Illinois Institute of Technology

# IPRO 321

Final Report

4/29/2011

## 1. Executive Summary

Beer brewing is as old as civilization. Around 10,000 years ago, some humans decided to end their nomadic lifestyles and began to farm. Grain was the first domesticated crop to start the farming process. Historians have traced the roots of brewing back to ancient African, Egyptian, and Sumerian tribes. IPRO 321, Introduction to Zymurgy, sought to introduce IIT students to a highly structured process that creates a product that is a significant part of our economy. IPRO 321 was split into three teams that made three different beers. This report is for the team named The Funky Brewsters.

The team chose a recipe for a particular beer and developed the brewing protocol. The Funky Brewsters then split into three sub-groups, known as the brew team, engineering team, and marketing team. The brew protocol was implemented by the brew team, who handled the brewing and fermentation of the beer. The brew team referred to literature to determine the sugar content of the beer and bottled the beer. The engineering team modeled the brewing process as a flow sheet in HYSYS. They also performed a cost analysis of the brewing process, and completed an analysis of the heat exchanger used for brewing. The marketing team created multiple surveys to determine what name and label would most appeal to our consumers. They also prepared a business plan for our beer.

## 2. Team Purpose

IPRO 321 consists of students dedicated to learning the art of Zymurgy (beer brewing). A multi-billion dollar industry, brewing has great importance within the American economy. Students within the IPRO will work in a multi-disciplinary fashion to design a sufficient brewing process capable of small-scale production and distribution among local organizations (The Bog, Faculty Club, etc). This will require a sufficient brewing process to produce 10-15 gallons of beer, knowledge of the regulations surrounding beer production, and an in-depth understanding of the marketing and economics of brewing beer.

## 3. Objectives

- Conceptualize/Design Brew-Train
- Obtain detailed knowledge of the science behind brewing
- Select a specific type of beer to brew
- Construct a brew-train and complete brewing
- Carefully ferment beer after filtration
- Develop process to assure quality of product
- Store fermented beer in kegs/bottles for distribution
- Perform economic/regulatory analysis on the cost of brewing beer
- Market the product to IIT staff and students
- Enter beer into an official contest to be judged for quality

## 4. Organization and Approach

To complete the multifaceted task of brewing and marketing beer, sub-groups dedicated to the brewing process, the engineering involved in brewing, and the marketing needed to successfully sell beer were created. Students researched these tasks by consulting various beer recipes, referencing several engineering textbooks, and using online surveys open to the public. We also received a presentation on brewing beer from our Teacher's Assistant, Chris Arges, at the beginning of the semester.

Each sub-group made goals and a timeline of how they were going to accomplish those goals early in the semester. Each group met once a week to assign and complete tasks, and evaluate their current progress. The entire IPRO team met weekly to determine each sub-group's progress, provided feedback, and assigned new tasks for the next week. iGroups was used to share important documents between team members, such as the brewing protocol or cost analysis.

### 4.1. Brewing

As the Brew Team, we were responsible for every step of production. We started by having every member of the team bring a unique blonde ale to our meeting. Being that we were all of the legal drinking age, we sampled a total of seven different blonde ales in order to analyze their flavor profiles and determine how we wanted our beer to taste. We settled on a lighter-flavored blonde ale with a fruity flavor. After presenting this

decision to the rest of our IPRO group, the group as a whole decided to select honey and orange as our fruit flavor.

After deciding on the flavor profile of our beer we looked up recipes online of existing craft brews that were similar to what we were trying to create. We researched how different grains, yeasts, and hops would affect flavor, and developed a recipe of our own.

We then spent a day brewing three different batches. The brew team first sanitized all equipment and weighed out all of the ingredients before brewing. We changed the recipe slightly for each batch, using different yeasts, amounts of grain, and additional flavorings. After brewing we quickly cooled the wort using an immersion chiller until the wort was cooled to a temperature between 66 and 72°F, pitched the yeast, and then poured the worts into three 6 ½ gallon glass carboys for primary fermentation. Ten days later, we transferred the brew into 5 ½ gallon carboys for secondary fermentation. While the beer was fermenting, specific gravity was measured frequently to determine when the beer was finished fermenting, based on sugar consumption.

Two weeks after entering secondary fermentation we cleaned and sanitized all of our bottles and bottle caps. We sampled the three different brews, and selected the best tasting beer to bottle, which is also chosen to be presented at IPRO day. In the end, we bottled around 5 gallons of beers which totaled 180 bottles. The beer then had to be carbonated and sealed with a cap to keep the carbonation in and bacteria and other flavors out. The remaining process was to stick our 'Bond on Blonde' label onto the bottles. Overall the entire process only took a little over a month. The majority of the work took place in the first month of the semester. This included all the recipe research and brewing. Once the wort was placed into fermentation, all that was left to do was wait.

Since we finished the blonde ale brewing quite succinctly and had plenty of hops, grains, and malt extract left over, we decided to brew one final beer. The fourth recipe chosen was one of an India Pale Ale (IPA) which has a stronger, hoppier flavor. This was brewed mainly for analysis purposes. A sample of this beer was sent to a lab to analyze

the chemical structure. This was brewed and fermented in a similar way as above, except with a shorter fermentation period.

### 4.1.1. Cleaning and Sanitizing

- No more than 49% of the overall alcohol content in beer can be from a flavoring or any other non beverage ingredient.[3]
- If the beer has more than 6% alcohol by volume, then no more than 1.5% by volume of the overall alcohol content should be from flavorings or other additives.[3]
- All objects that will come in contact with the beer should be cleaned then sanitized. (except things that will be boiled)[8]
- Never combine or mix any cleaners or disinfectants! (The gases that are released by chemical reactions are toxic and can kill you).
- Siphon hoses and plastic fermenters should appear clean, scratch-less and stain-free. Scratches and stains will harbor bacteria and shield them from the most caustic sanitizing solutions. Throw these away.[8]
- Glass should appear stain-free when clean. Use a long-handled bottle brush. Inspect for dried bacterial deposit ringing the inside neck of the bottle. If stained, immerse for 1 hour in a bucket of bleach cleaning solution: 2 oz. per 5 gal. water.
- You cannot reduce soaking time (for sanitizing objects) by increasing the concentration of sanitizing agent.(See Table 1 below)[8]
- Federal sanitation regulations can be found in Appendix D.

Table 1: Cleaning and Sanitizing Agents[8]

| Agent | Use | Mixture | Contact | Rinse | Environment |
|---|---|---|---|---|---|
| OxyClean | clean | 1-3 tablespoons per 20 liters | as required | Extremely Well | friendly |
| PBW | clean | 1-3 tablespoons per 20 liters | as required | Extremely Well | friendly |
| Straight-A | clean | 1-3 tablespoons per 20 liters | as required | Extremely Well | friendly |

| | | | | | |
|---|---|---|---|---|---|
| bleach | sanitize | 4ml / liter - 1 tbsp / gallon | 15 minutes | Extremely Well | unfriendly |
| diversol | sanitize | 4ml / liter - 1 tbsp / gallon | 15 minutes | Yes | unfriendly |
| iodophor | sanitize | read instructions | 60 seconds | No | unfriendly |
| Star San | sanitize | read instructions | 60 seconds | No | friendly |
| B-Brite | both | 4ml / liter - 1 tbsp / gallon | 15 minutes | Extremely Well | friendly |

### 4.2. Engineering

The engineering team's goal was to analyze and optimize the efficiency of the heat exchanger. The temperature profiles were obtained experimentally in the lab and the amount of heat loss was calculated. Next, the economic analysis of the brewing process was determined. Once the total cost of the brewing process was established, the cost per bottle was calculated solely based on the ingredients and the number of bottles available. Lastly, the modeling of the brewing process was completed using a HYSYS simulation for visual purposes.

