University of Ottawa
GNG 1103-B00: Engineering Design

Project Deliverable G:

Prototype II and Customer Feedback

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Abstract

In this deliverable the feedback received both from the client at the third client meeting and from other potential users was discussed, along with its implications. The creation, testing, and analysis of prototype two was discussed in detail. Finally, a prototyping test plan was created for prototype three.

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1. Introduction

In the previous deliverable, prototype one was created and the planning, testing, and analysis of the prototype was discussed. In the following document, the next phase of the prototyping process will be discussed in detail. This prototyping focused on the most critical aspects of our design: the load cells to measure mass and derive specific gravity, and the process of pumping beer into and out of the reservoir. This document will contain client and user feedback and its implications, prototype two, and plans for prototype three.

2. Client Feedback

The purpose of our first prototype was to understand the results of adding and removing liquids from our product. We did this by using a syringe of coloured water and injecting it into the water bottle, allowing us to measure the time taken for the coloured water to fully dissolve into the water bottle. Thus, giving us an idea of how much time we should take between taking our next samples of beer. When presenting this prototype to our user, Shane, he emphasized the importance of a pressure release system in our tank. Taking this feedback into consideration, we formed a second prototype which would help put Shane's problems at ease. Our second prototype is to create an airtight system and fill it up with water using the peristaltic pump to see what would happen to the pressure inside of the water bottle. Our theory is that when water begins to fill up the water bottle, the pressure will increase significantly due to the fact that the excess air will have nowhere to go. To prevent this from happening, we decided to add a balloon to the top of the water bottle, which has material flexible enough to be filled and emptied of the water bottle's air.

2.1. Revised Conceptual Design

Based on the feedback received at the third client meeting and on our previous deliverable, we have determined that our current conceptual design will not be able to move us further along in the design process, as it is too general, and needs to be refined. As a result, a revised conceptual design has been created to refine all parts of the system. A sketch of this revised design is shown below.

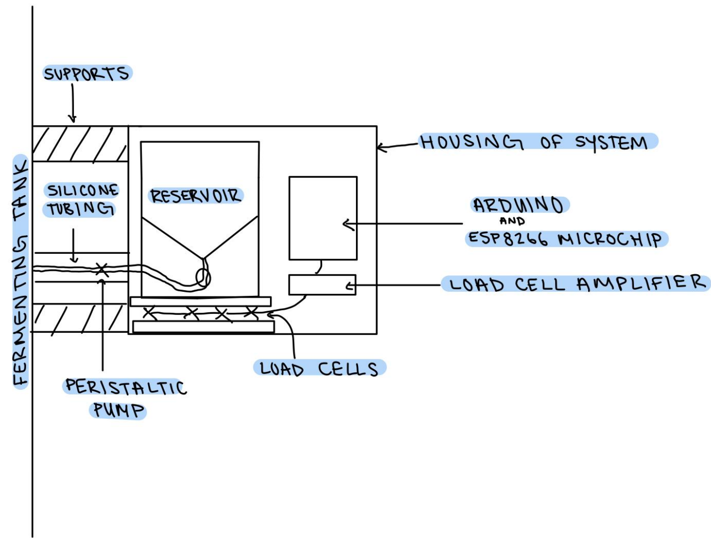


Figure 1: Revised Conceptual Design.

This system will be housed in a structure that will be attached to the side of the fermentation tank. In this structure will be a reservoir, which will be an upside down cone shape encased in a cylinder to allow the reservoir to sit on the load cells. Beer will be pumped in and out of the reservoir through silicone tubing using a peristaltic pump. The reservoir is a cone shape with tubing at the bottom to ensure that the entire sample will be able to be pumped out and back to the fermenting tank. This design is similar to our original, but is much more specific and feasible. Once this design was created, it was clear that the two most critical systems of our product are the load cells and pumping, so we decided to prototype these.

4. Potential User Feedback

Once our refined conceptual design was created, we sought out potential users of our design to receive feedback. Potential user feedback was received from an owner and brewer at an Ottawa brewery.

