Illinois Institute of Technology

IPRO 321

Project Plan

1/28/2011

I. Team Charter

A. Team Information

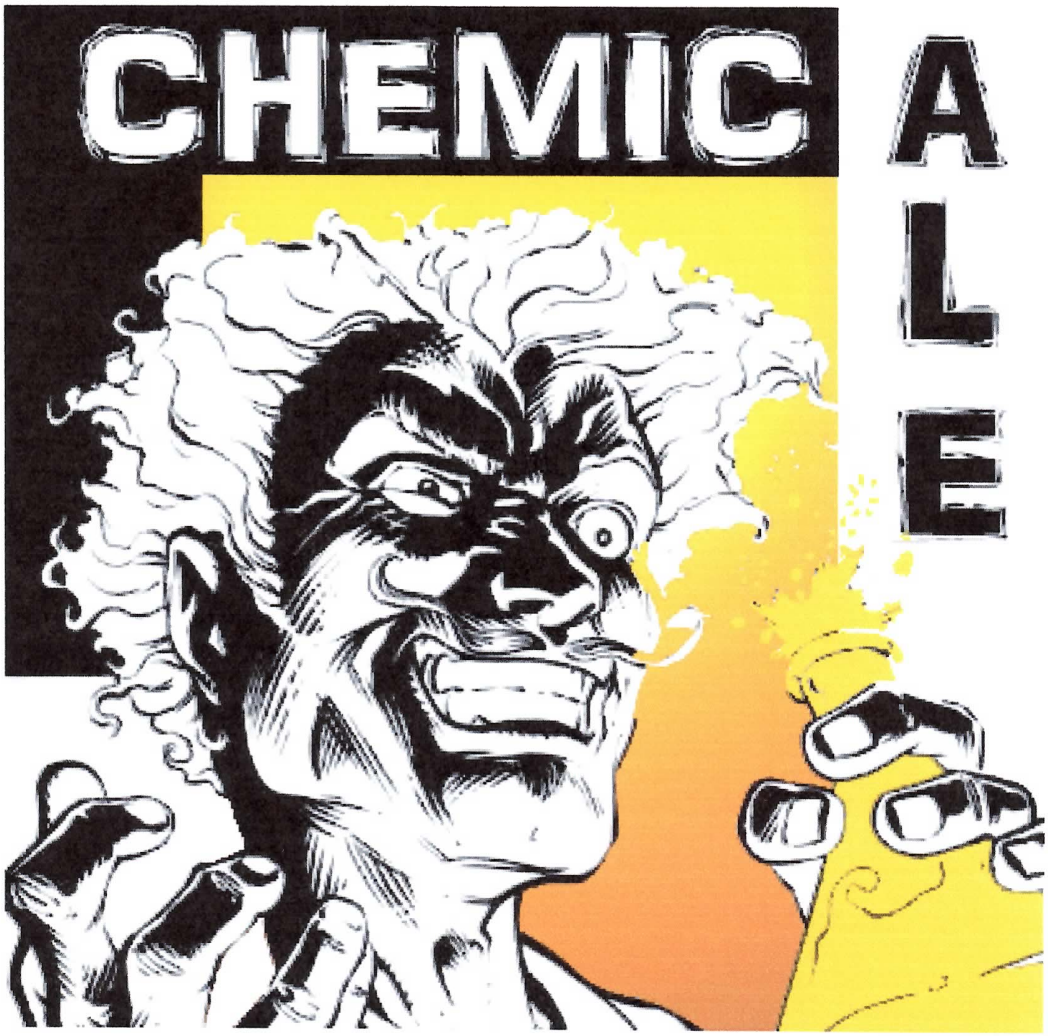
1. Details

a. See Appendix for names, majors, strengths, expectations, and tasks

2. Team Identity

a. Name: The Funky Brewsters

b. Logo:



c. Motto: Engineering at its tastiest

B. Team Purpose and Objectives

1. Team Purpose

a. 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/economics of brewing beer.

