EULAY with $1.91/SOCK and CAMBIVO with $4.49/SOCK). For the pulse oximeter, it eventually boiled down to the decision to go with MAXREFDES117# and the MAX30100. Both pulse oximeters are compatible with arduino and are significantly cheaper than any other oximeters online. The difference between the two is that MAX30100 is a chinese redesign of the MAXREFDES117#, reducing the price of MAXREFDES117# $20/unit to MAX30100's $4.68/unit. Normally, extremely cheap electronic components should be avoided as they are known to be unreliable and not durable, however, there are many good reviews online about the MAX30100 and the 4:1 price to unit ratio cannot be understated. For the power of the device we decided that a 9V battery would be most suited for the device, mainly for its compatibility, and because it synergises with our design. It also comes in an exterior casing which would make for an easy attachment to the compression sock. This also allows the user to only have to switch one battery instead of multiple.

The remainder of the components are available from the uOttawa Maker Store. There are alternatives to the Arduino UNO with microcontrollers such as the ones by Raspberry Pi, Teensy, and SparkFun, but the team agreed to stick with Arduino UNO because we are more familiar and comfortable with it and it is still one of the cheapest compared to the rest of the microcontrollers. The same could be said for the bluetooth module as well. The electronic element of the device will be contained in a 3-D printed housing for the components which would be constructed of PLA, and the human mounting element will be done comfortably by equipping the compression socks. These two elements will be homogenized through the use of Velcro tape. These plans are subjected to change, but it is the direction the team is headed towards.

Conclusion and Next Steps

In this deliverable, we created a plan for our project that will help us stay on course during the last half of our project. While, we complete all three prototypes and prepare for design day.

We've sectioned our plan into two main sections, the main sections include, tasks to be completed and estimated cost. For the first main section, it is divided into each of the three prototypes. Our first prototype will be focusing on the appearance of the device, while maintaining a low cost and low fidelity. Our second prototype will be focusing on the functionality of the bluetooth aspect and the mobile applications with the goal of having a medium fidelity/low cost model. For our last prototype, the focus will be to assess the performance of our design while maintaining a high value budget. We will use the first two prototypes to guide and ensure practicality of prototype 3. The second main part of this report is our estimated cost. Which includes a bill of materials, and a discussion aspect. This section of our plan is to ensure that we respect our budget.

It is a necessity to complete a detailed plan in order to effectively complete our current tasks, while respecting the due dates. After the completion of this plan, it becomes an important tool for us to use while finishing the project.

References

EULAY Compression socks
https://www.amazon.ca/Pairs-Graduated-Compression-Socks-15-20mmHg/dp/B01N6P15HP/ref=sr_1_13?dchild=1&gclid=Cj0KCQiA-bjyBRCcARIsAFboWg2eGWDfmsmIqjLuRzRV8hNfHAdgsqjp5gWjWVbfDkMG-6AYchIRWf4aAhv_EALw_wcB&hvadid=240284641866&hvdev=c&hvlocphy=9000671&hvnetw=g&hvqmt=e&hvrand=3668071594953562777&hvtargid=kwd-311122393401&hydadcr=818_10116048&keywords=amazon+compression+socks&qid=1582268606&sr=8-13

Cambivo compression socks
https://www.amazon.ca/Compression-Athletic-CrossFit-Pregnancy-Circulation/dp/B0773RWB8D/ref=asc_df_B0773RWB8D/?tag=googleshopc0c-20&linkCode=df0&hvadid=292986537011&hvpos=&hvnetw=g&hvrand=3636490153651260727&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000671&hvtargid=pla-471455270368&psc=1

Velcro tape
https://www.amazon.ca/Width-Adhesive-Sticky-Fastener-Black/dp/B077LMZ47W/ref=sr_1_5?keywords=velcro+tape&qid=1582268642&sr=8-5

MAX30100 (3pcs)
https://www.banggood.com/3pcs-MAX30100-Heart-Rate-Sensor-Module-Heartbeat-Sensor-Oximetry-Pulse-Oximeter-Ultra-Low-Power-Consumption-p-1508315.html?gmcCountry=CA&currency=CAD&createTmp=1&utm_source=googleshopping&utm_medium=cpc_bgs&utm_content=yixuan&utm_campaign=ssc-ca-all-0924&gclid=Cj0KCQiA-bjyBRCcARIsAFboWg07v

lOC14ewMETb_KVUXhGg4O14-tRpiFY7WMneZAzcIAOoIH1Mlo8aAqRGEALw_wcB&cur_warehouse=CN

MAXREFDES117#

https://canada.newark.com/maxim-integrated-products/maxrefdes117/ref-des-brd-heart-rate-pulse-oximeter/dp/96Y9339?gclid=Cj0KCQiA-bjyBRCcARIsAFboWg0Ccn3H4u2O5iZmEStoKLdIluHFj6HXIxa7i9exPnvPbWs7dJ_tiCQaAuTBEALw_wcB&mckv=sYRstoYDn_dc|pcrid|220095253120|plid||kword|maxrefdes117|match|p|slid||product||pgrid|40490913083|ptaid|kwd-196560258256|&CMP=KNC-GCA-GEN-SKU-MDC-NF

Raspberry Pi

https://www.amazon.ca/Raspberry-Model-2019-Quad-Bluetooth/dp/B07TD43PDZ/ref=asc_df_B07TD43PDZ/?tag=googleshopc0c-20&linkCode=df0&hvadid=335201232415&hvpos=&hvnetw=g&hvrand=16653962432871095162&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000671&hvtargid=pla-781430589105&psc=1

Arduino UNO

https://www.amazon.ca/ARDUINO-A000066-Uno-DIP-1-5/dp/B008GRTSV6/ref=asc_df_B008GRTSV6/?tag=googleshopc0c-20&linkCode=df0&hvadid=292998575882&hvpos=&hvnetw=g&hvrand=13019987603581822089&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000671&hvtargid=pla-457497319401&psc=1

9V battery clip Connector Cable

https://www.amazon.ca/Battery-Connector-Holder-Arduino-Baterries/dp/B07T7VX2SF/ref=asc_df_B07T7VX2SF/?tag=googleshopc0c-20&linkCode=df0&hvadid=335455954923&hvpos=&hvnetw=g&hvrand=1322590196232001745&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000671&hvtargid=pla-833492588045&psc=1