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Expanding Operations for Battery Steele Brewing

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Abstract

Battery Steele Brewing is a small, yet largely successful brewery located in Portland, Maine, looking to exploit new markets and expand into another New England location. Battery Steele seeks to increase production levels by purchasing high quality, more automated, and higher capacity equipment in the new facility. Our team made up of industrial and chemical engineers successfully created a plan wherein we recommended equipment, calculated payback, and designed a process-flow oriented floor plan for the new Battery Steele facility.

Acknowledgements

We would like to thank our sponsors at Battery Steele Brewing, Scott Kenney and Shane Noble, for allowing us to work on this project. We appreciate all their input and the freedom they gave us of taking this project in the direction we wanted while best accomplishing their goals.

We would also like to extend a thank you to the rest of the staff at Battery Steele for all of their help and answering our questions in our visits to the brewery.

Finally, we would like to thank our advisors, Sharon Johnson and Stephen Kmiotek, for their feedback and unwavering support and guidance. All of their feedback helped strengthen us, both as a team and with the report, and for that we are grateful.

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1. Introduction

Battery Steele Brewing (Battery Steele) is a relatively new, well-known brewery in the Portland, Maine area specializing in craft brewing and maintaining an industrial New England atmosphere. Battery Steele is seeking to expand its operations into another, less saturated New England market. Their main objectives in this expansion are to acquire their own in-house canning system, operate within a larger facility to allow for greater production, work with local entrepreneurs to have an attached restaurant to their tasting room and brewery, and obtain licensure for self-distribution.

The main goal of our project was to aid in Battery Steele Brewing's expansion by helping them in the planning phase of opening a fully functional brewery with a fifteen barrel (bbl) capacity and an attached restaurant. We were able to accomplish this by performing an equipment selection process, a cost analysis comparing the purchase of an in-house canning line to the continued use of a third-party, and designing a to-scale facility layout. We worked closely with Battery Steele to ensure we provided relevant suggestions and recommendations, both in this report and any presentations given, and to ensure that they stayed close to their needs and desires for the new facility. Throughout this report, we first introduce Battery Steele in greater detail, as well as the intricacies of craft brewing and the general brewing process. We then outline how we carried out the methods described above, followed by our results found from them and discussion surrounding these results. Finally, we acknowledge the benefits of continuous learning as found through the completion of our project, as well as our conclusion and final recommendations for Battery Steele.

2. Background and Literature Review

This chapter provides background information on Battery Steele Brewing, craft brewing, and analysis techniques that can be directly applied to effectively opening a new facility. Each section provides information that is relevant to, and may aid in understanding, later chapters of this report.

2.1 Battery Steele Brewing

Battery Steele Brewing is a relatively new craft brewery in Portland, sitting directly across Industrial Way from world-renowned Allagash Brewing Company. Thriving off a constantly rotating selection of craft beers, Battery Steele is committed to keeping a fresh New England feel in both their drinks and their atmosphere. The brewery takes pride in supporting local businesses and is committed to consistently serving customers with high quality, authentic, great tasting beer. Moving forward, Battery Steele aims to keep an authentic atmosphere within the restaurant, tasting room, and supply chain.

Currently, Battery Steele Brewing produces around 90 barrels of beer each month in their Portland location[1]. The brewery utilizes third-party canning company Iron Heart to periodically come with a mobile canning operation and prepare their product to be sold. All of the beer produced in the brewery is sold in either 16-ounce cans or in kegs. In order to reduce distribution costs and ensure customers are receiving fresh beer, Battery Steele self-distributes their products to local restaurants, warehouses, and other vendors.

At time of this report no location to build has been specifically chosen yet, but general dimensions of an ideally-sized facility were given to, and used by, us for purposes of the layout.

[1] Scott Kenney, phone communication, September 13, 2018

In a phone conversation with sponsor Scott Kenney in October 2018, we were told that the square footage of the new facility would be roughly 8,000 square feet (sqft), which is larger than the current Portland facility, measuring at 3,000 sqft[2]. Battery Steele is looking to increase the size of the fermenting tanks to accommodate 15 bbl per month and to incorporate a combined restaurant and tasting room to sell beer to customers firsthand. The new facility will be modeled to meet all process requirements in an efficient way to reduce costs over time and include a warehouse for storage purposes. The restaurant will be managed by a local partner, and will be determined as the location for the new facility is decided. Battery Steele is looking to create an authentic New England atmosphere, yet stay true to its roots of being an industrial brewery operation.

Similar to its current distribution arrangement, Battery Steele's goal is to obtain a distribution license in the new state of operation. Battery Steele has considered outsourcing distribution to local vendors in Portland; however, controlling the distribution network has created a more consistent and timely delivery of its products and has also created a more economically advantageous distribution channel. For this reason, Battery Steele has been self-distributing in the Portland area and aims to follow this distribution method in the new state of operation. This will cut costs and allow them to establish a face-to-face relationship with local vendors and ensure that the beer is fresh.

2.2 Craft Brewing

Before we could research how to layout a new brewery for Battery Steele, we had to understand craft brewing at a deeper level. This section highlights some key aspects of craft brewing, especially points and details pertinent to the project.

[2] Kenney, personal communication, October 2018

2.2.1 Overview

According to a case study in the *Review of Agricultural Economics*, craft brewing uses "diverse malt inputs to produce unique beers", and consists of brewpubs, microbreweries, and regional breweries. Craft breweries allow for customers to enjoy a greater product variety with different flavors, thanks to the aforementioned diverse malt inputs. The number of craft breweries in the United States has largely increased in the past few years, generally popping up in clusters in destination areas where the niche market is more popular[3]. Craft brewing is very similar to large scale and commonplace brewing strategies, with the main differences being the quantity and characteristics of the beer. All brewing follows the same key steps: Soaking malted barley in hot water to release sugars; boiling the malt sugar solution with Hops; cooling the solution and adding yeast to begin fermentation; and allowing the yeast to ferment the sugars to release carbon dioxide and ethyl alcohol[4]. Craft brewing differs from regular brewing through its wide selection of malts to create a diverse and unique flavor profile. Additionally, craft beers are brewed in much smaller batches than typical breweries, allowing a larger emphasis on their characteristics and flavors among the wider varieties available.