2. Objectives

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

C. Background

1. History

a. 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. In ancient times, beer was cloudy and unfiltered; thus, drinking straws were used to avoid drinking the bitter brewing residue, which was very bitter. An ancient Babylonian law established a daily beer ration depending on the social class of the citizen.
b. The first record of hops being used comes from England in the 15th century. Another important event in brewing history is the first established standards of brewing by the Germans, dating back to the 15th century. The Reinheitsgebot of 1516 is the most popular beer purity standard of the Germans. The law stated that only water, malted barley, malted wheat and hops could be used to make beer. Yeast is

excluded from the list but was acceptable, as it was assumed to be a key ingredient in the brewing process.

c. The next great development in the brewing process came during the mid-18th century. Luis Pasteur was the first to propose an explanation of how yeast worked. Shortly after, Bavarian yeast provided the successful identification of the single-cell and strain at the bottom of fermenting lager yeast. Lagering beer was first accomplished by the Germans in 1402 because fermenting beer was not practical during the warm months, since the wild yeasts prevalent in the summer time would sour the beer. The brewers discovered that brewing the beer in the cold months provided more stability to the beer and enhanced it with a cleaner taste.

2. Technical Issues

a. Sanitizing

1. All utensils must be sterile prior to use. Don't wait until the last minute to sanitize equipments or utensils. This can cause unwanted products. Cleanliness is important for every step of the brewing process.
2. Sanitize any objects that touch the cool wort, which includes, but is not limited to: tablespoons, measuring cups, yeast starter jars, fermentors, and lids, airlocks, thermometers, funnels, and stirring spoons.
3. Detergent: Use a mild unscented dish detergent. Rinse completely and thoroughly with hot water.
4. Bleach: Mix bleach with cold water. Don't use bleach or mix solution to clean brass or copper. Do not leave the metal in bleach for more than one hour. Rinse with boiled water and dry thoroughly.
5. Percarbonates: Sodium percarbonate (Arm and Hammer Super Washing Soda) + Hydrogen peroxide. One tablespoon per gallon. It's very effective for cleaning all types of brewing equipments.

b. Cooling

1. If the wort takes a long time to cool, unwanted products such as dimethyl sulfide are produced. This can cause off-flavors in the beer. The wort must be rapidly cooled below 80 degrees F before contamination or oxidation can occur.

2. Ice bath: Keep lid on and stir the pot to maximize heat transfer. The wort should cool to 80 degrees F in 30 minutes.
3. Copper Wort Chillers: You don't have to move the wort. The wort can stay in place while the copper wort chillers are attached. This method is most likely the best way to prevent any accidents.
4. Immersion chillers: Cold water is fed through the copper wire.
5. Counter-flow: Cold water flows around the chiller.

c. Temperature

1. The fermentation process with the yeast will depend on the temperature. If it's too cold, the yeast becomes dormant. If they are too hot, fermentation occurs. High temperatures can affect the taste of the beer drastically due to the production of diacetyl and fusel-alcohols. 10 degrees F above the nominal temperature is considered a high temperature.

3. Ethical Concerns

a. IPRO 321 is concerned with two major ethical issues: plagiarism and health.

b. All research will be cited in the correct format. Experimental data from lab sessions will be recorded, and will not be fabricated or falsified.

c. Also, health is prioritized in this project. The following chemicals shall not be added to our products in order to maintain a safe product to consume:

1. Sodium Hydrosulfite ($Na_2S_2O_4$) : Dangerous chemical added in beer to prevent degradation of the flavor and insure a "prefect' brew. This specific chemical is also used in industry as a reducing and bleaching agent.
2. Tannic acid (tannin): Brewers use this in order to eliminate the sediment or cloudiness of the beer. Tannic acid is known for causing gastric irritation and liver damage.
3. Cobalt (Co): This chemical is used to prevent over-foaming of the beer. Federal officials in the U.S. and Canada, as well as investigating physicians, have strongly implicated cobalt as the cause of 37 deaths and many other serious cases of beer drinker's heart disease. In this case, the heart of beer drinker will slowly degenerate and eventually stop working.

