Faculté de génie
Faculty of Engineering

Project Deliverable F: **Prototype I and Customer Feedback**
GNG 1103 - Engineering Design

# Overdose Detection Device


Submitted by

**GNG1103, Section C01, Group 3**

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# 1.Introduction

The goal of this deliverable is to document the production, analysis and results of the first prototype. The first prototype is a low quality, low fidelity shoe sole model. The prototype will be used to analyze the dimensions and feasibility of the shoe sole itself. It will be specifically helpful in determining the size of the sole relative to average shoes and the size required to fit the Arduino nano and associated parts. The results of the prototype will provide us with information that will be used in the production of the second and third prototypes. We will also get customer feedback on the prototype which will be used to adjust our design and will be implemented in future prototypes.

Our goals with prototype I:

- Arrange the physical aspect and appearance of the insole
- Get a realistic perception of the Arduino and other arduino modules' dimensions
- Get feedback on the layout of the opioid detection device
- Establish our final decision on which parts we have to get and update our BOM

# 2.Dimensions

To test the feasibility of the shoe sole model its size must be compared to both the size of an average to smaller size shoe and the size of the Arduino nano. The Arduino will also have a pulse oximeter and a battery, as well as a Bluetooth Module. It will function by being connected to a prototyping board, that will ideally be thin enough to fit within the shoe sole. The average shoe sole will modelled after women's feet since they are smaller. This will allow the sole to work for a larger audience.

Table 1: *Measurements of components*

| Measurement | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|
| Arduino nano | 45 | 18 | - |
| Battery | 48.5 | 26.5 | 17.5 |
| Pulse oximeter device | 12.7 | 12.7 | - |

| | | | |
|---|---|---|---|
| HC-05 Bluetooth Module | 15.5 | 39.8 | - |

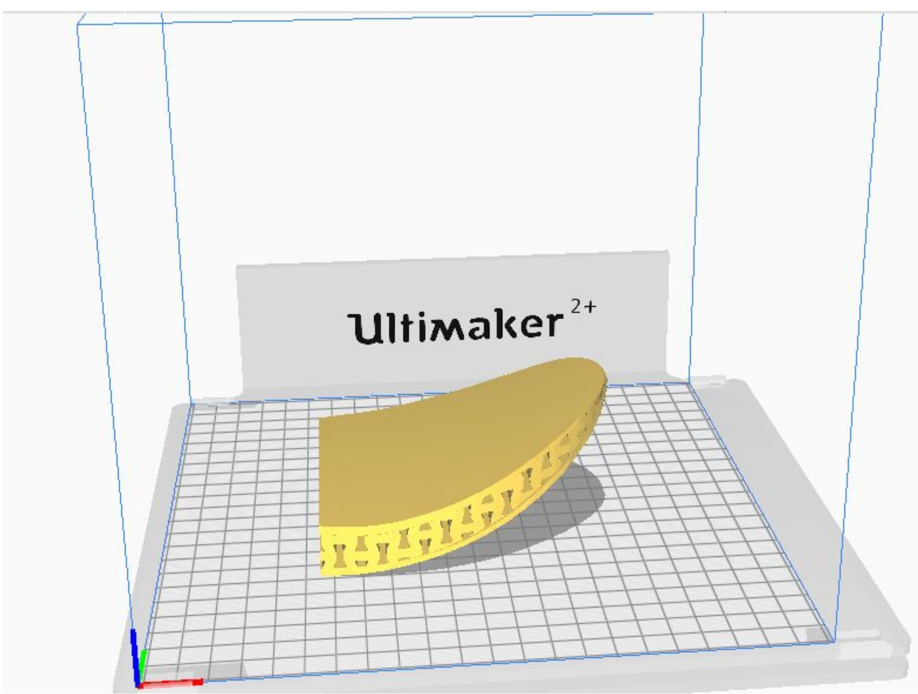
We consider the height of some parts as being negligible, since when everything will be soldered, height will be very small.

