University of Ottawa
GNG 1103-B00: Engineering Design

Project Deliverable F:

Prototype I and Customer Feedback

Group members:

Alan Wang - 300140660

Rebecca Kimbell - 300233280

Christopher Al-Rahi - 300304285

Abby Falkenham - 300324956

Mohamed Reda Raki - 300281028

Abstract

In this deliverable customer feedback received during the second client meeting was outlined, and the implications of this feedback were included. The process of developing our first prototype was described, including the test plan, analysis, and results. Critical components of the design were identified and analyzed, and feedback on the design was gathered from potential users. Finally, a prototyping test plan was created for our next prototype.

Table of Contents

Introduction -

In the previous deliverable, a project plan and cost estimate was created, using the design concept that was selected after the second client meeting. In the following document the feedback from this client meeting will be outlined, and decisions made based on this feedback will be explained. The process of developing our first prototype will be shown, including our prototyping test plan, analysis, and results. Critical components of our design will be analyzed, and feedback about our design will be gathered from potential users. Lastly, a prototyping test plan will be created for our second prototype, which will be developed in the next deliverable.

Client Feedback

At the second client meeting, we presented the client with three detailed design concepts. Based on the feedback received in this meeting, we were able to choose our final design concept, and continue to refine and change this concept to best fit the client's needs.

The client feedback for our process of measuring specific gravity was positive overall. The client liked the idea of taking the beer out of the fermentation tank to a side tank to measure the mass. He expressed the importance of not wasting beer, and as a result we decided to use a peristaltic pump that has the capability to reverse the direction of the beer flowing through the tube, and be programmed to pump beer in and out of the side tank. This is especially important as the client also expressed that he ideally wants measurements to be taken every ten minutes, so not having a system where the beer returns to the tank would cause a lot of waste, which the client does not want.

The client feedback for our method of storing and displaying data was positive. The client was familiar with grafana, the graphing software we will be using to display the data, and thought it would be an effective way to show the outputs. He also clarified a few things about the data storage and display. In the data tables, he wants time, specific gravity, and temperature to be shown, and wants to easily be able to go back to a certain brew and see all of this data for that specific brew. On the graph, he wants time and specific gravity displayed. This was helpful in refining this part of our design concept, as we know specifically what has to be included in the code to satisfy the client needs. The client also clarified that he would like the system to be wireless, rather than hard wired. This feedback helped us to refine our microcontroller subsystem, as we discovered we needed an ESP8266 microchip to connect our Arduino to wifi, which is going to be our means of transferring data to the outputs.

Prototype - Pump testing

Objective - The objective of our first prototype is to determine the disturbance that the pump creates while taking liquid or sending liquid into the fermentation tank. We believe that the repetitive circulation of the beer through the product may cause unnecessary gases that can create a disturbance inside of the fermentation tank, thus, possibly affecting the specific gravity of the beer.

What/When - The prototype used to test the objective will be a closed water bottle with a syringe adding coloured water to the side of the bottle

Why - The waterbottle will act as the fermentation tank while the syringe injected in the side of the waterbottle acts as our peristaltic pump. When the syringe injects the colored water into the water bottle, the bottle shows how quickly the colored water will dissolve into the regular water. This allows us to identify how large the gaps between taking our next sample of beer to test the weight (Waiting until water completely mixed with coloured). When the syringe pulls water out of the bottle, it gives us an example of how smoothly the liquid will be transferred into the product.

Analysis of Critical Systems

One of the most important parts of our design is the pump. We need a way to pump the beer into our device so that its mass can be measured. This pump needs to be strong enough to be able to move a large amount of liquid and be able to function regularly and reliably to get measurements every 1-2 minutes.

While we're pumping the liquid out into our closed system and then back into the tank, we want to make sure that it does not disturb the flow of the beer. That is the main test of this prototype, to make sure that when we are pumping the beer in and out of our device, that it is not disturbing the overall fermenting process. First, that it is not disturbing the flow of the liquid and that it is not causing a bubbling of the liquid.

Another system of our device would be the Arduino and its code. We will need to make sure that the Arduino works properly, and that our code sorts through all our data and does the proper calculations to find the specific gravity. This code will be tested and created for our second prototype.

