Deliverable C
Design Criteria

GNG 1103
Design

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Introduction

In this report, our team took the user needs which we derived from the client meeting on September 30th, 2022, with Shane from Beyond the Pale Brewing, and gave design criteria to each need to help rank solutions against each other to quantify which solution will be the best product for our client. Technical benchmarking can also be found in this report to ensure our team knows what products currently exist on the market and what features are present/missing to improve our future designs.

Design Criteria:

Table 1: Design Criteria

User Need	Design Criteria
The device must be automated and display results as they are produced	• Has a screen • Display result fast (seconds) • Minimal Display • Easy to Use display
The device must be compatible with a 3" fitting	• Width of the device must fit inside the gap (mm) • Height of the device must fit inside gap(mm)
The device must record and log data to be saved for future reference	• Measure specific gravity (kg/m^3) • Save logged graphs to a server
The device must record data every couple of minutes	• Must have memory storage (GB) • User-Friendly interface
The device must be a sample-less system	• The device must take measurements from inside the tank
The device must not be free float in the tank	• The device must be fixed to the tank
The device must be food grade	• Device must be legally allowed to be touching food (FSIR)
The device must be able to withstand 2-3 weeks of continuous monitoring	• The device must be able to withstand 2-3 weeks without failure (day) • The device must be waterproof to ensure it does not short circuit (IP)
The device must be easily removable for cleaning	• User-friendly for disassembly reassembly • Weight (kg) • Maintenance Cost ($)
The device must be able to measure temperature.	• Device can withstand operating Temperatures (°C)
The device must be hardwired to an electrical source	• Contains AC-DC Converter to power to hardwire device to the power supply • Contains DC backup power supply
The device must be cost-effective	• The device must be less than 25000$ for 16 tanks • Prototype Cost ($)

Design Specifications

Functional Requirements

- The device will measure the specific gravity which is the density (kg/m^3) of our fluid over the density of a reference fluid which is normally water (999 kg/m^3) [7]. It should be accurate to within +/- 0.002 and have a range of 0.990 to 1.120. This is the most ideal measurement because this allows the user to have all the necessary information to make decisions about the next steps to take.
- The fermentation of beer can last upwards of 14 to 21 days. Our device should be able to run constantly for more than 21 days. Ideally, the device can run for up to 28 days. Leaving plenty of time to encase the user wants to experiment or use the device longer than 21 days.
- Another one of our user's needs was to send data back and store this data to reference it so they can use the results to remake the product again. The device would ideally be able to store data before sending it to another location. Ideally, 1 Gb should be enough space to manage one complete cycle of fermentation. This will have to be tested to make sure that one fermentation cycle does not go beyond 1 GB.

Constraints:

- The device must have food-safe materials that follow the Canada Consumer Product Safety Act (CCPSA) [1]. To follow CCPSA standards, the materials must not expose hazards to the consumer via the product that is made with the device [3].
- Another constraint for the device involves the installation. Located on the front of the tank is a 13.5 to 17.5 inches opening. To install inside the tank the device needs to be no bigger than 13 by 17 inches to be able to fit in this opening. The device's data must also be available from a 3-inch diameter access point. This is the only location for a functional seal between the device and the tank to prevent any possible leaking.
- The device cannot free float because the volume of the tank is large, and it is easy to lose the product while filling or draining the tank. The device must be properly secured through the 3-inch hole to prevent the employees from wasting time searching for the device.
- During the fermentation process, the beer gets placed in very large tanks. To get an accurate reading, the device should be located 1 foot inside the tank. Ideally, it will be as close to the center as possible to ensure the most accurate data collection.
- The first phase of the production process starts with making sugar water which involves heating water and mixing in grains. This will cause the device to be exposed to temperatures up to 75 degrees Celsius. Ideally, this device should withstand temperatures over 100 degrees Celsius, to make sure that the device is still able to be functional without anything melting.

Non-Functional Requirements

- The client has requested to also measure the temperature of the beer as it is at different steps of the production process. The device will be fitted with a temperature sensor ideally it will be accurate to plus or minus 0.5 degrees Celsius.

- To be able to look at the current results of the device there will be a screen ideally attached to the outside of the tank that displays the current readings. The screen should show the current specific gravity at that moment as well as the current temperature.
- The device must be easy to remove and install. This will help the user set the device up correctly in a timely manner. Allowing them to move forward in their work without delays. Another reason it will be easy to remove, and install is that after every use, the device will be removed to be sanitized.
- Since the device will be cleaned frequently. It will be easy to clean. Ideally, the user will just have to soak the device in a cleaning solution to remove most of the by-products but may need to be cleaned with a light brush. If it is not easy to clean, the user will have to waste time making sure it meets the industry standard of sanitation.
- This device should be easy to use. The device should be very clear on the measurements it is receiving, and all the necessary information should be easily accessible. Ideally, it will take an 8-hour workday for someone to learn how to use this device. This includes being able to install, remove, clean, start and understand the data retrieved.
- Since the frequency of removal and installation is high, this requires the weight of the device to be enough for one person to lift without injury and install/remove without difficulty. Ideally, the best weight for the device is less than 6.8kg [2]. which is under the amount of weight one person can lift before a second person is required.
- To waste less product this device should be able to take all the necessary measurements without having to remove samples of the product. This will make sure the product doesn't have to be at the right temperature or degassed to be tested.