# 3.Prototype

We are making a focused physical prototype. The prototype focuses on the dimensions of the product and answers specific questions about how the prototype will fit together. The prototype is a physical model which provides a good approximation of the look of the final product. The prototype differs from the final product in size and some details therefore the final product may exhibit some non modelled behavior. This prototype is great for communication and presentation.

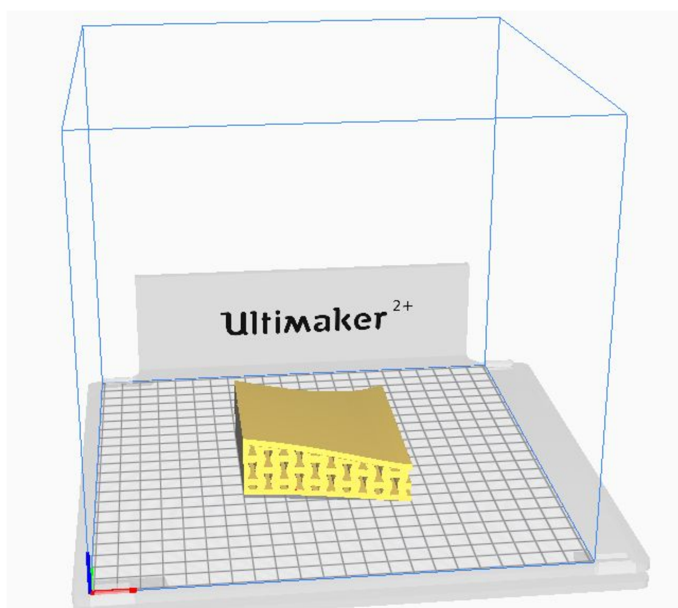
For our prototype we used a 3D model that we had found online. Using this model we went to MakerSpace and used the 3D printers to print them out. The model that we had found online was in multiple parts consisting of the toe, arc, and heel.

*Figure 1- Toe of insole*



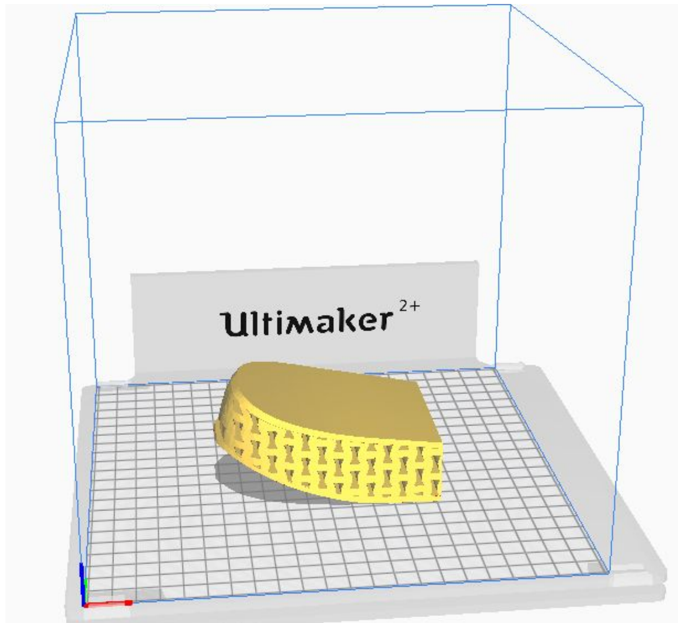
For the toe part of the insole, it will contain the most important functional aspects of the prototype. It will have the prototype board, bluetooth module, pulse oximeter, and the microcontroller. These will all be integrated within the honeycomb spacing of the shoe as shown above.
The prototype board will allow us to make connections to all parts of the insole, and is positioned in the front of the insole to ensure that it is in close proximity to the pulse oximeter for fast response times. The bluetooth module is also placed in the same region to ensure a quick response time. The pulse oximeter is placed underneath the big toe in order to accurately read the blood-oxygen levels in the user's body. The microcontroller sends signals throughout the system to do their respective functions.

*Figure 2- Midsole*




The arc of the sole only contains the clip cables that convert the power from the battery (which is located at the back of the sole).

