Improving and Evaluating the UV Tube for use in Mexico

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Executive Summary

Lack of access to safe drinking water is a world crisis affecting more than 1.1 billion people according to the World Health Organization (WHO 2000). Without access to proper sanitation, water can be contaminated with fecal matter containing pathogens. Drinking contaminated water causes the deaths of 1.8 million people every year (WHO 2000), and leads to many illnesses including diarrhea, cholera, and giardia, which can cause death, especially in children. People and governments have designed varying systems to disinfect water. From straining cloths to remove particulate matter to centralized systems, water treatment facilities have been implemented worldwide. However, these latter systems are expensive, difficult to implement and hard to maintain in developing countries. An alternative to these centralized systems are Point of Use (POU) disinfection systems. These systems are smaller scale and allow users to disinfect water either in their homes or community immediately before use.

The UV-tube is a POU water treatment technology investigated, tested, and promoted by students and researchers at the University of California Berkeley. It is a system that uses ultra-violet (UV-C) light to deactivate pathogens in water. After several design iterations, lab tests, and field studies, the UV-tube has proved to be a viable option for water purification in poor areas. An extended pilot study in Baja California Sur in the summer of 2005, showed that the UV tube, dubbed AquatUVo, successfully disinfects water, and that people use it effectively and correctly. Other results from the Berkeley led project suggest that several aspects of the design could be improved to better fit the needs of people in Baja California Sur. Various alterations to the unit were suggested to make the design more user-friendly, such as moving the outlet drain and the window to view the light.

As part of the Spring 2006 Design for Sustainable Communities class at UC Berkeley, we have developed a new design for the system that addressed these concerns. In order to get feedback on the new design, two Mexican families near the San Francisco Bay Area were chosen for a pilot study. They used the new UV-tube for two weeks and were interviewed on their perceptions of the product. They offered general suggestions ranging from aesthetics to specific design issues. These suggestions were examined and

will be taken into account for the next design. Over the summer, we will create and implement a new design while in Baja.

Project Background

According to the World Health Organization, approximately 1.1 billion people worldwide lack access to a clean water supply. These conditions lead to 1.8 million deaths due to diarrheal diseases from waterborne pathogens, of which 90% are children under the age of 5 (WHO). This world health issue is dire and has invoked many solutions. There are two types of solutions in use centralized decontamination, followed by distribution to people, and Point of Use (POU) treatment. The former system has several challenges in its application in financially constrained countries. One main drawback is recontamination of water throughout the distribution network. For water to remain disinfected by the time it reaches the end user, the distribution network must have residual ways to keep pathogens from infiltrating into the network, such as chlorine. Preventive measures to ensure against recontamination require prohibitive high maintenance costs for developing countries. Additionally, high costs associated with the construction of centralized treatment plants and distribution systems prohibit their use in underdeveloped nations (Mintz 2001; Reiff 1996). For example, according to the Inter-American Development Bank, central water projects in Mexico cost nearly $700 per family served for infrastructure alone (BID 1998). The maintenance requirements for centralized systems are often unmet for both rural and urban setting due to social, economic, and institutional reasons (Mackintosh 2003; Mintz 1995).

A good alternative for resource-constrained and rural communities is POU water purification systems. As opposed to cleaning the water at the source and then distributing it throughout a complex system of pipes to the end user, POU systems provide individuals and communities with the capability to treat water themselves. This eliminates the issue of expensive construction and maintenance of a centralized system and gives users control over maintenance and usage. For POU water treatment options to be successful, the technology must be affordable, culturally acceptable, easy to operate, provide safe water storage to avoid recontamination, and be accompanied with hygiene educational programs and materials to motivate and promote behavioral changes (Mintz

2001, Wright 2004). To minimize cost, ease maintenance, promote environmental sustainability, and reduce risk of dependence on long supply chains, all POU units should be constructed utilizing locally available resources. Currently, boiling and adding chlorine bleach or tablets are the most common POU methods. Their limitations reduce their sustainability and viability in developing countries; boiling water is time-consuming and resource intensive while chlorine alters the taste of water and requires complicated dosing procedures.

