IDEAS Competition
Cover Sheet

Project Name: PURE WATER FOR NICARAGUA

Team Members:

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Project Summary (100- 150 words):

Pure Water will find a feasible and sustainable solution for potable water accessibility in rural areas in Nicaragua. Nicaragua is the second poorest country in Latin America, with over half of the population unemployed and over 80% of the rural population without access to safe water. Our team will work closely with community partners (NGOs, local students and artisans) in all the stages for the creation, development, implementation and monitoring of a household water filter with optimized pathogen removal efficiency and flow rate.
Our solution will innovate in technology, methodology, monitoring and in the interaction model with community collaborators. We will use a real-time feedback and iteration system for our research and product development. Moreover, Pure Water will ensure local availability of knowledge and skill to reproduce the technology transferred. In order to accomplish this goal, we will train local potters from four rural settings (San Francisco Libre, San Juan Oriente, La Paz Centro and Calle Real de Tolapa) to produce home-maid filters to replace broken or malfunctioning devices. These potters will also act as promoters and information sources who provide incentives for appropriate usage of the technology. Finally, we will monitor and assess the results of our project for a period of 6 months.

BACKGROUND

1. Need

Pure Water is composed of three MIT students and it will collaborate with rural communities in Nicaragua, to address the problem of lack of access to pure water. The main communities involved are San Francisco Libre, La Paz Centro, San Juan Oriente and Calle Real de Tolapa, all of which have been hit by recent natural disasters. After Hurricane Mitch hit Central America in 1998, the water situation in Nicaragua was severely effected. The damage to water and wastewater systems was estimated to be over US$560 million, which had a negative impact on 800,000 people served. The lack of appropriate sources for safe and potable water is a problem not only in Nicaragua. The World Health Organization reports 1.2 billion people to be without access to clean drinking water and UNICEF affirms that 2.2 billion children die of diahrroea every year (2002). Children are among the most affected groups, many of whom have cases of stunted growth due to waterborne diseases (WHO 2000).

A wide variety of different technologies may be used to treat contaminated water. These may be applied in the household level, or administered by a municipal center. However, limited resources in developing countries restrain the number of options to those that are economical, sustainable, socially acceptable and that employ local materials. In Nicaragua, especially after the devastation caused by Hurricane Mitch, the re-construction and establishment of a reliable centralized treatment system was not feasible in the short-term. Therefore, household level filter treatment of water is potentially an efficient way of bringing a prompt solution to the immediate needs of the Nicaraguan population. The main benefits are the low cost, availability of raw materials, even in rural and remote areas, increased control of contamination by users and the ease-of-use. Moreover, efforts to improve water supply may be coupled with stimulation to local complementary industries, such as pottery entreprises.

Potters for Peace (PFP) is an independent, non-profit, international network of potters that manufactures water filters and other ceramics. The performance of such filters has not proven to be completely satisfactory. An improved design that enhances the removal of contaminants without increasing the costs would be a substantial contribution to Nicaragua's water problem, and a solution that could be transferred to other developing countries.

Nicaragua is located in the center of Central America with an area of 130,682 km^2 (PAHO, 1999). From the three topographical regions – the Pacific, Atlantic, and

Central-, the majority of the population lives in the Pacific coast. The total population is about 5 million.

Most people in the urban areas have some degree of access to water and sanitation, but rural areas lack these resources. According to PAHO (1999), only 12% of the rural population has access to safe drinking water. Both the World Bank (1999) and UNICEF (2000) report higher numbers (59%), but regardless of which is more accurate, there is room for considerable improvement. Infant mortality under 5 years old is 66 per 1000 live births, which is frequently linked to waterborne disease. Over 60% of the population lives in poverty (PAHO, 1999), and the illiteracy rate is 40% (PAHO,2000).

The reason why Nicaragua was chosen as the location for this IDEAS COMPETITION project was also the existence of a number of contacts who have expressed their desire to collaborate in this project. Ron Rivera, a key player in the foundation of Potters for Peace, has over 20 years of experience on water and sanitation problems in Nicaragua. He will interact with us closely during the whole course of the project. Our contacts in local universities will help us implement our project by seeking the collaboration of local student volunteer programs, such as the "Student Volunteering Groups." Moreover, Nicaragua is one of the poorest countries in this continent, and the need for prompt solutions is urgent. One more factor in favor of choosing Nicaragua is the existence of important data recently collected by several MIT students that will be useful on the successful implementation of the project.