*Figure 3- Heel of insole*




The heel of the shoe contains the battery and the charging port. The battery is a 9V, and will provide power to all components of the system through the Arduino Nano microcontroller. According to *Hardware Startup* (2013), the 9V alkaline battery that we will use to power our project has a capacity of 450 mAh, which means that the battery connected to the Arduino will be drained in approximately 30 hours, since it consumes mA to function. The battery will then need to be switched or charged, but it is guaranteed to last at least a full day.

# 4.Test Plan

The objective of this prototype is to test the feasibility of the shoe sole model. This analysis will give us more understanding of how we will assemble the final model. It will also allow us to receive feedback on our prototype. The first test we will do is print a larger scale 3D model of our shoe sole. The second test we do is a comparison of cardboard cut out pieces of the same dimensions as our parts with the size of a regular shoe sole.

## 4.1 Our Criteria:

- The sole area is able to fit the summed up area of the individual parts we will use to create the opioid detection device
- The sole is a physical model that can be manipulated by the client during Thursday March 5th’s client meeting
- The cut out parts are well identified and can be easily understood by our client
- The placement of the parts allows us to effectively and accurately read blood oxygen

## 4.2 Separation of Tasks:

*Table 2- Separation of Tasks*

| Task | Description | Person(s) responsible |
|---|---|---|
| 1. Make 3D print of sole | Print 3D model of the shoe sole. The print is split into three separate parts which are then glued together to make the printing process faster. | Brendan |
| 2. Research and dimensions | Research the dimensions of the required parts and calculate their respective areas. | Tara and Heidi |
| 3. Cardboard cutouts | Make cardboard cutouts with the same dimensions as the parts found in step 2. | Heidi |
| 4. Comparison of part size and shoe sole size | Compare the cardboard cutouts to a real life shoe sole to determine how the final model will fit together. Take notes on where parts will be placed and any adjustments which should be made before moving forward. | Tara and Heidi |
| 5. Comparison to 3D print | Compare the feasibility of the shoe tested in part 4 with the 3D model that will be used in the final product. Take notes on any adjustments that should be made moving forward. | Brendan and Tony |

This large scale sole allows us to have a physical model of our product that we can manipulate to see clearer when it comes to deciding where our electronic parts will be situated on the sole, and if the dimensions are feasible. To do so, we have to make some calculations.

