

UNIVERSITY OF OTTAWA – FACULTY OF ENGINEERING

ENGINEERING DESIGN

GNG1103

Project Deliverable E: Project Plan and Cost Estimate

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Introduction

After numerous days of analysis and research, we have outlined a plan and schedule for prototyping and testing their solution to the client's needs, by the end of the semester. We have separated our prototype into 4 major categories: hardware, software, comprehensive and a final prototype. In addition, we analysed the critical components of our system, to make sure that our all clients needs were respected and implemented in our design. The first prototype deliverable, due March 1st, will focus on the feasibility as well as the implementation of the first three major test cases for our prototype. The second deliverable which includes the second prototype will have all the detailed requirements in the rubric provided. Both the first and second prototype will be focused prototype, proof of concept. Material will be bought after the concept has been proven feasible under our current financial and time constraints. The third prototype, will be a fully functional design which will be modification based on the final feedback from the client. Finally, the last prototype, will be the the fully final version of our design with the modification suggested by the client.

Analysis

1) Feedback

After brainstorming and coming up with possible solutions for the given task of developing an overdose monitor with an alert system, we had another meeting with our client where we presented our ideas. To avoid having many solutions presented, we came to an agreement as a group and were able to narrow down our ideas. At the meeting, our client was informed of our progress and three best solutions which were the watch, toe sock and sensor focused device (all outlined in deliverable D). Out of the three we also spoke about our lead solution which was the sensor focused design; the client was pleased with our solution and liked that we were including both an oximeter and respiratory rate sensors for better accuracy in detecting an overdose. Also, commenting on our choice of the location of the device application of which she said it was a high risk area where people are unlikely to inject and would hence not inhibit drug use. To help with further progress, she gave useful feedback such as since the overdose monitor would be dependent on a cellular phone, it should not require that the phone be connected to data or wifi. This is because not everyone always has access to data and this could result in the device failing to save a life. Considering that our

device is of two parts one located on the ear and the other on the chest, we were concerned with users having an issue with the device having multiple located sensors. However, our client was able to assure us that if a user is buying the device to save their life it would be a decent trade off.

2) Contingency and feasibility

For this project which we have been tasked to build a device that helps to detect opioid overdose and request immediate assistance. For this project we developed various solutions however, as previously stated we have decided to move forward with the sensor focused device. Like every other solution ours comes with possible risk of which we have taken account of and made alternative plans. These risk could be related to the team or the device and some of them include:

- Late delivery of materials
- Expensive materials
- Size of materials
- Late completion of task
- Conflicts in time scheduling

To avoid delay caused by late delivery of materials, plans have been made to make online orders as early as possible. Alternative, in store materials within our budget of \$100 have also been researched for. A bill of materials has been made to help maintain cost and keep track of what is required. In the case of an inaccessibility to materials that would better fit the size of our device we decide that we could relocate it to a different part of the body for application. Also with respect to time being an important factor in our design, we decided that in a worst case scenario we would not be including the respiratory rate sensors if it would affect meeting the milestone deadline. For assigned tasks, if a team member is having difficulties completing theirs before the deadline, they should request assistance early, not at the last minute. Deadlines are also set for individual tasks with a few days before the main deadlines. This is done to help create time for corrections and formatting. In person meetings with team members are usually set to occur twice a week but if there is an issue with scheduling online meetings are set as back up to discuss updates or what needs to be completed.

As a team with a final goal to design an functional and discreet overdose monitor, we have put in place the above contingency plan to account for the stated risks. For the following weeks leading up to design day, the team project schedule has been organized in a clear and informative way. This is to help all members have a view on what needs to be done and when it should be completed. With all necessary factors considered, we believe that our plans can be executed and the overdose monitoring device completed by the deadline.