### 4.3. Marketing

At the beginning of the semester, the marketing team contributed to the project plan for the semester with an outline of the required tasks and a timeline. They also worked on proposing the budget for the IPRO. During the course of the semester, they looked into beer brewing laws, rule, regulations, and branding. The marketing team was responsible for coming up with the team/beer name and slogan. Surveys were developed and distributed around campus in order to gather information about potential customer's thoughts and opinions about our beer name, logo and labels. The marketing team worked on the business plan for our beer brewery and finally contributed to the final report at the end of the semester.

#### 4.3.1. Selling

- Required information on bottle[3]:
  - Brand name
  - Class

    - Name and address
    - Net contents
    - Alcohol content
    - Declaration of sulfites/ sulfiting agent (if any)
    - Certificate of label approval
- Label must be legible
- Labels cannot have the following graphics
    - Flags
    - Seals
    - Coats of Arms
    - Any other Insignia
- Labels should not use words implying high alcohol content, such as
    - Extra strength
    - Full strength
- If [producer] decides to add major allergens to the beer label, **all** of the major food allergens should be added. (unless there is a petition)
- If a taste test is to be administered, the name and the address of the testing administrator should be given.

# 5. Analysis and Findings

## 5.1. Brewing

Table 2: Beer Specifications

| | Original Gravity | Final Gravity | % Alcohol by Volume |
|---|---|---|---|
| Batch #1 | 1.065 | 1.014 | 6.68 |
| Batch #2 | 1.066 | 1.010 | 7.37 |
| Batch #3 | 1.066 | 1.014 | 6.82 |
| Batch #4 | 1.082 | 1.018 | 8.36 |
| Blonde Ale Specifications | 1.03-1.054 | 1.008-1.013 | 3.8-5.5 |

Table 3: Recipe #1

| Batch #1 Bond On Blonde | | | | |
|---|---|---|---|---|
| **Ingredients** | | | **Brew Schedule** | |
| 1 | lbs | Grains | steep | 20 min |
| 1 | oz | Cascade hops | Boil | 60 min |
| 0.5 | oz | Cascade hops | Boil | 20 min |
| 0.5 | oz | Cascade hops | Boil | 10 min |
| 1 | oz | Cascade hops | dry hop | flame out |
| 2 | tbsp | orange zest & peel | | flame out |
| 6.6 | lbs | Liquid Light Extract | | flame out |
| 3 | lbs | Orange Blossom Honey | | flame out |
| 1 | tbsp | Irish Moss | | flame out |
| 1 | sachet | British Ale Yeast | | @ 66-72°F |

Table 4: Recipe #2

| Batch #2 Bond On Blonde | | | | |
|---|---|---|---|---|
| **Ingredients** | | | **Brew Schedule** | |
| 1 | lbs | Grains | steep | 20 min |
| 1 | oz | Cascade hops | Boil | 60 min |
| 0.5 | oz | Cascade hops | Boil | 20 min |
| 0.5 | oz | Cascade hops | Boil | 10 min |
| 1 | oz | Cascade hops | dry hop | flame out |
| 2 | tbsp | orange zest | | flame out |
| 6.6 | lbs | Liquid Light Extract | | flame out |

| | | | | |
|---|---|---|---|---|
| 3 | lbs | Orange Blossom Honey | | flame out |
| 1 | tbsp | Irish Moss | | flame out |
| 1 | sachet | American Ale Yeast | | @ 66-72°F |

Table 5: Recipe #3

| Batch #3 Bond On Blonde | | | | |
|---|---|---|---|---|
| **Ingredients** | | | **Brew Schedule** | |
| 1.5 | lbs | Grains | steep | 20 min |
| 1 | oz | Cascade hops | Boil | 60 min |
| 0.5 | oz | Cascade hops | Boil | 20 min |
| 0.5 | oz | Cascade hops | Boil | 10 min |
| 1 | oz | Cascade hops | dry hop | flame out |
| 2 | tbsp | orange peel | | flame out |
| 0.5 | oz | Bitter Orange Peel | | flame out |
| 6.6 | lbs | Liquid Light Extract | | flame out |
| 3 | lbs | Orange Blossom Honey | | flame out |
| 1 | tbsp | Irish Moss | | flame out |
| 1 | sachet | London Ale Yeast | | @ 66-72°F |

Table 6: Recipe #4

| Batch #4 ChemicAle | | | | |
|---|---|---|---|---|
| **Ingredients** | | | **Brew Schedule** | |
| 1.5 | lb | Grains | steep | 20 min |
| Fermentables | | | @ original boil | |

| | | | | | |
|---|---|---|---|---|---|
| 6.6 | lbs | Light Liquid Malt Extract | | | |
| 1 | lb | Golden Dry Malt Extract | | | |
| Specialty Grains | | | | | |
| 3.5 | oz | bittering hops | | boil | 60 min |
| | 1.5 | oz | columbus | | |
| | 2 | oz | cascade | | |
| 1 | oz | Cascade Aroma | | Boil | 20 min |
| 0.5 | oz | Ginger Root | | flame out | |
| 1 | sachet | American Ale Yeast | | @ 66-72°F | |

### 5.1.1. Brew Process and Problems

The brew process itself is difficult to keep track of precisely. While concentrating on factors such as time, temperature, boil level, etc…, it has proved hard to add ingredients at the precise time designated by the brew schedule. Even though the entire brew team was around, it still proved difficult to measure ingredients and add them all at the right time and/or temperature, especially when the group brewed two five gallon batches at one time. Brewing the first batch went fairly well. The only slight problem was not adding ingredients at the exact time. Ingredients were pre-measured and the cooling coil was placed in the drum in preparation for the wort cooling. For the second and third batch, that were brewed together (only staggered by 10 minutes), it proved much harder to keep all the ingredients pre-measured with the limited quantity of clean containers to hold them. Since the batches were only separated by 10 minutes, there was some delay when it came to the "pitching" of the wort. The third batch had to wait for the first batch to completely cool and for the cooling coil and drum to be sanitized. This can potentially cause harm to the flavor of the beer because the longer the beer sets, the more bacteria that can form in the beer and alter the final taste. Another problem encountered was a slight

boil over in the second batch. This happened due to lack attention while dealing with the third batch. The slight boil over could have potentially caused problems such as changing the concentration of the beer itself if there were any grains or extract that where highly concentrated in the top of the boil.

## 5.2. Engineering

Three different methods were researched for determining the most efficient heat exchanger: Immersion wort chiller, counterflow wort chiller, and plate chiller. The immersion wort chiller was chosen due to the cost and the basic set up of our brewing process. The immersion wort chiller is submersed into the tank containing the wort. The wort must be chilled to 65° F - 70° F within 5-10 minutes to reduce unwanted products in the beer[8]. The temperatures of the wort and cold water were recorded every 10 seconds and graphed to develop the temperature profile. Three different trials were recorded for the three different batches.