Another issue could be ensuring that our device is contained in a completely closed system so that no beer is contaminated in the process. If we are not able to make a closed system, then another option would be that we would lose a certain amount of beer at every measurement which would end up as a large loss by the end of the process.

Prototyping test plan - Procedure

1. Empty one third of the waterbottle so it can better act like the fermentation tank and make sure it is completely sealed (airtight) to procreate the closed system of the tank
2. Fill syringe with coloured water
3. Penetrate the side of the water bottle with the syringe
4. Shake the bottle a bit to cause flow within the water
5. Slowly inject the coloured water inside the flowing water while still shaking the bottle lightly
6. Measure the amount of time it took for the water to completely turn coloured
7. Take some water back out of the bottle using the syringe
8. Observe what happens with the liquid in the syringe tank

Analysis - Observations

After injecting the coloured water into the bottle, the bottle slowly filled with colour. It took approximately 22 seconds for the food colouring to completely dissolve into the water bottle. During step 3, small bubbles were formed showing that little air managed to escape while injecting the coloured water. When watching the video of steps 3-6, you can see that the food colouring only slowly rised and dissolved into all the water. This means that our original design would work where we only grab another sample of beer every couple minutes to allow the last sample to fully dissolve into the fermentation tank. It also shows that not much turbulence would be caused from the addition of the old sample making the pump work well as a part of our system.

Results

Time to dissolve - 22 seconds

This prototype defers one of our largest problems with our design which would be the peristaltic pumps. These pumps were mimicked using a syringe prototypes that proved to us that there would be no major problem using the pump. Therefore, allowing us to keep the design of our final product to be the same with no major changes or updates needed.

Video of steps 3-6:
https://drive.google.com/file/d/1hPek81qJEuaYBYEYp3W6oXXPFkbxH3-P/view?usp=share_link

Video of steps 7-8:
https://drive.google.com/file/d/1hBynMP3HY6vJVz1oAHJKmL6A-65boyAs/view?usp=share_link

Feedback and comments from a potential user

In order to improve our product, we have sought feedback on our ideas and prototypes from another potential user. In addition to our concept, we have presented a pump testing prototype that is meant to determine the disturbance that the pump creates while pumping the beer in and out of the fermentation tank.

The feedback we received is that our concept as a whole is good. They like the idea of having a side tank where all the measurements take place. However, as pumping the beer back in the fermentation tank may affect the specific gravity, it would be better to get rid of it after each measurement. Therefore, in order to avoid wasting a lot of beer, it was suggested that we use a smaller side tank, and measure the specific gravity at longer integrals of time.

They think that the pump testing prototype is somewhat effective to determine whether the pumping system affects specific gravity by creating unnecessary gas or not. Although the water bottle and syringe may not be a perfect closed system, the prototype confirms that the pumping system would not affect the specific gravity or the accuracy of the measurements. Even after approving this prototype, they still think that avoiding even a small change of the specific gravity is worth getting rid of some beer.

Prototyping Test Plan - Second Prototype

Our next prototype is going to be focusing on the code for our device. This code is going to need to take the data obtained by our device and do the calculations with mass to find the specific gravity.

Prototype(2)-Coding of Program

What: This prototype is focusing on the program that we will be using to calculate density. It will take pressure/mass as input(by sensor) and density as output(on screen). Also, to fit in different sizes of side tanks, if we have any in the future, the program is able to custom set the bottom area and volume of the tank inside.

When: While the sensor gets the data, the program could start calculating. In the final design, the program will calculate the data base on a custom setting time. In this prototype, the main goal is to test if this function is working fine. So time setting has not been added yet.

Why: In this testing program, we will use the program terminal and type in the pressure/mass as input, acting as the sponsor transforming data.

Testing Plan: We will test the program by entering some date we already know to test if the program is working fine. For example, test the density of a bottle of salt water by finding the volume and weight in the lab. We would then enter the pressure/mass and tank data to the program and check if the output data matches our lab measurement.