2. Existing Solutions

Potters for Peace has manufactured and distributed ceramic water filters since last year. The small pore size of the ceramic component removes the main contaminating particles. Besides this physical separation, there is need of a disinfectant that inactivates or kills the microorganisms present in polluted water sources, such as *E-coli*. The filter designed by Potters for Peace is coated with colloidal silver, a compound known to be effective and safe in eliminating the bacteria present in the water. This filter consists of a plastic bucket and a ceramic cyllinder open on the top. The ceramic part performs the filtration, and fits perfectly in the plastic component (figure 1). The design is simple and inexpensive, but unfortunately, field tests of the PFP filters currently in use have shown poor performance. Danielle Lantagne, former student at MIT, has completed a consulting investigation in which she determined that despite satisfactory laboratory tests (98-100% removal of organisms), field tests rendered inconclusive results. Out of a total of 33 homes visited, 24 were using the filter. The summary of the results are:

Figure 1. PFP filter

- 4% removed total coliform
- 25% removed H2O-producing bacteria

- 53% removed E.coli when initially present flow rate in 14 out of the 24 homes did not meet basic requirements for drinking water (2L/person/day)

These results show that households that use the filter are still exposed to water born diseases. There is plenty of room for improvement. For example, besides the bacteriological treatment enhancement, the flow rate of the filters may be increased. Currently, flow rate averages about 2 L/hr. WHO recommends a minimum of 2 L/day of drinking water for an adult weighting 60 kg (Water Quality Guidelines 1993-1998). For a household of 7, only the drinking needs would take up the filter all day. The current flow rate of the filter would not be sufficient for cooking or hygene purposes. Further improvements may result in filters that are more resistant, durable, and easier to handle and maintain. More detailed descriptions of our innovation is shown in the next section.

Other initiatives for water treatment besides the Potters for Peace filters have been the Nicaraguan rope pump wells (Figure 2). This technology enables groundwater to be lifted up to 6 meters (Sandiford, 1993). Rope pump wells have been shown to perform better than bucket wells and are easy to use, inexpensive and simple to maintain.The proposed improved water filters may be used as good complements to this technology. In certain areas, in particular the rural sector, problems associated with scarcity of potable water have not found sustainable solutions. The twin diasters of Hurricane Mitch and the coffee industry crash have generated famine and misery for a large percentage of the population. Unemployment, malnutrition and lack of access to basic health care have made the poorest even more prone to illnesses, such as water borne diseases. Therefore, affordability is a main constraint, and this restricts the number of alternatives for water treatment. Most existing solutions have failed to offer reliable safety for an affordable price. It is important that we collaborate with local users in order to develop a more adequate solution for Nicaragua.

Figure 2. Rope pump well

INNOVATION

1. <u>Description of our product</u>

This project has innovations in four categories. The first is a **technological innovation**: the development of a filter that performs more efficiently in particle and bacterial removal by using colloidal silver as disinfectant. This chemical is available in Latin America, and has shown great potential as an efficient water purifier. To the best of our knowledge, there are no filters in the market that are affordable to the poorest sectors, and that also meet the ideal bacterial removal rate and flow rate requirements . The results of our improved filter will be two-folded: first, it will offer an efficient and immediate solution for the water problems in Nicaragua, and second, it will stimulate local manufacturing industries by enhancing the performance of artisan products. Moreover, we are planning on interacting with local artisans to learn how to manufacture clay filters, and use that information for a second iteration of our design. Our desire is to do carry out this project using a participatory approach. This project is not merely a scientific research on water filters. It intends to combine chemical and environmental engineering, urban planning and sociology to find the optimal solution for Nicaraguan rural villages. The target users will be consulted from the first stages of development, which makes this approach unique. For these purposes, the Center for Reflective Community Practice was asked to provide feedback on the best way of achieving our goals. This new **methodology** of conducting research and learning will be our **second innovation**. With our model, the target users and manufacturers will be consulted in order to receive real-time feedback. We want to find the solutions that the future users desire, to the extent that such solutions are technically and economically viable. Therefore, this interaction is a key component in our work. Once a suitable product is developed, we will proceed to ensure local availability of sources and knowledge. When NGOs distribute or subsidize these filters, it is usually a one-time event. In other words, community members receive their water filters, but they do not have local sources to replace the device in case of breakage or filter exhaustion. Filters are recommended for use only for a year without rehabilitation. This way, the impact of introducing the filters to the community is constrained due to the lack of a local sources where new filters can be purchased. Hence, we will organize a training session for potters with years of experience so that this new skill may be transferred to the local communities. These trainees will be able to provide advice on the maintenance and operation of filters, as well as fabricate new ones when they are needed. Since these artisans already have a wide range of products that they make regularly, adding one more product will result in additional revenue for them. The attached film shows an example training session.