A common component of craft breweries is an emphasis on the atmosphere of the brewery that is open to the public. Treehouse Brewing, a large craft brewery in Sturbridge, MA, knows this well; they often have customers waiting in line for hours to try their special flavors of the month, and sell out of their supply almost every time[5]. The popularity of craft brewing leads to strong competition but allows a favorite for everyone because of the diverse amount of flavors offered in each brewery.

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[3] Niche Market Potential: The Case of the U.S. Craft Brewing Industry
[4] How to Brew
[5] Here's what it's like to wait in line at Treehouse Brewing

2.2.2 Brewing Process and Equipment

The standard craft brewing process is complex and involves many pieces of equipment[6]. Grains are an integral part of brewing; they are stored unmilled in a silo and milled in a grist tank. A silo is used to store base malt in bulk to optimize space and save money on grains. A grain auger is used to transport grain from a truck to a silo and from a silo to a mill. The mill is used to the to crack the kernel of the grains, but not break the husk. A grist tank, typically located just above the mash tun, is used to store and feed milled grains to the mash tun. The milled grains that are fed to the mash tun vary based on the recipe but generally consist of base malt and specific grains.

The primary components of a brewhouse are a mash tun, hot liquor tank, and kettle. The brewhouse starts the brewing process by preparing milled grains for fermentation. The mash tun converts the starches from milled grain to sugars and breaks down proteins by mixing the milled grain with water at higher temperatures. The hot liquor tank is connected to a boiler and feeds hot water to both the mash tun and kettle. The grains are separated from the liquid in the mash tun and fed to the kettle where the mixture is combined with hot water and boiled after reaching the desired volume, with hops being added intermittently depending on the recipe.

From the kettle, the mixture is transferred to a whirlpool vessel. In the whirlpool, the wort is separated from the solids and run then run through a heat exchanger to cool it to room temperature. From the heat exchanger, the wort is fed to a fermentation tank. Yeast is additionally added to the fermentation tank to convert sugars to ethyl alcohol and carbon dioxide. The temperature of the fermentation process is typically maintained, through the use of an automatically controlled glycol machine, in a five-degree range; fermentation can take between

[6] Beer Brewing System and Method

about 4-14 days depending on the variation of beer and desired flavor. The beer is allowed to rest for two days and then chilled, following the completion of the fermentation process, to allow the yeast to settle. The beer then is transferred from the fermentation tank to a conditioning tank, also known as a Brite tank. The beer is carbonated, through the injection of carbon dioxide, in the conditioning tank and then canned or kegged[7].

A process flow diagram (PFD) which visually shows the product flow at Battery Steele's Portland, Maine facility is shown in Figure 1. In the Maine facility, there were complications with the supplier, so the grist tank is not located just above the mash tun; the grains are instead fed to the mash tun through the use of piping and a pump, as shown in the PFD.