Project History

In 1999 Berkeley's Renewable and Appropriate Energy Laboratory (RAEL) launched the UV-tube project, a POU system, to address the growing need for an effective method for water borne pathogen inactivation in underserved communities. The UV-tube offers an effective alternative to boiling water and complicated chlorine dosing for drinking water treatment. The UV-tube uses ultra-violet light to deactivate pathogens. The UV-Tube design incorporates a germicidal UV bulb suspended over water in a horizontal tube or covered trough. The water enters at one end through an inlet in the top of the tube, and then flows along the bottom (beneath the germicidal bulb) until it reaches an outlet at the opposite end, where it exits. The height of the outlet sets the depth of the water in the tube and regulates the hydraulic retention time. Because the UV-Tube does not require water pressure to operate, it may be connected directly to a faucet or filled with a funnel and bucket. Different tube sizes and geometries are possible, because various germicidal bulb sizes are available. Stainless-steel sheets, galvanized gutter, copper sheet, pottery, ferro cement, PVC pipe, and ABS pipe prototypes have been used as construction materials.

The system's constraints include the need for electricity and reduced effectiveness in turbid water. Initially, the project faced other limitations that were specific to the manner in which UV disinfection systems were manufactured for commercial markets, including their high initial costs, high maintenance requirements, and dependence on vertically integrated supply chains. All of these limitations were addressed through a series of design test iterations. By 2003, Berkeley researchers had developed a low-cost and user-friendly system that could be built and distributed using locally available resources. The key difference between this new UV-tube system and the commercial systems is that the bulb is placed above the water instead of being submerged (as shown in figure 2). This UV-tube characteristic was adopted from a system developed by Dr. Ashok Gadgil, a scientist at the Lawrence Berkeley National Laboratory.

The UV tube as a POU has many advantages over commercial systems and other UV-disinfection units that make them ideal for use in developing regions. First, UV-tubes are easy to use and can be constructed from common, low cost materials available in developing areas. Other small UV disinfection units on the market cost between US$300 and US$1000, a price too high for POU use in developing countries. Depending on the design and region of implementation, the cost of household and communal UV tube ranges from US$30 to US$100. With an operational flow of 5 liters per minute, UV tubes meet users' needs for effective, fast, and reliable water disinfection, without changing the taste of the water. They have less environmental impact than most methods of obtaining safe drinking water. Finally, UV tubes are a community-level solution to the problem of contaminated drinking water. They can be built and sold by local entrepreneurs or built and maintained by those wanting to sell treated water, and evaluated by users who provide feedback on the design.

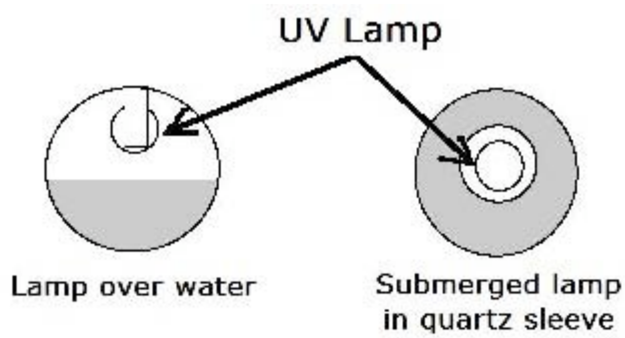

Figure 1: Schematic of different UV systems

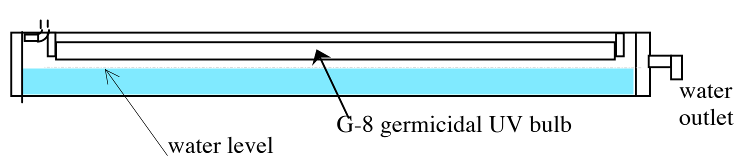

Figure 2: Basic working concept of UV-Tube Design

The UV-tube has been tested both in the field and in the lab. The inactivation effectiveness of the UV tube was tested against the bacteria *E. coli* and the MS2. The tests showed that the design delivered twice as much dosage required by NSF/ANSI standard 55 for commercial UV systems. The design has been field tested in several locations and improvements have been made from conclusions drawn from the field studies. In January 2003, a version of the UV-tube named "el tUVo" was implemented in a community in Morelos, Mexico. In collaboration with the Mexican Institute of water Technology (IMTA), students conducted a small-scale pilot study involving 18 families in two communities.