Technology cannot be tested to be appropriate from a laboratory only. Field tests are necessary to find out problems in usage, maintenance, adaptability to local customs and habits, and cultural acceptability. Local manufacturing conditions, such as facilities, infrastructure and availability of raw materials must be evaluated on site. Even the water to be filtered is difficult to simulate in laboratory conditions, which means that we must conduct experiments with the community to diagnose the real performance of the improved filters in the right context. Through a *contingency valuation*, which is a strategically planned survey conducted among randomly selected household samples, we will estimate the actual willingness-to-pay and acceptability of the improved system. Personal interviews will be conducted, which will give us precious feedback. As a result, a second version of the improved filter will be designed by taking into account the new information learned. This is the *monitoring* component of our project. Through several conversations with users and NGOs, it was possible to infer a general lack of follow up once the projects had ended. For example, we noticed that buying and distributing filters were the end of the interaction between the agency and the users. Daniele Lantagne, a former student at MIT and current lecturer at the Civil and Environmental Engineering Department, has performed consulting work on the improvements that the filter needs. One of her conclusions was that projects without monitoring do not have good results. When she visited families who had received filters, she noticed a clear difference between those who received some kind of regular follow-up visits and those who did not. Over 90% of the households with monitoring visits were using the filter correctly, compared to 30 to 40% of those without visits. Our project will guarantee monitoring through the collaboration with local students. Therefore, our **third innovation** is to include a well planned follow up for an extended period by local students. This monitoring will encompass both bacteriological testing of water samples and assessment of sociocultural acceptance.

A **fourth innovation** is the organization of a brainstorming day in which university students will be asked to form teams and come up with creative ideas on how to increase the penetration of filters and public awareness in water treatment. This day will be called the “Best Business Idea Contest” and will award a cash price of $100 to the winner. The types of ideas we are looking for may be illustrated by the following business concepts. Local entrepreneurs may be encouraged to be small producers of filters and distribute them to other rural areas, including isolated locations. On the other hand, neighborhood workshops may be organized in which people are taught how to make their own filters using a communal oven, such as the training event we are planning. Another idea would be to fabricate communal size filters that will be shared by a couple of families. Local students know the real needs and conditions and will possess the necesary background to come up with proper and intelligence solutions. The interaction and collaboration with local college student in all phases of the project (brainstorming, development, implementation of product and monitoring of results) is a valuable component that makes our project appealing.

2. Justification

Our innovation exceeds the current available technology for several reasons. First of all, the improved filters will remove both particles and microorganisms efficiently, while the current system does not. Also, the new system will possess a more adquate flow rate to satisfy the minimum daily needs of drinking water. Second, we are generating a collaboration medium for three parties: NGOs, university students and artisans. The three sectors will contribute with their exclusive skills and knowledge to create a hybrid optimal solution. Our solution is sustainable, since we will provide the medium to monitor the performance of the improved filters and a local source of filter producers and promoters. We are also developing local leadership and promoting community organization. Moreover, we are actively transferring technology and knolwdge from *and* to Nicaragua. At another level, we are transferring skills from Managua to rural settings and vice versa. Figure 3 shows summarizes this concept.