[7] The Beer Brewing Process: Wort Production and Beer

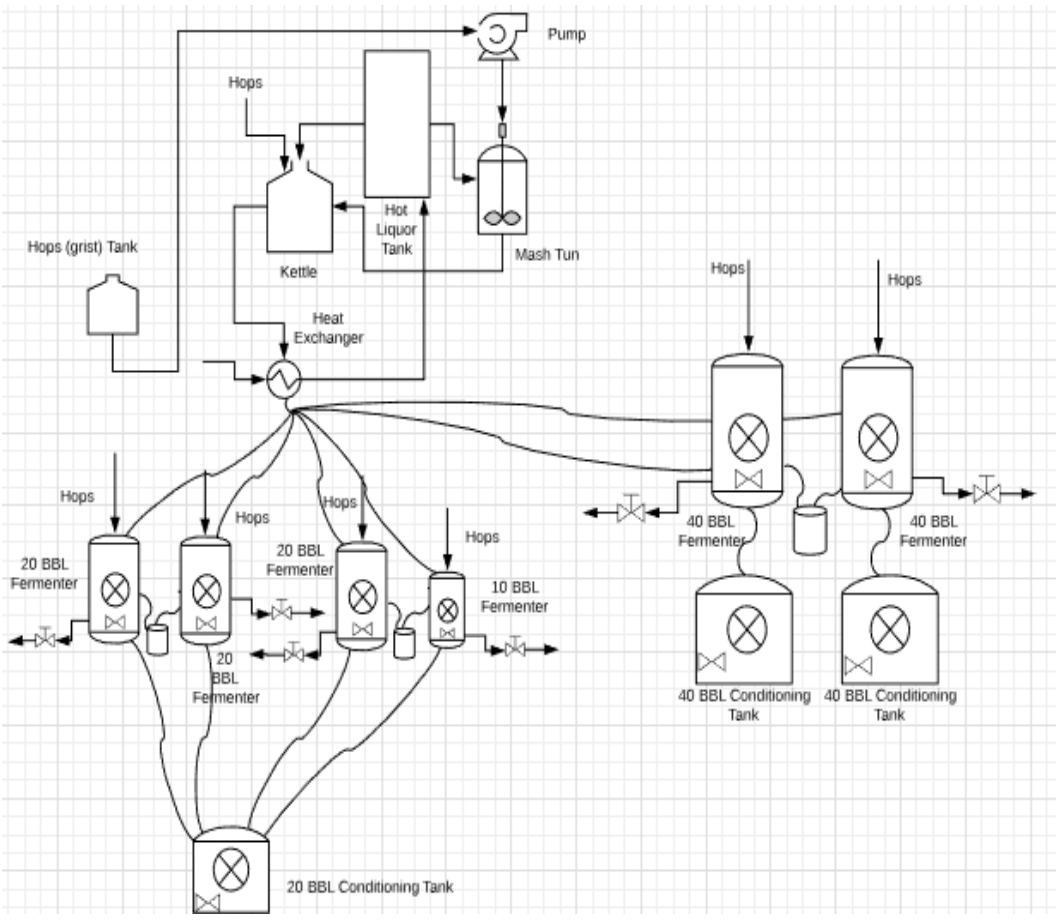

Figure 1, Process Flow Diagram of Battery Steele Portland

2.3 Brewery Canning Process

In consideration of technical concepts of industrial and chemical engineering, we carried out a cost analysis on the canning process to ensure long term success of the facility. The current bottleneck in the Portland location is the outsourced canning process. Because Battery Steele currently uses Iron Heart to can their beer, canning operations are planned months in advance. This predetermined schedule often causes overstocking and understocking which can comp. By adding a canning line in the new facility, they will be able to better coordinate production and canning without compromising the quality of beer, accruing storage costs, or disrupting production.

The necessary equipment needed to set up an entire canning line and the associated costs can be found in Figure 2[8]. Currently, Iron Heart sets up their complete mobile canning line inside the Battery Steele facility on pre-scheduled days, charging a set cost that includes materials and labor. The canning line currently takes up the majority of the open floor space, about 20 feet by 10 feet in dimension. The canning line pumps the beer from the conditioning tanks, feeds the empty cans from the pallets to the rinser and conveyor, then fills, seals, and labels the cans. The beer is then stacked in cases and is ready for distribution.[9] In the new facility with more floor space, Battery Steele would like to purchase their own canning line so that they will no longer need to outsource this part of the production process and can save on convenience fees and outsourced labor costs.

Equipment Description	**Cost (USD)**
Auto-Can Depalletizer	$31,762
Can Twist Pre-Rinser	$1,976
Deluxe Ink Jet Date Coder with Product Spacer	$15,871
Conveyor Extension	$1,377
Digital Brite Tank Monitor	$1,678
Complete Canning System	$82,647
Pressure Sensitive Can Labeler	$20,998
Pack-Off Conveyor	$6,848
Shipping and Handling	$3,962
On-Site Startup and Training Service	$2,250

Figure 2, Canning Line Equipment Costs

In order to perform a cost analysis on the purchase of an in-house canning line, the team compared current costs of outsourcing to Iron Heart with the cost of materials and labor that would be spent if Battery Steele were to invest in an in-house canning line. We compared the

[8] American Beer Equipment Proforma Invoice, July 24, 2017
[9] Team observation, February 21, 2019

price per barrel that Iron Heart charges with the finance payments and labor costs associated with the in-house canning line using an annual cost breakdown of the two canning systems. The analysis considered the set cost of using Iron Heart, material costs, labor costs, and the qualitative added benefit that Battery Steele will experience by being able to can beer at their convenience instead of having to schedule canning in advance. This analysis is explained in greater detail through the Methodology and Results and Discussion chapters.

3. Methodology

This chapter reviews the main objectives we aimed to accomplish and approach carried out for our project.

The main goal for Battery Steele Brewing's expansion was to open a fully functional brewery in another New England location with a fifteen barrel capacity and an attached restaurant/tasting room. Battery Steele asked us to provide recommendations for several specific objectives, while also allowing us to offer help and input wherever else we saw fit, to aid in meeting this goal. The objectives our team pursued and met are as follows:

- Suggest equipment suppliers for the new facility based on an evaluation of features and cost
- Determine if Battery Steele should implement an in-house canning system as opposed to continuing to use a current third-party canning company by performing a cost analysis
- Design a to-scale layout for the New England facility to best utilize the assumed space and give Battery Steele the room needed to grow, both now and in the future, if desired
- Provide recommendations for the facility based on our observations, research, and results throughout the project, as well as best practices of both industrial and chemical engineering

This project was completed over the course of roughly one academic year. Our schooling structure is split into four quarters. Throughout this report, we refer to the first quarter as A-term, the second quarter as B-term, and so on. To better understand and determine our goals, we performed background research on Battery Steele Brewing. We became familiar with the process of craft brewing and how a canning system works. During A-term, we visited a number of craft distilleries and breweries to gain an understanding of best practices, including:

- GrandTen Distilling: September 2, 2018 (Boston, MA)
- Bully Boy Distillers: September 2, 2018 (Boston, MA)
- Wachusett Brewing Company: September 23, 2018 (Wachusett, MA)
- Surly Brewing Co: October 22, 2018 (Minneapolis, MN)

At the same time, we also focused on communicating with Battery Steele to understand their current process and what they wanted us to achieve over the course of the project. In B-term, we had numerous conversations via email and phone with our sponsors, Scott Kenney, owner, and Shane Noble, co-founder and brewer, to gather relevant information and answers to questions to aid us moving forward, as well as equipment suppliers. We also developed a layout of the current Portland facility to use for planning purposes for the new facility we designed. During C-term, we completed the bulk of the analyses, the proposed layout for the new location, and the written report, as well as presented our findings, recommendations, and results at Battery Steele. This chapter explores the specific methods we carried out of the course of the past academic year, as seen in Figure 3.

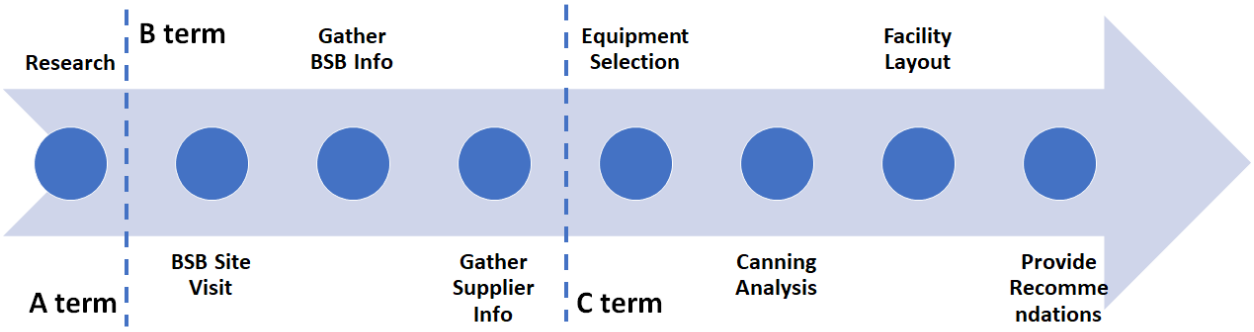

Figure 3, High-level Project Overview

3.1 Equipment Selection

The analysis of three equipment suppliers, American Beer Equipment (ABE), Premier Stainless Systems (PSS), and TD Tanks (TD), allowed us to lay out the differences in both features and price, and provide Battery Steele with a well-rounded and confident recommendation of which supplier to purchase the desired equipment from.