The line of best fit, a second-order polynomial, was extracted from the temperature profiles of the wort and cold water. The line of best fit was then used to calculate the heat loss. The amount of heat loss from the cold water and wort was found using[5]:

$$\dot{Q}_{water} = \dot{m} * C_p * (T_{in} - T_{out}(t))$$

$$\dot{Q}_{wort} = m * C_v * \left(\frac{dT}{dt}(t)\right)$$

The total heat loss was then further calculated using:

$$\underline{\dot{Q}_{wort} - \dot{Q}_{water} = \dot{Q}_{loss}}$$

The economic analysis was evaluated for the brewing process. The costs were categorized into initial investments and ingredients. The initial investments include the equipment used during the brewing process, which can be recycled for future brewing. Only the ingredients have to be purchased for future brewing.

## 5.3. Marketing

### 5.3.1. Rules and Regulations for Beer Labels

In addition to having a logo that appeals to our target market, the logo had to be designed in a manner that stayed within the legal boundaries for an alcoholic beverage logo. We researched the federal regulations for alcoholic beverages labels, since they will definitely apply to in-state regulations. The regulations are outlined below [3]:

1) Brand name
2) Class
    A. This is contingent upon how the beer is sold or distributed
        i. For example Ogden, Utah has beer classes as follows[1]
            1. *Class A:* On-Premise Retailer
            2. *Class B:* On-Premise Restaurant
            3. *Class C:* On-Premise Tavern
            4. *Class D:* Private Club
            5. *Class E:* Single Event
            6. *Class F:* Recreational
    B. Name and address
    C. Net contents
    D. Alcohol content
    E. Declaration of sulfites/ sulfiting agent (if any)
    F. Certificate of label approval
    G. Label must be legible
    H. Labels cannot have the following graphics
        i. Flags
        ii. Seals
        iii. Coats of Arms
        iv. Any other Insignia
    I. Labels should not use numerals implying high alcohol content
    J. If producer decides to add major allergens to the beer label, **all** of the major food allergens should be added (unless there is a petition).

### 5.3.2. Logo Results

1) Created a poll with Zoomerang and had the pictures polled on Facebook
    A. Feedback
        i. ChemicAle Sketches 1 and 2 were, based on the feedback, lacking uniqueness.
        ii. Doux was friendly yet confusing. It should have been placed in the poll that “Doux” was French for sweet.
        iii. Scarlet Sanguine had a catchy name (poll participants liked the alliteration); however, they thought the star was irrelevant and the logo was too feminine and boring.
    B. Used feedback and improved the critiqued sketches and created two more potential labels.
        i. Upon making a second poll, IPRO 321 came up with two new names for the beer (Bond on Blonde and Chemically Blonde)
    C. Made a new poll with the new sketches as well as the improved sketches.
        i. Out of the six logos, Bond on Blonde was the favorite
    D. Scaled labels to fit the display beer bottles.
    E. Went to IIT to have labels printed.
    F. Labels successfully printed.

## 6. Conclusions and Recommendations

The brewing of beer by undergraduates at IIT has proven to be an extremely successful and fun endeavor. The members of this IPRO have definitely enjoyed getting out of the classroom and working on a hands-on project. Because they produced something that will be judged by its taste, the team members were strongly invested in the project. The brew team discovered all of the tasks involved in brewing beer, which included purchasing all of the necessary equipment, brewing, and monitoring fermentation. The engineering team discovered the science behind brewing, which included cost analyses and the importance of heat exchange. The marketing team discovered the importance of developing a product to the tastes of the consumer by obtaining opinions through surveys, creating attractive labels, and developing a business plan.

If this IPRO continues in a future semester, they should attempt to innovate the brewing process. We obtained all of the equipment necessary to brew, so the next IPRO could try to

develop a sustainable brew process or an entirely new way to brew beer. Also, the next IPRO should look more in depth into the business side of beer. They could come up with a way to sell their beer to IIT alumni.

### 6.1. Brewing

The production process for brewing beer is a complex one, involving many stages that span the duration of a few weeks. Our IPRO group successfully completed brewing three batches of an orange-flavored pale ale. All three batches were brewed with quality ingredients, using a refined recipe, which was ultimately placed in bottles containing our design logo “Bond on Blonde.” We investigated the electric spray mass spectrometry on the beer over the course of the fermentation process in order to determine its sugar profile. This is something that typically is not done, but that we felt could give us further insight into the composition of the beer. Overall, this project was popular amongst all the students enrolled in IPRO321, and received widespread interest from many students and professors in the IIT community.

Admittedly, our IPRO differed in scope compared to other projects due to the fact that there was nothing novel that we could have done. We did choose a flavorful and unusual beer to brew, but there was no way to fundamentally reshape the process by which beer is brewed. Thus, future IPROs should focus on how brewing beer at IIT could be promoted commercially. The materials and equipment required to brew beer have already been purchased, and are available to use in future years. Indeed, our project received lots of interest from students who wanted to taste our final end product. In this regard, it could be interesting to see whether beer made by IPRO students could be sold in the Bog, and whose profits could be donated towards a charitable cause. Furthermore, future IPROs could also hold beer tasting events that students can come to, and learn more about the brewing process.

Our IPRO has begun what could be a great tradition on campus; future IPRO students should focus on how to promote the project within the IIT community.

## 6.2. Engineering

From the heat loss profile, Trial 1 showed to cool the fastest. This could have been due to many factors. The velocity of the cold water could have possibly varied for each run. We assumed the velocity of the cold water was constant throughout the three trials. Also, the amount of wort in the tank could have varied for each trial. Some of the wort is boiled off during the copper stage. Because there's no way to measure the amount boiled off, the amount of wort added to the tank for cooling must be assumed to be the same for each trial.

For this brewing process, the only disadvantage was the high initial cost. Once the equipment was purchased, only the ingredients, bottles, and propane tank had to be purchased for each subsequent trial run. We calculated the cost to be $1.72 per bottle. The costs can be reduced if there are remaining ingredients available for the next trial run. Additionally, we purchased more bottle caps than the number of bottles. Therefore, the bottle caps can be saved for future bottling. For future studies, the costs per bottle should be compared to the cost of the beer if it was inserted into a keg.

## 6.3. Marketing

Overall, the marketing team learned a great deal about the various aspects of marketing a product, and was able to successfully apply it to the act of zymurgy on a small scale. It also helped to be divided into teams, as team organization skills were built and improved by members. Different avenues for creating and distributing surveys, creating posters, and digitizing logos were learned. We also took advantage of the individuals' various strengths to efficiently carry out the different tasks throughout the semester.

If IPRO 321 will proceed in the future, it would be recommended that time is taken to look at various picture digitizing programs in the beginning of the IPRO. This will ensure that various programs can be experimented with, and people with little to no experience will have a chance to practice, or find experienced individuals to assist in the digitizing process. Also, it is also recommended that careful attention is paid to the feedback that is given by the judges with respect to the logo and the beer. If the IPRO proceeds, it would also be recommended to create not only a logo poll for the general

public, but to create a campus wide poll for the IIT community (faculty, staff, etc.).