Feedback received consisted of concerns with the pumping system, one being the shear force that would be inflicted on the beer. The potential user referred to studies about the shear force on wort and beer and how it can be detrimental to yeast health and attenuation. The user clarified that the small pump might not have much of an effect on this; however, it is something to be aware of. Another concern surrounded the removal of oxygen in the system. The user emphasized this point as a very important aspect of our design. The potential user's final concern was with sanitation. It was made clear that being able to use standard brewing cleaning agents is necessary, meaning that all internal components of the system need to withstand high temperatures and extreme pH. The main area of concern with the user was the reservoir and pump, as it was stated that by pumping the beer in and out of the tank, there are more risks involved.

This feedback has been responded to in current prototypes and plans for future prototypes. The concern about the removal of oxygen is tested and resolved in our pump prototype, which will be discussed in this deliverable. The impact of the pump on the beer's health will be a factor to research before our next prototype, as even though the user did not think it would have a large impact, it is imperative to make sure this is true. The sanitization of the product will be tested in future prototypes, as it is a big concern for the potential user and our client, Shane. Finally, the potential user suggested measuring the mass inside of the tank instead of pumping samples into a reservoir; however, at our second client meeting, the client was provided with the choice between the two systems, and he favoured the pump and reservoir. Therefore we will keep this as the design but test each of the user’s concerns.

5. Prototype II - A(Pump and Gas)

For this prototype, we decided to test the pump for our device. First of all, we wanted to ensure that the pump worked properly and could also reverse the flow direction. We also wanted to test the pump with a closed system to see how much the pressure increased when the water was being pumped inside. To test this, we created a closed system with a water bottle. We secured the tubing into the water bottle and attached a balloon to the top to see how it would expand when water was pumped into the bottle.

5.1 Prototyping 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	Test to make sure pump worked properly	Testing pump functionality and reversibility. Attached properly sized tubing to the pump.	How the pump worked.	The duration of this test was 5 minutes.
2	Testing the pressure release system in a closed system	Used balloon attached to the water bottle to observe the air being released as the pressure built up in the reservoir.	As the water was being pumped into the reservoir, the pressure increased and the balloon expanded. This meant that the balloon idea worked well as there was space for the air to go and the pressure did not grow too much inside of the tank/water bottle.	This test took around 20 minutes when including the setup.

5.2 Analysis and Results

After testing our pump, it proved that our pump worked in both directions and that it worked in a closed system. Because we won't be able to create an overall product, the final prototype that we will present on design day will be a similar size as a water bottle. It will have a cone shape at the bottom so that when the fluid is pumped back out of our reservoir, it will all come out. However, with this prototype, we tested it with the water bottle. As explained above, the first test was to ensure that the pump worked properly and that we could easily reverse the flow direction. This test was successful; we worked the pump properly and found the appropriate tubing (Figure 1). Our next test was using a closed system with the water bottle. We attached the tubing and wanted to observe how the water bottle would expand or contract with the flow of the pump. We found that as the water was being pumped into the water bottle, the pressure increased, and the balloon expanded and then the opposite happened when we were pumping the water out. An issue in the product with this would be that, as a closed system, we need to find a way to release the air in the tank so that the pressure does not build up too high. In our prototype, the solution was a balloon but for the actual product we would need to find another device that would act like a balloon (Figure 2).