In December 2018, we inquired about quotes for three pieces of equipment Battery Steele wanted: A three-vessel brewhouse with a whirlpool vessel, six 40-barrel fermenters, and two 80-barrel Brite, or conditioning, tanks. Emails were sent to ABE, PSS, and DME Brewing Solutions (DME). These three suppliers were chosen due to their reputation in the brewing industry, as well as per the recommendations/requests of our sponsors. DME failed to respond to any inquiries, so we did not include them in our consideration for the purchasing of equipment. ABE and PSS were prompt and thorough in their replies and quotes given and included quoted prices for other pieces of equipment a brewery may need, as well as answering some questions Battery Steele wanted us to have answered. These questions did not affect the analysis, but the answers were still given to our sponsors for their purposes. These questions served to give some insight directly from brewery equipment suppliers and included:

- Is a spent grain auger worth the investment on a 20bbl system?
- [What are the] benefits for using a multi-stage glycol chiller?
- Does your brewhouse offer pneumatic valves everywhere except the ones accessible from the brew deck?

Once the prices of the relevant pieces of equipment were obtained from ABE and PSS, we entered them into a simple spreadsheet to ease the comparison of cost between suppliers. This

spreadsheet can be found in Section 4.1, Equipment Selection. In addition to the cost of equipment, the shipping and installation costs were also of interest, especially because they tend to drive the total cost up by a significant amount[10]. We were given rough estimates of the shipping and installation costs since exact numbers would not be known until the equipment was purchased and installed, so if a range was given, we used the average/middle of the range for analysis purposes.

The third supplier actually taken into consideration as aforementioned was TD, which is the supplier for Battery Steele Brewing's current fermenters and conditioning tanks in the Portland facility. After discussing the quotes from ABE and PSS and our ideas at the time with our sponsors, they said that due to the price, they would most likely use their current supplier for the fermenting tanks and conditioning tanks in the new facility because of their drastic difference in cost[11]. After further research and discussion, we found the prices of these tanks to be substantially cheaper than options from both ABE and PSS.

3.2 Cost Analysis of Canning Line

The cost analysis helped to determine whether or not an in-house canning system would be cost effective. By assigning monetary values to the costs for both purchasing a new canning system and continuing to use Iron Heart, we analyzed whether or not Battery Steele should purchase and set up their own canning line.

In performing an annual cost analysis for the different options for canning systems (in-house versus third party), we quantified the overall cost of the investment and compared it with the costs of the current operation to show how much money the investment would save. In the

[10] Noble, personal communication, January 2019
[11] Noble, personal communication, February 2019

cost analysis, we took into consideration the possible loss of product the brewery faces with using a third party. Iron Heart is scheduled to can the product multiple months in advance, thus Battery Steele Brewing runs the risk of producing too much or too little beer to be profitable. For example, any excess beer produced may go to waste if Iron Heart does not bring enough cans, and too little beer produced can lead to a higher unit cost per canned product. This analysis allowed the team to take varying costs into consideration and determine whether a higher fixed cost of the in-house canning line would be more cost-effective than the higher variable costs of a third party canning system.

In our cost analysis, we considered the following:

a. The cost Iron Heart charges to can on a pre-scheduled day, as this is currently the largest bottleneck in the process
b. The costs of purchasing an in-house canning line: down payment, monthly payment for the remainder of the investment with five percent interest over five years, labor required to run the machine, maintenance required
c. Materials (cans, labels, etc) when canning through Iron Heart and through an in-house system

3.3 Facility Layout

In terms of facility attributes and budgeting, we made decisions based on both industrial and chemical engineering principles. Factors that were especially considered were location and equipment-optimized budgeting, design (tasting room and restaurant layout), and partner selection. Equipment and process selection/layout focused on saving as much as possible on utilities through the use of natural factors, such as gravity to lessen the need for pumps. The process was also designed to minimize unnecessary movement of product in the actual

production process and after the beer is ready to be canned. We designed the facility to meet current demands, and to be able to expand to meet future increased demand.

Being familiar with the equipment and process allowed us to plan out an optimal process layout to minimize product movement and additional process costs, such as insulated tubing. Within the design, we took into consideration forecasted future bottlenecks and generated a facility that would be able to eliminate them. The process design also focused on best fitting Battery Steele Brewing's brewing process, which they plan on keeping and only changing in terms of size and volume for the new facility. Regarding facility design, we also considered the atmosphere, tasting room, attached restaurant, and outdoor seating area. We designed the facility to make it a destination location that has Battery Steele's genuine New England feel, helping to truly showcase their authentic craft beers.

4. Results and Discussion

The following section outlines the results we found via our methods over the course of the project, as well as some discussions of the results found and their relevance towards the main goal of opening a fully functional fifteen barrel capacity brewery with an attached restaurant and tasting room in a new location. Again, our methods included suggesting equipment suppliers for the new facility, determining any benefits of an in-house canning system, designing a layout for the new facility, and providing observation-base recommendations

4.1 Equipment Selection

As described in the Methodology, an equipment selection process was carried out in order to find what we felt best matched Battery Steele Brewing's wants and needs based on cost and features. After receiving quotes on equipment, shipping, and installation from both ABE and PSS, we entered the data into a simple spreadsheet shown in Figure 4.

