IPRO 325
Developing Affordable Solutions for the World's Rural Poor

Midterm Report

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Water Purification Subgroup

1.0. Revised Objective

IPRO 325 water subgroup's objective is to develop and implement an extremely affordable method of efficient water filtration and disinfection that can be adapted to the needs of the poor of western Nicaragua. Our primary objective is to produce a prototype of an adaptable water filtration device made only from materials available in western Nicaragua that surpasses existing treatment methods in water quality, rate of filtration, ease of use, durability, and cost. Our secondary objective is to develop an implementation scheme that will overcome the obstacles posed by language, education, and cultural barriers.

The original objective was to develop several versions of our solution that would allow our system to adapt to any area of the world in which a solution is needed. The scope of our IPRO does not allow for such an expansive project. Thus, we will focus on solving the problems faced in western Nicaragua and hope that our findings will be beneficial in other areas facing similar circumstances.

2.0. Results To Date

Brian Schiller and Ryan Witthans met with IPRO director Tom Jacobius to present to him a budget for IPRO 325. This budget was approved for all prototype construction materials, but not for a nephelometer. This piece of testing equipment was later deemed unnecessary by the water subgroup. Dave Curtin met with BCPS chairman John Zasadzinski to discuss further funding our project. He indicated that the BCPS department will be more than willing to share some of the eventual cost of the project.

Jessica Henson did extensive research as to the conditions in western Nicaragua. She provided information regarding the locally available materials, locally grown vegetation, and local water sources. Ashley Ono researched previous projects that have dealt with similar problems, including Klaraqua. Dave Curtin researched water-borne pathogens that cause disease and determined that rapid filtration alone is unlikely to reduce microbial counts to even near safe levels.

Ryan Witthans, Brian Schiller, Dave Curtin, and Ashley Ono acquired prototype construction materials for our filtration system, which included lava rocks, six 2.5 and three 5 gallon buckets, cloth scraps, hay, gravel, numerous plastic soda bottles, and sand. Dave Curtin produced fire ash and activated charcoal to be used as filter media as well. Two separate methods to make carbon filter media were attempted. The first method entailed heating wood in a covered pot for several hours and then uncovering the pot. The second involved simply burning wood as one would a campfire and scavenging the ashes after it had extinguished itself. Pictures were taken of each successive step. Here are a few of them:

The lava rocks and charcoal were both pulverized and sifted into a powder form to be used as filtration media.

Three of the 2.5 gallon plastic buckets were used by Brian Schiller, Ryan Witthans and Ashley Ono to construct a prototype of the "three-bucket" pre-treatment system. Holes were made in two of the buckets. One bucket serves as a water collection reservoir post-treatment, one bucket serves as a container for the filter medium through which the water flows, and the third bucket serves as a holding reservoir for the water pre-treatment. This is depicted below:

Using this apparatus, several of the filtration media which were acquired have been tested. Brian Schiller, Ryan Witthans, and Dave Curtin brought this device to the 31st Street beach and used it to filter lake water. Thus far, the filter media that have been tested include sand, crushed lava rock, and 1:2 ratio active carbon powder to sand mixture. The 1:2 carbon sand mixture appeared to be extremely successful. A clear and astounding reduction of turbidity took place.

Samples were collected of the filtered water, which have not yet been tested using a UV-Vis spectrophotometer. Also, mixtures of 1:2, 1:8, and 1:16 fire ash to sand and 1:8 and 1:16 active carbon to sand were made in the lab, but not tested at the lake due to unforeseen wind conditions which made it impossible to keep equipment from blowing away.

3.0. Revised Event/Task Schedule

(See attached PDF)

4.0. Task Assignments and Designation of Roles and Team Organization

Team Members

Name	Major	Skills	Interests
Curtin, Dave	Chemistry	Microsoft Office, Biology Lab, Chemistry Lab, Spanish Language	Improving quality of life through science and engineering. Eliminating the pandemic of diarrheal disease through simple water treatment.
Henson, Jessica	Architecture	Microsoft Office, AutoCAD, 3D Max, Photoshop, Illustrator, SAP2000, MathCad, Spanish Language	Improving the quality of life for all human beings, Water Systems (natural and man-made), and helping in developing countries without infringing on their culture.
Ono, Ashley	Architecture	Microsoft Office, AutoCAD, 3D Max, Photoshop, Illustrator,	Improving the quality of life for those who live in developing countries to the best of my capabilities.
Schiller, Brian	Chemistry	Microsoft Office, Spectrometry, Lab Techniques	Helping improve the quality of life in developing countries through.
Witthans, Ryan	Chemistry	Microsoft Office, Spectrometry, Lab Techniques	Improving the heath and welfare of humans, especially in developing countries.

Team Responsibilities:

1. Obtain necessary resources.
2. Set efficiency standards for filtration/sedimentation through extensive research
3. Design and Build a Working Prototype
4. Test Prototype
5. Design Field Manual for Implementation of the Overall Water Treatment System

Individual Member Responsibilities:

Name	Role	Task Group	Tasks

Curtin, Dave	Chemist	Design Testing	Research Microbes, Set efficiency standard for prototype, Design and Testing of Prototype, Secure Funding for Project
Henson, Jessica	Team Leader Engineering Binder	Location Educational Materials	Manage administrative tasks, In-depth location research, Act as Liaison to other subgroup leaders, research similar projects
Ono, Ashley	Subgroup Secretary Building Leader	Design Location Educational Materials	Lead prototype construction, Take Minutes, Aid in Location Research, Manage Schedule In MS Project, research similar projects
Schiller, Brian	Chemist	Design Testing Educational Materials	Code of Ethics, Secure Funding for Project Research Existing Methods and SODIS, Design and Testing, Education Materials
Witthans, Ryan	Chemist	Design Testing	Research Turbidity, Manage Schedule in MS Project, Secure Funding for Project Midterm Presenter

5.0. Barriers and Obstacles

One of the biggest obstacles our team encountered while trying to complete the planned tasks for the project was in obtaining the use of proper laboratory equipment, specifically the nephelometer needed to test the turbidity of our test solutions of water. Measuring the turbidity of the test solutions is critical to correlating our data with the documented SODIS requirements for water purification through solar disinfection.

We attempted to resolve this obstacle by gaining access to a nephelometer from another source. We spoke with BCPS chairman John Zasadzinski to ask if anyone else in the department or university might have a nephelometer. When that search turned up empty, we expanded our search to other universities in the area. We spoke with JoBeth D'Agnostino and David Crumrine, the chairpersons of the life sciences and chemistry departments at Loyola University, but neither was able to obtain a nephelometer. We then sent out requests to Northwestern University and the University of Chicago, but have gotten no response.

Discovering that the barrier to obtaining a nephelometer was much greater than we anticipated and, having exhausted all external solutions, we turned inwards. The SODIS group published all of their water clarity requirements in terms of Nephelometric Turbidity Units (NTUs), which are measured using a nephelometer. Because the SODIS data is critical to our research, we assumed that we would have to conduct our research using the same method, but this was not necessarily true. Turbidity is measured by shining a light on a solution and measuring how much of that light is reflected in another direction (usually 90 degrees from the source of the light). This reflectance is caused by the light bouncing off of particles that are suspended in the solution. Therefore the amount of light reflected off the solution is directly proportional to the amount of particles suspended in the solution.

Although turbidity is the most commonly used factor in determining water clarity, it is not necessarily the most appropriate for this case. The key factor in the case of solar water disinfection is the penetration of ultraviolet light from the sun. The distance and strength of this penetration can be measured more accurately by using a spectrophotometer which, like a nephelometer, shines a light on a solution, but instead of measuring the amount of light reflected by the solution at 90 degrees, the spectrophotometer measures the percentage of the source light that passes through the solution entirely. Since we are primarily concerned about how much light can penetrate through the solution, use of the spectrophotometer would actually serve our purposes better, plus, we already have access to one.