Working together with staff from Consejo Nacional de Fomento Educativo (CONAFE), students documented water quality and its relation to health in 25 rural communities across the state of Baja California Sur (BCS) in the summer of 2004. According to the project results, more than 50% of the water sources sampled had presence of *E. coli,* indicating fecal contamination of the water. These results coincide with the high rates of diarrheal diseases that were found in the area. Students also documented water practices in the region and found that residents were interested in options to disinfect water at the household level.

This knowledge motivated students to design a new iteration of the UV-tube for a pilot project specific to BCS. In the summer of 2005, a team of students implemented the latest UV-tube (AquatUVo) design in two communities in BCS. These students installed 30 AquatUVos in homes and monitored them over an 8 week time period. Participants were interviewed at the end of the study to better understand their use and perception of the AquatUVos. They were then asked questions addressing the usability of the device, willingness to pay for the technology, and their perceptions of its usefulness.

Characteristics of Targeted Communities

The current UV-tube iteration is designed to meet the needs of small rural communities in Baja California Sur (BCS). The terrain and cultural landscape of BCS make it a good candidate for UV-tube installations. Baja California Sur is a predominantly rural state in Mexico with a tenth of the state's population living in communities of 500 people or less. Only 5% of the total population lives in one of the three cities: Ciudad Constitución (pop. 36,000) in the north, La Paz (pop. 162,000) in the middle, and Los Cabos (pop. 70,000) in the south (INEGI 2000) Since the state is predominantly rural, a centralized water distribution system is not a viable option; POU treatment options offer good alternatives. When the option was presented to them, people showed interest in POU systems. Generally speaking, individual families collect drinking water from wells or springs, and carry it home to be stored in large container, out of which the family takes its drinking water. Some of the wells are used by many community members, while others are used by only one family; few families purchase water. BCS residents tend to be wealthier than residents of other Mexican regions because the state has a higher amount of people who own land. Therefore, they have higher disposable incomes, with which to buy devices such as the AquatUVo. These communities also have reliable access to electricity, facilitated by governmental subsidies towards supplying solar panels in rural communities.

Current Project Goal*s*

The UV-tube project has been handed down through generations of UCB students. Many new designs have been developed, refined, and tested in the laboratory and field. Consequently, the UV-Tube has become a design concept, rather than a single design. As part of the Energy and Resources Group course "Design for Sustainable Communities (ERG 291)", we have implemented improvements to the design of the AquaUVO based on results from the pilot study in the summer of 2005.

Figure 3: Previous Iterations of UV Tube Design

Over the course of the spring semester, the goal was to implement design improvements on the previous bucket and steel sheet metal design concept as pictured in Figure 3. The UV Tube Team identified several areas on the current design that were in need of improvement as recommended by previous users from the pilot study. Figure 4 shows that the current placement of the drain tube can be confused with the clean water outlet, given their close proximity. Additionally, the window that acts as an indicator for the UV lamp during the disinfection process has been perceived to be too small and in an awkward location. Figure 3 also shows several versions of the UV tube installed in the field in Mexico and their individual application and usage location. Note that some tubes are placed on uneven (non-level) surfaces such as a stool, dresser, sink countertop, wooden crates and even bolted to a cement block wall. In this configuration, the UV-tube can be placed in a variety of spaces in a household. Although this allows the system flexibility to meet the space of the house, it invites misuse. Without being fixed to a surface, the UV tube can be placed on an uneven surface or tilted in a way that water flows faster than the optimum maximum flow of 5 liters per minute This action can reduce the detention time of the water in the device to less than that required to effectively deactivate pathogens. In addition, if the tube is not level, water may contact the UV lamp inside the tube and sediment deposits can grow on the surface, over time blocking much of the beneficial UV light. Creating an all-inclusive user-friendly design would eliminate this problem as well as create the appearance of a central space for water disinfection. The best option for addressing all of these issues was to create a small table to house the AquatUVo and all its components.

Figure 4: Previous Iterations of UV Tube Design

This new table-based design is built on the idea concept of simplicity, and incorporates the following design guidelines: **minimization of materials, ease of manufacturing, intuitive design, level surfaces, compactness, attractiveness, sturdiness/durability, and most importantly low cost**. Figure 5 shows CAD drawings of the UV tube and table that allowed the group to virtually modify the design. The dimensions of the table or tube were modified frequently to best design for material minimization and optimal dimensions. Note that the tube is now strapped level to the bottom surface of the table top.