			Unit Price		
Item	**Size**	**Size/Quantity**	**ABE**	**Premier Stainless**	
3-Vessel Brewhouse	20 bbl	1	$86,833.00	$138,700.00	
Fermenter	40 bbl	6	$17,965.00	$16,250.00	
Brite Tank	80 bbl	2	$27,043.00	$22,750.00	
Shipping	n/a	1	$9,400.00	$17,500.00	*estimates*
Installation	n/a	1	$2,475.00	$7,500.00	*estimates*
		Total:	$260,584.00	$306,700.00	
Equipment from both facilities expected to last "the life of the brewhouse" with no routine maintenance required or expected, unless in case of extrenuating circumstances.					

Figure 4, Equipment Cost Breakdown

As shown, ABE's equipment was significantly less expensive than PSS's equipment with all things considered. After consulting with Shane Noble and looking into the differences between the brew houses offered by the two suppliers, we learned that the brewhouse offered by PSS was far more automatic, which would allow brewers to dedicate time to other needs within the facility (Noble, personal communication, February 2019). This would save time and money,

and could therefore increase production. These added benefits of the PSS brewhouse make it the better choice of the two suppliers.

The price differences between the two suppliers' fermenting and conditioning tanks were small, and neither had a clear advantage, especially with the more expensive PSS brewhouse being the better option. TD Tanks, Battery Steele's current supplier of fermenting and conditioning tanks at their Portland location, were substantially less expensive than the other two suppliers at $13,300 for a 40 bbl tank. Due to the minimal differences between fermenting and conditioning tanks of different companies, and TD's reliability to date, TD's tanks became the evident choice.

4.2 Cost Analysis of Canning Line

There is a significant opportunity to reduce costs and increase operational productivity presented in the canning process at Battery Steele. They have shown a strong interest in purchasing their own canning system, and this section focused on a discussion of the overall savings that will result in purchasing a canning line for the new facility.

4.2.1 Monthly Payment Options

Battery Steele has estimated that the total cost of a canning line, including the canner, depalletizer, dissolved oxygen meter, and labeler will cost $185,000[12]. We are assuming that these costs are accurate and that all the components are necessary to purchase. Out of the total cost, Battery Steele is looking to make a down payment between $25,000 and $50,000 and to finance the remaining amount over 5 years, assuming a standard 5% interest rate. In order to conceptualize the monthly costs of the investment and aid Battery Steele in deciding which down

[12] Shane Noble, email communication, January 23, 2019

payment best suits their needs, we determined a breakdown by choosing the minimum, middle, or maximum down payment. Battery Steele will be able to see the long term financial commitment of their investment, and to choose which down payment is most suitable for them. Figure 5 shows a breakdown of these payment options.

Initial Investment	$25,000 (minimum)	$37,500 (middle)	$50,000 (maximum)
Monthly Payment	$3,333	$3,072	$2,813
Annual Payment	$40,000	$36,800	$33,750
Total Spent	$225,000	$221,500	$218,750

Figure 5, Investment Option Cost Breakdown

4.2.2 Cost Comparison

The factors that contribute to the overall annual cost of the canning line are the down payment, monthly payments for the investment, materials costs, and labor costs. Factors contributing to Iron Heart costs include the price per barrel that Iron Heart charges. In completing the cost comparison, we assumed that Battery Steele chooses a down payment of $37,500 so that the annual payment for the investment is $36,800 for estimation purposes. As such, the equipment costs of the canning line are $36,800 annually for the first five years, and are estimated to drop down to zero after the investment is paid off.

The following costs and production information are crucial to consider in estimated annual costs of the canning system:

- Maintenance costs are estimated to be around $500 annually
- Labor costs are estimated at $500 per canning run (varying number of people depending on the day, all monitoring the machine to ensure it runs smoothly at different points, such as labeling, sealing, etc.)
- Materials are estimated to cost $65 per barrel

- The current facility produces an average of 148 barrels of beer per month with spillage accounted for
- The distribution of beer that is packaged in cans and in kegs is 60% and 40%, respectively[13]

From this information, we deduce that Battery Steele would be able to can 89 barrels per month, which could be canned with an estimated 1.5 runs on the canning line every month. Currently, Iron Heart is scheduled to come about once every three weeks, but Battery Steele produces enough product to be canned more frequently- three times every two months (1.5 runs every month). At 1.5 runs every month and $500 per run, this will cost $9,000 in annual labor due to more frequent visits and perhaps more employees of Iron Heart coming per run. At 89 barrels produced each month, materials costs will be $69,420 annually.

The overall cost breakdown can be found in Figure 6, at an annual cost of $115,720 for the first five years of financing the equipment, and $78,920 annually after the investment is paid off. In comparison, Iron Heart charges $125 per barrel, including labor and material costs[14]. Packaging 89 barrels per month at $125 per barrel comes to a $133,500 annual cost with Iron Heart. Even in the first five years with financing costs, Battery Steele will be cutting costs by purchasing an in-house canning line. The cost breakdown over ten years can be seen in Figure 6, with a total savings of around $300,000 that could be reinvested into the company if Battery Steele purchases the canning line to package their canned beer.

[13] Shane Noble, email communication, January 23, 2019
[14] Scott Kenney, phone communication, February 20, 2019

Year	Canning Line	Iron Heart
0	$35,000	0
1	$115,220	$133,500
2	$115,220	$133,500
3	$115,220	$133,500
4	$115,220	$133,500
5	$115,220	$133,500
6	$78,420	$133,500
7	$78,420	$133,500
8	$78,420	$133,500
9	$78,420	$133,500
10	$78,420	$133,500
Total	**$1,003,200**	**$1,335,000**

Figure 6, Cost Analysis

4.2.3 Added Production Time

With the added value of being able to can at Battery Steele's convenience, three to five days are estimated to be saved in each brew cycle that will not be spent waiting for Iron Heart to arrive[15]. With seventeen brew cycles per year, Battery Steele would essentially be adding 51 possible production days to their process. This has unquantifiable benefits, as they could use this time to can beer in a less time-constrained environment, decrease brew quality errors since there is more time to spare, or even spend time on experimental batches that could add value to the company.