*Figure 4- Isometric View of Insole*

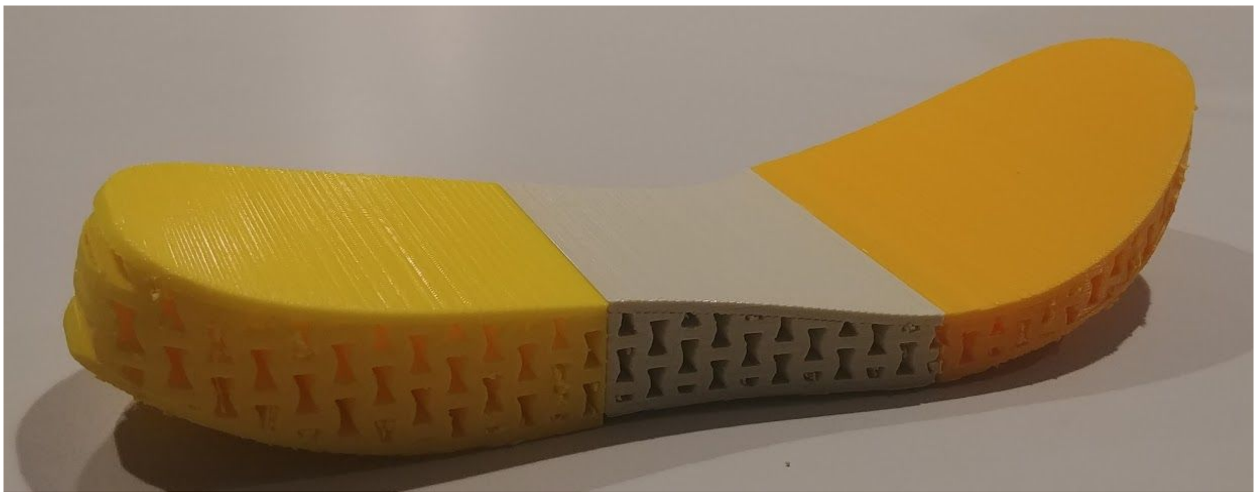


*Figure 5- Side View of Insole*

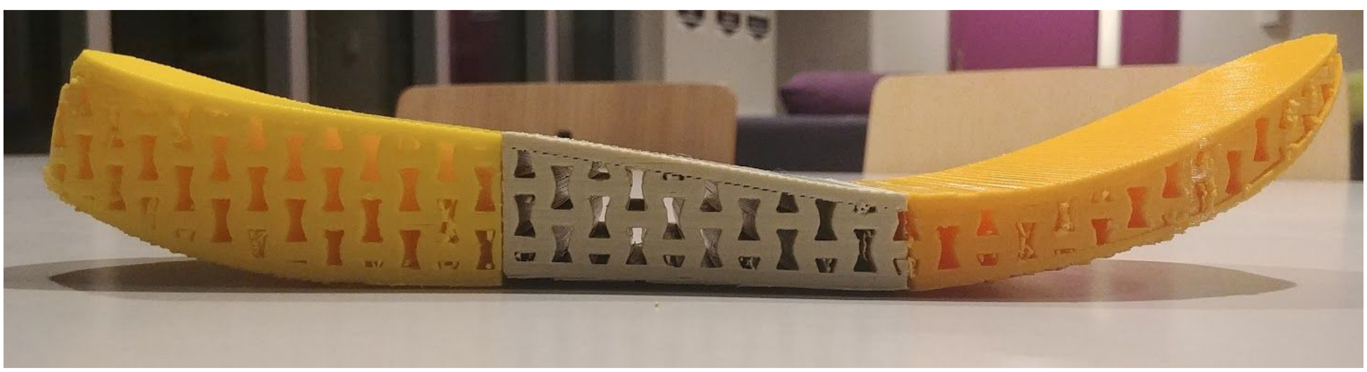


*Figure 6- Top View with location of component*

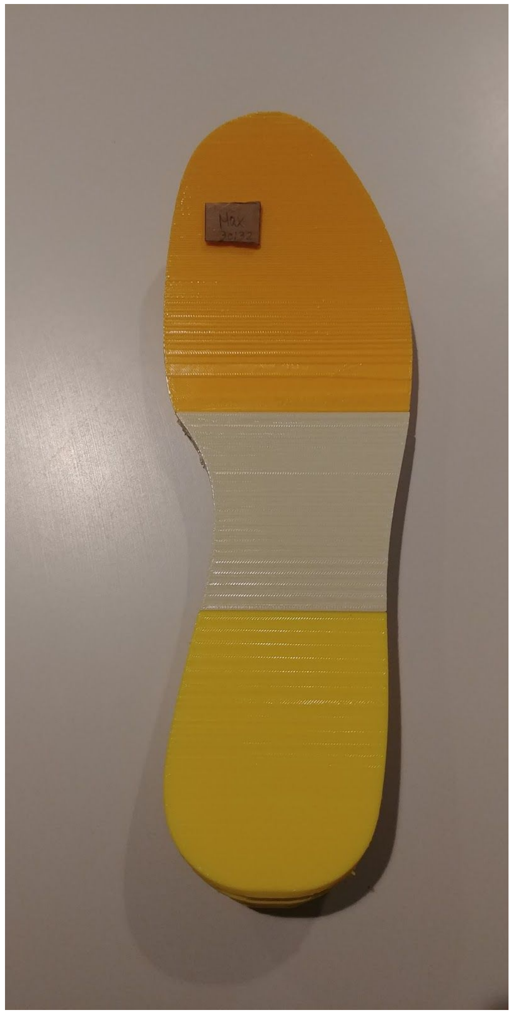
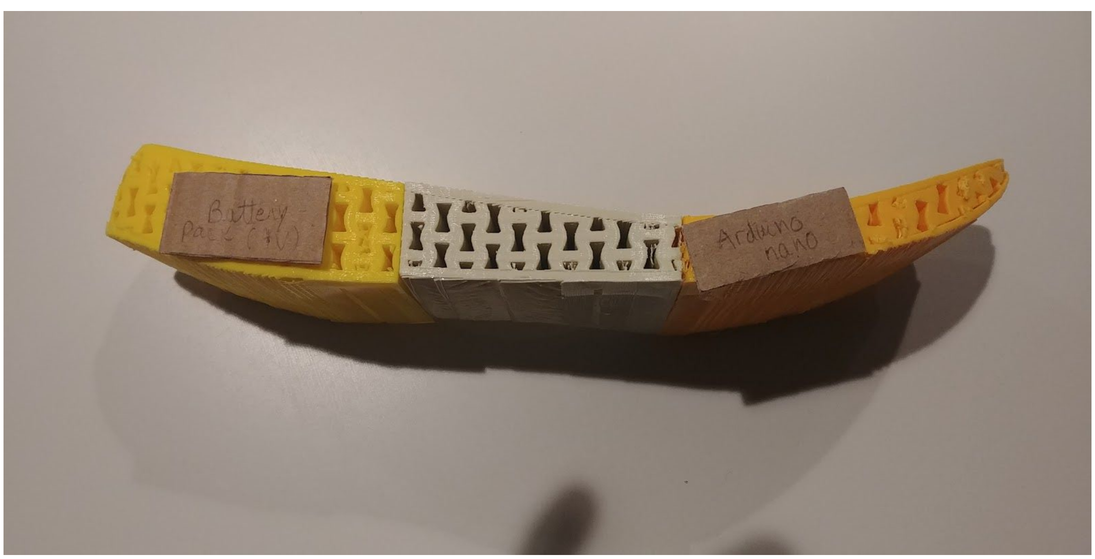



Figure 7- Side View with location of components



## 4.3 Calculations

Area of Arduino Nano:

45 mm x 18 mm = 810 $mm^2$

Area of Bluetooth module (HC-05):

15.5 mm x 39.8 mm = 616.9 $mm^2$

Area of pulse oximeter (MAX30102):

12.7 mm x 12.7 mm = 161.29 $mm^2$

Volume of 9V battery:

48.5 mm x 26.5 mm x 17.5 mm = 22 491.875 $mm^3$

Total area occupied by the electronic parts:

810 $mm^2$ + 616.9 $mm^2$ + 161.29 $mm^2$ = 1588.19 $mm^2$

*Table 3: Measurements of different shoe sizes*

| Measurements | Enlarged 3D printed insole | Small sized insoles for women (size 5) |
|---|---|---|
| Length (mm) | 279.4 | 228.6 |
| Width (mm) | 101.6 | 76.2 |

Area of small sized insole for women:

228.6 mm x 76.2 mm = 17 419.32 $mm^2$

Note: We approximate that the area of the smallest shoe insole is a little lesser than the calculation because it is not a perfect rectangle and contains rounded areas around the toes. We can subtract 3000-4000 millimeters squared to make sure the comparisons we make with the area covered by the electronic parts are accurate.

# 5.Discussion

While our enlarged model of the insole we 3D printed allows us to effectively observe the layout of the different microcontroller parts we will use for our project, our calculations and comparisons while using the dimensions of an x-small size insole lets us conclude that if the total area of the parts is smaller than the total area of a small size insole, we will have no trouble fitting our Arduino setup in a larger sole for a bigger women's size or any men's size.

For this prototype, we cut pieces of cardboard found in the MakerSpace according to the different dimensions of the different microcontroller parts and we stuck those parts on the sole to be able to visualize the Arduino setup.

During our future prototypes, we have to figure out a situation for the battery placement, since the battery has a bigger volume than expected. For now, we plan on placing the battery perpendicularly to the sole at the back of the shoe since, if we want the sole to stay thin and comfortable, we can't insert the voluminous battery inside the sole.