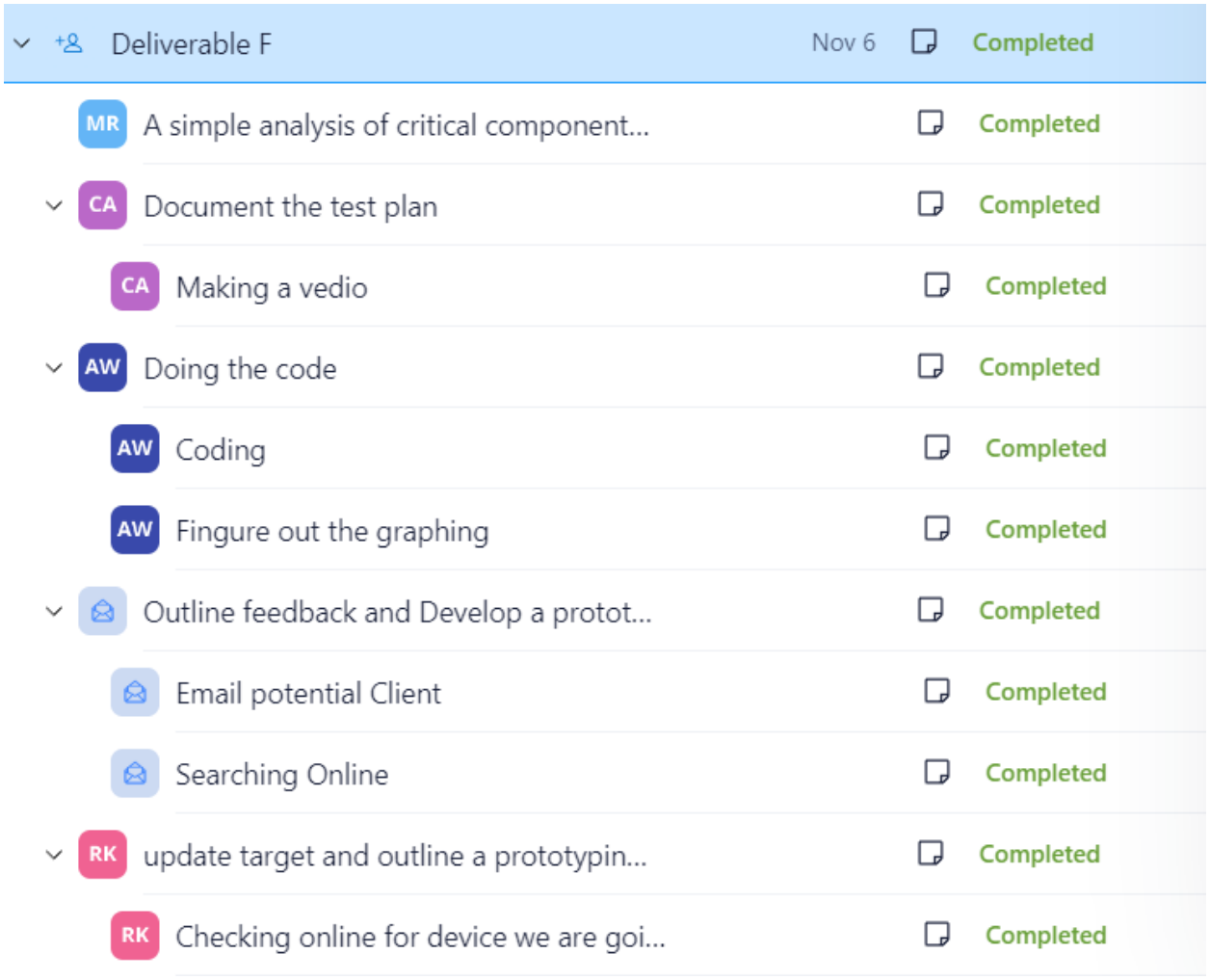
Screenshot of program:

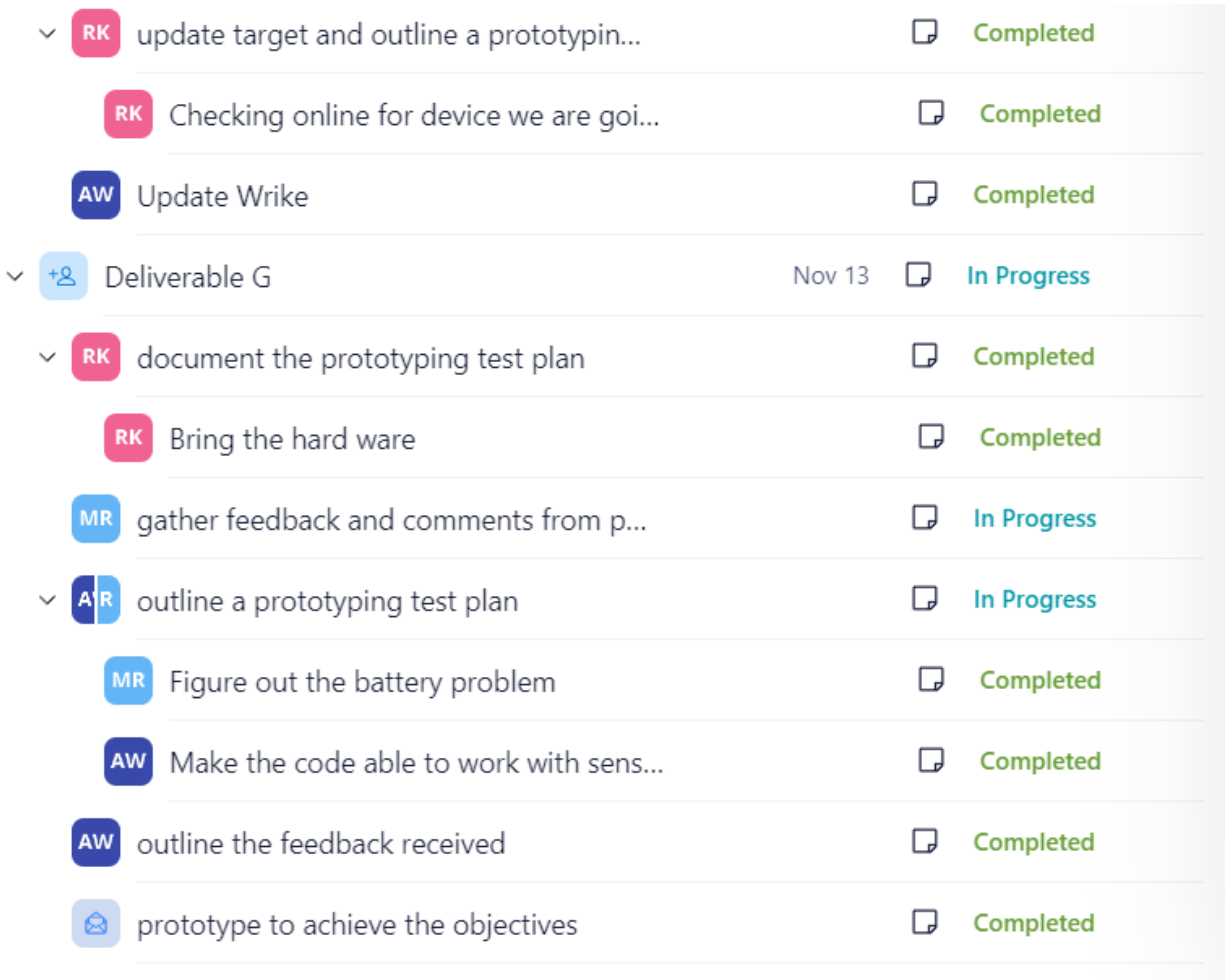
```
#include <iostream>
float pressure_input = 0;
float* p_pressure_input = &pressure_input;
float mass_input = 0;
float* p_mass_input = &mass_input;
//--------
float area = 0;
float* p_area = &area;
float volume = 0;
float* p_volume = &volume;
float gravity_constant = 6.6743*(10^(-11));
float ac_due_to_Gravity = 9.81;
int update_Data;
int* p_update_Data = &update_Data;
float result = 0;
float* p_result = &result;

float testing_Density(float pressure){
    float density = 0;
    density = (pressure * area * ac_due_to_Gravity)/(volume * gravity_constant);

    return  density;
}
```