Table 2: Design Specification and Metrics

Design Specification	Relation	Value	Units	Verification Method
Functional Requirement				
Measuring Specific Gravity	=	+/- 0.002	Kg/m^3	Analysis
Run for 14 to 21 days	=	21-28	days	Test
Send and Log Data	<	1	Gb	Test
Constraints				
Food safe material	=	Yes	N/A	Safe food for Canadians Regulation
Device Dimensions	<	13.5 by 17.5	inch	Test
Not free floating	<	Yes	N/A	Test
Output results through 3''hole	<	Yes	N/A	Test
Location in tank	<	1' away from edge	ft	Test
Exposed to high temperature	=	75	C	Test

Cost	<	$1,562.00	CAD	Final Estimates, and Budgeting
Non-Functional Requirements				
Measure Temperature	=	+/- 0.5	C	Analysis/Test
Screen	<	Yes	N/A	Test
Power is Hardwired	=	Yes	N/A	Test
Easy to clean	<	Yes	N/A	Test
Easy to use	>	Yes	N/A	Test
Weight	=	6.8	kg	Test
Easy to remove and install	=	Yes	N/A	Test
Sample less	=	Yes	N/A	Test

Technical Benchmarking

To complete our technical benchmarking, we looked more at possible automatic/non-handheld options rather than using a regular manual hydrometer or refractometer. It seems that most of the other options use buoyancy to find specific gravity and are free floating (This is something that we want to avoid as the client has stated they do not desire an instrument that free floats). Overall, the best option for pricing and fitting the client's criteria is probably the Liquid Density Analyzer DM8C, VD6 [4][10]. The best overall while not considering the client's criteria would be the TILT Hydrometer [8][9], which has the best pricing overall and accuracy, not to mention is able to measure the temperature of the liquid as well. EDM Density meter 5000 major problems are 1. it's not constantly measuring the specific gravity and 2. it requires taking samples out. It is also one of the most expensive out of all the available options, it must be taken into consideration as the price was a user need. It is the most accurate out of all the different density members. The SG-100 Electronic Battery Hydrometer [6] seems to be very similar to the TILT except more expensive and worst in every aspect. Other ways of measuring specific gravity are through oscillation and vibration. These methods should be noted as they give additional ways, we could measure our specific gravity in one of these ways instead of using buoyancy. To rank these existing products, we compare their technical specification to our design specifications and rank them accordingly. The colour associated with the specifications is worth different points. Green is worth 2 points, yellow is worth 1 point, and red is worth 0 points depending on what we thought was good, moderate or bad based on our specs.

Table 3: Technical Benchmarking

Device **Specification**	***SG-100 Electronic Battery Hydrometer***	***TILT Hydrometer***	***Liquid Density Analyzer DM8C, VD6***	***EDM Density Meter 5000***
Company	Eagle Eye Power Solutions	Toronto Brewing	Yokogawa	Schmidt
How it Measures SG	Uses buoyancy	Uses buoyancy and angle	Uses Vibration	Oscillating U-tube [5]

SG Density Accuracy	±0.005 g/cm3	±0.002 g/cm3	±0.05 g/cm3	±0.0005 g/cm3
Density Range	0.550 - 2.000 g/cm3	0.990 - 1.120	0.5 to 2.0 g/cm3	0 to 3 g/cm3
Measures Temp?	No	Yes (±1°F)	No	Yes (±0.03°C)
Operating Temp.	- 20 to 106°C	-10 -to 100°C	-10 to 100°C	10 to 95°C
Price/Piece	$ 5 585	$ 220	$ 900	~ $ 5 000
Sample Require	No	No	No	Yes
Free Floating	Yes	Yes	No	No
Blue tooth or hard wire	Hardwire/ 3-30.5 m cable	Bluetooth	Both	Separate machine
Total Points	8	13	11	11

Reflection

The client meeting with Shane from Beyond the Pale Brewing Company was very important in helping us determine our design criteria and our specifications. During the client meeting, our team was able to ask Shane specific questions which helped us narrow down what actual needs were important for this product according to the user instead of guessing what was important to him and picking what we thought was important. From the meeting, we all took notes of the raw data which helped us derive those needs, which then helped us derive the design criteria we will use to design solutions and to evaluate said solutions. Since deliverable B, our needs and criteria have not majorly changed. Our team was able to send a member to visit Beyond the Pale's brewery to get some extra details about Beyond the Pale's existing infrastructure which helped us determine specific metrics regarding what the limiting size of our device can be.

Wrike Link

https://www.wrike.com/workspace.htm?acc=4975842&wr=20#folder/966341779/list?filters=status%3Dactive&sidePanelItemId=974786389&sortOrder=1&spaceId=-1&viewId=108931260

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