
# University of Ottawa

# GNG 1103: Engineering Design Project

# Deliverable G: Prototype II, and

# Customer Feedback

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# Introduction

In the last deliverable, we constructed our first prototype, focusing on more physical aspects of the design such as the fluid pipe, and CAD modeling for the housing box and clamp. In this deliverable, we are aiming to refine aspects from our last deliverable, as well as producing readings from our sensor. The goals for this deliverable are to: relocate the sensor window in the tube, test for waterproof capabilities and cleanability, 3D print the sensor housings and clamp, connect the Arduino and sensors, and finally conduct tests to produce an ultrasonic reading through the tube and fluid.

## Updated Project Plan

| Task | Owner | Duration | Due Date |
|---|---|---|---|
| Prototype 1 | Group | 7 Days | November 6th |
| Prototype 2 | Group | 7 Days | November 13th |
| Prototype 3 | Group | 7 Days | November 27th |
| Final Prototype | Group | 7 Days | November 30th |
| User manual | Group | 2 Days | December 7th |
| Design Day | Group | 1 Day | December 1st |

# Updated Client Meeting Feedback

During client meeting III, group 18 presented our first prototype, as well as inquired about limitations regarding the composition of the fluid traveling through the tube, and the cleanability of the tube. Shane from Beond the Pale explained that the composition of the wort passing through the tube would not compromise or interfere with the reading, nor would the buildup inhibit the functionality of the tube. Our physical design was well received by the client. He enjoyed the modular nature of the design and cleaning. From client meeting III, group 18 concluded that we would need to relocate the transmission window for prototype III, in addition to designing the clamp housing to be removable.

# Prototype II Test Plan

### Objective

The objective of prototype II is to refine and complete the physical construction of the prototype involving the tube, clamp and housing. We are also aiming to finalize the code and achieve sensor readings and computation of specific gravity.

| ***Test ID*** | ***Test Objective (Why)*** | ***Description of Prototype used and of Basic Test Method (What)*** | ***Description of Results to be Recorded and how these results will be used (How)*** | ***Estimated Test duration and planned start date (When)*** |
|---|---|---|---|---|
| **1** | Test waterproofing of the pipe and window. To ensure security of fluid and electronics. | The tube was capped off on both ends and filled with water. | The tube will be observed to note any leakage of fluid. Observations will be documented through photos and notes. | November 10th 10 minutes |
| **2** | Arduino and sensors housing, to better protect the internal workings of the system. | Further detail and development on CAD case. (Comprehensive) | Fully complete CAD design must be presented and ready for material consideration and implementation | November 9th (Couple hours) |
| **3** | To more accurately and consistently ensure the data recovery for the customer | Test to see how long code takes to respond and process (analytical) | Measure the amount of time it takes to repeat measurements. Ensure no interference or difficulties by running test runs. | November 9th (Couple of Hours) |
| 4 | To more accurately and consistently gain results from the ultrasound device. | The Updating of the code for sound travel speed/test it. (analytical) | We will measure the speed of sound response, and ensure it is accurate to what the code says it is. By comparing we can tell if its working properly | November 9th (Couple of hours) |

### Specific demands

1. The Location of the Ultrasonic Window has been moved to the center of the pipe, allowing for room to clamp and fit the sensor housing overtop.
2. The ultrasonic device must get a reading that is accurate to 2 or 3 decimal places (which means it needs to be able to tell difference between water and thicker liquid) because the speed might not have an observable difference if the accuracy is deficient.
3. The whole test project can be covered with waterproof material, but it must be 100% waterproof and it cannot affect the spread of the ultrasonic wave.
4. Make sure the pipe's shape creates as little echo as possible, if the echo is affecting the receiver's reading, then the outcome will create a considerable number of errors.
5. The parts of the prototype II must be able to easily be removed, the box will need to detach from the tube in order to perform modifications or maintenance on the project.
6. The test readings have been achieved and a reading is produced
7. The mathematical equations to determine specific gravity have been completed and produce a value for specific gravity.