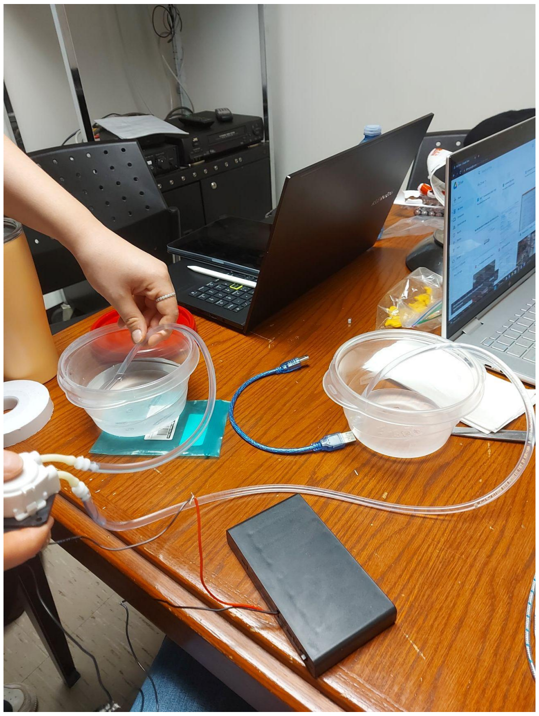


Figure 1: Pump Test

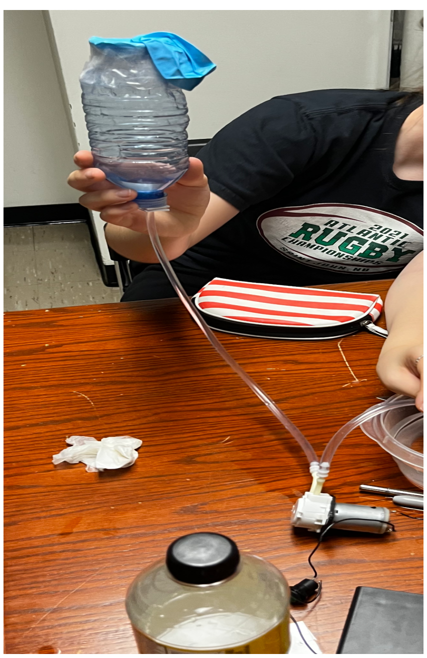


Figure 2: Closed System Pump Test

Videos from Test:

6. Prototype II - B(Loading Cell)

Objective - The main purpose of this prototype was to complete the assembly part of the load cells. We used tools: a plastic platform to hold the weighted object, four load cells, a load cell amplifier, an Arduino board, the HX711 library and a computer. A cell phone served as the weighted object in the testing process.

6.1 The Loading Cell Set Up

After discussing in previous labs. We decided to use load cells in our project. It is a sensor that can measure weight. In our daily life, they are commonly used in products like weight scales.

In our project, they will be used to measure the weight of the beer sample. And in this prototype, they will measure the weight of known mass objects. We first connect those four load cells according to the Instruction Manual on the Website (Figure 1). Then, we put a plastic platform on the cells to serve as a surface holding weight. The cells are also connected to an Arduino board and computer. (Figure 2). We used two codes for this prototype. The first one was calibrating the load cells by getting a calibration factor, which is calculated by dividing the reading by the actual known weight. When we get our calibration factor, we implement it into our second code, which is then supposed to measure the weight of objects put on the load cells. With the help of the HX711 library found on Github, we could transfer data to the computer and print it out in the terminal (computer end).