Although this was a significant victory for our team, it was by no means the end of our struggles. We are still left with the obstacle of correlating the spectrophotometer data we record, with the data already collected by SODIS. We are currently investigating a couple possibilities in order to overcome this obstacle. First we will research any attempts to correlate turbidity with transmittance. If that doesn't work, we will then seek to obtain or create stock solutions of a specific turbidity and measure the transmittance using our spectrophotometer. By comparing these measurements, we should be able to create an appropriate conversion between our data and the SODIS data.

Later in the semester we will be forced to overcome two additional significant obstacles. First, we must deal with the lack of a channel of communication between the researchers (our group here in Chicago) and the people we are trying to help (the rural villagers of Nicaragua). Our attempts to overcome this obstacle in the short-term have been limited to the occasional e-mail correspondence with aid workers who have-been, or currently are working in Nicaragua, our long-term solution to this obstacle is to have three volunteers from our group travel to western Nicaragua this winter to measure the effectiveness of our solution and collect feedback from the people we are trying to help.

The second significant obstacle for us to overcome is the language barrier. Our group has decided to approach this barrier not only as it applies to the people of rural Nicaragua (many of whom are literate Spanish speakers), but as it would apply to the poor, illiterate people across the world. To overcome this obstacle, our group is developing an entirely picture-based instruction manual that will inform the villagers how to prepare, build, maintain, and replicate our solution. Because our solution can be built from entirely local materials it will be possible for an individual to, just by sharing the manual, spread our solution to neighboring villages far more efficiently than we ever could.

Energy Subgroup

1.0 Revised Objective

IPRO 325 energy subgroup's objective is to develop and to provide a low-cost solution addressing the problem of cooking stove efficiency for the world's rural poor. We seek to do this; firstly, by familiarizing ourselves with the common means of cooking and current stoves options in certain impoverished regions of the world, identifying the technical and economical deficits associated with, and selecting designs that we think have the greatest potential for enhancement. Second, we will be studying current designs of one or two chosen (commercially available) stoves, conducting tests to gain a better understanding of their working process, and reverse engineering them to implement our designs. And, finally, we will be delivering a prototype of an improved stove that can be easily fabricated by our target population with a fairly low cost. Through this research, we hope to learn from similar projects done in the past, and at the meantime find other schools and organizations that are currently endeavoring in relevant projects for possible partnerships.

Since the Project Plan Report, specific sites for prospective system implementation have been identified. These regions included the rural villages of Nicaragua and western China. The stoves of interests are hence influenced by the choice of locations since the demand and capacity of cooking differs geographically. The appropriate testing of select stoves will be conducted simulating these variants in achieving the best understanding of how they operate. As for the delivering designs and their prototypes, they will be based on the availability of locally affordable materials.

2.0. Results to Date

The Energy (Cooking) team has thus far completed the research phase of our project and has moved into the development phase.

In the research phase, we identified many factors affecting our project. Among these factors are the extent of the problem, current usage and implementation of energy efficient cooking methods, testing parameters, testing procedures and factors for selecting options for field testing locations.

Upon selecting Nicaragua and China as the locations of interest, we investigated the resources and cooking methods of those areas. We have ascertained which fuels and stoves were most promising, while accounting for socioeconomic constraints. We have also attained two benchmarks to use as a comparison in our tests. The first is a *Sun Ovens International* solar oven, which is currently being sold in rural poor areas around the world. While the product does address the need for solar cookers, it comes with a price tag of $160 wholesale, which is well above our team's monetary goal of $5. The second benchmark purchased is a commercially built and sold *Rocket* stove. This product is currently being sold as camping equipment for a price tag of $25; again, above our goal. After purchasing and receiving both benchmark products, the team identified the advantages and disadvantages of each in order to determine what areas of improvement are needed.

In the development phase, we have begun to design our prototypes and collect materials relevant to our locations in Nicaragua and China. We will soon begin to build and test our two stoves. One of which, will burn biomass, and the other will use solar energy as fuel. The collected data from these tests will include time for water to boil, and peak temperature achieved. The biomass tests will also measure the amount of fuel consumed as well as emissions released. The solar tests will also measure the solar intensity and sun angle.

The results of these tests will determine the viability of our prototypes. Optimally, our prototypes will perform as well as the commercially available models, yet only cost a fraction of the price. This would create a flexible approach to cooking where free fuel (solar) could be used when available, and an efficient stove could be used otherwise.

Achieving these results would reduce the amount of time that the poor must spend gathering fuel, diminish health risks, abate deforestation, and create more opportunities to rise above the cycle of poverty.

3.0. Revised Task / Event Schedule

[See Attached PDF]

4.0. Task Assignments and Designation of Roles and Team Organization

Team Members

Name	Major	Skills	Interests
Aubry, Curtis	Architectural	HVAC Analysis, AutoCAD, Photoshop, MS Office	Alternative materials for construction and sustainable energy
Dogbe, Ernest	Electrical		Affordable renewable energy for use in developing countries.
McClain, Jaime	Architecture	Microsoft Office, AutoCAD, 3D Max, Photoshop, Illustrator	Creating affordable solutions for use in developing courtiers. Micro-enterprising and micro-loans.
Przybysz, Nicholas	Mechanical	Microsoft Office, AutoCAD, Pro Engineer, Matlab, some programming.	Creating the most efficient energy for the least amount of fuel
Seagren, Ian	Electrical	MATLAB, RET screen, MS Office, Pspice, Java, Assembly	Power electronics, sustainable energy & development, communications & economy
Shi, Heling	Mechanical	SolidWorks, Microsoft Office, Photoshop, iWork, iLife, basic	Mechanical and thermal design of energy infrastructures and/or appliances

Team Responsibilities:

1. Identify cooking problems in rural impoverished areas of the world
2. Conduct extensive research into existing solutions, programs, and outreach
3. Identify target area and local populace
4. Develop a prototype that addresses a specific issue
5. Propose future IPROs

Individual Member Responsibilities:

Name	Role	Task Group	Tasks
Aubry, Curtis	iGroup Organizer Engineering Notebook	Conventional Oven	Testing Procedures, Midterm Presenter Prototype building, Design of Metal Rocket Stove
Dogbe, Ernest	Ethics Organizer	Solar Oven Code of Ethics Location	Research Current Ovens Testing, Materials Collecting, Box Solar Oven design Code of Ethics
McClain, Jaime	Team Leader Subgroup Leader	Conventional Oven Location Interest Group	Contact w/ P.Land, Alternative Rocket Design Oven Research, Midterm Presenter Materials collection,
Przybysz, Nicholas	Team Member	Conventional Oven Project Management	Testing Facilities; contact w/ Mast Location Specific Research, Terracotta Prototype building and design
Seagren, Ian	Meeting Minute taker Subgroup Co-Leader	Solar Oven	Testing Procedures, prototype building Parabolic Design and build
Shi, Heling	Engineering Notebook Organizer	Solar Oven Location Interest Group	Location research, prototype building Parabolic Design and build, contact w/ CSA Notebook meetings with Advisor

5.0. Barriers and Obstacles

A. Describe any obstacles encountered while completing the planned tasks for the project.
   a. Long lead times for commercial benchmarks
   b. Testing Equipment
      i. Expensive
      ii. Difficult to Acquire
   c. Gas Emissions Testing Procedure
   d. $5 Constraint
   e. Expensive Implementation Costs

B. Explain how the team or subteam resolved these obstacles.
   a. Long Lead Times
      i. Wait for product to arrive
   b. Testing Equipment
      i. Obtain equipment from the University

        ii. Propose to IPRO office for money to cover costs
    c. Gas Emissions Testing Procedure
    d. $5 Constraint
        i. Adapt designs to be built of local materials
    e. Expensive Implementation Costs
        i. Found sponsor to match funds raised.