### Stopping criteria

| Specific demands | A reading has been achieved | Water has inhibited the function of the pipe | Minimum of three tests | Clamp or housings fail | 3D Prints fail |
|---|---|---|---|---|---|
| Points (1-5) | 3 | 5 | 5 | 4 | 2 |

# Prototype II

## 1.1 Relocation of Sensor Window

The sensor window had been re-located to the middle of the pipe to allow for the housing to be mounted to the pipe. The total length of the pipe was also decreased to minimize unused space in the Beond the Pale production facility.

## 1.2 Waterproofing of Pipe

As pictured the pipe was tested by capping off ends and observed for water leakage. No water leakage was observed; therefore this criterion was met.

## 2.2 Updated CAD Files for Sensor and Arduino Housing

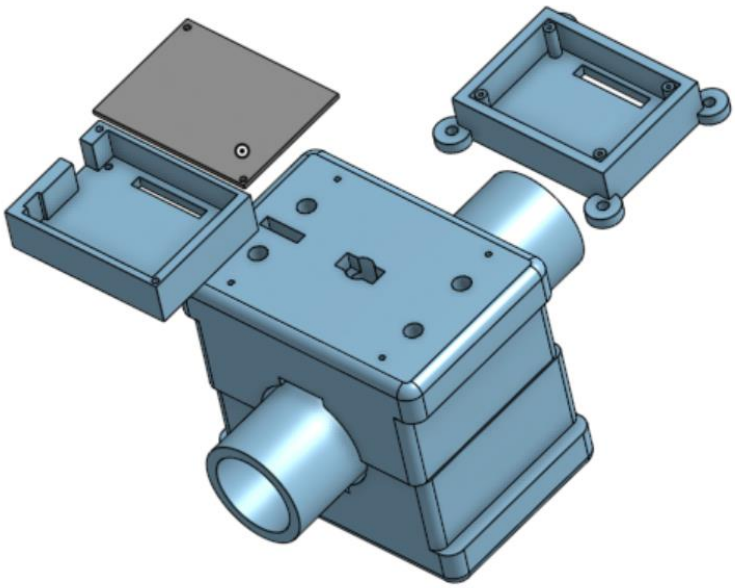


Figure 1.0 : CAD model top right view

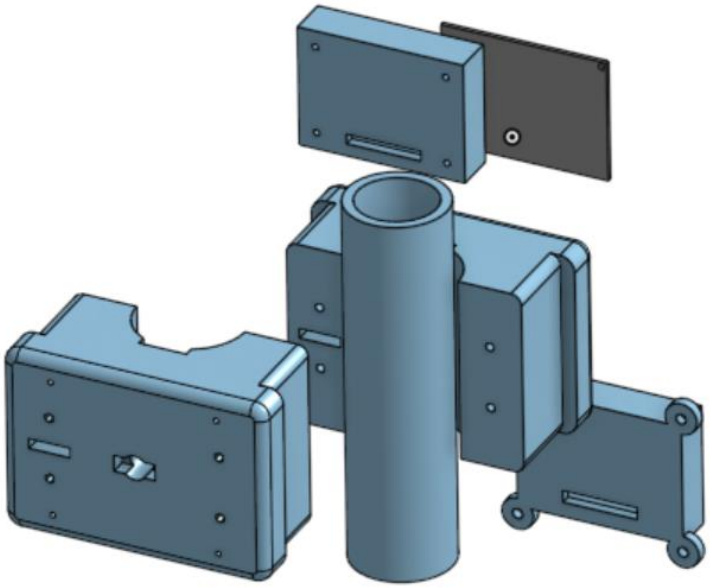


Figure 1.1: CAD model bottom right view

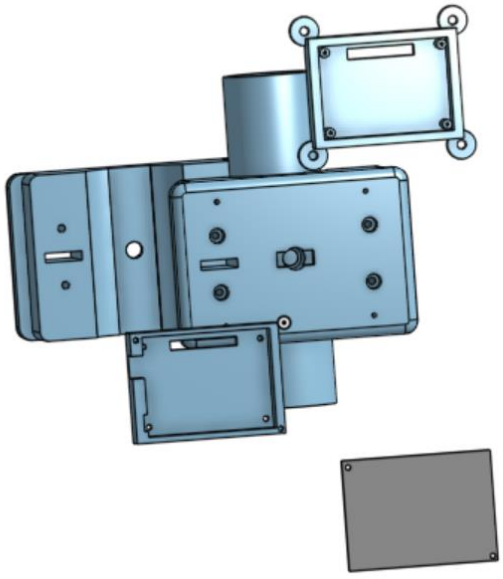
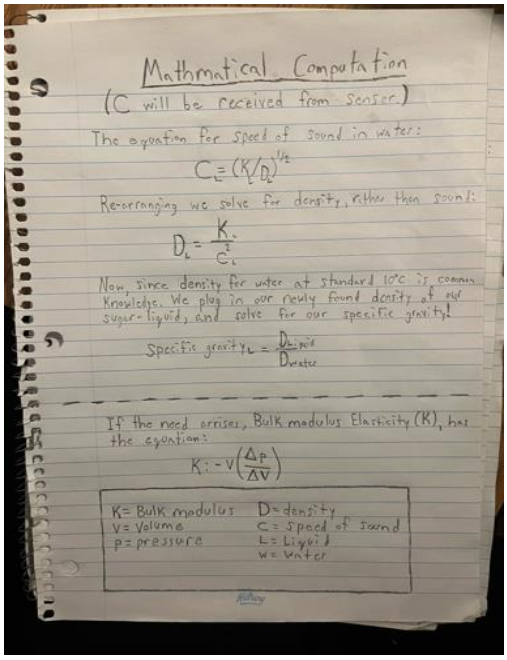


Figure 1.2: CAD model top view

The updated CAD files feature a more refined design, focusing on the routing of wires, in addition to the ability to completely remove the housing from the pipe, as well as updated design for