4. **Potential Applications**
    a. In the engineering team, we will use our expertise in heat transfer to find the best way to chill the beer wort as quickly as possible. Quickly chilled wort will produce a clearer and better tasting beer.
    b. We will find a way to control the temperature while boiling the wort. Although we may not be able to choose our own equipment, we will make a list of what we find to be the best and explain our reasoning for each choice.
5. **Critical Documents**
    a. Daniels, Ray. *Designing Great Beers: the Ultimate Guide to Brewing Classic Beer Styles*. Boulder, CO: Brewers Publications, 2000. Print.
    b. Fix, George J. *Principles of Brewing Science: a Study of Serious Brewing Issues*. Second ed. Boulder, CO: Brewers Publications, 1999. Print.
    c. Janson, Lee W. *Brew Chem 101: the Basics of Homebrewing Chemistry*. Pownal, VT: Storey Communications, 1996. Print.
    d. McCabe, John T., and John Britnell. *The Practical Brewer: a Manual for the Brewing Industry*. Third ed. Wauwatosa, WI: Master Brewers Association of the Americas, 1999. Print.
    e. Snyder, Stephen. *The Brewmaster's Bible: the Gold Standard for Home Brewers*. New York, NY: Harper Perennial, 1997. Print.

D. Team Values Statement

1. **Desired Behavior**
    a. Efficient communication through prompt email responses
    b. Proper observance of laboratory safety protocols
    c. Strong, consistent attendance
    d. Respect for teammates
    e. Creation of a workplace environment that is amicable
    f. Willingness to share ideas and research
    g. Proper scientific research citation
    h. Efficient time-management skills
    i. Follow through on assigned tasks
    j. Take the project seriously
    k. Desire to take initiative

2. **Addressing Problems**

    a. In addressing problems in the group, we will make sure that active listening is used, information is gathered, and issues are clearly identified. Brainstorming will then be used to develop possible solutions, and a solution will be negotiated. Problems will initially be dealt with by talking with a peer or a subgroup leader. If the problem persists, then it will be addressed by the team leader, and finally, the IPRO advisor, Professor Vijay Ramani. Problems will be prevented by open communication between teammates, meeting deadlines to the best of our abilities, and reliance on our collective teamwork to complete large tasks. To reinforce these points, peer reviews will be conducted at multiple points throughout the semester.

II. Project Methodology

A. Work Breakdown Structure

1. Problem Solving Protocol

a. In order to best meet our team goals, the sub groups will meet on their own on a weekly basis to discuss their progress in completing tasks and meeting deadlines. The entire group will meet as a whole during class time on Tuesdays and Thursdays to discuss the project, collaborate between sub groups, and discuss upcoming events and deliverables.

2. Team Structure

a. Team Leader
    1. Joshua James

b. Brew Team
    1. Emily Kunkel*
    2. Rich Byrne
    3. Liam O'Rourke
    4. Samantha Hoskinson
    5. Joe Farkas
    6. Nick Shattuck
    7. Carl Schleich

c. Engineering Team
    1. Daniel Kim*
    2. Nicole Reigle

3. Logan Manlove
4. Heon Ki Cho
5. Robert Jackson
6. Say Yeong Siah
7. Ton Trieu
8. Ryan Heneghan

d. Marketing Team
   1. Kunle Popoola*
   2. Remi Adejinle
   3. Kevin Richardson II
   4. Mallory Rollins

e. Deliverables Team
   1. Goldey Khanna*
   2. Joshua James
   3. Peter Johnson
   4. Moshe Calm
   5. Hazel Michael
   6. Tom Mathews

B. Schedule

Task	Start Date	Due Date
Project Plan	January 21	January 27
Work on (group specific) midterm ppt.	January 28	March 3
Individual Ethics Reflection Paper	March 4	March 19
IPRO Day Presentation Rehearsal Reviews	March 20	April 14
Exhibit Poster	April 1	April 15 (by noon)
Abstract/Brochure	April 1	April 17
Presentation	April 1	April 20
IPRO Day	April 21	