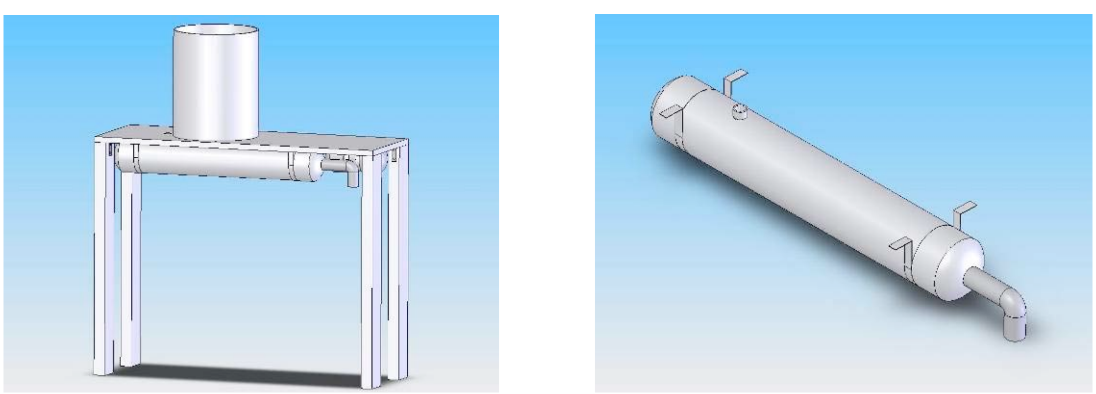

Figure 5: Working CAD Drawings of UV Tube and Table

The major design modifications to the current bucket and tube based design are shown in figure 5. Three support beams were added for stability, leaving one side open for the *garaffon* (large clean water storage bottles used in Baja California) access. The **placement of the drain** was changed to the back end of the tube to prevent users from confusing it with the clean water outlet as shown in figure 3. An **in-line ground fault circuit interrupter** (GFCI) was added for safety to prevent electrical shock and equipment damage in case the tube ever became clogged and overflowed with water. The location of the **indicator light** window was moved from the front of the tube (as seen in figure 3), to the rear so that it is slightly protruding out of the tabletop near the bucket water inlet. In addition, the window was also made larger. Window location was chosen based on the idea that the user will find it easier to check if the light is on before opening the water release valve on the bucket before they begin disinfection. Other minor modifications include grounding the UV tube, using a three pronged plug to allow for a GFCI, and adding an **on/off switch** for convenience.