# 7. Appendix

## 7.1. Appendix A (Figures):

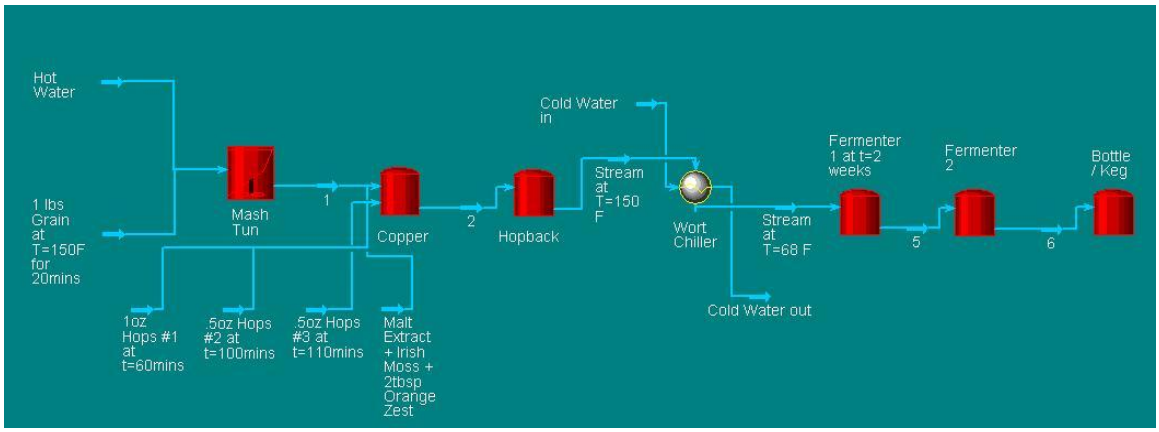


Figure 1: Schematic of the brewing process using HYSYS.

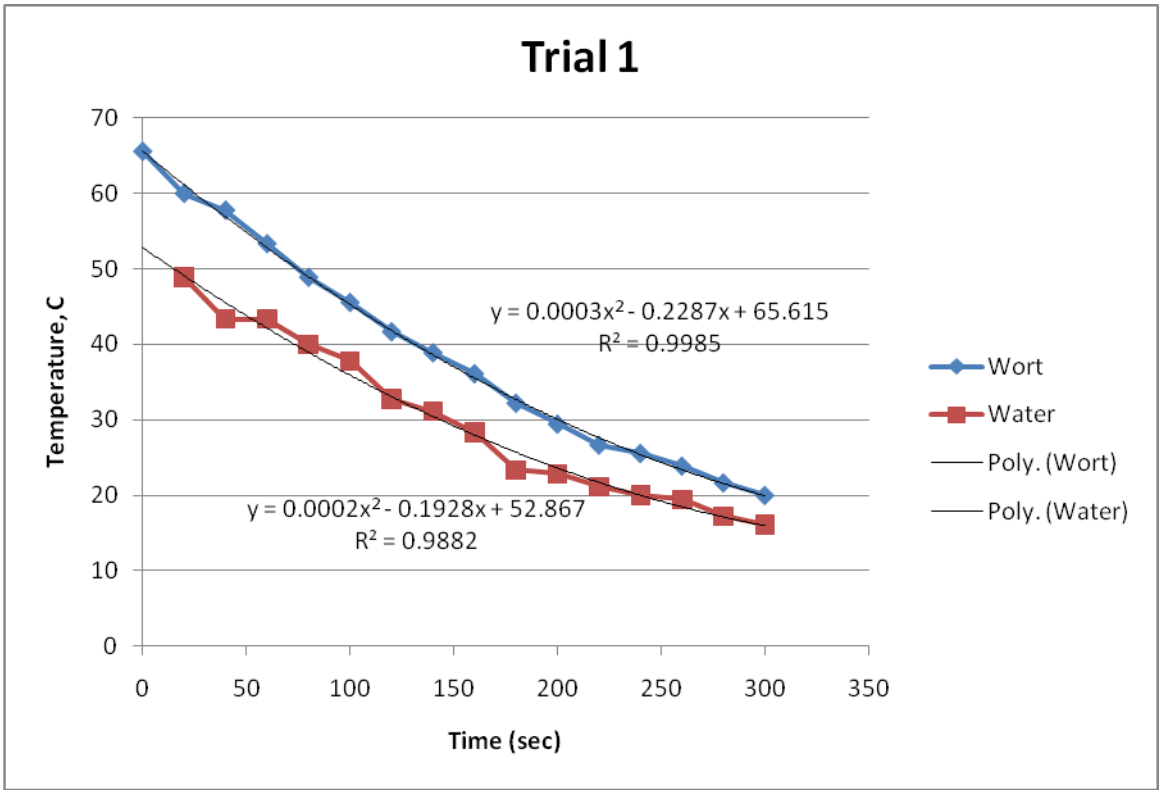


Figure 2: Temperature profile for wort and cold water for Trial 1.

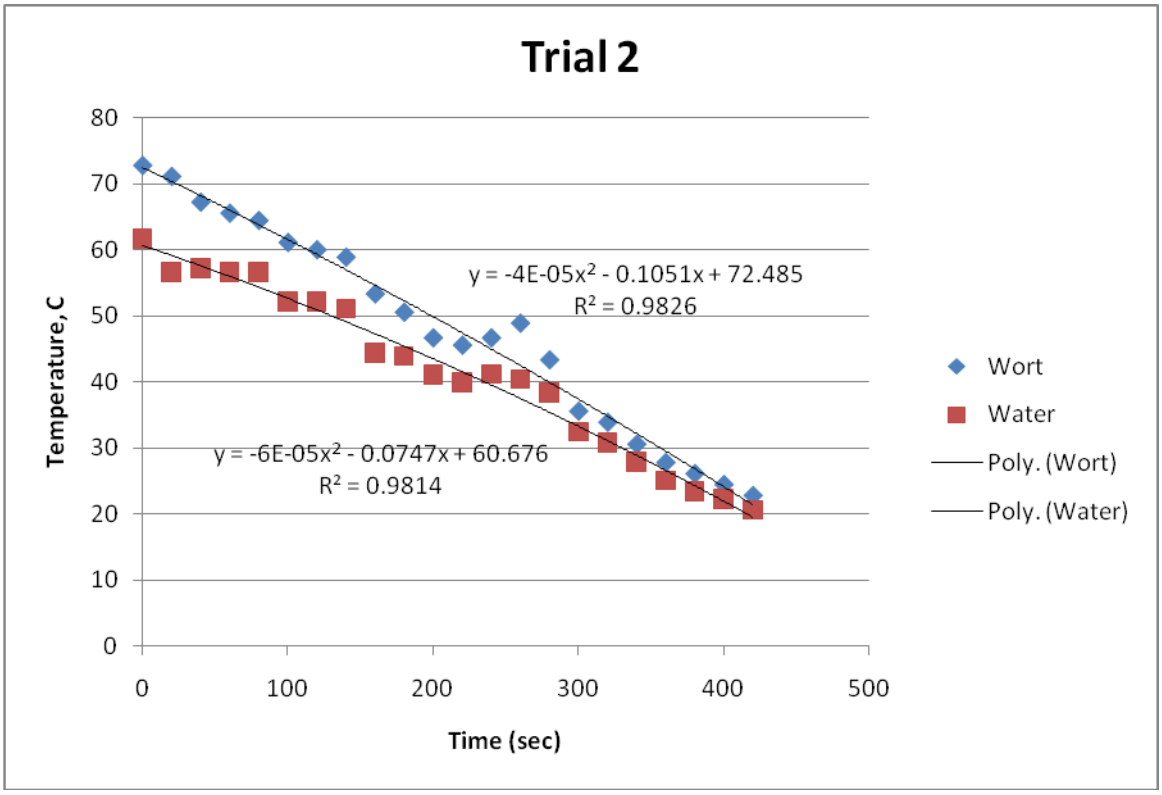


Figure 3: Temperature profile for wort and cold water for Trial 2.