3) Meeting Preparation

By our next meeting with the client we would be presenting the first prototype of our overdose monitoring device. In preparation for this, the group has been divided into subgroups one in charge hardware and the other in charge of the software development. Although we may be working separately on our different task assignment, there has been an arrangement for group meetings where we would converge and track progress. The hardware aspect of the first prototype which would be presented would have been tested for accurate communications between sensors and would also give a view of the expected final size of the device. For the software part, the pseudocode for the program that would read the sensor-provided readings and detect if an overdose occurs would be presented. An interview script would also be prepared to get feedback from the client and to also pass information of our next steps.

Design Prototype

Prototype 1:

The objective of the first prototype is to create a foundation on how the device looks physically and also how can the arduino detect an overdose.

Hardware

Analytical

Test Plan 1: Sensors communication

-In order to detect an overdose, all sensors have to communicate to the central platform, the Arduino, where the data will be put together in order to decide if there is an overdose or not. The testing can be made by connecting the Arduino to a computer and seeing if the information of all the sensors reaches the Arduino.

Physical

Test Plan 2: Device physical size and discreteness

-Create a physical concept of the device by using simple materials such as paper and cardboard with reference to the design specifications and design concept chosen aiming to physically visualize how suitable is the device in aspect of size and positioning in respect to a human body and also how discrete is the device, an essential feature of the device.

Software

Test Plan 1: Pseudocode

-The code needs to be able to combine the information of the sensors and determine if the data from the oximeter and heart rate monitor together result in an overdose. The testing can be done by manipulating data in the code editor and compiling to see if the software understands when there is an overdose happening.

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Prototype 2: Focused prototype

This prototype concentrates on ensuring the core of design is effective. The prototype developed will be for the sole purpose of conducting tests related to the fundamental workings of the final device.

Hardware

Analytical

Test Plan 3: accurate measurement of physiological symptoms

- The purpose of this test is to ensure that the device is capable of detecting both the blood oxygen concentration, and the respiratory rate.
- Writing the code and setting up the core hardware of the device allows us to test it's quality without the aesthetic and convenience design features that could take the focus away from the system.
- We can test to make sure the blood oxygen concentration and respiratory rate are detected by doing repeated tests ourselves.

Test Plan 4: Information are accurately recorded

- The purpose of this test is similar to the previous one, and aims to ensure that the device is capable of detecting physiological symptoms accurately.
- Testing the quality is slightly more difficult, as we will not be able to actually test an overdose. Even creating a simulation can be challenging with our available resources.
- Because of this, the best way to test for detection accuracy will be using alternative methods. Repeatedly testing the device on the same individual can help to determine how wide of a threshold the detection records over a series of tests. For this to be a suitable testing method, we would have to assume the oxygen concentration and respiratory rate of the individual stays relatively constant.

Test Plan 5: Information is accurately sent and stored

- This test is essentially to ensure the software is correctly written to reflect the detection of the hardware.
- Testing should include repeated tests and analysis of the results and errors.

Software

Test Plan 2: Alert sent accurately

- The goal of these trials are to ensure the device can reliably send the notice of an overdose to third-party contacts.
- Testing the device in a series of situations will give the user confidence that the device is a dependable option.
- Therefore, the device should be tested when the connected cell phone is on wifi, off wifi, has low power, and has a low service connection.
- The device should also be tested when connected to a series of different phone brands and cellular carriers, to make sure it is capable of sending the alert, no matter the circumstances.

Test Plan 3: App work and easy for client use

- The purpose of this test is to show that the app which reflects the data is user-friendly.
- We can test this feature by ensuring it follows certain user-friendly criteria such as easy navigation and accessibility.
- Testing can also include pushing the app software out to users and other individuals and analyzing how they interact with it.

4	Prototype I and Customer Feedback
	Activity 4: Group feedback on Prototype
build	build oximeter
te	e test oximeter
b	build respitory system + test
a	add Bluetooth module

Prototype 3: Comprehensive Prototype

This prototype has all the planned functionalities working well and the device's aesthetics and comfort can let the user feel satisfied when using the device.