C. Identify any remaining barriers or obstacles that need to be addressed before the team can successfully complete the planned work.
    a. Poor Solar Conditions for Testing
    b. Inability to test conventional stove indoors
    c. Expensive Implementation Cost

D. Discuss how the team intends to deal with the identified barriers and obstacles.
    a. Poor Solar Conditions for Testing
        i. Schedule multiple days for available testing times
    b. Inability to test conventional stove indoors
        i. Test stoves outdoors
    c. Expensive Implementation Cost
        i. Develop plan to fundraise money to have funds matched

Evaporative Cooling Subgroup

1.0 Revised Objective

Our objective is to develop and implement a more effective and efficient way for the world's poor to store food. Our primary objective is to create a working prototype of an evaporative cooling refrigeration system that can successfully store food for a longer period of time than our benchmarks (no refrigeration system at all and a standard cooler). Through our testing, we plan to establish guidelines and standards of maximum performance and efficiency. The prototypes will be made entirely out of materials local to our site. Our secondary objective is to design a manual explaining the benefits of our system as well as how to use and assemble it. This manual must be understandable to people of any language or level of literacy.

2.0 Results to Date

To date our group has focused on the development of our prototype. This has begun with the construction of the outer layer, made of adobe bricks, and the inner layer made of clay pots.

Adobe:

- John Sullivan-Fedock, Amber Heinz, and Phil Korol developed the design of the prototype, made material decisions, and calculated the amounts of materials needed.
- Amber Heinz and Phil Korol built the formwork for the adobe bricks. 2x6 studs were cut to make 6 – 4x8x16 forms.
- John and Bryan Murillo obtained the materials necessary for adobe bricks (1 part clay, 4 parts sand, ½ part straw, and water as necessary) from various locations.
- John, Bryan, Shreyas Dole, and Eliza Bober dug a hole in Bryan's back yard. In this hole they mixed the materials necessary for adobe bricks at the ratios and amounts recommended by Professor Peter Land of the architecture program at IIT.
- Bryan, Amber, Phil, John, Eliza, and Dole tested the mixture to make sure it was correct for brick-making. This was done by rolling a small amount of the mixture into a tube and holding it horizontally until it broke in half. The mixture broke within the required 5-10cm range and was thus correct for brick-making.
- Dole, Eliza, Amber, John, Bryan, and Phil used the 6 forms and created a total of 71 full sized bricks and two "Chicago bricks" (to prove that the dimensions are too small for adobe). The bricks were laid out on plywood, tables, and on the ground in Bryan's back yard. Clear tarps were purchased to protect the bricks from the rain while continuing to allow sunlight to dry the bricks. Bryan's parents have been more than kind in volunteering to protect the bricks from the elements. The bricks take approximately 3-4 weeks to dry to the proper construction needs, and are currently nearing the end of this drying period.

Clay Pots:

- Professor Steve Stanard of the psychology department has been kind enough to allow us to use his private home studio and low-fire kiln for the making of our clay pots. Upon his recommendations Amber, John, Phil, Dole, and Bryan designed the forms and sizes of the clay pots and calculated the amount of clay necessary.
- Amber purchased the clay for the pots.
- John, Dole, Bryan, Amber, and Phil began the pots by rolling and smoothing out the slabs needed for each side and the base of each pot. Each slab has to dry for 2-3 days until the clay is "leathery."

- John, Dole, Bryan, Amber, and Phil cut the slabs to size and then assembled these slabs into their respective pots. Once assembled, these pots once again had to wait 2-3 days before they are ready for the kiln.

3.0 Revised Task/Event Schedule

Week	Tasks	Hours	Members
1. Sept. 18-24	Prototype Research	4hrs each	Amber, Phil, John
	Background Research	4hrs each	Dole, Eliza, Bryan
	Project Plan	4hrs each	Eliza, Phil, Bryan, John, Dole, Amber
		48hrs Total	
2. Sept. 25- Oct. 1	Plan Adobe Making	4hrs each	Bryan, John, Dole
	Mold Making	3hrs each	Amber, Phil
	Get Materials	2hrs each	Bryan & John
	Make Bricks	6hrs each	Eliza, Bryan, Phil, Dole, John
		55hrs Total	
3. Oct. 2-8	Make Pots	4hrs each	Amber & Eliza
	Work on Midterm Presentation/ Report	5hrs each	Bryan, Phil, Dole, John
	Check Adobe Bricks	2hrs	Bryan
		30hrs Total	
4. Oct. 9-15	Start Researching/ Designing Manual	2hrs each	John, Dole, Eliza
(Midterm Due)	Finish Designing Prototype 2	2hrs each	Amber, Phil, John
	Practice Presentation	2hrs each	Amber, Bryan, Phil, John, Dole
	Check Bricks	2hrs	Bryan
	Start Testing Prototype 1	3hrs each	Amber, Dole, John, Bryan, Phil
	Code of Ethics	3hrs each	Bryan, Amber, Phil
		48hrs Total	
5. Oct. 16-22	Continue Testing Prototype 1	4hrs each	Amber, John, Dole, Bryan, Phil
	Start Constructing Prototype 2	2hrs each	Amber, John, Dole, Bryan, Phil
	Continue Manual	2hrs each	Dole & John
		34hrs Total	
6. Oct. 23-29	Build Prototype 2	6hrs each	Eliza, John, Dole, Bryan, Phil, Amber
	Continue Manual	2hrs each	Dole & John
	Testing	2hrs each	Amber, John, Dole, Bryan, Phil
		50hrs Total	
7. Oct. 30-Nov. 4	Test Prototype 2	4hrs each	Eliza, John, Dole, Bryan, Phil, Amber
	Continue Manual	2hrs each	Dole & John

	Start Presentation/ Data Analysis	2hrs each	John, Dole, Bryan, Phil, Eliza, Amber
		40hrs Total	
8. Nov. 5-11	Continue Presentation/ Data Analysis	2hrs each	Phil, Bryan, Dole, John, Amber, Eliza
	Continue Testing Prototype 2	4hrs each	Amber, Eliza, John, Bryan, Dole, Phil
	Work on Manual	2hrs each	Dole & John
		40hrs Total	
9. Nov. 12-18	Meeting Minutes	2hrs	Amber
	Continue Testing	2hrs each	Amber, Eliza, John, Dole, Bryan, Phil
	Finish Manual	1hr each	John, Dole, Bryan, Phil, Amber, Eliza
	Continue Presentation/ Analysis	3hrs each	Dole, Phil, Bryan, Amber, Eliza, John
		38hrs Total	
10. Nov. 19-25	Testing Wrap-up	4hrs	Eliza
(Thanksgiving)		**4hrs Total**	
11. Nov. 26-Dec. 2	Finish Everything	6hrs each	Amber, Dole, John, Eliza, Bryan, Phil
(IPRO Day Nov. 30)		**36hrs Total**	
	TOTAL PROJECT HOURS:	**423 hours**	

4.0 Task Assignments and Designation of Roles and Team Organization

Team Interest/ Skill Summary

Name	**Major**	**Skills**	**Interests**
Eliza Bober	Architecture	Familiar w/ PC and Mac AutoCAD Accurender Photoshop Illustrator	Sustainable Architecture Learning about efficiency in water and energy usage
Shreyas Dole	Mechanical Engineering	Familiar w/ PC and Mac Microsoft Office Group Work Problem Solving AutoCAD	Discussing / Problem Solving Mathematics Power Systems Circuit Design/Analysis
Amber Heinz	Architecture	AutoCAD Hand Drafting Sketching Model Making Presentation Boards Rendering	Sustainable Architecture Discussing / Problem Solving
Phil Korol	Architecture	AutoCAD 3D Studio Max	Sustainable Architecture Design/Build

		Photoshop Illustrator Rhino Dreamweaver Microsoft Office Sketch-Up Model Making	Philosophy Physics
Bryan Murillo	Electrical Engineering	PSPICE JMP JAVA Photoshop Microsoft Office Secretarial Work Group Work Problem Solving	Mathematics Power Systems Circuit Design/Analysis Philosophies of Science
John Sullivan	Architecture	Various CAD software with emphasis on 3D Design Ecotect Microsoft office	Sustainability Passive Climate control and thermal comfort zones

*See Project Milestones table for individual team member tasks.