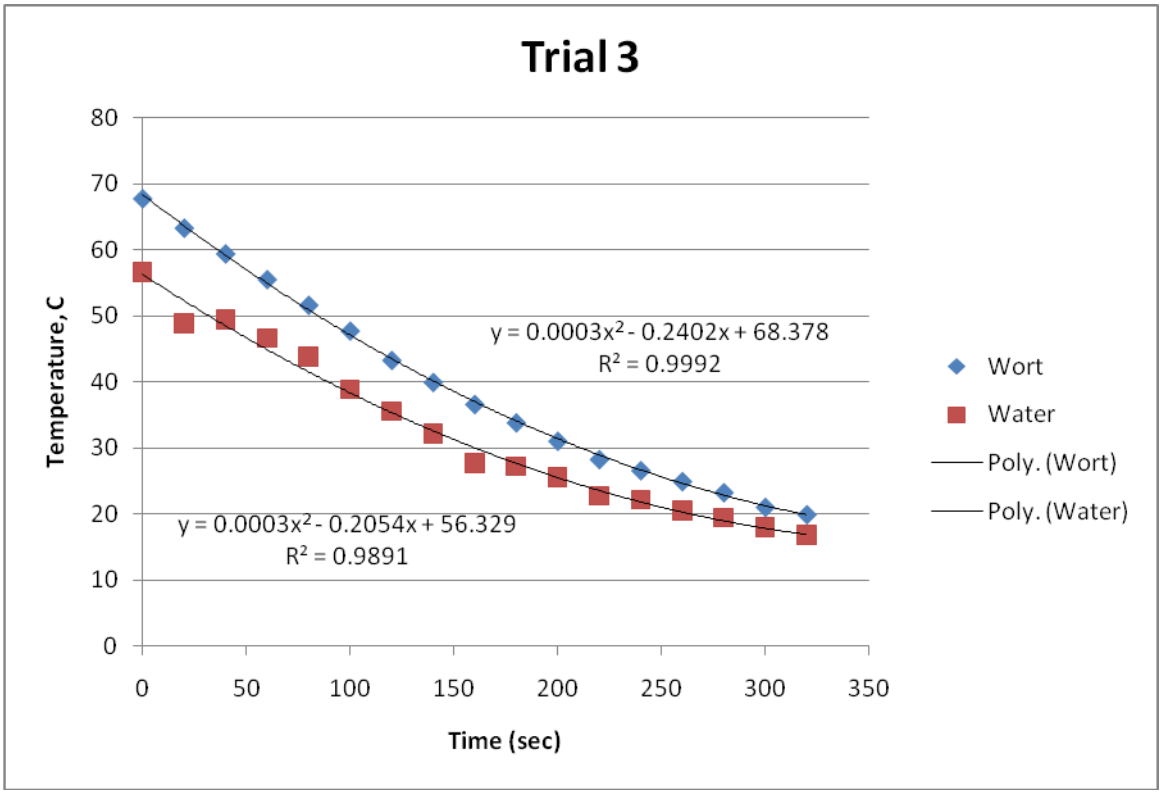


Figure 4: Temperature profile for wort and cold water for Trial 3.

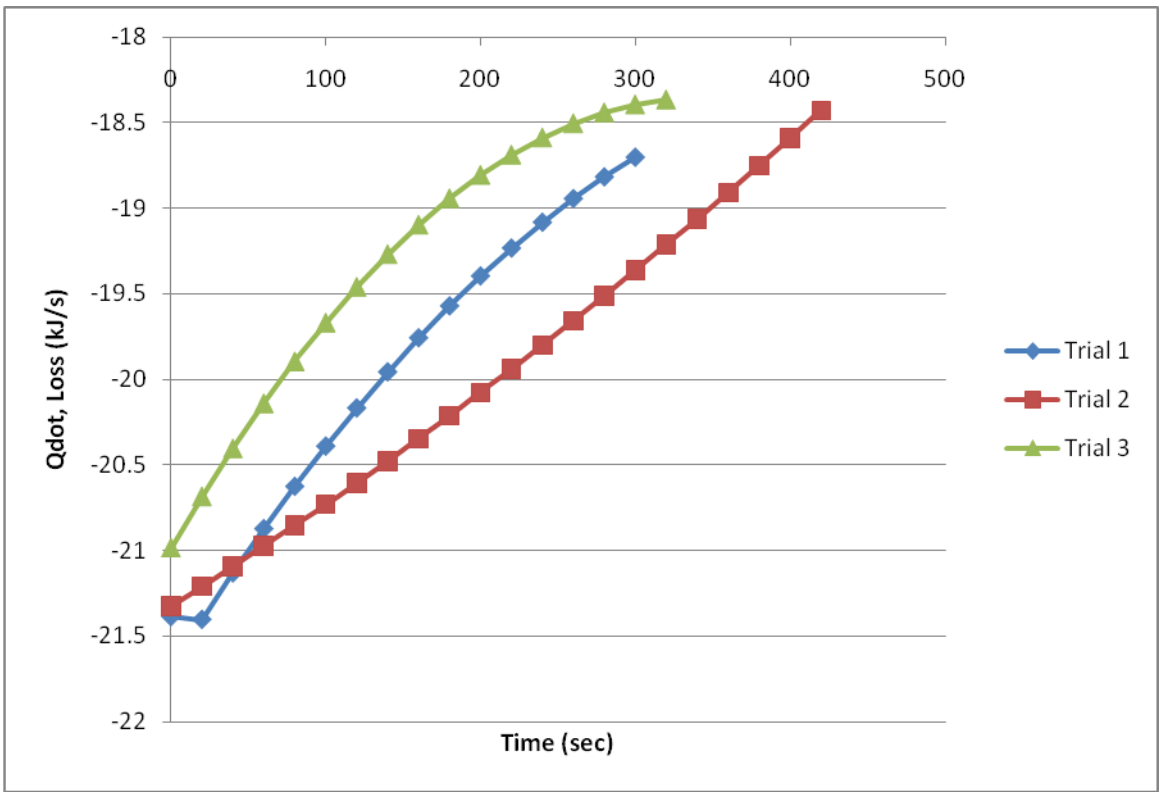


Figure 5: Heat loss ($Q_{loss}$) over time for all three trials.

### 7.2. Appendix B (References)


**1)** Business Licensing. City of Ogden, Utah: http://www.ogdencity.com/en/doing_business/business_licensing.aspx. Assessed 19 April 2011

**2)** Daniels, Ray. *Designing Great Beers: the Ultimate Guide to Brewing Classic Beer Styles*. Boulder, CO: Brewers Publications, 2000. Print.

**3)** Electronic Code of Federal Regulations: Title 27: Alcohol, Tobacco, and Firearms: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr;sid=d8f4daac6c93cd8... Assessed 3 February 2011

**4)** Fix, George J. *Principles of Brewing Science: a Study of Serious Brewing Issues*. 2nd ed. Boulder, CO: Brewers Publications, 1999. Print.

**5)** Geankoplis, Christie John. *Transport Processes and Separation Process Principles*. 4th ed. Upper Sadle River, NJ: Prentice Hall, 2007. 130-14

**6)** Palmer, John J. *How to Brew: Everything You Need to Know to Brew Beer Right the First Time*. Boulder, CO: Brewers Publications, 2006. Print.

**7)** Papazian, Charlie: The Complete Joy of Home Brewing, 3rd Edition, 2003

**8)** Sanitation. *Bodensatz Brewing: The Beer Site*: http://www.bodensatz.com/staticpages/index.php?page=sanitation .Assessed 3 February 2011.