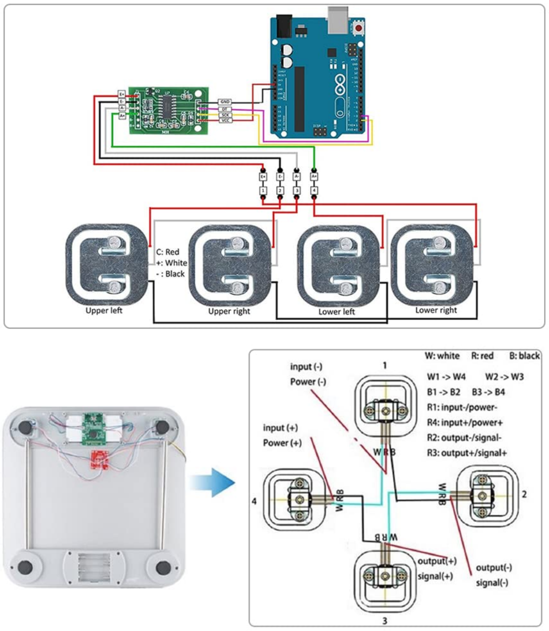


Figure 1

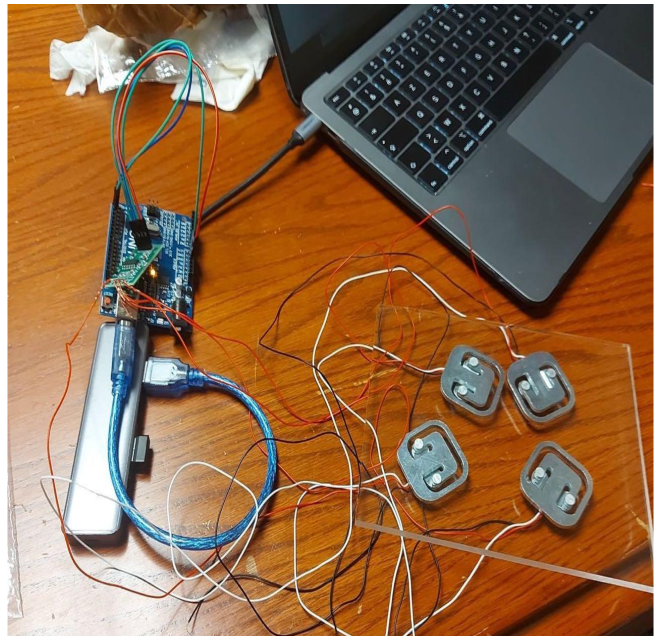


Figure 2

First code - Calibrating the load cells

```
#include "HX711.h"
const int LOADCELL_DOUT_PIN = 2;
const int LOADCELL_SCK_PIN = 3;
HX711 scale;
void setup() {
  Serial.begin(57600);
  scale.begin(LOADCELL_DOUT_PIN, LOADCELL_SCK_PIN);
}
void loop() {
  if (scale.is_ready()) {
    scale.set_scale();
    Serial.println("Tare... remove any weights from the scale.");
    delay(5000);
    scale.tare();
    Serial.println("Tare done...");
    Serial.print("Place a known weight on the scale...");
    delay(5000);
    long reading = scale.get_units(10);
    Serial.print("Result: ");
    Serial.println(reading);
  }
  else {
    Serial.println("HX711 not found.");
  }
  delay(1000);
}

//calibration factor will be the (reading)/(known weight)
```

Second code - Weighting objects

```
#include <Arduino.h>
#include "HX711.h"
const int LOADCELL_DOUT_PIN = 2;
const int LOADCELL_SCK_PIN = 3;
HX711 scale;

void setup() {
  Serial.begin(57600);
  Serial.println("HX711 Demo");
  Serial.println("Initializing the scale");

  scale.begin(LOADCELL_DOUT_PIN, LOADCELL_SCK_PIN);

  Serial.println("Before setting up the scale:");
  Serial.print("read: \t\t");
  Serial.println(scale.read());      // print a raw reading from the ADC
```

```
  Serial.print("read average: \t\t");
  Serial.println(scale.read_average(20));   // print the average of 20 readings from the ADC

  Serial.print("get value: \t\t");
  Serial.println(scale.get_value(5));   // print the average of 5 readings from the ADC minus the tare weight (not set
yet)

  Serial.print("get units: \t\t");
  Serial.println(scale.get_units(5), 1);  // print the average of 5 readings from the ADC minus tare weight (not set)
divided
            // by the SCALE parameter (not set yet)

  scale.set_scale(*******);
  //scale.set_scale(*******);// this value is obtained by calibrating the scale with known weights;
  scale.tare();               // reset the scale to 0

  Serial.println("After setting up the scale:");

  Serial.print("read: \t\t");
  Serial.println(scale.read());                 // print a raw reading from the ADC

  Serial.print("read average: \t\t");
  Serial.println(scale.read_average(20));       // print the average of 20 readings from the ADC

  Serial.print("get value: \t\t");
  Serial.println(scale.get_value(5));   // print the average of 5 readings from the ADC minus the tare weight, set with
tare()

  Serial.print("get units: \t\t");
  Serial.println(scale.get_units(5), 1);        // print the average of 5 readings from the ADC minus tare weight, divided
            // by the SCALE parameter set with set_scale

  Serial.println("Readings:");
}

void loop() {
  Serial.print("one reading:\t");
  Serial.print(scale.get_units(), 1);
  Serial.print("\t| average:\t");
  Serial.println(scale.get_units(10), 5);

  delay(5000);

}
```

6.2 Prototyping Test Plan

Using the feedback we got from our previous prototype, we made prototype II undergo more rigorous and actual testing. After searching online for one of our group members' cell phone's weight and measuring it on a regular food scale to get the accuracy of how much the phone truly weighed. The phone will be put on the surface, and we will compare the output showing up on the terminal with the actual weight.