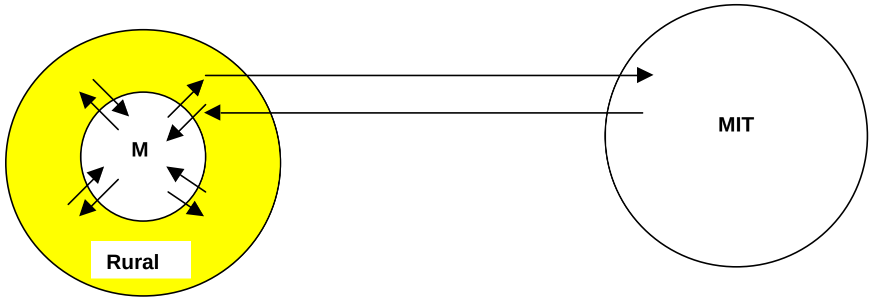

Figure 3. Transfer of technology from MIT to Managua (M), from Managua to the rural area, and viceversa.

In summary, we believe that our proposed idea is innovative and is justified because it is multidisciplinary, sustainable and with a large impact. We combine improved technology and methodology to achieve an integrated solution (figure 4):

1) **Innovative technology**: The current filter will be improved to meet a vastly improved standard of efficiency and flow rate
2) **Innovative methodology**: The research for the most appropriate improvements will be performed by using real-time feedback from target users and manufacturers. Laboratory testing and analytical modelling will be complemented with simultaneous field testing. This is also an innovative learning tool that has started to generate great interest and excitement at MIT (The Civil and Environmental Engineering Masters of Engineering Program, The Public Service Center with the service learning project, and the Thinkcycle project at the Media Lab). In our project, we do not stop after providing the technology, we ensure local availability of skills and knowledge for sustainable usage of the technology.
3) **Innovative monitoring of project**. Our follow-up will consist in both assessment surveys and also a long-term study of the change of the filter variables with time. For example, determing the flow rate behavior vs. age of filter will establish the groundwork for future teams who want to work on further improvements of the filter.
4) **Innovative interaction with local students**. Our collaboration with Nicaraguan volunteer students can be used as a model for future community service and research projects at MIT and other colleges.

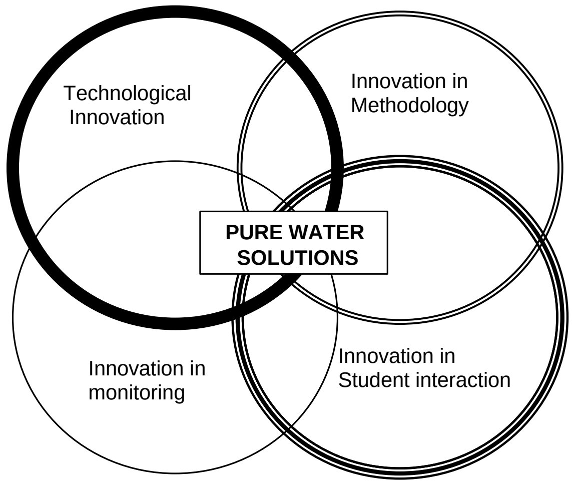

Figure 4. Pure Water integrates four innovations categories.

IMPLEMENTATION

1. Work to date

Students at MIT have done background work that we will use for our project. Junko Sagara (2000), lecturer Danielle Lantagne (2001) and Jason Low (2002) have studied extensively different types of ceramic filters and colloidal silver application methods.

Pure Water has already studied the PFP filter and determined the reasons why it did not perform well. We have proposed potential redesigned models and are currently conducting several laboratory experiments on different prototypes. One of the main problems seems to be the deficient absorption of colloidal silver into the clay. Changing the pH of the environment, such as pre-coating with a mild acid or base (eg., vinegar) may improve the penetration of colloidal silver. Extensive literature research on packed beds, porous materials, mathematical models on flow rates for porous materials, colloids, colloidal silver, community behavior assessment projects and alternative technologies has been performed. Flow rate profile measurements on three different filters have been studied. One filter has colloidal silver coating, the other one has a comparable flow rate but no colloidal silver, and the third one has been baked so that the flow rate is approximately double the other two filters.

We have also contacted the community partners on April 11th to 16th. Thanks to the Materials Grant offered by the IDEAS competition, Rebeca Hwang has met with Ron Rivera, the university contacts, Potters for Peace artisans, and some local families currently using the filter (please see pictures attached). This first contact has enabled enormous progress. Thanks to this meeting, the planning of the community events to take place during the summer has started. We have also investigated the general water situation in Nicaragua, such as the water privatization debate. Two of the participating villages were visited: San Juan Oriente and La Paz Centro. Rebeca has talked to local potters and community members and proposed the idea to them. All the consulted people responded enthusiastically and made a commitment participate (please see pictures in the appendix). During the visit, every day was started with a brainstorming session in order to find out more creative ideas on how to approach our problem and reach our objectives. Then visits to facilities and communites followed during the day, complemented to literature search and interviews with experts during the evenings. This trip has helped us scale the project to fit the real context and allowed us to identify the real needs and feasibility of each component of our project.