**9)** Title 11: Alcohol, Horse Racing, and Lottery: Subtitle A: Alcohol….Joint Committee of Administrative Rules: http://www.ilga.gov/commission/jcar/admincode/011/011001000001600R.html

**10)** Assessed 19 April 2011

**11)** White, Chris, and Jamil Zainasheff. *Yeast: the Practical Guide to Beer Fermentation*. Boulder, CO: Brewers Publications, 2010. Print.

### 7.3. Appendix C (Brewing Protocol):

- Grinding of grains should be done away from fermentation, and avoid pulverizing into dust. Grain dust carries bacteria that can contaminate your beer.
- After boiling the wort and specialty grains are being removed, be careful the wort doesn't boil over when adding malt extract, minerals, boiling hops and other sugars.
- During fermentation, the wort is cooled to below 70°F and should be stirred or agitated with a sanitized plastic or long-handled metal spoon, taking temperature, and a small amount of wort should be poured or ladled so that a specific gravity can be read.
- After adding the yeast, keep fermenter in a dark, out of the way place and away from direct sunlight, which will react with hops & create skunky or rubbery aroma and flavor.
- Vessels for fermentation must be sealed to keep out any bacteria or debris that could alter the flavor, yet still be able to allow excess gasses from fermentation to escape.

### 7.4. Appendix D (Federal Sanitation Regulations) :

1) All licensed beer manufacturers should keep a clean brewing and storage environment at all times.[9]
2) If cleansing systems such as "glycol," "constant cold," "electronic," or "constant cleaning," which are designed to prevent build-up of contaminants in the dispensing system are being used, it will be required that the coils and other equipment used in drawing draught beer or wine cleaned at least once every two weeks in some manner or means, either chemical or mechanical, and monitor the operation of the system to determine it is operational and to verify its proper functioning, at least once every week. [9]
3) If a cleaning system mentioned above will not be used, then coils and other equipment used

in drawing the beer or wine must be cleaned at least once every week in some manner or means, either chemical or mechanical. Steam or hot water alone is not sufficient for proper cleansing. [9]

4) Record should be taken of who cleaned the brewing equipment with the date the equipment was cleaned. [9]
5) Beer should not be distributed if containers of any sort are contaminated with putrid substances or insects. [9]
6) A licensed beer distributor should not distribute beer unless proper cleaning and sanitizing equipment is present on licensed manufacturing premises. [9]

7) If a beer manufacturing facility has alcoholic beverages that are premixed, adhere to the regulations in sections 100.160 and 100.290 c. All of the premixing containers or systems must be cleaned thoroughly once every week. If mechanical premixing system is used, a record of the individual(s) who cleaned the machinery as well as the date that the machinery was cleaned should be on the manufacturing location at all times. [9]

A. Sanitation of brewing equipment [8].
    i. In small scale and large scale brewing, equipment is sanitized and not sterilized.
        1. It is not possible to get rid of all of bacteria; one can only rid the vast majority of the bacteria.
    ii. One does not need to sanitize equipment that will be boiled.
        1. Example 1: The brew pot in which the wort will be boiled.
        2. Example 2: The spoon stirring the boiling wort.
            a. However, the spoon stirring the cooled wort must be sanitized.
    iii. How to sanitize equipment.
        1. Clean equipment with a mild dish detergent.
        2. Then rinse with warm to hot water.
        3. Note: Do not scrub plastics with abrasives.
            a. This puts scratches in the plastic, which is a breeding ground for bacteria.

4. Fill a bucket with water and put the appropriate amount of sanitizing agent (different sanitizing and cleaning agents are in table 1) and soak for amount of time given on label.
5. Rinse equipment well with hot water. (Degree of rinsing is specified in Table 1)

### 7.5 Appendix E (Cost Analysis):

Table 7: Cost Analysis of Equipment and Ingredients

| | **Item** | **$/each** | **Total** |
|---|---|---|---|
| Initial Investments (excluding ingredients and bottles) | VacuBrew All Grain Brewing System | | 600 |
| | Grain Mill | | 150 |
| | Airlock | 1.25 | 6.25 |
| | 5/16" Autosyphon | 9.95 | 19.9 |
| | 5/16" Tubing 15' | 0.45/ft | 13.5 |
| | Hydrometer | 6 | 12 |
| | Carboy Brush | | 4.75 |
| | Bottle Brush | 2.75 | 11 |
| | No-Rinse Cleaner | | 8 |
| | Burner | | 70 |
| | 9' Anti-Flash Funnel with Strainer | 11 | 22 |
| | 18' Stirring Paddle | 2.95 | 11.8 |
| | Nylon Grain Bags | 4.25 | 8.5 |
| | Muslin Boiling Bag | 0.45 | 4.5 |
| | Plastic Spring-Tip Bottle Filler | 2.75 | 5.5 |
| | Bench Capper | | 32.95 |
| | Labeling | | 25 |
| | Basic Homebrew Draft System | | 186 |
| | Propane | | 25 |
| | 6 Gallon Glass Carboy | 38.95 | 194.75 |
| | Rubber Stopper | 0.6 | 3 |
| | | **Total ($)** | **1414.4** |
| | **Item** | **$/each** | **Total** |
| Ingredients | American 2-Row | | 6.5 |
| | American Vienna | 1.8 | 3.6 |
| | Orange Blossom Honey | | 69.5 |
| | Cascade (Pellets, 5.4 %AA) boiled 60 min | 1.95 | 19.5 |
| | Fuggie (Pellets, 5.1 %AA) boiled 15 min | 1.2 | 4.2 |
| | Wyeast 1056 American Ale | 6.5 | 26 |
| | Irish Moss | 1.25 | 3.75 |
| | Orange Blossom Extract | 1.95 | 5.85 |
| Bottle | 12 oz. Bottles | 12.95/24 | 77.7 |
| | Caps | 3.50/144 | 7 |

| | | | |
|---|---|---|---|
| | | **Total ($)** | **223.6** |
| | | | |
| | | **Total # of bottles** | **130** |
| | | **Cost per bottle** | **1.72** |

## 7.6 Appendix F (Business Plan):

Business Plan

FUNKY BREWSTERS Brewery

**1.0 Executive summary**

1.1 Objectives

1.2 Keys to success

**2.0 Company summary**

2.1 Start-up summary

2.2 Company ownership

2.3 Company locations and facilities

2.4 Company values

**3.0 Product**

3.1 Product description

3.2 Competitive comparisons

3.3 Technology

**4.0 Market analysis summary**

4.1 Market segmentation

4.2 Target market (market trends, market growth, market needs)

4.3 Competitive edge

**5.0 Strategy and implementation summary**

5.1 Sales strategy/forecast

5.2 Marketing strategy

5.3 Pricing/ promotion strategy

5.4 Distribution strategy

5.5 Product packaging

**6.0 Production summary**

6.1 Raw materials suppliers

6.2 Production (site etc.)

**7.0 Management summary**

**8.0 Financial plan**

## 1.0 Executive Summary

Funky Brewsters is a small-scale brewery located on the Illinois Institute of Technology (IIT) campus in Chicago, IL. It is relatively new business in its start-up phase. It started as an Inter-professional Projects (IPRO) Opportunity for senior students at the Illinois Institute of Technology to put their knowledge acquired from the classroom to real life use. Our motto is 'Engineering at its tastiest'.