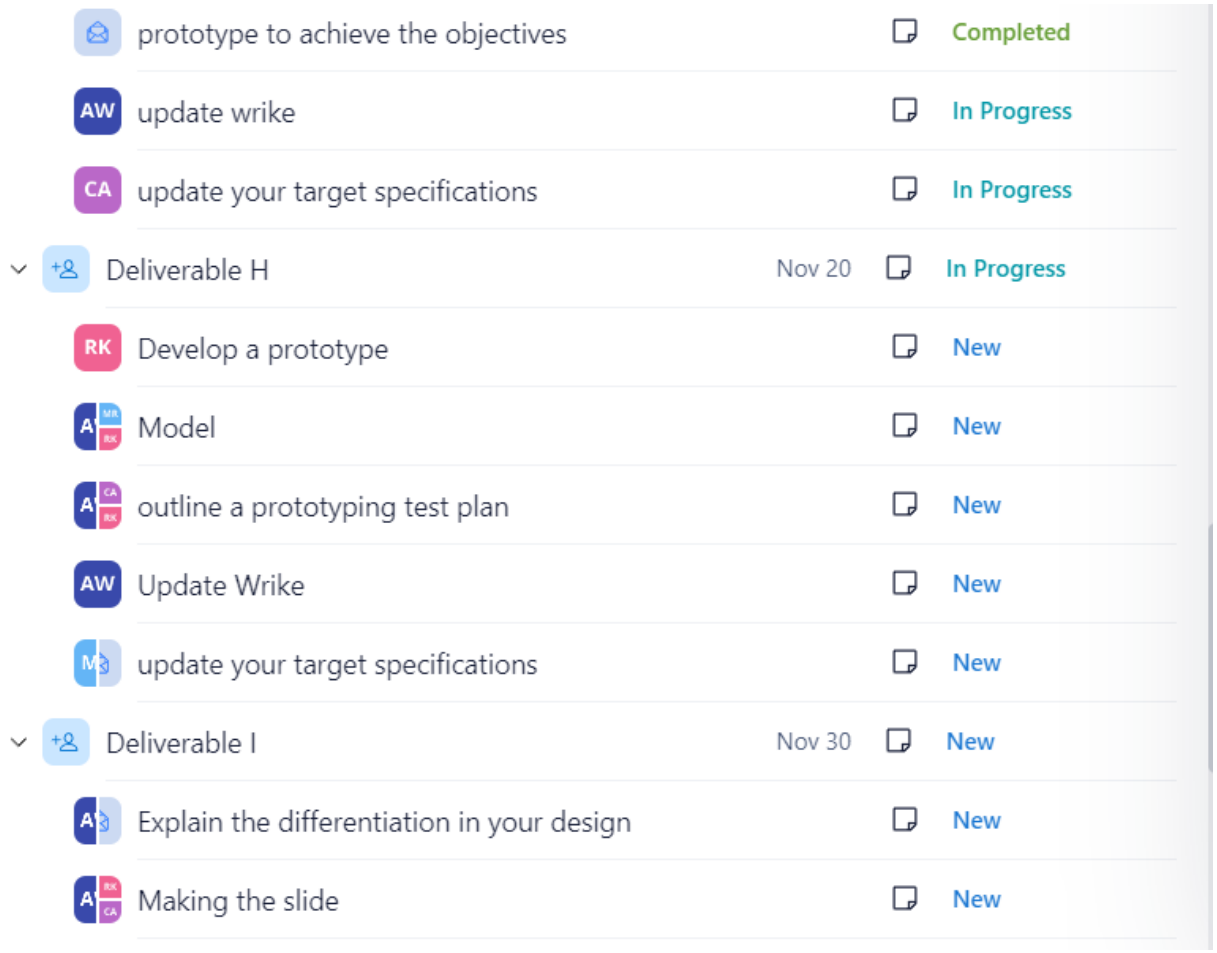
```
float testing_Density_2(float mass){
    float density = 0;
    density = (mass_input)/(volume);

    return  density;
}

float ask_For_Input_pressure(){
    std::cout << "Please enter current pressure: " << std::endl;
    std::cin  >> pressure_input;

    return pressure_input;
}

float ask_For_Input_mass(){
    std::cout << "Please enter current mass: " << std::endl;
    std::cin  >> mass_input;

    return mass_input;
}
```