4.3 Operations Logistics

The new facility will be very different in terms of layout than the Portland facility, and will have more of a focus on implementing best brewing and supply chain practices that are further explained in this chapter.

[15] Shane Noble, email communication, January 23, 2019

4.3.1 Warehouse, Cooler, and Freezer

The proposed warehouse facility will have access to a walk-in cooler and freezer, but will not be connected to the main facility to save on heating, insulation, and space. In Battery Steele's current site in Maine, the storage space is contained within the 3,000 sqft facility. In the new facility, we recommend that a warehouse be built separately but connected to the main facility; a separate facility will provide a better use of space and Battery Steel will be able to optimally organize their utilized grains and save on utilities. To minimize motion and distance needed to travel with materials, we also suggest that the warehouse be close to the canning line and milling room.

Within the warehouse space, we recommend that the freezer for grains and the walk-in cooler to store packaged beer be within close proximity of the bay area. We also recommend that the warehouse and freezer be organized by how much the items are used, with the most used grains being at the closest point of access. Palletized cans can also have their own designated area within the warehouse that is relatively close to the canning line. The grains within the warehouse and freezer could also be kitted, meaning that grains could be grouped and organized based on the production schedule with the soonest produced being closest to the production area. We recommend that the new warehousing space utilize upward space, through organized shelving units, that was previously not accessible in the Portland facility. When implementing warehouse supply chain procedures, Battery Steele can also put an inventory management system in place. This system would allow them to easily identify when they are running low on a specific grain so that it can be ordered before it halts production. The new facility will also focus on ensuring that Battery Steele will be able to utilize the full height of their walk-in cooler by being able to stack three cases at any point within the cooler.

4.3.2 Silo and Mill Room

At Battery Steele's new facility, a silo and mill room will be implemented to minimize both storage area and cost of base malt. The silo will be outside of the facility on a slab of concrete to allow for significant savings on rigging costs and space within the facility. One truckload will be able to supply close to three month's worth of base malt for the facility based on a prospective production of 4,200 bbls each year[16]. The grains will be fed from a truck into the silo from an auger, the silo will then feed, via an auger, into a grain mill. This grain mill will be contained in a separate room since grains are highly combustible and can create large amounts of dust. We recommend installing an exhaust fan in the mill room to mitigate health and safety concerns. This exhaust fan will be kept away from people and the boiler room, since the boiler room is most likely to cause ignition, as much as possible. Another auger will feed the milled grain from the mill room to the brewhouse. The distance that grains need to move with the assistance on an auger was minimized.

4.4 Facility Layout

The following sections outline the facility layout that we recommend based on Battery Steele's recommendations, industry best practices, and our suggestions.

4.4.1 Outdoor Equipment and Storage

Regarding the new facility, the warehouse and any equipment that can be outside should not be accounted for in the main facility. The warehouse, grain freezer, and walk-in cooler will be contained within a separate facility that is attached to and within close proximity of the main facility. The warehouse itself will have an area to unload and transport goods; the unloading area will also be in close proximity to both the freezer and walk-in cooler, as they will also be a part

[16] Noble, personal communication, February 2019

of the unloading and loading process. Since the cooler, freezer, and glycol machine all generate a large amount of heat, it is most cost effective and efficient to keep this machinery outside. Additionally, the warehouse will contain a second floor that houses offices and testing spaces. The quality assurance/quality control space will specifically have an area designated to blind taste testing. The silo, bay area, and grain trailer will all be accessible via the same paved path. This area is shown below in Figure 7.

Figure 7, Warehouse-centered Area and Outdoor Area

4.4.2 Brewing Area

The brewing area will be able to handle the currently desired expansions, as well as desired future expansions. The boiler room will be contained in a separate room, as per health and safety regulations. The brewhouse will be in close proximity to both the mill and boiler rooms. After going through the brewhouse, the beer will run through a heat exchanger and then to the fermenting tanks via steel piping that will run through the ceiling. The mill room, boiler room, and brewhouse will be kept away from the public portions of the facility since they generate a large amount of heat; both rooms would be unsafe for the general public.

For optimal utilization of space, we recommend that the fermenters be placed in two lines 4 feet apart to allow for a catwalk near the top of the tanks. A catwalk will allow workers to be able to easily add hops to the tanks, minimizing safety hazards and time spent on the task. We also recommend that a drain be present below the tanks to make cleaning easier and increase facility sanitation. From the fermenters, the beer will be run through steel piping in both a feed and return line to the conditioning tanks. The conditioning tanks will be located near the canning line and depalletizer. Since the canning line can be so loud, there will be a wall behind the canning line and conditioning tanks, closer to the public portion of the facility, to minimize the sound reaching the restaurant area. To maintain the desired New England feel, we recommend that the remainder of the brewing area be divided from the public portion through the use of a railing. A large amount of space within the brewing area was left for additional fermenting and conditioning tanks as Battery Steele continues to expand within the proposed facility, as shown in Figure 8.