### *1.1 Objectives*

The objective of this IPRO is to brew good quality beer and to allow students the opportunity to learn how it is done.

### *1.2 Keys to success*

One of our keys to success will be to select our market strategically and reach the right set of consumers. We ensure that we produce good quality beer because this will determine our customer retention level/rate. We also intend to effectively advertise our beer by setting up beer tasting events and also surveys to gather the opinions of our potential consumers. Distribution network is also an important factor that determines success of our business. We plan to eventually collaborate with the campus events center called the BOG where students go for fun and relaxation. Meanwhile our first target customers will be on IPRO day.

## 2.0 Company summary

### *2.1 Start-up summary*

Total start-up capital and expenses (including equipment, ingredients, storage, surge tanks, bottling etc.) came up to $1650.95.

### *2.2 Company ownership*

The Chemical Engineering department at IIT owns the business. The plan is to make this a continuing IPRO or beer-brewing firm that provides beer for sale to students above 21 through the BOG.

### *2.3 Company locations and facilities*

Funky Brewsters is located on IIT campus. This is the only location equipped with the needed apparatus and conditions for brewing.

*2.4 Company values*

We intend to conduct our business ethically and transparently, respecting all applicable laws. We will ensure production of safe and good quality beer to meet our customer's needs; our IPRO's biggest priority is the health of our consumers.

**3.0 Product**

Currently there is only one product.

*3.1 Product description*

The beer is named 'Bond on Blonde', which is a blonde ale. The beer was made using a malt extract instead of an all grain beer. The flavor profile came from using Cascade hops which have a citrusy flavor, along with orange blossom honey and orange rind.

*3.2 Competitive comparisons*

Our only competition is the two other beer brewing IPROs at IIT. We all are employing the same techniques and technology to produce different kinds of beers.

*3.3 Technology*

The technology used for the production of 'Bond on Blonde' is the generic but effective technology used by most small- scale breweries. Five gallons of each batch was brewed in large vats using a propane burner for the heat source. After the wort schedule was completed, it was cooled via a coiled heat exchanger. This comprised of cooper tubing with cold water running through it extracting heat from the hot wort located in a bucket. Once the wort was cooled to below 70°F the yeast could be added. After this, the beer was placed into carboys to ferment for two weeks in primary and then another two weeks in secondary. After about a month of fermentation the beer was carbonated and bottled.

**4.0 Market analysis summary**

*4.1 Market segmentation*

Funky Brewsters will be focusing on IIT students above 21 and faculty who appreciate good quality beer.

*4.2 Target market (market trends, market growth, market needs)*

Our main targets are IIT students above 21 and faculty and staff of IIT.

*4.3 Competitive edge*

An important competitive edge is the branding of the product. We at *Funky Brewsters* feel that the name of the beer in itself, 'Bond on Blonde', provides a catchy and fun platform for consumers, as opposed to other beers that have quite generic names, and are branded basically as historical or old products. Also, 'Bond on Blonde' has an advantage with its targeted market because it is a product of the creation by people who are in the same age bracket and live in the same environment as the target market. As such, it is easier for them to relate.

**5.0 Strategy and Implementation Summary**

*5.1 Sales Strategy/Forecast*

As mentioned previously, our sales strategy for the time being consists of selling our beer to students of Illinois Institute of Technology (IIT) who are above 21, and also to any faculty member who might want to purchase it. Based on preliminary information obtained from surveys, we predict that majority of the market will be students, between the ages of 21 and 25.

*5.2 Marketing Strategy*

As a preliminary measure, a survey was carried out to determine what demographic the beer was most likely to attract. The results of the survey showed that the beer attracted mostly students between the ages of 21 and 25. This led to the *Funky Brewsters* deciding to market their product primarily towards this age group. We also plan to have the beer available at the BOG, the campus bar/hang out spot, so as to make it easily accessible to the students.

*5.3 Pricing/Promotion Strategy*

A price for the beer has not yet been decided on. However, in terms of promotion, our biggest means will be word of mouth. As students of IIT ourselves, we intend to spread the word to our colleagues by telling them about the beer and where they can get it. Also, by having the beer available in the BOG it will be promoted, as the name of the beer will have to appear on a menu. We may also decide to put up posters as advertisements.

*5.4 Distribution Strategy*

As our catchment area for the moment consists of only the IIT campus, our distribution strategy is not very sophisticated. We only plan to supply the beer to the BOG, as it is the only establishment on campus where alcohol can be sold.

*5.5 Product Packaging*

Our product is going to be sold in a brown tinted glass bottle, with a label on it displaying the beer name and logo.

**6.0 Production Summary**

*6.1 Raw Materials Suppliers*

The supplies and ingredients were all purchased from Brew and Grow. The ingredients included malt extract, grains, hops, yeast, and honey. The only other ingredient needed was orange rind and spring water purchased from Jewel.

*6.2 Production*

The beer was produced on the IIT campus, in a laboratory. Dr. Vijay Ramani was kind enough to let the brew team use space in the laboratory to brew and store our beer. Three batches of Bond on Blonde were brewed in one day with the entire brew team present.

**7.0 Management Summary**

*Marketing Team*

Number of students: 4

Team Members: Olakunle Popoola (Team Leader)

Kevin Richards

Mallory Rollins

Remi Adejinle

Thomas Matthews

*Brew Team*

Number of students: 8

Team Members: Emily Kunkel (Team Leader)

Omaditya Khanna

Richard Byrne

Samantha Hoskinson

Joe Farkas

Liam O'Rourke

Carl Schleich

Nicholas Shattuck

*Engineering Team*

Number of students: 9

Team members: Daniel Kim (Team Leader)

Nicole Reigle

Logan Manlove

Heon Ki Cho

Robert Jackson

Say Yeong Siah

Ton Trieu

Ryan Heneghan

India Lucas

## 8.0 Financial Plan

See Appendix E (Cost Analysis)

## Appendix

http://www.bplans.com/brewery_business_plan/executive_summary_fc.cfm

## 7.7 Appendix G (Team Members):

**Remi Adejinle**

Remi is a fifth year chemical engineering student and was a member of the marketing team for the whole semester and joined the brochure team at the end. She assisted with the project plan and proposed budget for the semester. Then she worked on researching beer brewing laws and beer branding. She also helped with coming up with names, logos and labels for 'The Funky Brewsters' and she finally worked on the business plan and contributed to the team's final report.

**Richard Byrne**

Richard is a senior Chemical Engineering student whose focus is in Energy, Environment and Economics. Richard served as a member of the Brew Team and helped with the brochure. His knowledge of beer brewing complimented the team during the planning, brewing and bottling stages of the operation. With his experience in equipment purchasing and networking ability gained through an undergraduate research project concerning algae, he was able to find equipment and brewing resources at various locations around the Chicago land area. He also developed a strong familiarity with local brew pubs and people within the craft beer community.

**Moshe Calm**

Moshe is a second-year chemical engineering student. This was his first time participating in an IPRO. At the beginning of the semester, Moshe joined the deliverables sub-group, which was responsible for compiling the project-plan. After the first few weeks, he joined the Engineering sub-group which discussed the heat-exchange data given from the brewing sub-group. Moshe learned about simple heat-exchangers and about the brewing process.

**Heon Ki Cho**

As a junior in this IPRO, Heon Ki was introduced to the IPRO system. He was in the engineering group and worked in the lab. He suggested the team slogan and

researched which wort chiller was the best to use. As a team member, Heon Ki investigated the toxins produced during brewing.