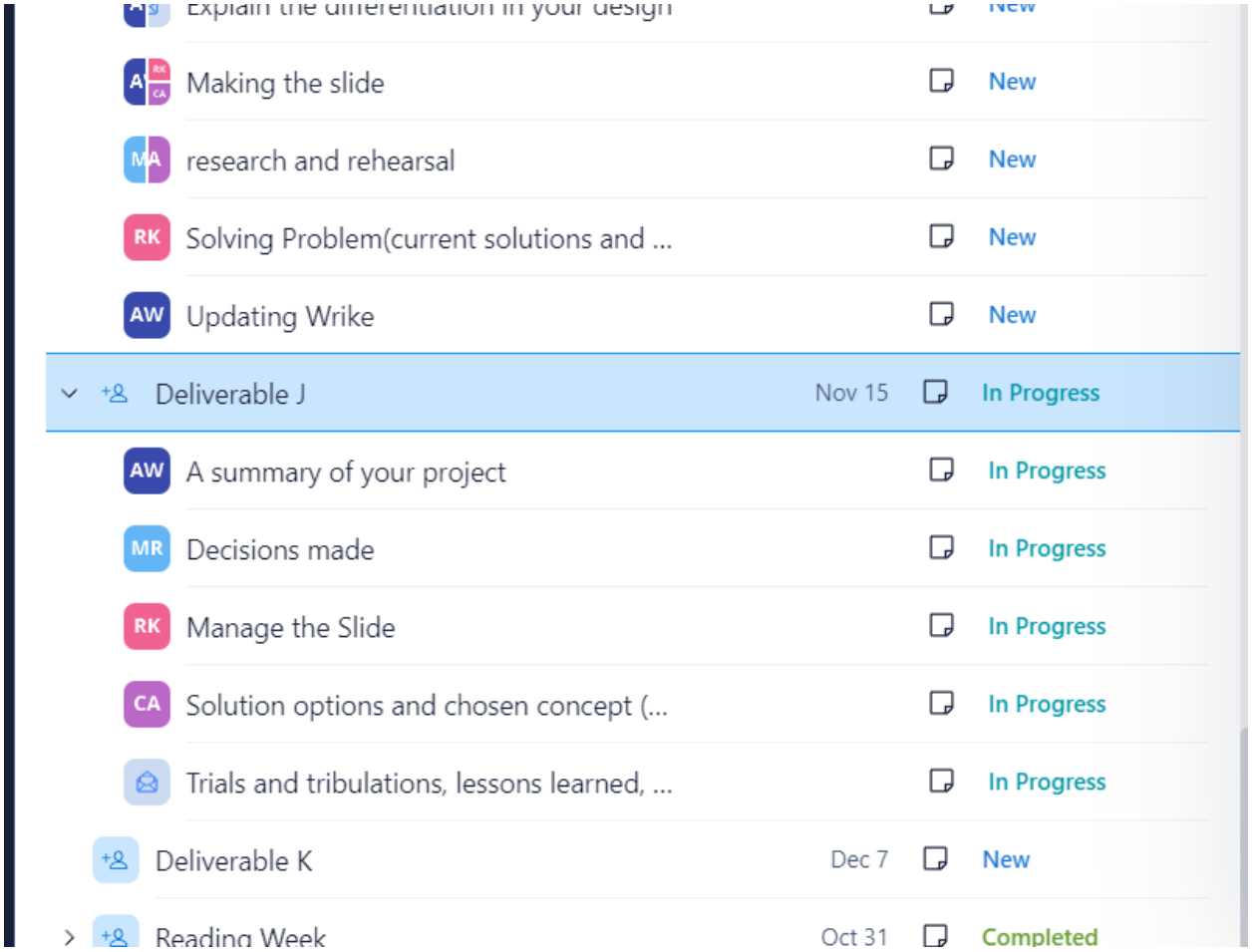
```
void update_data(){
    std::cout << "Do you want to update equipment data? " << std::endl;
    std::cout << "Enter 1 to update, 0 to skip" << std::endl;
    std::cin >> *p_update_Data;
    if (*p_update_Data == 1){
        std::cout << "Please enter new area" << std::endl;
        std::cin >> *p_area;
        std::cout << "Please enter new volume" << std::endl;
        std::cin >> *p_volume;
        std::cout << "Date updated" << std::endl;
    }else{
        std::cout << "Skipped" << std::endl;
    }
}

int main() {
    std::cout << "Testing our Prototype Function." << std::endl;
    update_data();
//  below is testing by pressure
    *p_pressure_input = ask_For_Input_pressure();
    *p_result = testing_Density(pressure_input);
//  below is testing by mass(not active now
//    *p_mass_input = ask_For_Input_mass();
//    *p_result = testing_Density(pressure_input);

    std::cout << *p_result << std::endl;
    return 0;
}
```

Wrike:


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


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


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