Subgroup	Task	Start Date	Due Date
Brewing	Have malt mashed, boiled and cooled for batch 1	02-08-11	02-10-11
	Ferment wort batch 1	02-10-11	03-03-11
	Bottle and condition batch 1	03-03-11	03-24-11
	Mash, boil and cool malt for batch 2	02-10-11	02-15-11
	Ferment wort for batch 2	02-15-11	03-08-11
	Bottle and condition batch 2	03-08-11	03-29-11
Engineering	Choose possible temperature control and wort chiller equipment	01-27-11	02-04-11
	Choose equipment and order	01-27-11	02-11-11
Marketing	Project budget	01-25-11	01-28-11
	Project poster	01-28-11	04-15-11
	Project brochure	01-28-11	04-18-11
Deliverables	Project Plan	01-28-11	01-28-11
	IPRO Presentation	01-28-11	04-20-11

C. Expected Results

1. Details of Expected Activities

a. A member of Dr.Ramani's research group will provide a presentation on the procedure for brewing beer. Much of the IPRO group is unaware of the different types of beer, how they are categorized, and the function of the different ingredients that go into producing beer. This will help familiarize everyone with the process of brewing beer, and serve to get all members caught up to speed.

b. The team members will vote upon what type of beer to brew, based on the difficultly and feasibility of obtaining a rich, flavorful beer using the limited resources and funds available.
c. Team leaders will meet with our faculty advisor, Dr.Ramani, in order to determine the materials and machinery that must be purchased in order to carry out our brewing process.
d. The Engineering team will provide process designs for brewing beer, taking into account the materials and machinery available to us. Students will provide input on how to streamline and enhance the process design in order to obtain the highest yield of desired product (beer) while producing the least amount of waste.
e. The Brewing team will use the process design put forth by the Engineering Team and brew a first batch of beer.
f. Students will be asked to solicit designs for beer bottles, and all students in the Team will vote upon the winning design.
g. Students will be expected to deliver a plan outlining how to package the beer into bottles in order to ensure its longevity (i.e. bottles must be tinted so as long to let in sunlight that would adversely affect its taste).
h. A survey will be written that serves to gauge the quality of the beer based on several different categories. A focus group will be assembled, preferably composed of individuals who have experience in critiquing beer, and they will be asked to complete our survey.
i. Individuals of the focus group will be given samples of the first batch of beer brewed and their feedback will be solicited. Based on their feedback, the Brewing Team and Engineering team, in tandem, will optimize the process design in order to improve the quality of the beer.
j. The Brewing team will brew a second batch of beer, taking into accounts the improvements made in the process design.
k. Members of the focus group will once again be given samples of beer, and will be asked to fill out the same questionnaire. The data will be compiled and analyzed in order to determine whether the second batch of beer was improved compared to the first batch. The results of the survey will be used as a means of gauging the success of the beer brewing process developed and our IPRO as a whole.

2. **Expected Data**
    a. Duration of different processes and temperature ranges within these processes
    b. Length of time to boil and cool
    c. Quantities of different ingredients used
    d. pH of water used
    e. Process diagram / flow-sheet
    f. Data will be analyzed from a questionnaire answered by beer taste testers
3. **Potential Products**
    a. At least two batches of beer will be produced. One will be a blond ale, while the other will be determined upon completion of the first.
    b. Packaging for the beer with a unique label and name. The packaging will consist of bottles or kegs.
    c. A cooling coil or other type of thermo system may be developed.
4. **Potential Outputs and Deliverables**
    a. One test batch of beer will be brewed, following the plan outlined by the Brewing team and using equipment and a process flow sheet designed by the engineering team.
    b. A survey will be generated and distributed to an impartial group of tasters, in order to rate the quality of the test batch of beer. The survey will hopefully comprise of a range of tasters, from legal college students to older professors.
    c. A second batch of beer will be the final product, which will be bottled with the final logo design, taking into account the feedback from the focus group.
    d. A budget report including the cost of the equipment, beer ingredients, and other supplies necessary to complete the brewing process. This could be used in the final report, to show the cost of home brewing.
    e. A full-scale market analysis and business model for the product will be generated.
5. **Challenges and Risks**
    a. Excellent communication within the team members is necessary for the team to deliver a reliable solution to the given problem. This will enable the subgroups to interact and stay in contact, which will play a vital role in finishing assignments on time.