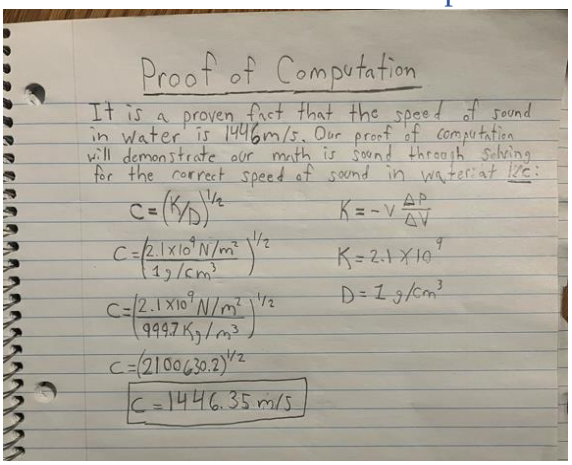
sensors and holes for screws and bolts. The 3D printing was not completed in time for the delivery; therefore, this criterion remains inconclusive. Due to this setback, we adapted to attempt readings without hardwired components.

## 3.1 Mathematical Computation



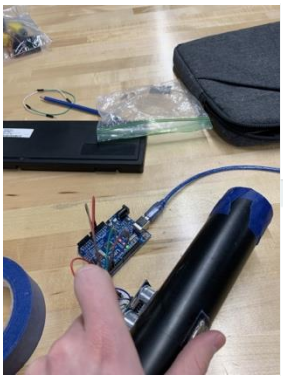

Above, the mathematical computation for the specific gravity is pictured,

## 3.2 Mathematical Proof of Computation Using Water




Using the above computation, Group 18 completed an analog computation of the specific gravity of water using an ultrasonic sensor and the value it received passing through the tube. The Specific gravity was confirmed by comparing it to the universally known specific gravity of water.

### 4.1 Ultrasonic Reading Using Arduino and Ultrasonic Sensor



```
  Serial.begin(9600);
  Serial.println(F("Initialize System"));
  //Init Microphone
  pinMode(micPin, INPUT);
}

void loop() {
    Serial.println(micPin);
}
```

Output Serial Monitor ×

Not connected. Select a board and a port to connect automatically.

New Line 9600 baud

An Arduino Uno was used to demonstrate the ability to compute distance through the windows placed in the pipe. A reading was achieved, meaning the criterion was met.