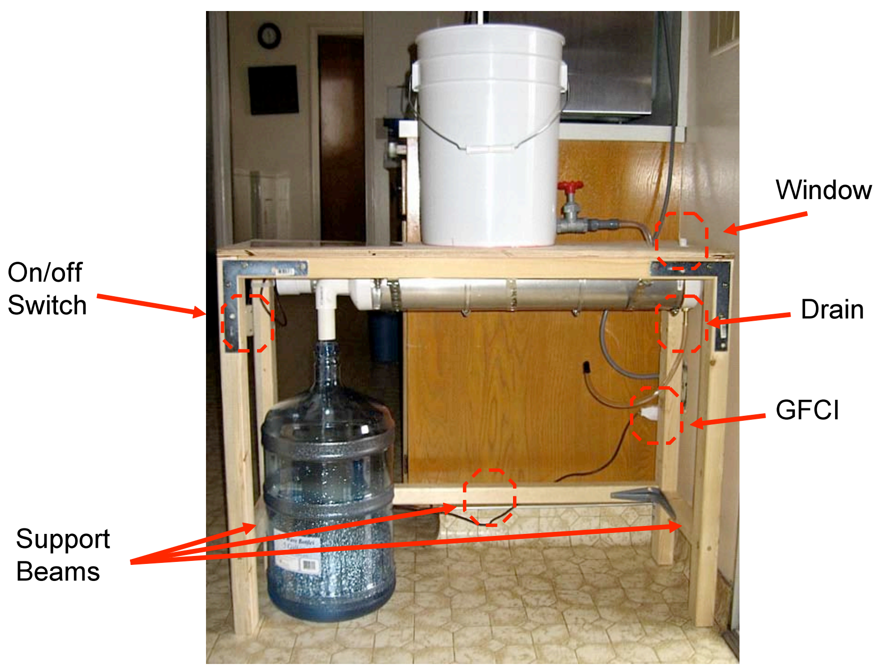

Figure 5: Major Design Improvements to UV Tube

There were a few lessons learned from the challenges/obstacles faced during the course of creating this new design. Perhaps the largest challenge was spending a disproportionate amount of time focusing on the design and construction the table ourselves, rather than having a professional carpenter build them quickly. Early on, effort should have been focused on making the UV Tube modifications and sending it out to be tested in the field to gain valuable user feedback. Another challenge was obtaining the different components to build three UV Tubes in one centralized hardware store. The parts had to be purchased at multiple locations. Finally, the UV Tube team met to build three tubes: two for the pilot installation and one for personal use/test. Troubleshooting of two of the three tubes during the construction process proved challenging (see figure 6).

Figure 6: Team Members Troubleshooting and Building 3 UV Tubes/Tables

The next steps in designing the UV tube are to analyze the user feedback and see how to implement suggestions in a future design of the tube.

Implementation

To assess our new design, the group sought the input of those who would be using the AquatUVo in the end: community members in Mexico. Its user-friendliness, convenience and design specifications were developed with the end-user in mind, so they are in effect the experts who can tell how effective the system is, and what should be modified. However, since we are all full-time students at UC Berkeley, traveling to the final end user was not feasible, so the end-user was approximated by choosing Northern California families with strong ties to Mexico. Systems were installed in two homes to allow the families to use it for two weeks and report their suggestions upon the groups return.

Criteria

A household was identified in the agricultural area of Santa Rosa, California that was willing to participate in the study. From there, the group traveled door-to-door in the neighborhood, trying to recruit other families to pilot test the new AquatUVo. In determining which families to include in the study, we looked for the following characteristics:

- At least one generation born and raised in Mexico
- Family with close ties (friends and family) in Mexico
- Willingness to participate
- (preferred) Families procuring drinking water from wells
- (preferred) Families that face a water quality problem

The recruitment process consisted of describing our project's goals to tweak the design of a Point Of Use water treatment technology to improve access to clean drinking water in Mexico and assessing the ability of the families to meet our criteria. After talking to several families, we selected two families for our pilot study.

Family Profiles

The first family included in our study meets the profile of the "first adopter." This family was our initial contact in the community; they were suggested to us directly by a member of the Mexican Consulate as a family that would likely participate in a study like ours. Six people lived in the home; 2 parents and 4 children, the eldest of which was 18 and preparing to go to college. Spanish and English were spoken in the household; the children answered the phone in English. The parents were teachers and had lived in the US for about 30 years. They still had many family members in Mexico, and visit very frequently. Drinking water was obtained from a well behind their house, but came into the home after passing through a filter, through pipes. The family's current water practices included filtering all their water from the faucet through a Brita filter. They were very enthusiastic about this project, and willing to do anything they could to help out with our project.

The second family consisted of an elder couple and their grandchild. They lived on a ranch, owned by the company that employed the male of the household. The father figure was a laborer, and the mother figure worked at home. They had been in the US for over 30 years, had family in Mexico whom they visited sporadically, and spoke Spanish in the home. The family's water also came in piped, from wells on the property. However, many of them complained that the tap water tasted like chlorine, so they had been buying large containers of bottled water. This family was also very willing to participate in our study, not because of immediate benefits they would reap, but for the possibility of helping people in Mexico.

Pilot Installation

We returned to each household, one week after recruiting them for our project, and brought one AquatUVo for each home. In each home, we asked them where they thought the system would be most convenient, and in both cases, it was placed in the kitchen, near the sink and an electrical outlet. We reiterated the purpose of our project, described how the AquatUVo disinfects water (and what it does and does not change about the water), and demonstrated how to use the system. We also distributed laminated instructions for use, which both families later affixed to the wall near the system. Most importantly, we told them the role that they would play in our project by participating in this pilot study. We asked them to use the AquatUVo every day for two weeks –for all their drinking water needs – and told them we would return to ask them detailed questions, to get their opinions and suggestions for improvements on the system.