b. Developing a preliminary beer brewing process that could be enhanced into a mass production process.
c. Maintaining completely hygienic conditions in order to avoid yeast interacting with other potential substances other than used in beer brewing process.
d. Developing a maximized solution to our problem within the given time period.
e. Motivating each subgroup members to complete their individual tasks on time.
f. Not having sufficient background research that could lead to undesired solutions.
g. The final product should be market acceptable, having taking into account the feedback from the focus group.
h. Regulating temperature, constancy of pH, concentration of materials used, and other potential changes that could affect the control system/environment of the experiment.
i. Not addressing variations within the results of the same experiment.
j. Staying within the given budget.

6. Proposed Solution

a. Maintaining excellent communication within the group by using emails, chat rooms, Google groups, and IIT iGroups.
b. To ensure each task is being completed , the team will be divided into subgroups of:
    1. Brewing
    2. Engineering
    3. Marketing
    4. Deliverables
c. In order to maintain hygienic conditions, thorough precautions will be taken into consideration during the beer brewing process by consulting with research and engineering application subgroups.
d. Motivating each team member will be facilitated by having group discussion.
e. Gantt chart/Ram chart will enable the entire team to be able to stay on task within the selected due dates.
f. Evaluate existing beer brewing processes and determine plausible methods or integrate into the team's developed solution.
g. Staying within the budget by determining the feasibility of a proposed solution.

D. Project Budget

1. Equipment

a. $7738

b. See appendix for further breakdown of costs

2. Materials and Supplies

a. $1100

b. See appendix for further breakdown of costs

3. Publications and Communications

a. $180

b. See appendix for further breakdown of costs

4. Student Stipends

a. $2000

b. $2000 is requested for Chris Arges, a graduate student with experience in beer brewing who will assist with this IPRO.

5. Other Expenses

a. $884

b. 0% overhead on equipment and materials/supplies budget – this is only for shipping and taxes

6. Total Budget

a. $11,902

7. Note

a. Please note that IPRO 321 has 75 students. This IPRO is split into 3 groups of 25 (each group will be pursuing an independent brewing project). The costs reflect all three groups. Also note that the expenses for equipment will be 1-time expenses. Future offerings of this IPRO will be able to utilize the same equipment.

E. Designation of Roles

1. Minute Taker: Hazel Michael

a. Hazel will take minutes and attendance during class time and post them to iGroups for reference. Each sub group will be responsible for their minutes, which will be completed by the sub group leader and posted on iGroups.

2. **Agenda Maker: Joshua James and Sub Group Leaders**
    a. Joshua will be responsible for creating agendas for class time. Sub group leaders will make agendas for their weekly meetings.
3. **Time Keeper: Joshua James and Sub Group Leaders**
4. **iGroups Moderator: Deliverables Sub Group**
    a. The deliverables sub group will be responsible for making sure that IPRO deliverables are completed on time and properly uploaded to the iGroups website. Additionally, they will organize iGroups files and aid group members in uploading and updating files and timesheets.