2. Implementation Plan

The general guidelines on our approach have been described in previous sections. The following schedule outlines the main steps to take.

The first phase of the project will be performed in the Susan Murcott's Building 1-047 laboratory space available at the Civil and Environmental Engineering Department at MIT. The tests to be performed are listed as follows:

PHASE I

2.1 *Laboratory tests*

- Effect of filter pore size on efficacy of removal
- Role of colloidal silver at different application concentrations. Study dilution factor vs. performance
- Maximum feasible flow rate for satisfactory efficacy. Study increase in tortuosity by combining different sizes of pore size (by using different sizes of saw dust). Increase surface area by denting bottom of filter.
- Innovations on design. By using analytical models, decide on whether the current shape is optimal

Currently, our prototype has the modifications from the PFP filter specified below (figure 5). All changes are accessible for the local manufacturing facilities.

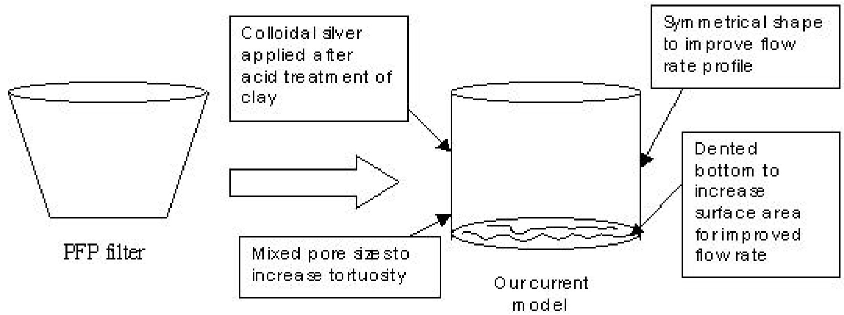

Figure 5. Current model of modifications to the PFP filter

2.2 *Literature search*

Companies such as Apyron, Katadyn and Brita manufacture colloidal silver. Research on the mechanisms of removal reported by these companies will be used to understand and improve current system.

PHASE II

The second phase will be in Nicaragua, where the performance of the new designs developed in Phase I will be field-tested. A community project will be organized in order to assess the reaction of the local users and stimulate more innovations and improvements for the prototype. Also, a "Best Business Idea" contest will be organized in collaboration with Nicaraguan university students in which sustainable ways of achieving high penetration of filters will be analyzed. The winner of the contest will be awarded $100. The organization of these two events will be planned from Cambridge with the collaboration of our local contacts.

2.3 Field tests and monitoring

- Performance of filter in field
- Microbiological tests on Nicaraguan water sources
- Field monitoring of household water practices that affect filter performance
- Community survey to assess reaction and obtain feedback
- "Best Business Idea" contest
- Apprenticeship with local pottery artisans to learn manufacturing techniques that will be used for a second and final iteration of the design
- Training Program for local potters

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2.4 *Training of Local Potters*

Four villages have been selected to be trained in hand filter manufacturing: San Juan Oriente, San Francisco Libre, La Paz Centro and Calle Real de Tolapa. Ron Rivera will coordinate invitations to selected potters. About 14 potters will be transported to La Paz Centro, where facilities are available for production (two large ovens, enough space, raw materials, etc.). The first day, the first session will offer information on filter usage and water purification. The rest of the session will cover the skills necessary for filter production (please see video with sample training day). The products will be left to dry and baked in a second session a week later. Each artisan will be coupled with our contact NGO in each locality in order to assure quality control in all filters produced during the first 6 months.

2.5 *Best Business Idea Contest*

The presence of an efficient alternative for water purification does not necessarily mean that it will reach the users. There are cultural and economical barriers which must be determined and targeted. This contest will inform us of creative possibilities to distribute the filters. This competition will be a brainstorming day in which participant students will think of ideas that could be applied to increase access to water for rural communities. The best idea will be rewarded with $100 cash. Our local university contacts will start publicizing the event in May.