6.3 Analysis and Results

After connecting the load cells to the Arduino board, then to the computer, we uploaded our first code to calibrate the load cells. On one hand, we had an output showing that the value of the mass was changing depending on the weighted object; on the other hand, the values were inconsistent as we didn't get the same weight for the same object each time. Therefore, we could not determine a calibration factor to make our weight values as accurate as possible. Even though we could not determine a calibration factor, we uploaded our second code, which is supposed to get the exact mass of the object put on the load cells. But since our calibration factor was not the right one, we could not get the right values. There could be multiple reasons for that, one of them being that the platform is not fused to the load cells as it should be; another one would be that the load cells are not distributed in a way that would apply equal forces on them (one on each corner for example), it could also be a wiring problem, or that one or more load cells are dysfunctional.

7. Prototype IV

Our next prototype will essentially be an integration of our last two prototypes and the new 3D-printed model (figure 1&2) designed by Abby as a standing ground for our water bottle. This 3D-printed model was formed using CAD with the purpose of being the base of our product. The diameter of the model was built to be the perfect size for a water bottle to fit precisely into the hole. The smaller hole shown in figure 1 will be the space needed for the tube to exit the water bottle and enter our second air-tight system. This contraption will work while being fixed on the load cell platform (Prototype II - B). This will allow the load cell to measure the difference in weight from when Prototype IV is empty to after it is completely filled with a liquid. After testing this prototype's functionality, we can deduct the accuracy of our product and if it will work overall. To conclude, this prototype will integrate Prototype II - A with a 3D model testing the weight of the liquid as it is pumped on the load cells (Prototype II - B). This prototype will allow us to see if we can get the pumps working with the Arduino instead of connecting it directly to the battery.

Figure 1

Figure 2

8. Conclusion

In this deliverable, feedback received from the client and a potential user was outlined, and the implications of this feedback were discussed. Our second prototype was created, which assessed the two critical systems of our design: the load cells, and the pump system. The process of this prototyping was thoroughly explained, going through the planning, testing, and analysis stages. Finally, a plan for prototype three was made, allowing for this prototype to be created in the next deliverable.