III. Appendix

A. Team Details

Name	Major, Year	Strengths	Desired New Skills and Knowledge	Expectations	Individual Tasks	Contact Information
James, Joshua	BME/ChE, 4th	Leadership, organization, engineering	Learn new lab skills/techniques, gain knowledge of the beer brewing process, gain experience in project management	Group members will follow through with their commitments and have a fair distribution of work, we will produce a quality product that we are proud of, and we will win our IPRO track	Manage deliverables, lead IPRO meetings, monitor sub groups, provide team with direction, and provide advice on engineering problems	jhjames713@gmail.com [redacted]
Khanna, Goldey	ChE, 4th	Organization, writing, team-building, engineering	Learn how to integrate chemical engineering processes to brew beer; learn how to develop a project plan and follow its course	Group members will contribute an honest effort towards making sure our tasks are completed	Deliverable, project plan, beer brewing	okhanna@iit.edu [redacted]
Kim, Daniel	ChE, 4th	Engineering	Learn to brew beer, teamwork experience	To gain full IPRO experience	Engineering Team	dkim56@iit.edu [redacted]
Kunkel, Emily	ChE, 4th	Presentation giving, mandating tasks, idea-building, engineering	Learn new techniques in beer brewing, develop laboratory experience	To participate in an IPRO where its members hold themselves accountable for their work	Beer selection and brewing team	ekunkel@iit.edu [redacted]
Popoola, Kunle	ChE, 4th	Presentation giving, scheduling, organizational skills	Experience in brewing, learning about different types of beer, and techniques for brewing.	Equal and willing contribution from each team member; brewing experience.	Marketing Team	opopool2@iit.edu [redacted]

Reigle, Nicole	ChE, 4th	Engineering	Learn how to brew beer, learn more about process design	Work as a team to create a quality final product, finish all deliverables in a timely fashion	Engineering Team	nreigle@iit.edu [redacted]
Adejinle, Remi	ChE, 5th	Engineering, Business, Communication	Learn the beer brewing process, gain more experience working in teams	Expect the IPRO team to successfully complete the project and be ready for IPRO day	Work on the marketing team	annatraa@gmail.com [redacted]
Byrne, Rich	ChE, 5th	Organization, leadership, dedication	Gain experience in beer brewing, encourage others to learn alcohol fermentation and distillation	To achieve a quality beer and be successful on IPRO day	Beer Brewing Team	rbyrne@iit.edu [redacted]
O'Rourke, Liam	ChE, 3rd	Organization and communication	Learn how to brew beer	To make a tasty beer	Brewing Team	lorourke@iit.edu [redacted]
Manlove, Logan	ChE, 3rd	Engineering	Continue to develop my engineering skills	Be able to apply what has been used in a semi-practical project.	Engineering team	Lmanlove@iit.edu [redacted]
Richardson II, Kevin	ChE, 2nd	Teamwork, organization	Develop engineering skills	To successfully complete IPRO	Marketing Team	krichar1@iit.edu [redacted]
Hoskinson, Samantha	ChE, 2nd	Engineering, Teamwork, Organization	Develop engineering skills	To successfully complete IPRO	Brewing Team	shoskins@iit.edu [redacted]
Rollins, Mallory	ChE, 2nd	Engineering	Learn the process of manufacturing and marketing beer; teamwork experience	To successfully complete IPRO project	Marketing team	mrollin2@iit.edu [redacted]
Cho, Heon Ki	ChE, 3rd	Engineering	Learn the process of brewing beer	Design a successful brew train	Engineering	hcho11@iit.edu [redacted]
Jackson, Robert	ChE, 3rd	Engineering	Gain team work experience	To complete IPRO	Work on engineering team	rjacks4@iit.edu [redacted]
Farkas, Joe	ChE, 2nd	Engineering	Gain beer brewing and team work experience	To complete IPRO	Brewing team	jfarkas1@iit.edu [redacted]