Group Roles	**Team Members**
Subgroup Leaders	Amber Heinz & John Sullivan
Minute Taker	Eliza Bober & Amber Heinz
Agenda Maker	Amber Heinz & John Sullivan
Time Keeper	Phil Korol
Weekly Timesheet Collector/ Summarizer	Shreyas Dole
Master Schedule Maker	Bryan Murillo
IGROUPS	Eliza Bober

5.0 Barriers and Obstacles

Certain factors have affected the amount of time that aspects of our project have taken. The adobe bricks needed to be a specific size, which altered the design of our prototype. Because the bricks are significantly larger than we initially expected the design now includes an outer wall that is made of adobe and an inner layer that is made of clay pots. This created an opportunity for more specific testing by using a series of clay pots of varying sizes and shapes. This as a result, made the pottery making process much more time consuming. Instead of creating two distinct prototypes, we are now using the series of pots and the adobe outer wall in order to allow many variations for testing within the parameters of a single prototype.

Once we learned more about how terracotta is constructed we quickly realized that this process has taken more time from our original schedule than we had allotted time for. Therefore, our testing time table has been delayed and the amount of data we can accumulate before the semester is over has been limited from what we had originally planned.

We are currently unsure whether we will have remaining time to make and test the "how to" manual as we had scheduled the development of the manual to coincide with the testing period and are now devoting more resources for testing.

A major issue we are currently dealing with involves the transport of our prototype. With each adobe brick weighing around 35 pounds, our prototype will end up weighing around 2,000 pounds. We had initially planned to build the prototype at Bryan's house and test it in a small shed he has in the backyard. The issue would be getting the prototype onto and off of a truck for transportation over to campus for IPRO day. We are currently looking for a small lab space on campus. In the case that we cannot find a *small* lab space, we are currently designing a small enclosure (most likely a simple frame covered in plastic tarp) in which we can conduct our experiments.

6.0 Code of Ethics

Overarching Principle: "Provide solutions to improve the quality of life of the World's Poor."

1) Law

Canon: Shall obey all laws, foreign and domestic, when researching, designing, and implementing the project.

Pressure: Time constraints in completing work and researching foreign laws.
Pressure: Speed up implementation to meet deadlines.
Risk: Failure to understand details of local laws and they are broken due to ignorance.

Pressure: Laws in the poor countries we serve might conflict with the laws in the US.
Risk: Disregard the foreign laws due to feeling superior as Americans.

2) Contracts

Canon: Shall abide by the contracts created, formal and informal, and if necessary take the proper procedure when a mistake is made.

Pressure: Complete the project on time.
Risk: We rush work and cut corners to meet deadlines stated in the contract which could result in poor implementation of the project.

Pressure: We want our design to be implemented.
Pressure: To establish a relationship with an important member of the village.
Risk: Give inappropriate gifts through bribes which can jeopardize our contract.
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3) Professional Codes

Canon: Shall follow the guidelines and codes of conduct set forth by the National Society of Professional Engineers. (The NSPE code of ethics may be found at: http://www.nspe.org/ethics/eh1-code.asp).

Pressure: Attract more sponsors to fund our project.
Risk: Reporting adjusted data about the efficacy of our solutions in order to secure funding.

Pressure: We need information that is crucial to our project from a local source/ government.
Risk: Issuing bribes to obtain information.

4) Business and Industry Environment

Canon: Shall acknowledge the work of other individuals and teams and seek to build upon previous work in our field to create a novel solution and/or product.

Pressure: Improve the quality of our designs to serve the needs of the people better
Risk: Make our solutions expensive and less sustainable.

Pressure: Put the project in motion as quickly as possible.
Risk: Introducing our products without adequate testing.

Pressure: Complete the project successfully.
Risk: Out of not wanting to admit failure, we mislead others about the results of our testing.

5) Community
Canon: Shall hold paramount the health and welfare of the community while striving to obtain a sustainable solution.

Pressure: Upon seeing the conditions of extreme poverty in which these communities live, we will be pressured to implement a solution to help them as quickly as possible.
Pressure: When living in a community setting that is so different from the one with which we are comfortable with, we will be pressured to finish our work quickly so that we can return home to more comfortable conditions.
Risk: In trying to help the community as quickly as possible, we will sacrifice the sustainability of the project.

6) Personal Relations
Canon: Shall work honestly with all individuals to create a unified and sustainable solution.

Pressure: By establishing a relationship with our target village through contacts we will be subject to their personal bias as it may exist among groups or individuals within the village.
Risk: Our goal to help the entire community may be subverted by the prejudices of the individuals with whom we work.

Pressure: We may have to work in the presence of people who our hostile to our presence in their village.
Risk: We create a condition of inequality in the village because of our relationship with some of the villagers.

7) Moral and Spiritual Values
Canon: Shall not participate in actions that violate the moral and spiritual values of its members and the people we work with.

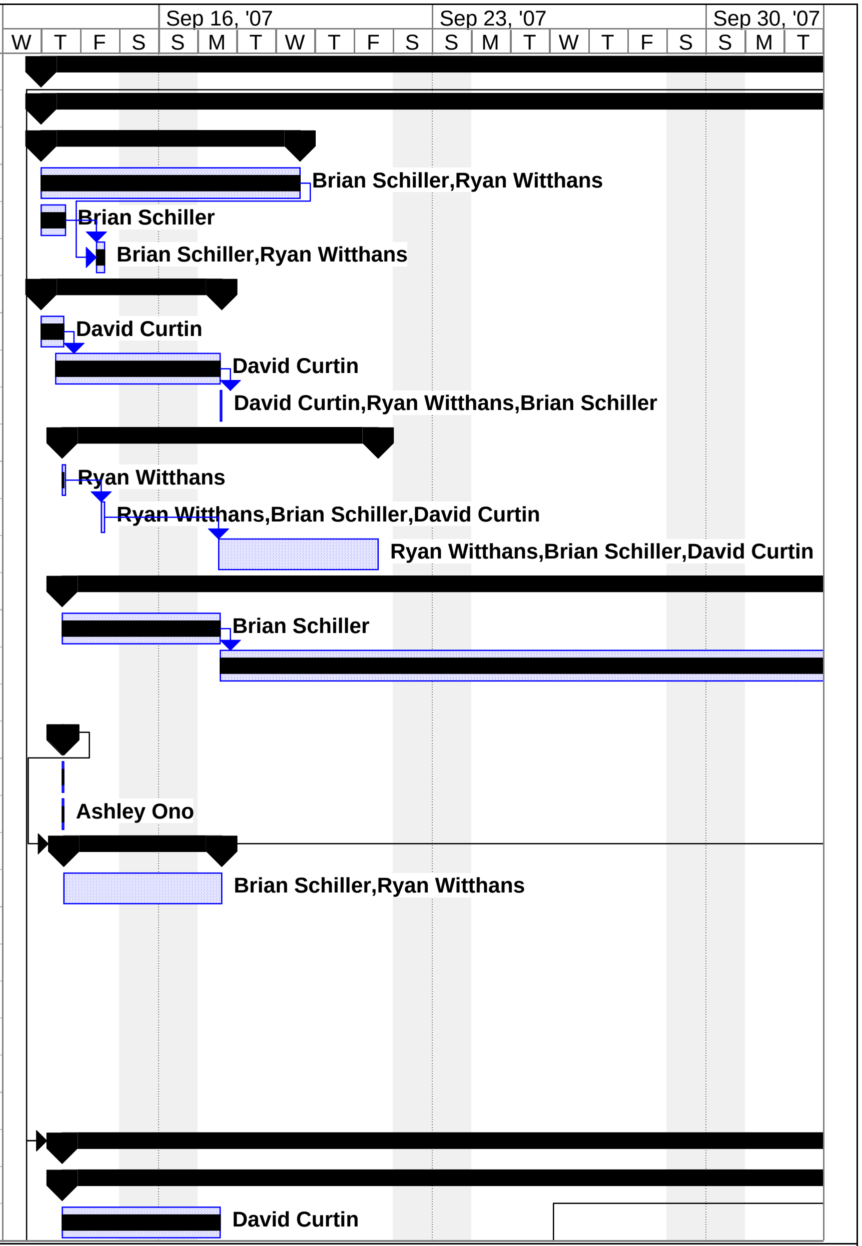
Pressure: To help people at all costs.
Risk: Settling for a lower standard to enable quick implementation.
Risk: Going against one's own values as a result of one's desire to help others.