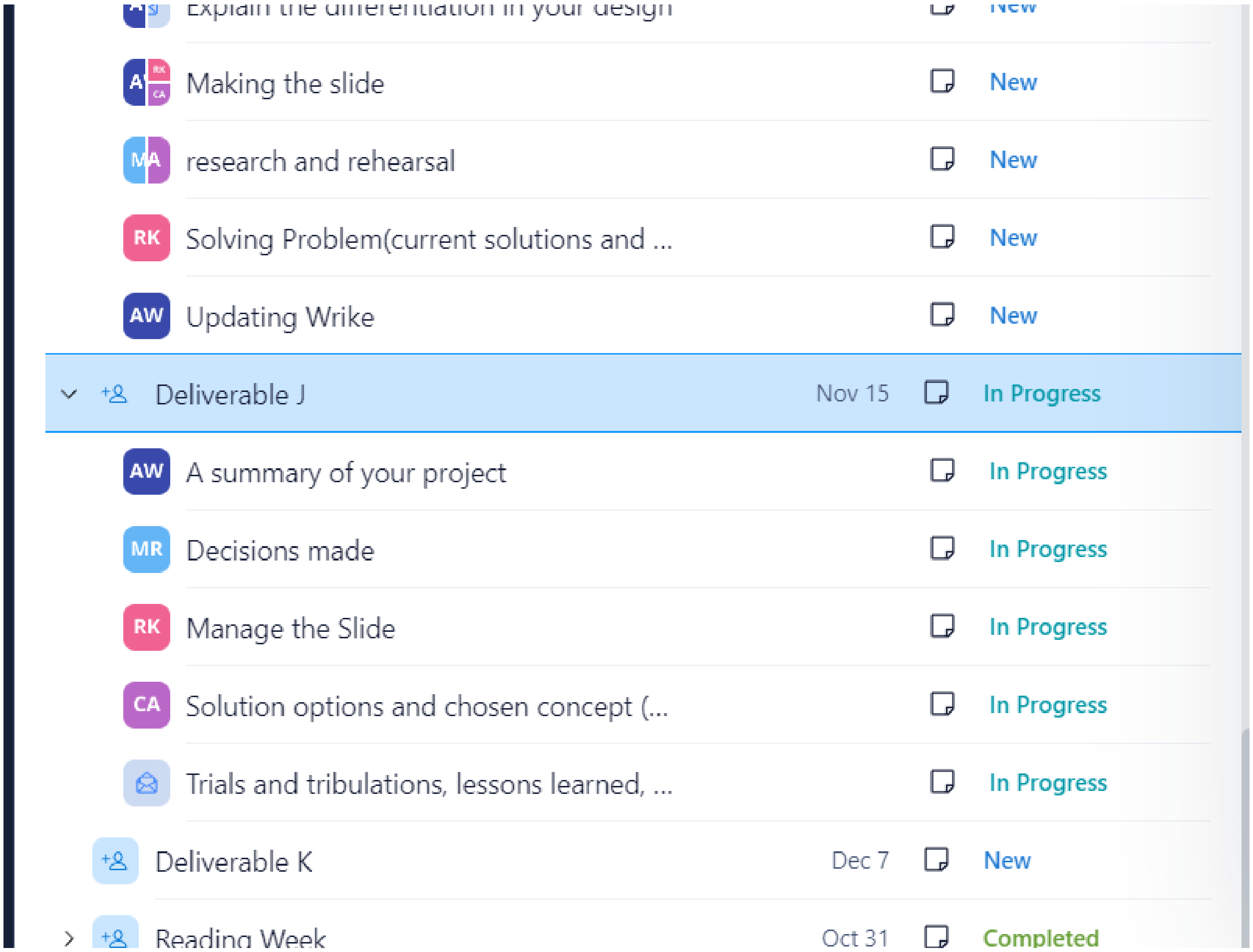
9.Wrike

We have a problem with Wrike. The student who is doing Wrike has his pass expired and is removed from Wrike. After trying to connect to Wrike twice this week by calling. We already emailed this situation to our TA. Until we were writing this part on Sunday, Wrike didn't give any solution and feedback. So, this week we can only do the screenshot for our planning. Also, we have included our last week missing Wrike(Deliverable F) plan in screenshots below.

Assignee	Task	Due	Status
	Deliverable F	Nov 6	Completed
MR	A simple analysis of critical component...		Completed
CA	Document the test plan		Completed
CA	Making a vedio		Completed
AW	Doing the code		Completed
AW	Coding		Completed
AW	Fingure out the graphing		Completed
	Outline feedback and Develop a protot...		Completed
	Email potential Client		Completed
	Searching Online		Completed
RK	update target and outline a prototypin...		Completed
RK	Checking online for device we are goi...		Completed

Assignee	Task	Date	Status
RK	update target and outline a prototypin...		Completed
RK	Checking online for device we are goi...		Completed
AW	Update Wrike		Completed
	Deliverable G	Nov 13	In Progress
RK	document the prototyping test plan		Completed
RK	Bring the hard ware		Completed
MR	gather feedback and comments from p...		In Progress
A R	outline a prototyping test plan		In Progress
MR	Figure out the battery problem		Completed
AW	Make the code able to work with sens...		Completed
AW	outline the feedback received		Completed
	prototype to achieve the objectives		Completed

	prototype to achieve the objectives		Completed
AW	update wrike		In Progress
CA	update your target specifications		In Progress
	Deliverable H	Nov 20	In Progress
RK	Develop a prototype		New
	Model		New
	outline a prototyping test plan		New
AW	Update Wrike		New
	update your target specifications		New
	Deliverable I	Nov 30	New
	Explain the differentiation in your design		New
	Making the slide		New



Making the slide
New
research and rehearsal
New
RK
Solving Problem(current solutions and ...
New
AW
Updating Wrike
New
Deliverable J
Nov 15
In Progress
AW
A summary of your project
In Progress
MR
Decisions made
In Progress
RK
Manage the Slide
In Progress
CA
Solution options and chosen concept (...
In Progress
Trials and tribulations, lessons learned, ...
In Progress
Deliverable K
Dec 7
New
Reading Week
Oct 31
Completed