PHASE III

2.6 *Community Survey and Monitoring*

Contingency valuation studies will be conducted. A well-designed questionnaire will be distributed to randomly selected households and answered during a personal interview. Questions will address preferences between the current and the improved filter, as well as willingness-to-pay for the new filters. Nicaraguan volunteer students will perform this task for a period of 6 months. We have discussed the details with the program coordinator, Moises Lopez. Usually, these five volunteer students pair up with a mentor to work full-time in a rural project for 12 months. We will ask two students to collaborate with us. After filters have been distributed, each student will cover 6 to 8 households per day, totaling a sample of 100 families. An exhaustive analysis of the data collected will be performed back at MIT. Moreover, feedback will be requested on any further improvements, and on which variables are the most appreciated (water clarity, , flow rate, mobility of the filter, etc.). Fortunately, we found a collaborator in MOVIMONDO, an Italian NGO that has just purchased 1,400 filters from PFP and who will distribute the filters during May. This is an ideal situation, since we will be able to monitor filter usage and performance from the very first day. Each household will be visited every month, and water samples will be taken. In order to guarantee reliable results, we will use double sampling in each house by collecting water samples before and after the filtration.

3. Scope

The purpose of this project is three-fold in the technological innovation: first, to study the effect of colloidal silver as a disinfectant applied to ceramic media in a household filter. Second, to design a colloidal silver-coated filter media that has a flow rate larger than 2L/hour in order to provide sufficient drinking water for a typical household in developing countries. Third, to determine the optimal method of colloidal silver application to this media. The filter will be prototyped, tested, distributed and monitored. The ultimate goal of the project is to increase the availability of safe water for the Nicaraguan population. After preliminary laboratory and literature investigation performed at MIT , the new prototype will be re-designed in the field during the summer. In the long run, monitoring and local generation of colloidal silver will be considered, and implemented. Eventually, this solution may be expanded to other similar contexts in other developing countries. As an added plus, the interaction between MIT and the local university and artisans will be a valuable resource for future projects.

4. Timeline

Phase I

The planning process has begun in March 2002. Weekly meetings experts in the area, such as Prof. Susan Murcott, Danielle Lantagne, Jason Low and the Center for Reflective Community Processes will contribute to the proper planning before the field trip in summer 2002. Literature research and aboratory work to design an improved prototype filter have been started. Community partners have been contacted and collaboration has begun.

Phase II: Field project

The field investigation will be held in summer 2002 in Nicaragua, after the laboratory tests have been accomplished and a prototype of an improved filter is available. The fieldwork is expected to last for about a month. During that month, a short apprenticeship of pottery techniques will contribute substantially in the second iteration of the design. One team member, Bruno Miller, will return to Nicaragua at the end of the summer in order to check on the user responses.

Phase III: Post-Trip analysis and monitoring

After the first field test, the second iteration for the design of the filter will occur at MIT during the Fall semester. Simultaneously, monitoring and community assessment will be performed by student partners in Nicaragua.

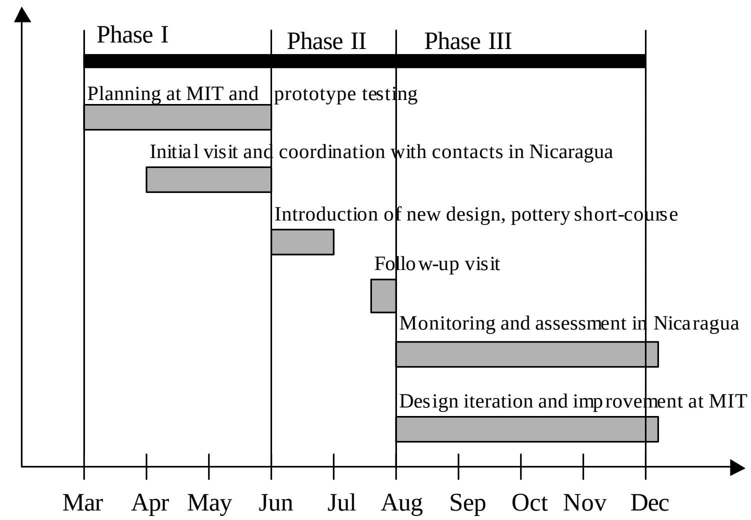


Figure 6: Timeline of the project for 2002.