Pressure: To meet on certain days to work on the project in order to meet deadlines.
Risk: Impinge upon the spiritual values of the village or a team member.

7.0 Slide Presentation

[See attached PDF]

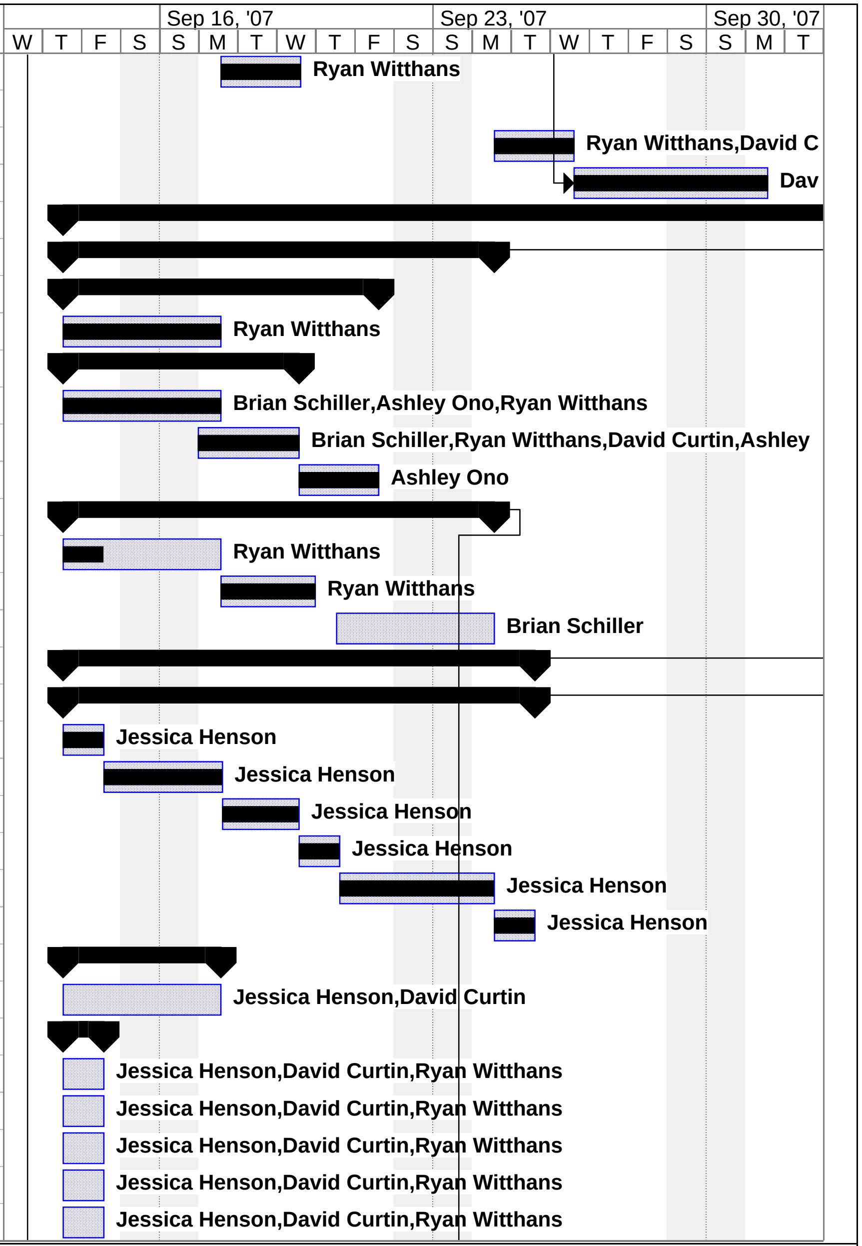
ID	ℹ	Task Name	Duration	Start	Finish
1		**Aquire resources**	**7.13 days**	**Thu 9/13/07**	**Tue 10/23/07**
2		**Raise funding**	**4.63 days**	**Thu 9/13/07**	**Tue 10/9/07**
3	✓	**IPRO funding**	**1.25 days**	**Thu 9/13/07**	**Wed 9/19/07**
4	✓	Prepare presentation	10 hrs	Thu 9/13/07	Wed 9/19/07
5	✓	Arrange meeting with Dr. Jacc	2 hrs	Thu 9/13/07	Thu 9/13/07
6	✓	Meet with Dr. Jacobius	2 hrs	Fri 9/14/07	Fri 9/14/07
7		**BCPS money**	**0.75 days**	**Thu 9/13/07**	**Mon 9/17/07**
8	✓	Meet with Dr. Zasadzinski	1 hr	Thu 9/13/07	Thu 9/13/07
9	✓	Prepare project summary	5 hrs	Thu 9/13/07	Mon 9/17/07
10		Follow-up meeting with Dr. Za	1 hr	Mon 9/17/07	Mon 9/17/07
11		**Alumni BCPS newsletter funding**	**1.75 days**	**Thu 9/13/07**	**Fri 9/21/07**
12		Arrange meeting with editor	2 hrs	Thu 9/13/07	Thu 9/13/07
13		Meet with editor	2 hrs	Fri 9/14/07	Fri 9/14/07
14		Answer follow-up questions fr	10 hrs	Mon 9/17/07	Fri 9/21/07
15		**McNight fellowship**	**4.63 days**	**Thu 9/13/07**	**Tue 10/9/07**
16	✓	Research grant proposal requ	5 hrs	Thu 9/13/07	Mon 9/17/07
17	✓	Prepare grant proposal	30 hrs	Mon 9/17/07	Mon 10/8/07
18		Contact grant review board	2 hrs	Mon 10/8/07	Tue 10/9/07
19	✓	**Arrange space**	**0.13 days**	**Thu 9/13/07**	**Thu 9/13/07**
20	✓	Request lab space	1 hr	Thu 9/13/07	Thu 9/13/07
21	✓	Request shop space	1 hr	Thu 9/13/07	Thu 9/13/07
22		**Acquire equipment**	**0.63 days**	**Thu 9/13/07**	**Mon 9/17/07**
23		Turbidometer	5 hrs	Thu 9/13/07	Mon 9/17/07
24	✓	**Aquire materials**	**2.5 days**	**Tue 10/9/07**	**Tue 10/23/07**
25	✓	**Containers**	**1.25 days**	**Tue 10/9/07**	**Tue 10/16/07**
26	✓	Bottles	10 hrs	Tue 10/9/07	Tue 10/16/07
27	✓	2.5- and 5-gallon buckets	3 hrs	Tue 10/9/07	Wed 10/10/07
28	✓	Steel drum(s)	5 hrs	Tue 10/9/07	Thu 10/11/07
29	✓	Filter media	20 hrs	Tue 10/9/07	Tue 10/23/07
30		**Set SSF effectiveness standards**	**9.38 days**	**Thu 9/13/07**	**Mon 11/5/07**
31		**Literature search**	**9.38 days**	**Thu 9/13/07**	**Mon 11/5/07**
32	✓	Research microbes	5 hrs	Thu 9/13/07	Mon 9/17/07



Project: water-timeline-2
Date: Thu 10/18/07

Task	▨	Milestone	◆	External Tasks	▨
Split	┈	Summary	▬	External Milestone	◆
Progress	▬	Project Summary	▬	Deadline	⇩