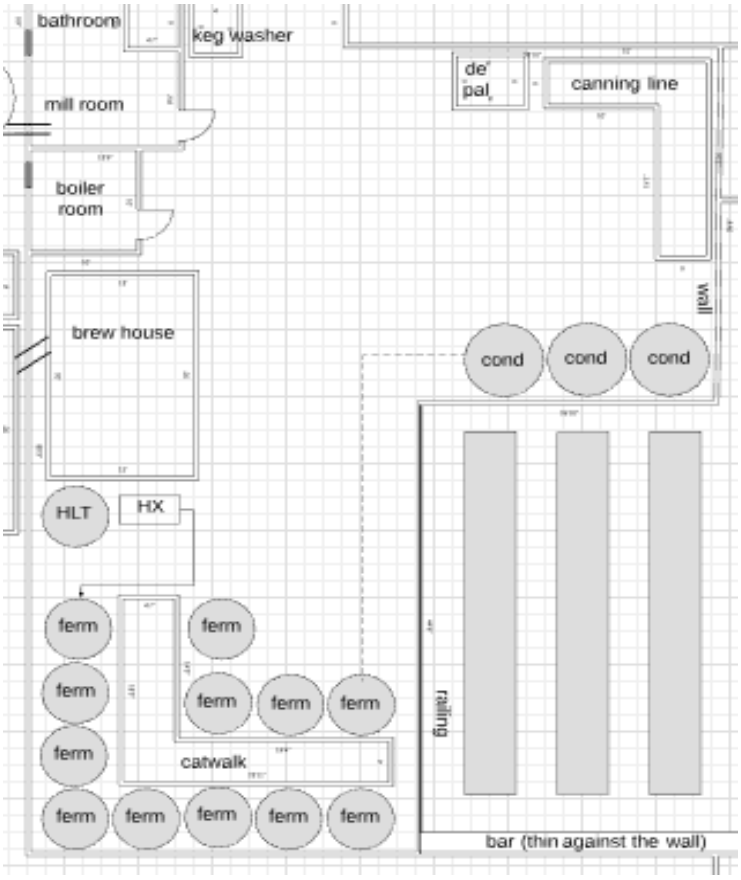

Figure 8, Brewing Area and Restaurant

4.4.3 Restaurant and Tasting Room

Based on desired characteristics from Battery Steele, we recommend that there should be a bar area and long tables on the inside of the facility on the first floor. We also recommend that a kitchen area of approximately 360 sqft and about 250 sqft for bathrooms be implemented to accommodate the capacity of the building; the number of toilets (i.e., water closets) have a direct correlation to the capacity of generally one toilet for every 20 customers[17]. Assuming a minimum of 2,000 sq ft. for the restaurant area and a space requirement of at least sixteen sq ft. per person in a commercial cafeteria[18], the maximum capacity of the facility will be at least 125 customers, leading to a necessity of approximately six water closets. A general area for restrooms was

[17] Facilities Planning
[18] Facilities Planning

approximated for layout purposes, given to us by Shane Noble. We also recommend that the facility have two doors to accommodate guests and to make the facility easily accessible. We suggest that the area outside either have long tables with a contained source of fire in the middle of the table or an awning that can create an enclosed space. Due to the northern location, we also recommend having a fire pit outside surrounded by chairs; this fire pit is recommended to be outside of the enclosed area if desired. The public portion of the new facility will also have a second floor that functions as a tasting room.

The second-floor tasting room will have a bar taking up most of the wall space. There second floor of the public space will also have tables in the center and couches in the corner, with a potential fireplace near the couches. The overall goal of the public space is to create an area that can accommodate large crowds and cater to the traditional New England environment. For the new facility, we recommend that allocation provided for parking spots be based on standards associated with the capacity to-be-determined by our sponsors. The restaurant and tasting room layouts are shown in Figure 9.