5. Challenges

Working in developing countries pose different kinds of challenges. First of all, harmonizing a common timing and working pace is difficult. Things tend to function more slowly er in Latin America, and we must take that time lag into account when we make plans. The other difficulty is to assure the proper usage of our technology. Even the best performing filter will not be of much help if users are not aware of the precautions, such as disinfecting the collecting bucket or scrubbing the filter regularly. Any effort must be coupled with education of other basic hygiene practices, which poses an appreciable challenge, since habits are hard to change. The short time available makes us feel challenged on arriving to the right technical solution in time and implementing it in a sustainable way. Our partners in Nicaragua and our advisor, Susan

Murcott, will be essential for a successfull ending. On that note, it is not easy to assess the degree of success of a project of these dimensions, since the benefits are usually long term. For the same reason, following up on the project may not be an easy task. However, the fact that all members of the team are returning students who will continue to be at MIT in the 2002-2003 academic year, and one member in particular will be continuing work on this project during the Fall term and IAP, ensures an appropriate follow-up.
Another challenge is raising enough funds to ensure the economic feasibility of a long project. Our budget shows a larger amount than the grant offered by the IDEAS competition. However, we believe that this is a realistic assessment and that it is essential for a successful completion of our project. Therefore, we have applied for funding from other sources, such as the Public Service Center at MIT (PSC). PSC has expressed enthusiasm on our project and interest in funding part of our expenses. We are still actively searching more alternative matching sources.

6. Support Network

We are fortunate to have a very strong supporting staff. Prof. Susan Murcott will be supervising the project closely. She is one of the best resources available at MIT on water treatment systems. Professors Jennifer Davis, Raul Lejano and Kaushik Basu are experienced individuals in developing countries and may be available to answer specific questions that may arise. Moreover, the Center of Reflective Community Practices is handy and would be ready to help us plan a sustainable community project.

In Nicaragua, Ron Rivera, Moises Lopez (UN, coordinator of volunteer group), Luciano Palmitesta (MOVIMONDO), Graciela Scheller (NGO in San Francisco Libre) will support us with information on local conditions. Please refer to attached pictures.

IMPACT

1. Magnitude of effect

We forecast several layers of impact achieved by our project. First of all, this will directly effect villages La Paz Centro, San Juan Oriente, San Francisco Libre and Calle Real de Tolapa in Nicaragua, where we will be offering training of skills improved filters. Our solution will offer them a reliable alternative for potable water.

It will also benefit local artisans that work for Potters for Peace. This opportunity to manufacture and market well functioning filter will have a positive effect on their business.

Other stakeholders are MIT and its students. This project will provide the roots and background for future students who aspire to do community-oriented activities in developing countries. This will result in a better use of MIT's intellectual resources to solve real problems in this world. The relations that our team establish with the volunteer groups and/or local NGOs will remain as resources for future MIT students to apply an integrated and interactive learning methodology.

Many more projects may come out of this initial project, and solutions will optimized after each iteration. Ultimately, solutions will be able to be transferred to other locations, and more importantly, the concepts behind the solutions may be reiterated by future teams.

2. Addictional effects

Further implications of this project are the increased collaboration of MIT with foreign universities and non-profit organizations. Learning through helping, and through serving the community may become a more common feature of the MIT experience.
Our vision is to see more and more students critically thinking about and working to solve real-life problems, while applying their scientific, engineering or managerial skills. Setting the example for this kind of initiative, and laying the foundation setting the ground for future projects will likely result in more concrete solutions for those in the world who most need them.

BUDGET

The total cost for the three phases has been estimated to be approximately US$ 9974.10. Please refer to the attached excel sheet for details.