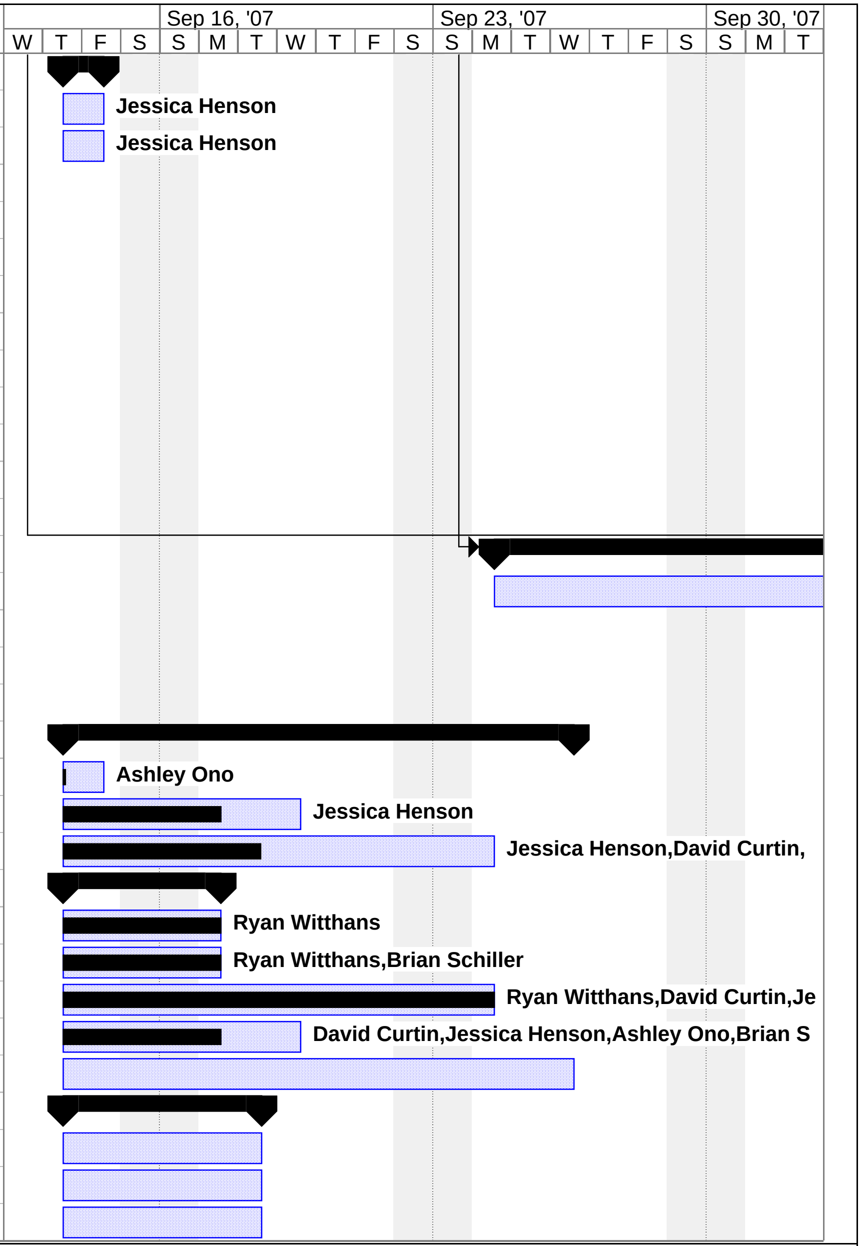
ID	ℹ	Task Name	Duration	Start	Finish
33	✓	Research turbidity units/measurem	5 hrs	Mon 9/17/07	Wed 9/19/07
34	▦	Determine initial turbidity	5 hrs	Thu 11/1/07	Mon 11/5/07
35	✓	Research SODIS requirements	5 hrs	Mon 9/24/07	Wed 9/26/07
36	✓	Write formal standards	5 hrs	Wed 9/26/07	Mon 10/1/07
37		**Research and development**	**18.38 days**	**Thu 9/13/07**	**Tue 12/25/07**
38		**Literature research**	**1.88 days**	**Thu 9/13/07**	**Mon 9/24/07**
39	✓	**Previous designs**	**1.75 days**	**Thu 9/13/07**	**Fri 9/21/07**
40	✓	SODIS system	5 hrs	Thu 9/13/07	Mon 9/17/07
41	✓	**Filtration systems**	**1.13 days**	**Thu 9/13/07**	**Wed 9/19/07**
42	✓	Designs	5 hrs	Thu 9/13/07	Mon 9/17/07
43	✓	Materials	5 hrs	Mon 9/17/07	Wed 9/19/07
44	✓	KlarAqua	5 hrs	Wed 9/19/07	Fri 9/21/07
45		**Introduction strategy**	**1.88 days**	**Thu 9/13/07**	**Mon 9/24/07**
46		KlarAqua	5 hrs	Thu 9/13/07	Mon 9/17/07
47	✓	SODIS system	5 hrs	Mon 9/17/07	Wed 9/19/07
48	▦	Contact International Develop	5 hrs	Thu 9/20/07	Mon 9/24/07
49		**Determine specific location qualities**	**2.25 days**	**Thu 9/13/07**	**Tue 9/25/07**
50		**Materials**	**2.25 days**	**Thu 9/13/07**	**Tue 9/25/07**
51		Containers (bottles, drums)	3 hrs	Thu 9/13/07	Fri 9/14/07
52		Vegetation	3 hrs	Fri 9/14/07	Mon 9/17/07
53		Volcanic rocks	3 hrs	Mon 9/17/07	Wed 9/19/07
54		Soil type	3 hrs	Wed 9/19/07	Thu 9/20/07
55		Textiles	3 hrs	Thu 9/20/07	Mon 9/24/07
56		Other salvagable materials	3 hrs	Mon 9/24/07	Tue 9/25/07
57		**Water quality**	**0.63 days**	**Thu 9/13/07**	**Mon 9/17/07**
58		Turbidity	5 hrs	Thu 9/13/07	Mon 9/17/07
59		**Pathogens**	**0.38 days**	**Thu 9/13/07**	**Fri 9/14/07**
60		Bacteria	3 hrs	Thu 9/13/07	Fri 9/14/07
61		Viruses	3 hrs	Thu 9/13/07	Fri 9/14/07
62		Parasites	3 hrs	Thu 9/13/07	Fri 9/14/07
63		Cysts	3 hrs	Thu 9/13/07	Fri 9/14/07
64		Polution	3 hrs	Thu 9/13/07	Fri 9/14/07



Project: water-timeline-2
Date: Thu 10/18/07

Task	▨	Milestone	◆	External Tasks	▨
Split	┈	Summary	▬	External Milestone	◆
Progress	▬	Project Summary	▬	Deadline	⇩