Johnson, Peter	ChE, 3rd	Engineering	Knowledge in brewing beer and working in a team	To make good beer and work well as a team to complete IPRO	Deliverables	pjohns13@iit.edu [redacted]
Calm, Moshe	ChE, 2nd	Engineering, Teamwork	Project Planning, Bath Process	Complete IPRO	Deliverables	mcalm@iit.edu [redacted]
Siah, Say Yeong	ChE, 3rd	Engineering, Finance	Beer Brewing experience	To enjoy our product	Engineering team	ssiah@iit.edu [redacted]
Michael, Hazel	BME/CHE, 4th/3rd	Engineering, leadership, organization	Project Planning, IPRO experience	complete IPRO	Deliverables	hmichae2@iit.edu [redacted]
Trieu, Ton	ChE, 3rd	Engineering, Business	Beer Brewing experience, team working skills	Complete IPRO successfully	Engineering team	tontrieu2012@gmail.com [redacted]
Shattuck, Nick	Chemistry, 3rd	5 Years Beer Brewing Experience, Chemistry, Biology, Leadership, organization	To further my knowledge about the manufacturing and marketing of beer. To gain more leadership experience as well as team working skills.	To successfully complete the IPRO project with a good quality product	Beer design and production, monitor my sub group and provide team with direction/advice after deliberating with the other teams.	nshattuc@iit.edu [redacted]
Heneghan, Ryan	ME, 4th	Engineering, Leadership, Business, Marketing	Beer brewing and lab experience	To develop a low-cost brew train and win our IPRO track	Engineering Team	rheneghа@iit.edu [redacted]
Schleich, Carl	Aerospace, 4th	Leadership from military experience, public speaking, engineering, organization and task management	How to brew beer, and work with new people	To develop a brew train and brew something that I actually like to drink! Get a chance to work with other students on a challenging project	Brewing Team	cschleich@sbcglobal.net [redacted]
Matthews, Tom	Biochemistry, 3rd	Biology, Biochemistry	Brewing experience, teamwork experience, Interprofessional relations	A completed IPRO embedded in fun, useful experiences.	Deliverables	tmathews4@gmail.com [redacted]

B. Budget

Project Title:		**Introduction to Zymurgy**	
IPRO Number:		**IPRO 321**	
Lead Faculty:		**Vijay Ramani**	
Semester:		**Spring 2011**	
Fill in ONLY the yellow highlighted cells and the Justifications area, as total and percentages will automatically generate.			
Round to the nearest whole dollar. For example, $274.95 would be entered as $275.			
Expense Category		**Amount**	**Percent of Total**
Equipment	$	7,738	65.02%
(Describe **briefly** below in Justifications area.)			
Materials and Supplies	$	1,100	9.24%
(Describe **briefly** below in Justifications area.)			
Publications and Communications	$	180	1.51%
(Describe **briefly** below in Justifications area.)			
Student Stipend(s) - *May not exceed $2,500*	$	2,000	16.80%
Faculty Stipend(s) - *May not exceed $8,000*	$	-	0.00%
Other Stipend(s) - (translator, advisor from field, support from someone outside your institution, etc.)	$	-	0.00%
(Describe **briefly** below in Justifications area.)			
Travel Expenses	$	-	0.00%

(Describe **specifically** below in Justifications area - re: # of trips and # of people traveling.)			
Prototyping	**$**	-	0.00%
Other Expenses (10% Overhead on Equipment and supplies for Shipping and Transportation	**$**	884	7.43%
(Describe **very specifically** below in Justifications area.)			
Total	**$**	11,902	**100.00%**

Total budget may not exceed $12,000. If you have received or plan to receive other funding for this project, please note this in a separate budget document.

Packaging Equipment				
Item	Cost per unit ($)	Quantity	Cost	Comment/Justification
Amber glass bottles (24 per unit)	15	8	120	Packaging and storing beer.
Caps - oxybarrier (1 gross per unit)	6	2	12	Protecting beer from the environment.
Bench capper	40	1	40	Needed for placing caps on bottles.
Kegging equipment Deluxe Kegging Equipment Kit	350	1	350	All external supplies for Turing refrigerator into a keg-gerator.
Refrigerator for keg	450	1	450	Refrigerator is needed for storing beer and to setup keg-gerator. Cooling beer and delivering to glasses.
Labels	100	1	100	Label bottles with type of beer.
	Subtotal		1072	
Grain Processing/Preparing Wort				
Item	Cost per unit ($)	Quantity	Cost	Comment/Justification
JSP Malt Mill w/ Accessories	250	1	250	Mill grains into small particles for making malt extract