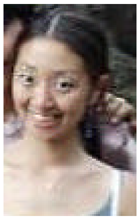
BIOGRAPHIES

Bruno Miller

He received his BS and MS in Aeronautics & Astronautics from MIT and is currently a graduate student in the Technology and Public Policy Program. Current research of Mr. Miller focus on mitigation of environmental effect of air transportation, particularly on emissions reductions through operational measures. His areas of interest involve air transportation, economic and social development of developing countries and technology transfer to developing countries. He has participated in a number of multi-disciplinary projects focused on designing relief housing for victims of Hurricane Mitch in Honduras (1998) and the August 1999 earthquake in Turkey. Developed a strategy for renewable energy and sustainable water systems provision. Mr Miller is member of the National Engineering Honor Society (Tau Beta Pi) and Sigma Xi. He was recently recognized as a Martin Family Fellow for Sustainability for his work at MIT. His role in the project will focus on organizing the field community events.

Bruno, our Project Manager, will use his vast experience in the field to accomplish our milestones.

Rebeca Hwang



Senior in Chemical Engineering. Born in Korea and raised in Argentina, she is planning on pursuing further studies on Environmental Engineering. She is very interested in developing leadership and institutional capacity in developing courntries. Rebeca has travelled extensively in Asia, India and Latin America. Her most recent passion has been water supply and sanitation in rural areas. Her role on the project will focus on the technical redesign of the filter and the overall leading coordination.

Murray Height

PhD candidate, Chemical Engineering, MIT
Academic background: B. Eng in Chemical Engineering from University of Newcastle (Australia); B.Math in Chemical Engineering from University of Newcastle (Australia)
Graduate research focussed on developing methods to synthesize carbon nanotubes and carbon nanomaterials in flames. Particular interest toward a means of producing bulk quantities of materials for hydrogen storage, water treatment and other emerging applications. Interests include reenewable energy technologies and strategies to foster wider utilization of these technologies. Hydrogen based transportation. Distributed electricity generation and transmission networks. Also interested in designing technology for developing countries such as cheaper easier methods for cholera treatment.

His role on the project will be to provide technical assistance, in particular on the topic of porous materials and colloid properties.

ADDITIONAL MATERIAL SUBMITTED

- Sample prototype PFP filter
- Pictures taken during the community visit in April
- Video showing hand-manufacturing of filters

BUDGET for PURE WATER

Team members: Murray Height, Rebeca Hwang, Bruno Miller

ITEM Description	Price/unity($)	Quantity
Plane tickets Boston-Managua. In Phase II, June 2002, all team members will travel to Nicaragua to implement the project.	700	3
Room and Board for team members for 1 month in Nicaragua. Food costs about 13 dollars day/person Board is about $200 per month in Managua, but will be provided by PFP	390	3
Transportation in Nicaragua for team members. PFP will in most cases offer us a car to travel back and forth from Managua to the rural communities. However, gas will be paid by Pure Water. An average of 2 trip per day and 20 days/months. With $12 per trip, a total of 40*12 trips to communities in a month	480	1
Training day . For the training day, 14 potters will be transported from their local towns to La Paz Centro. Two cars will be made available by Graciela and Ron Rivera. Shelving=$100, Table=$40, Firewood=$10, Molds for filter=$42, Colloidal silver=$30, Saw dust=$0, Clay=$0, Plastic bags=$0, Plywood plates=$0, Tranportation of potters=$134, Refreshments and lunch=$128	34.57	14
Laboratory equipment (membrane filtration, vacuum pump). Laboratory equipment will be needed for both Phase I and Phase II. For Phase I, supplies will be covered by the M.Eng Program in Course 1 at MIT For Phase II, assessment and testing of improved filter in field will require a membrane filtration unit for bacteriological testing ($524),a vacuum pump (=$43), filter supplies ($92 for pack of 100), 100 vials (0.45 each)	704	1
Business Idea Contest. This event will occur during Phase II. A cash reward of $100, printing materials and publicity ($100), photocopies ($40) and refreshments ($50) will be required.	290	1
Testing chemicals . For Phase III, monitoring of households will require a presence/absence test. Two tests, double sampling, for water before and after filtration for 100 households once a month for 6 months will require chemicals for a total of 2400 tests.		
Chemicals	0.67	2400
Sampling bottles	4.67	36
Student partners room and board for six months. For Phase III, two student partners will live in the assigned rural town for 6 months. Room and Board will be provided by our team.		
Board in rural area ($150 per month for 6 months)	150	6
Food in rural areas ($9 per day per person for 180 days)	9	180
Insurance (basic health insurance required by university, 10/month/student)	20	6
Transportation from their hometowns to the rural town (average of $50 per student)	50	2
TOTAL		**US$**