With this prototype proving that the layout of our final product is actually feasible, we escape the risk of having to change our whole final product idea. Prototype 1 has allowed us to have a clearer vision on the parts we need for our final product and has allowed us to move past the uncertainty of having to come up with a whole new other idea.

Our criteria:

Will be determined after client contact during March 5th presentation

Accomplished

- The sole area is able to fit the summed up area of the individual parts we will use to create the opioid detection device
- The sole is a physical model that can be manipulated by the client during Thursday March 5th's client meeting
- The cut out parts are well identified and can be easily understood by our client
- The placement of the parts allows us to effectively and accurately read blood oxygen

# 6.Cost

This first prototype did not cost us anything, since we used resources that were offered to us through the MakerSpace. The only materials we had to use was the plastic filament that made our sole through the 3D printer and some scrap cardboard we found in the MakerSpace.

## 6.1 Updated BOM

The making of this prototype has also allowed us to make our minds about the parts we are actually going to get and our bill of materials has slightly changed.

*Table 4- Cost of Materials*

| ID | Description | Vendor | Part Number | Qty | Cost |
|---|---|---|---|---|---|
| 1 | 1.75mm MATERIAL 3D PLA FILAMENT | MakerStore uOttawa | -- | 1 | FREE |
| 2 | Jumper Cables | Amazon | -- | 120 | $9.99 |
| 3 | Arduino Nano | MakerStore | ATmega328 | 1 | $22.00 |
| 4 | 9V Batteries | Amazon | - | 3-Pack | $18.99 |
| 5 | Pulse Oximeter Sensor | MakerStore | 700-MAX30112EWG+T | 1 | $5.64 |
| 6 | Bluetooth Module | roboJax | HC-05 | 1 | $18.30 |
| 7 | Breadboard | MakerLab | 424-240-131 | 1 | FREE |
| 8 | USB Cable | MakerSpace | - | 1 | FREE |
| 9 | Clip Battery Connectors | Amazon | a13110100ux0258 | 10-Pack | $9.37 |

# 7.Feedback

For this deliverable, we are required to give feedback on our first prototype. Now, since it is hard to get in touch with opioid users without putting ourselves in a position of danger.

We thus decided to get feedback from regular University students that don't really have ties with opioids or knowledge about microcontroller devices, though we understand the feedback from those people is less valuable.

*Table 5- Feedback from University Students*

| Name and age | Criticism | Grade out of 10 | What more could we add |
|---|---|---|---|
| Mark, 19 | Could cause problem if person is not wearing shoes (indoors) | 7 | - Customizable settings<br>- Failsafe |
| Tom, 18 | Could cause problems if user doesn't own phone | 9 | - Could contact more than one person in case emergency contact is not reachable |
| George, 21 | Could cause the person to be uncomfortable if the shoe does not fit correctly | 8 | - Ensure that the shoe is comfortable |
| Kim, 28 | May get worn down through constant use, especially in a construction setting | 9 | - Quality materials to have high durability |

NB: Names used may be fictional to keep the confidentiality of the students' feedback.

# 8.Conclusion

In our first round of prototyping the group concluded that the outcome was good and resulted in a learning experience.By 3D printing our model of sole, we were able to make a design of the prototype in order to a tangible paradigm that the final product will be. For our second round of prototyping we will be working on the functional aspects of the design, all of the components are bought online and well-prepared for the second stage.

Moving forward, the group will need to do more collaborative work in order to improve the prototypes. This will require us to meet more often together in order to do this, whether it be staying longer after labs, or more meetings throughout the week. Concluding, our first prototype was successful and we will soon be getting very helpful feedback from our client on the direction in which our next prototype should go.

## Bibliography

STL files retrieved from: https://www.thingiverse.com/thing:2897250

"HOW TO RUN AN ARDUINO (CLONE) ON A 9V BATTERY FOR WEEKS OR EVEN MONTHS" (2013, March 11). *Hardware Startup*. https://hwstartup.wordpress.com/2013/03/11/how-to-run-an-arduino-on-a-9v-battery-for-weeks-or-months/