ID	ℹ	Task Name	Duration	Start	Finish
65		**Weather patterns**	**0.38 days**	**Thu 9/13/07**	**Fri 9/14/07**
66		Research historical weather c	3 hrs	Thu 9/13/07	Fri 9/14/07
67		Calculate overhead/bottle requ	3 hrs	Thu 9/13/07	Fri 9/14/07
68	✓	**Create prototype**	**5 days**	**Tue 10/23/07**	**Tue 11/20/07**
69	✓	Brainstorm preliminary designs	20 hrs	Tue 10/23/07	Tue 11/6/07
70	✓	Sketch designs	10 hrs	Tue 11/6/07	Tue 11/13/07
71	✓	Create CAD drawings	10 hrs	Tue 11/13/07	Tue 11/20/07
72	✓	Select single design (interchangeal	2 hrs	Tue 11/13/07	Wed 11/14/07
73	✓	Construct prototype	40 hrs	Tue 10/23/07	Tue 11/20/07
74		**Run tests**	**5 days**	**Tue 11/20/07**	**Tue 12/18/07**
75		Turbidity tests	40 hrs	Tue 11/20/07	Tue 12/18/07
76		Bacterial count	40 hrs	Tue 11/20/07	Tue 12/18/07
77		Evaluate prototype/filter media	10 hrs	Tue 12/18/07	Tue 12/25/07
78		**Create implementation scheme**	**6.88 days**	**Mon 9/24/07**	**Wed 10/31/07**
79		Author field manual	20 hrs	Mon 9/24/07	Mon 10/8/07
80		Test manual	20 hrs	Mon 10/8/07	Mon 10/22/07
81		Evalutate manual	5 hrs	Mon 10/22/07	Wed 10/24/07
82		Revise manual	10 hrs	Thu 10/25/07	Wed 10/31/07
83		**Produce IPRO deliverables**	**2.5 days?**	**Thu 9/13/07**	**Wed 9/26/07**
84		Meeting Minutes	3 hrs	Thu 9/13/07	Fri 9/14/07
85		Weekly Reports	10 hrs	Thu 9/13/07	Wed 9/19/07
86		Engineering Notebook	15 hrs	Thu 9/13/07	Mon 9/24/07
87	✓	**Project Plan**	**0.63 days**	**Thu 9/13/07**	**Mon 9/17/07**
88	✓	Timeline	5 hrs	Thu 9/13/07	Mon 9/17/07
89	✓	Methodologies	5 hrs	Thu 9/13/07	Mon 9/17/07
90	✓	Midterm report	15 hrs	Thu 9/13/07	Mon 9/24/07
91		Peer reviews	10 hrs	Thu 9/13/07	Wed 9/19/07
92		Website	20 hrs	Thu 9/13/07	Wed 9/26/07
93		**IPRO Day**	**1 day?**	**Thu 9/13/07**	**Tue 9/18/07**
94		Make posters	1 day?	Thu 9/13/07	Tue 9/18/07
95		Write abstract	1 day?	Thu 9/13/07	Tue 9/18/07
96		Create presentation	1 day?	Thu 9/13/07	Tue 9/18/07



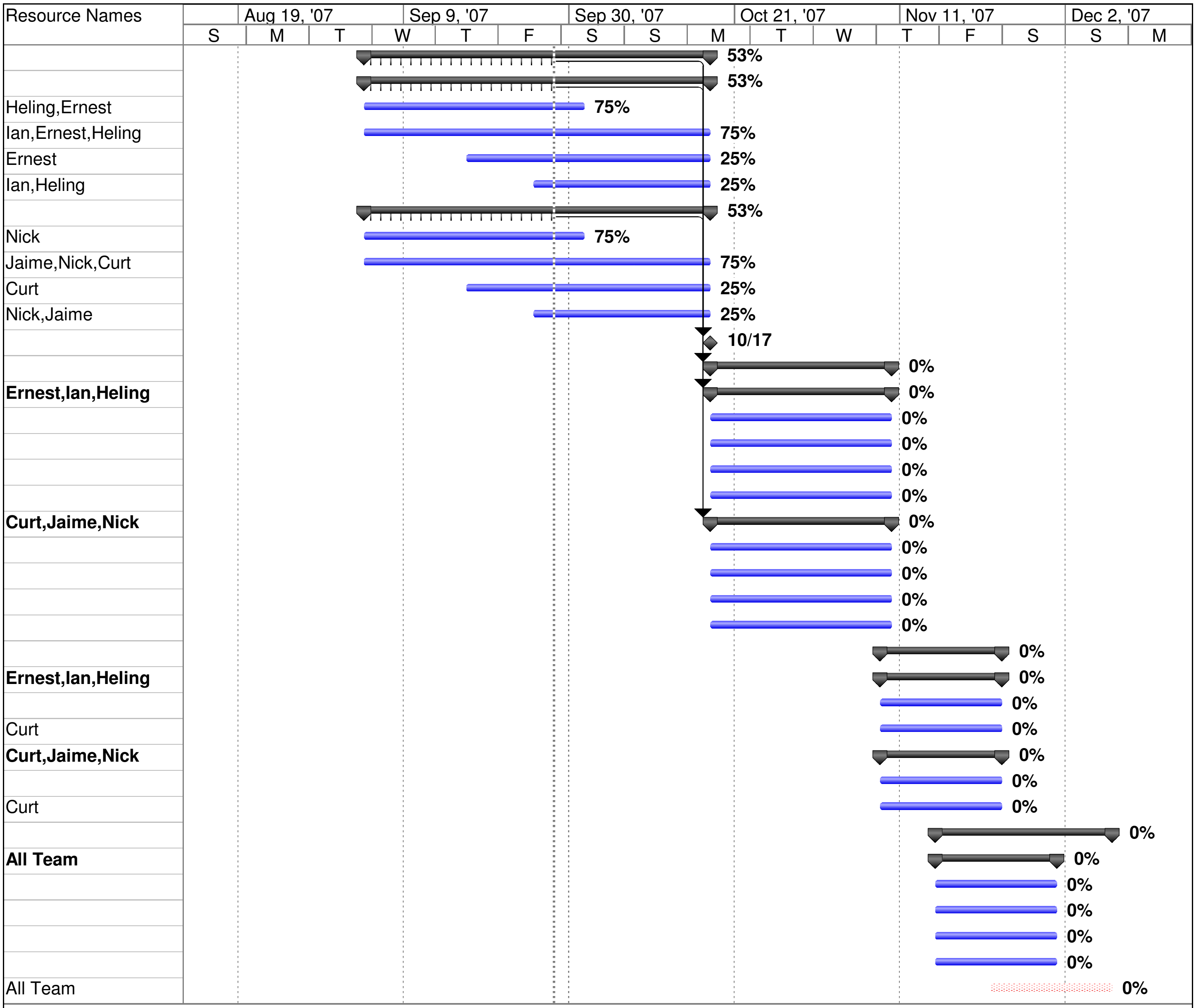
Project: water-timeline-2
Date: Thu 10/18/07

Task	▨	Milestone	◆	External Tasks	▨
Split	┈┈┈	Summary	▬	External Milestone	◆
Progress	▬	Project Summary	▬	Deadline	⇩

ID	ℹ	Task Name	Duration	Start	Finish
1		**Phase 1: Research**	**29 days**	**Tue 9/4/07**	**Wed 10/17/07**
2		**Solar Cooker**	**29 days**	**Tue 9/4/07**	**Wed 10/17/07**
3	▦	Location Information	18 days	Tue 9/4/07	Mon 10/1/07
4	▦	Current Solutions	29 days	Tue 9/4/07	Wed 10/17/07
5	▦	Testing Parameters & Standards	21 days	Mon 9/17/07	Wed 10/17/07
6	▦	Benchmark Selection and Defintion	15 days	Tue 9/25/07	Wed 10/17/07
7		**Conventional Cooker**	**29 days**	**Tue 9/4/07**	**Wed 10/17/07**
8	▦	Location Information	18 days	Tue 9/4/07	Mon 10/1/07
9	▦	Current Solutions	29 days	Tue 9/4/07	Wed 10/17/07
10	▦	Testing Parameters and Standards	21 days	Mon 9/17/07	Wed 10/17/07
11	▦	Benchmark Selection and Defintion	15 days	Tue 9/25/07	Wed 10/17/07
12	▦	Midterm Report	0 days	Wed 10/17/07	Wed 10/17/07
13		**Phase 2: Design & Build**	**15 days**	**Thu 10/18/07**	**Fri 11/9/07**
14		**Solar Cooker**	**15 days**	**Thu 10/18/07**	**Fri 11/9/07**
15	▦	Analysis of Benchmark	15 days	Thu 10/18/07	Fri 11/9/07
16	▦	Analysis of New Prototype	15 days	Thu 10/18/07	Fri 11/9/07
17	▦	Collection of Materials for Design Modifciations	15 days	Thu 10/18/07	Fri 11/9/07
18	▦	Prototype Modification	15 days	Thu 10/18/07	Fri 11/9/07
19		**Conventional Cooker**	**15 days**	**Thu 10/18/07**	**Fri 11/9/07**
20	▦	Analysis of Benchmarks	15 days	Thu 10/18/07	Fri 11/9/07
21	▦	Design of New Prototype	15 days	Thu 10/18/07	Fri 11/9/07
22	▦	Collection of Materials for Build	15 days	Thu 10/18/07	Fri 11/9/07
23	▦	Prototype construction	15 days	Thu 10/18/07	Fri 11/9/07
24		**Phase 3: Testing and Analysis**	**10 days**	**Thu 11/8/07**	**Fri 11/23/07**
25		**Solar Cooker**	**10 days**	**Thu 11/8/07**	**Fri 11/23/07**
26	▦	Obtain testing equipment	10 days	Thu 11/8/07	Fri 11/23/07
27	▦	Testing Procedures	10 days	Thu 11/8/07	Fri 11/23/07
28		**Conventional Cooker**	**10 days**	**Thu 11/8/07**	**Fri 11/23/07**
29	▦	Obtain testing equipment	10 days	Thu 11/8/07	Fri 11/23/07
30	▦	Testing Procedures	10 days	Thu 11/8/07	Fri 11/23/07
31		**Phase 4: Conclusion**	**14.5 days**	**Thu 11/15/07**	**Fri 12/7/07**
32		**IPRO Presentation**	**10 days**	**Thu 11/15/07**	**Fri 11/30/07**
33	▦	Abstract	10 days	Thu 11/15/07	Fri 11/30/07
34	▦	Poster	10 days	Thu 11/15/07	Fri 11/30/07
35	▦	Presentation Practice	10 days	Thu 11/15/07	Fri 11/30/07
36	▦	Question and Answer Practice	10 days	Thu 11/15/07	Fri 11/30/07
37	▦	Final Written Report	10 days	Thu 11/22/07	Fri 12/7/07