**Joseph Farkas**

Joseph is a transfer student majoring in chemical engineering. He was a member of the brewing subgroup. He spent the first part of the semester working with the brewing group to decide on what type of beer to brew and the process with which to brew it. The second part of the semester was spent brewing the beer and choosing the best product to present on IPRO day.

**Ryan Heneghan**

Ryan was part of the engineering team and a senior majoring in mechanical engineering. He researched the history of the brewing process in order to give the team more insight on brewing in general. He also helped determining different cooling methods and temperature control methods for the brew train. He spent some time working with the marketing team creating the logo to be displayed on the beer bottles.

**Samantha Hoskinson**

Samantha is majoring in chemical engineering. She was part of the brewing sub-group. Samantha helped producing and bottling the final product. At the end of the semester she helped with the poster.

**Robert Jackson**

Robert is a CHE 296 student. He is a member of the engineering sub-group. He assisted in designing the brewing process.

**Joshua James**

As team leader, Josh managed and organized IPRO 321. He led class meetings, coordinated with sub-groups, and delegated all of the tasks that needed to be completed. In order to help with the efficiency of completing tasks, he would send out weekly emails of each member summarizing what needed to be completed for the next week. He prepared agendas for each meeting and facilitated decisions made by the group. Josh also worked with the Brew Group to purchase the brewing equipment and helped to organize an Ethics Bowl. He worked extensively on the Project Plan, Midterm Presentation, and Final Report, too.

**Peter Johnson**

Peter is a sophomore majoring in chemical engineering. He was part of the brewing sub-group.

**Daniel Kim**

Daniel is a senior chemical engineering major. He was the sub-group team leader for the engineering team. He divided the tasks between the engineering team for determining the best method of heat exchange for the wort. He contributed in analyzing the amount of heat exchange, as well as figuring out the total cost of the brewing system. Finally, he worked on the engineering section of the brochure.

**Goldey Khanna**

Goldey Khanna is a 4th year senior in the Department of Chemical and Biological Engineering. Goldey worked primarily in the brew team for IPRO 321. He assisted his team mates with carrying out the recipe to brew the beer in a research lab in Perlstein Hall. He also served on the deliverables team, helping coordinate everyone's reports and compiling it towards a final report. Moreover, Goldey was the director for the video that was shot to detail the goals and successes of IPRO321.

**Emily Kunkel**

Emily is a senior chemical engineering student. She was the subgroup team leader for the brew group, in charge of overseeing the beer brewing and recipe selection process. She researched various beer recipes and compared flavor profiles of many craft recipes. After selecting a recipe, she helped in the 6 hour process of brewing a total of 15 gallons of beer. Emily was also the group leader for the brochure group. Within this group, Emily was responsible for collecting and analyzing data given by each of IPRO 321's subgroups.

**India Lucas**

India is a CHE 296 student. At the beginning of the semester she assisted in Marketing and Product Branding. She was instrumental in creating surveys to determine what the majority of the Beer Drinking market would prefer as far as flavor and bitterness. She then worked with the Engineering team for the remainder of the semester, analyzing the thermodynamics of the brewing system.

**Logan Manlove**

Logan Is a CHE 296 student. Logan spent the majority of the semester on the engineering team primarily researching heat exchangers and helping to determine what the best option for the project was.

**Tom Matthews**

Tom Mathews is a 3rd Year biochemistry student. Originally part of the deliverables team, Tom was moved to the marketing team for the majority of the semester. Within the marketing team, Tom set up and administered multiple surveys to evaluate the general opinion of the public on blonde ales and the team's rough-draft logo designs, allowing for the best design to be chosen.

**Hazel Michael**

Hazel Michael is a third year Chemical Engineering and fourth year Biomedical Engineering student. She was appointed as a secretary for IPRO 321. She was responsible for taking attendance and team minutes for every meeting IPRO 321 held this year in order to complete the project. Being part of this team was a learning growth for her as she not only learned about the brewing process but also what regulations are involved in the making the beer. She also learned a lot about being involved in a team and how communication and determination is a major element in completing a project successfully. Furthermore, she also contributed towards making the final poster for IPRO day and digitizing the logo.

**Liam O'Rourke**

Liam is a student enrolled in CHE 296, and a recent transfer student to the Chemical Engineering program. He was a member of the Brew Team and helped brew, bottle, and label the product. Liam assisted in researching recipes and processes in which to produce a brew, in order to provide the IPRO with several suitable recipes to choose from. He attended weekly meeting with the Brew Team to insure quality during the brewing and fermentation process. Liam was present and assisted in every step of creating the craft brew. He also developed several names for the beer, including the final name, Bond on Blonde.

**OlaKunle Popoola**

"Kunle" is a senior majoring in Chemical Engineering. As the team leader for the Marketing Team, his responsibilities included delegating tasks among the team

members, making sure that nobody was left idle and that the tasks were performed in a timely manner. He planned meeting times for the group members to fill each other in on their progress, and to gather ideas on how to tackle future problems. He worked on digitizing the logo for the beer, as well as writing the business plan for the IPRO.

**Nicole Reigle**

Nicole is a senior chemical engineering student. She was part of the engineering team, which helped in researching heat exchangers and different types of equipment. She also worked on estimating the total cost of the beer brewing process. Nicole also helped with writing the project plan and final report.

**Kevin Richardson II**

Kevin was a sophomore and was a part of the marketing team. He did research on making labels and assisted with writing up the project plan and creating the questions asked on the surveys.

**Mallory Rollins**

Mallory Rollins is a second year chemical engineering student. She participated in researching rules and regulations for beer brewing and labeling as well as researching the process of branding a product. She contributed potential beer label sketches to be polled via Facebook. Mallory also participated in producing the finished beer labels. She contributed to the poster on behalf of the marketing team.

**Carl Schleich**

Carl is a member of the brewing team. The brew team's focus was recipe selection, equipment acquisition, the brewing process and monitoring, bottling, and storage. Carl worked primarily on the recipe selection, equipment setup, and brewing stages.

**Nicholas Shattuck**

Nicholas is a junior majoring in chemistry. He acted as the technical expert in the brewing process for all three IPRO 321 groups and was a member of the Brew Team for the Funky Brewsters. Nicholas has brewed his own beer for the last five years and brought his expertise to the Brew Team. He participated in researching and developing recipes as well as overseeing the brewing and bottling process. Nicholas also came up with the idea to analyze the sugar profile of the beer over the course of the fermentation.

**Say Yeong Siah**

Beer brewing is indeed a fun and great experience. Throughout the whole semester, Say Yeong learned that beer brewing is not only about mixing chemicals. You also need to know a lot besides that such as fermentation; heating and cooling and packaging. With the skills he learned, Say Yeong can brew his own beer in the future. He was on the Engineering team and responsible for calculating the rate of cooling and other energy losses. Besides that, he was also there to make sure that the whole process occurred smoothly and efficiently.

**Ton Trieu**

Throughout the IPRO, Ton had experienced how teamwork is divided among all team members to achieve the highest efficiency within all the team members. Our IPRO team is divided into 3 different sub-groups including marketing, engineering, and brewing team. He also learned how the team leader kept wonderful communication between our team members by sending regular emails asking for tasks to be done. This was the first IPRO for Ton. He learned a lot of members' skills. Also, he was responsible for doing some research on the ethical concerns relating to which chemicals must not be added into our final product, and he learned a bit more about the process of brewing beer.