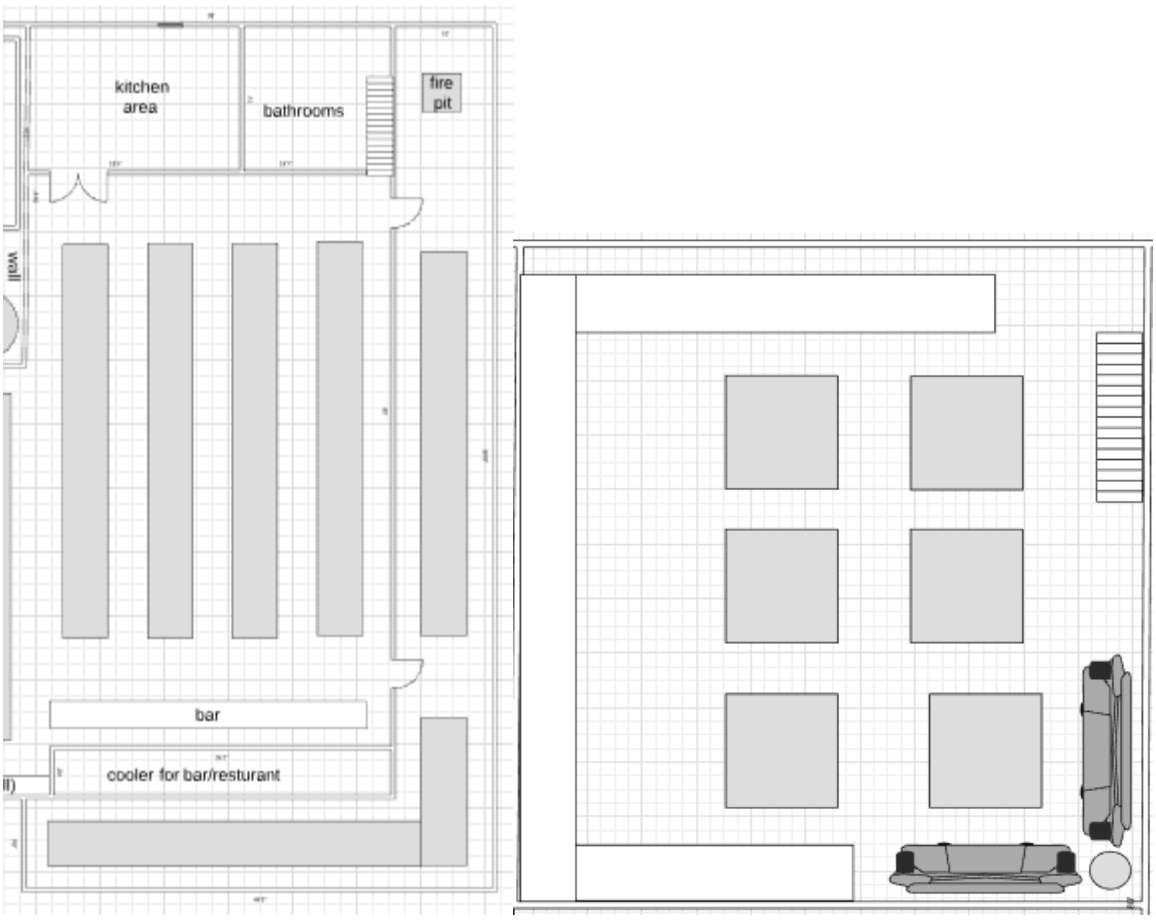

Figure 9, Restaurant and Tasting Room

4.5 Continuous Learning

Through working as a team over the last three terms, we have discovered many valuable experiences that we will be able to carry with us into our future projects and careers. First, we gained an appreciation for the importance of objectively observing without limiting our scope when beginning the project. As a team, we were not initially very knowledgeable on the brewing cycle and the production process. We were able to approach a brand-new area and consider an open-ended problem in a way that allowed us to gain more knowledge about the overall process of the business, rather than focusing on information pertaining to only one issue. Battery Steele gave us the very broad objective of providing suggestions on ways that they could improve their process in the new facility. This goal gave us the freedom to understand the many ideas they had

for improvement, and with time we were able to focus in on a few main objectives and gauge which ideas were most recurring and plausible to attack in the time allotted.

We learned that there were significant differences in the backgrounds and the approaches between our team and the team at Battery Steele. We realized that we tend to be data-driven and detail-oriented, while our sponsors at Battery Steele excelled at seeing the big picture and adapting easily to change without having to plan every detail of production. At WPI, we tend to always want to give the most exact and correct answer we can, once we have collected as much data as possible. In working with this business, we realized that simply giving an estimate of what something will cost or look like can be very helpful in conceptualizing what may have just started as an idea. We used their profound expertise in unison with our ability to observe and draw conclusions in order to create a plan that will ultimately help them expand in the future.

With this difference in expertise and backgrounds, we learned that we had to have a balance in specificity and open-endedness when asking for information that we thought would be helpful to achieve our deliverables. We were sure to explain what information we thought would be useful and why, but were simultaneously very receptive to any suggestions they had to push us in the right direction. In turn, Battery Steele was able to share a great wealth of knowledge with us about the details of their brewing process and what their main goals were for the expansion of the business. We learned that it is crucial to balance critical thinking with receptiveness to ideas and the needs of the business.

5. Conclusion, Recommendations, and Reflection

After familiarizing ourselves with the process used by Battery Steele Brewing, defining their needs, and performing multiple analyses, we were able to reach a number of conclusions and present quality recommendations towards the main goal of opening a new, fifteen-barrel facility with an attached restaurant and tasting room. We concluded that purchasing the brewhouse from Premier and the conditioning and fermenting tanks from TD Tanks is the best mix of cost-effectiveness and high-end quality that Battery Steele should invest in. Additionally, we designed a floor plan for the brewing area, restaurant area, warehouse space, and outside storage that should be utilized as an outline for the new facility. Lastly, we performed a cost analysis on the canning line and concluded that it would be an extremely cost-effective purchase that could also have positive effects on decreasing production errors and allow more time for experimental brewing.

We recommend that Battery Steele create a long-term brewing schedule so that they are better able to plan for ordering shipments, canning, and when they will be releasing batches of beer. We have shared our current layout with them so that they can edit and make revisions as they progress with more ideas and information. Creating a virtual layout of the space will be very effective in envisioning the process flow of the new location. Additionally, with a more automated brewhouse, Battery Steele should look into how they can better allocate their labor, which will help them determine how many employees and brewers they will need to hire for the new facility. Lastly, in order to aid in potential further improvements with other MQP teams or external sources they may consult in the future, Battery Steele could benefit from collecting consistent data in order for deeper analysis of the company and previously stated recommendations. This data should consist of explanation and frequency of brewing errors, sales

and cost information, production cycles, and information on wasted material. The conclusions and the recommendations we have put forth will ultimately contribute to more efficient process flow and decreased costs at Battery Steele Brewing.

Our selection of equipment, canning line analysis, and facility layout all contributed to an overarching theme of engineering design, which is the process of devising a system, component, or process to meet desired needs. The system, to be comprised of our recommended equipment and the key component – the in-house canning line – directly makes up the proposed process, shown in the layout figures and process flow diagram. The equipment was selected by analyzing and comparing the costs and features offered among suppliers, primarily ABE, PSS, and TD Tanks. The in-house canning line, one of the largest component changes between the Portland facility and the proposed new facility, was compared to the current use of Iron Heart, a third-party canning company. The facility layout was designed with optimality and ease-of-use at the forefront of our minds. The integration of these components, pieces of equipment, and process tie directly in with our methods and contribute to quality engineering design.

Of course, we were faced with some challenges during the completion of our project. Due to the very broad scope of the project, at times it was difficult for the team to give direction to the information we were given. Additionally, we were not given much raw data to work with, which limited our ability to dive deep into the root causes of some of the potential areas of improvement for Battery Steele. Although there was a broad scope and limited data, we were able to focus the scope on just a few deliverables and gather as much information as possible on just those areas.

The successful completion of this project would not have been possible without the skills we all learned along the way as a result of working as a team. We each came in with our own

strengths and areas we were most confident in, including naturally leading meetings, confidence in editing, process analysis, writing, and familiarity with cost analyses, to name some. Throughout the year, we have each lent and shared our skills to and with one another, honing in on our strengths and working together to overcome our weaknesses. We made sure to share the leadership roles and rotate tasks every meeting, setting an internal timeline and holding each other accountable, and offering assistance and tips in a group setting when required. Each objective was met via a collaborative and collective effort between all teammates, done as such to ensure the thorough understanding by every team member of the project in its entirety, as well as the confidence by each of us in our recommendations to steer the future of Battery Steele.

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