				(raw ingredient for making beer).
Temperature Controlled Oven (toaster oven)	250	2	500	Toast grains and barley. Give a distinct flavor for beers .
Banjo Burner	100	2	200	Heating beer wort/brew pots.
Blue Rhino Propane Tank	50	2	100	Needed for preparing beer wort. For gas burner. Local grocery store.
Balance	35	2	70	Weighing out ingredients.
	Subtotal		1120	
Fermentation/Product Storage until Packaging				
Item	Cost per unit ($)	Quantity	Cost	Comment/Justification
Glass Carboys	50	6	300	For storing beer prior to packaging and for performing other fermentation steps. Used for transporting deionized water.
Carboy Accessories	50	1	50	Accessories needed for transporting/carrying carboys.
Fermentation Tanks	650	2	1300	Primary tanks for carrying out fermentation steps.
Leg Extenders for Stainless Steel Fermenters	150	2	300	Needed for fermentation tanks. Help in placing tanks in lab without taking up lab bench space.
Brew pots (Blichmann Engineering)	330	3	990	Vessels for boiling beer wort, water, and steeping grains. Used for preparing barley malt.
Spoons (stainless steel and non-steel)	25	4	100	Used for mixing components during brewing.
False Bottom	65	3	195	Prevent the hops from clogging drains of the brew pots.
Hop Blocker	60	2	120	Prevent undissolved hop components from entering beer wort.
Refrigerator for cold fermentation	400	1	400	Needed for preparing lager and other type of specialty beers. These beers required cold temperatures during fermentation.
	Subtotal		3755	
Transportation, Heat Transfer, and Filtration Equipment				
Item	Cost per unit ($)	Quantity	Cost	Comment/Justification

Top Tier Modular Brewing Stand	500	1	500	Use for transferring components from one fermentation stage/tank to another. Used for filling beer bottles.
Pump (High temperature transfer)	200	1	200	Used for transferring beer from one tank/stage to another tank/stage.
Hoses Tubing	100	1	100	Needed for transferring beer solution from one tank/stage to another.
Wort Chiller	50	1	50	Needed for cooling steeped water or water after heating quickly.
Plate Heat Exchanger (therminator)	200	1	200	Needed for cooling beer wort quickly after heating.
Air Lock and Stoppers	50	1	50	Needed for venting carbon dioxide from glass carboy during fermentation, but still protecting the carboys from foreign material entering.
Aeration system items	70	1	70	Needed for specialty brews were concentrated oxygen is fed into the beer wort.
Strainers	35	2	70	Needed for filtering undissolved particulate from beer wort.
	Subtotal		1240	
Control and Measuring Instrumentation Equipment				
Item	Cost per unit ($)	Quantity	Cost	Comment/Justification
pH meter and accessories	110	1	110	Monitor the pH of water before brewing beer. And for pH adjustment of water using mineral salts.
Thermometers	100	1	100	Measure temperature of solutions during operations.
In-line thermometer (Thermometer) for heat exchanger	26	1	26	Measure the temperature of the beer solution during operation of the in-line heat exchanger.
Hydrometers	150	1	150	Monitor the alcohol content during fermentation.
Iodine test (also for sanitation)	15	1	15	To monitor the conversion of starches to sugars.
Autosparge	50	3	150	To control the height of liquid in brew pot containers during heating.
	Subtotal		551	
Chemicals				

Item	Cost per unit ($)	Quantity	Cost	Comment/Justification
Sanitation reagents	100	1	100	Sterilize the equipment prior to brewing beer.
Beer Ingredients (grain, yeast, hops, sugars, fruits, and spices)	1000	1	1000	Raw ingredients for brewing beer.
	Subtotal		1100	
	Overall Subtotal		8838	
	Overhead, tax, and shipping (20%)		1767.6	
	Grand Total		**10605.6**	