## Prototype III Test Plan

| ***Test ID*** | ***Test Objective (Why)*** | ***Description of Prototype used and of Basic Test Method (What)*** | ***Description of Results to be Recorded and how these results will be used (How)*** | ***Estimated Test duration and planned start date (When)*** |
|---|---|---|---|---|
| **1** | Compare specific gravity of a liquid to theoretical specific gravity of that liquid, to ensure device gives accurate specific gravity reading | Fill capped off tube with wort, Display specific gravity with complete prototype. (comprehensive) | Results will be recorded for different wort samples, comparing to specific gravity of wort found by mass/volume | November 16th (couple hours) |
| **2** | Ensure windows application displays and data logs information from Arduino, accurately and live. | Connect Arduino with application via Wi-Fi. (comprehensive) | Results being displayed via application will be compared to the results directly from Arduino | November 15th (less than an hour) |
| **3** | Ensure all parts fit within tolerances and the device is sturdy. | Assemble all parts (comprehensive) | Solder wires to breadboard, fit breadboard, Arduino and sensors in case. | November 14th (less than an hour) |

| | | | | |
|---|---|---|---|---|
| | | | Clamp case to pipe. | |
| 4 | Ensure Arduino sends information to computer via Wi-Fi | Arduino, Wi-Fi chip, and sensors used to test transfer of data wirelessly. (analytical) | Power Arduino through USB and connect to windows using WI-FI chip. | November 13th |

## Target Specifications

Updated Bill of Materials

| Part # | Part Name | Description | Cost ($) |
|---|---|---|---|
| 1 | Arduino Uno | Arduino UNO R3 Microcontroller | $9.00 |
| 2 | PVC Pipe | 1ft in of 1 ½in ABS pipe | $2.14 |
| 3 | Wires | 2 packs of jumper cables | $2 |
| 4 | Plexiglass | 0.in x 0.75in x 0.5in thick | $0.10 |
| 5 | AC Adapter | USB Plug Power Adapter | $12.74 |
| 6 | Ultrasonic Transmitter | Transmits an ultrasonic signal | $12.18 |
| 7 | Ultrasonic Receiver | Detects an ultrasonic signal | $12.97 |
| 8 | USB (storage) | Kingston DataTraveler Exodia 32GB USB 3.2 Flash Drive | $6.99 |
| 9 | Sealant | Clear waterproof sealant | $0.10 |
| 10 | Arduino IED | IED | $0 |
| 11 | Arduino libraries | (Newping, SonarI2C, DueTimer) | $0 |
| 12 | CodeBlocks | Secondary IED | $0 |
| 13 | TinkerCad | Design software | $0 |
| 14 | USB Cable (A-B) | Arduino Uno Cable | $7.00 |
| 15 | Protoboard | Protoboard | $1.00 |

| | | | |
|---|---|---|---|
| 16 | Wifi Module | 8266 | $4.79 |
| Total | | | $62.12 |
| Total Used | | | $23.93 |
| Total Remaining | | | $76.07 |

Updated Potential Risks

## Issues with the error reading:

Because of the reflection of the 2 sealant pieces between the transmitter and the receiver, the output could vary.

## Issues with the board design and the electrical designs:

There is a chance that the wires and the codes give us a wrong output which can be manually adjusted.

## Issues with unprecise readings:

We might experience data that is close to what we get but it is coming from the wrong source, we can reduce the chance of that by testing multiple times.

| Categories | Chance | Impact | Contingency |
|---|---|---|---|
| Issue with the error readings | high | low | With an extremely high frequency of income readings, an average of every 0.5 second could eliminate these errors. |
| Issue with the board design and the electrical designs | low | low | All the wires and the codes are changeable at any time, it should give us wrong output that we can compare to the internet info and tell if it is right or wrong. |
| Issue with the unprecise readings | low | moderate | If the reading it keeps output is incorrect(unprecise), and the output is still in a normal range, then it could create |

| | | | |
|---|---|---|---|
| | | | fatal errors to the system, which is hard to notice. |

## Conclusion

In prototype II, we refined many hardware problems found in the first deliverable; adapting according to the feedback received in our client meeting. The sensor windows were moved, the CAD housings were refined, and the pipe was tested for waterproofing and clarity. In addition to these advancements, we calculated our mathematical data required to compute readings from our sensor to specific gravity. Additionally, we wired and ran trials for the ultrasonic receiver. In the third prototype, we look forward to assembling and running more comprehensive and unified tests with the system.