Project: EnergyProjectPlan
Date: Fri 9/28/07

Critical	▨	Baseline Milestone	◇
Critical Split	┆	Milestone	◆
Critical Progress	━	Summary Progress	┆
Task	━	Summary	━
Split	┆	Project Summary	━
Task Progress	━	External Tasks	━
Baseline	━	External Milestone	◆
Baseline Split	┆	Deadline	⇩



Project: EnergyProjectPlan
Date: Fri 9/28/07

Critical	▨	Baseline Milestone	◇
Critical Split	⁞	Milestone	◆
Critical Progress	▬	Summary Progress	⁞
Task	▬	Summary	▬
Split	⁞	Project Summary	▬
Task Progress	▬	External Tasks	▬
Baseline	▬	External Milestone	◆
Baseline Split	⁞	Deadline	⇩

IPRO 325

Developing Affordable Solutions
for the World's Rural Poor

The Problem

3 billion people live on less than $2 a day

Team Overview

- **3 Subgroups**
  - Water
  - Cooking
  - Evaporative-Cooling
- **Location Interest Group**
  - Identified 3 regions for field testing & implementation
    - China, Nicaragua and Peru
  - Identifying potential sponsors
  - Fundraising

Trips planned for January & June 2008 to Nicaragua and Peru

Water Purification

Jessica Henson, Ashley Ono, Brian Schiller,
David Curtin, Ryan Witthans

Problem

- Tainted water kills 5 million each year
- Secondary effects on village
- Need for extremely cheap solution
- Current solutions don’t fit every village

SODIS method

Design & Build

A working prototype

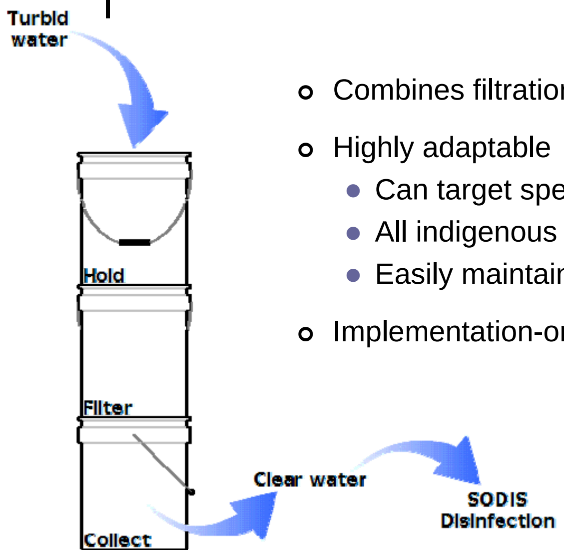
A “how to” manual

Testing

Through various tests we will establish standards of maximum performance and efficiency

- Solar disinfection process
- Some drawbacks

Our Solution



- Combines filtration with SODIS
- Highly adaptable
  - Can target specific pollutants
  - All indigenous materials
  - Easily maintained
- Implementation-oriented approach

Progress

- Determined location resources and needs
- Examined current purification methods
- Developed a prototype
- Completed first round of testing

Future work

- Complete testing
- Create a field implementation manual
- Implement in real world situation

Cooking

Curtis Aubry, Jaime McClain, Nick Przybysz, Ernest Dogbe, Ian Seagren, Heling Shi

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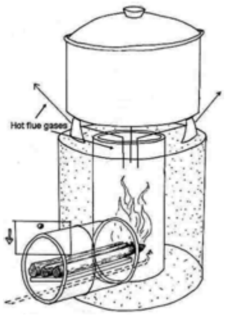
Problem

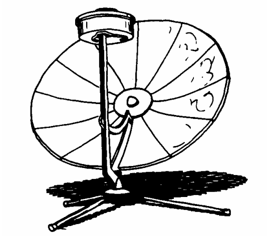
- 1.6 Million premature deaths each year caused by indoor air pollution due to cooking.
- Inefficient cooking methods such as open fire cooking, lead to social, economical and environmental problems.

Solution

- **Design & Build**
  - Conventional Oven
    - Improved Efficiency
    - Simple Construction
  - Solar Oven
    - Umbrella Design
- **Testing**
  - Conventional Oven
    - Time to boil, peak temperature, gas emissions, fuel consumption
  - Solar Oven
    - Time to boil, peak temperature, solar intensity, sun angle



Rocket Stove



Parabolic Solar Oven

Progress

- **Research**
  - Research has been conducted to identify:
    - Extent of problem
    - Types of ovens and current usages
    - Locally available materials
    - Existing projects in field
    - Testing Procedures
- **Design & Build**
  - Design nearing final design phase.
  - Construction beginning.
- **Testing**
  - Parameters have been defined.
  - Benchmark comparisons defined and acquired.
  - Testing procedures are being adapted.

Evaporative-Cooling

Amber Heinz, Bryan Murillo, Eliza Bober, Phil Korol, Shreyas Dole, John Sullivan-Fedock

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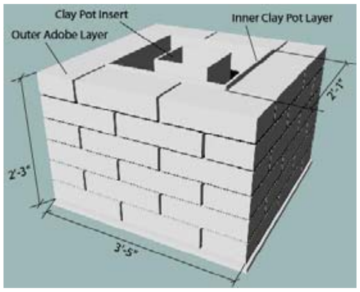
Objective

- **Problem**:
  - Food storage is a major issue preventing the advancement of the world’s rural poor.
- **Solution**:
  - Our subgroup’s objective is to develop and implement a more effective and efficient way for the world’s rural poor to store food.
- **Design & Build**
  - A working prototype
  - A “how to” manual
- **Testing**
  - Through various tests we will establish standards of maximum performance and efficiency



Results to Date

- The outer layer is to be constructed of adobe bricks

The mixing process…

The brick making process…

Results to Date

- The inner layer is to be constructed of clay pots

Each side must be rolled out into a slab and dry until "leathery"

The sides are then assembled…

The pots must sit for 1-2 days before entering the kiln

Professor Steve Stanard made two circular pots for the group

Testing

- **Benchmarks**
  - leaving the fruits and vegetables open to the elements
  - a standard cooler
- **Tests will include:**
  - Varying the sizes and shapes of the inner layer
  - Varying the saturation levels of the sand
  - Testing covering methods and materials