Test Plan 6: the device works correctly with both components combined

 In order to test if the device is correctly working, the Arduino can be connected to a computer and checked if the component is receiving accurate data from all the sensors in the determined interval of time, 10 seconds. Then, by manipulating data in the code editor create a situation of overdose and test if the alert is sent correctly through the cell phone app via Bluetooth.

Test Plan 7:aesthetic and comfortable

- In concern of the well-being of the user, the device has to pursue a pleasant aesthetic as avoiding any possible embarrassment or repugnance when using the device. The testing can be done by creating different aesthetic concepts and surveying people from different backgrounds to vote on their favorite design.
- Also in concern of the well-being of the user, the device must be comfortable, preventing nuisance from the users. The comfort can be tested by surveying people with different characteristics, height, weight, etc., and receiving their feedback on present annoyances and how the device can be more comfortable.

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Things 7 Prototype 2020/03/23	Prototype III and Customer Feedback

Prototype 4: Final Prototype Test plan: Modification

The final prototype should include all of the best features of the previous prototypes to create the most refined version. Each addition or alteration of the core system is considered another step in the prototype modification, which helps to develop and lead to the final design. To test the final prototype, we can use all the previous tests we conducted on the previous prototypes. We then can compare the results to make sure they are consistent with the results on the more focused prototypes. This helps to prove that functionality is consistent among the design testing process.

Design Schedule

In terms of scheduling we have designed our gantt chart in such a way that we are able to meet every single deadline with some "wiggle room". Despite not having the software on our side, we have created charts to visualize all our major tasks. We also separate our team into two sub sections: software and hardware. We have separated the team as such to make sure we cover all parts of our design effectively. Our deadline for our first prototype which will be basic proof of concept is March 1st. After we complete this prototype we will receive customer feedback and we have also decided to get feedback from within our group on ways to improve the design. From this feedback we will create our second prototype which will ensure our design will work; this needs to be completed by March 8th. The deadline for our third comprehensive prototype is March 22nd. From the customer feedback we receive we should only have some slight modifications that need to be done by Design Day (March 26th).

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Cost and List Materials

MATERIALS	COST(Taxes not included)
Microchip ATtniy85	1.20\$
ARDUINO NANO 33 IOT WITH HEADER (BLE) Bluetooth Low Energy	20.00\$
"MAX30102 High-Sensitivity Pulse Oximeter and Heart-Rate Sensor for Wearable Health"	4.34\$

3mm LED:red	0.15\$
Resistor 1k ohm	0.10
Arduino Nona R3	20.70\$
push button (6X6X5 tact buttons 100pieces)	6.80\$
Total Cost	53.29

Conclusion and Lifelong Learning

Above we have outlined a well-thought-out plan to ensure that our group can produce quality prototypes by the specified deadlines. We have outlined in our gantt chart our required tasks, their durations and the owners of each task. We will be splitting the group into subgroups; one working on the hardware and the other on the software. Since we have five people in our group we have decided to put two people on the hardware tasks and three on software because we believe that the software may require more tasks to be completed. We have determined several different test plans within each prototype for the hardware and software to ensure high quality of our product. Our first prototype which illustrates the basic concept of our sensor focused device is due March 1st. Our second prototype, to be completed by March 8th, will ensure the device will work. From this prototype we will learn if we will have to implement any of our contingency plans i.e. moving the device to another location of the body or excluding the respiratory sensors from our design. Our third prototype will be a fully functional comprehensive prototype and it is to be completed by March 22nd. From our feedback we receive we will complete any minor alterations needed before Design Day on March 26th. We have completed a bill of materials to ensure we are within the limits of our target budget. Our total cost (before tax) comes to \$53.29 which is less than our maximum budget of \$100. This will allow us to have additional funds left over in case we have any unexpected costs to complete our design. By developing a thorough plan, schedule and bill of materials we have done our due diligence to ensure we produce the best device for the client. This process will aid in any future product development.