Interviews

We conducted one interview at each home, primarily to the male of the household, who was, in both cases, our primary contact in the home. The interviewers asked the following types of questions:

- General feedback on system
- Tested the user on knowledge of how the system works

- Specific design-focused questions on how to improve/change certain aspects of the system
- Demographic information

The interviews were conducted in Spanish. One member of the group asked questions, another took notes, while the rest of the group observed and made additional comments or asked questions at the end. For a list of questions, and notes on the answers provided, please see Attachment A.

Relevance of Pilot Study

In order to analyze the results from our pilot study, we must be certain of its relevancy. Because our end users live in Mexico and are unavailable to us, we found a reasonable approximation of the end user in the Bay Area. We chose to follow a user-centered design approach rather than a technology-based approach, and thus are more interested in finding similarities in culture than similarities in water issues. We recognized that the families we chose to interview did not have any real need for a new water treatment system. Our aim was rather to find a population to sample from that was as culturally similar as possible to the rural communities in Baja California Sur, Mexico. With this emphasis, we were to gain insight on the cultural subtleties and context for the UV tube. In consideration of the similarities and differences listed above, we believe that our pilot test is a good approximation of our end user. When making decisions concerning the design of the UV tube, we must keep in mind these points so that we can accurately meet the needs of the end-user.

In many ways, the families that we interviewed were very similar to our end users. The UV tube users in BCS, Mexico mostly live in very rural areas. The majority of the population lives away from the cities in underdeveloped areas of Baja. The communities are very small, and often home to less than five hundred people. The families that we interviewed both lived in a fairly rural community near the vineyards and Santa Rosa. The houses were located in the middle of the vineyards far from neighboring homes. The families we chose for the pilot study still retained close ties to Mexico. Both families were originally from Mexico. The interviews were conducted in Spanish and our test subjects seemed most at ease in their native language. In addition, the second generation also seemed very much at ease speaking Spanish, suggesting close ties to Mexican heritage and minimal assimilation. In addition, both families indicated that they still had many family members still living in Mexico and whom they visited often. The families that we chose to interview were willing to participate in this project because they believed that they could help their own people in Mexico. Both of the families referred to specific communities that they felt would benefit from the use of the UV tube. These communities were places where either they themselves or their friends had lived. The family members told anecdotal stories about the contamination of the water sources in these areas.

While the family members came close to approximating our end user, there were still many key differences. The test families we interviewed clearly have a very different motivation for using the UV tube than our end users. They did not have any real need of a new water treatment system since their water was already very clean. Though their water came from wells, they primarily drank bottled water or filtered water. Their enthusiasm for participating in the study came from their eagerness to make a difference and help their own people in Mexico. Because of this difference, it is possible that the test families might have overlooked factors of use that would come from a real need for clean water. Our end users in rural BCS live in small houses and have much lower incomes. In contrast, the families we interviewed seemed to be of a higher socioeconomic class. Their houses were one story tall and seemed slightly larger than a typical house in Mexico. They often had some expensive items in their houses, such as a treadmill and a large screen TV. This difference could provide some discrepancy when we are trying to gain information for determining the appropriate costs and space limitations in a house in rural Mexico. While our test families may have similar origins to our end users, they are somewhat removed from Mexico. One family we interviewed had come to the United States in 1978 and the other had immigrated in 1971. Since the families are not recent immigrants, it is possible that the Mexico that they remember is somewhat different from reality and that the opinions and viewpoints they express would not mirror those of today's population of rural Mexico.

Key Recommendations

Both families were very pleased with their system, and when initially asked if they would change anything, they responded that they would change nothing. However, when we asked more specific questions about particular aspects of the design, they did give us more feedback.

Altering Indicator Window

Both families believed that the indicator window was not visible enough. They suggested making it bigger to allow for more light through. Another concern was raised addressing its location. We had originally placed the window near the valve, expecting that people could check to see whether the light was on before they turned the valve to allow water to flow into the tube from the bucket. From our response, it seems as though people would prefer the window to be placed closer to the on/off switch so that the user could check that the light was on right after you turned on the switch. We must determine whether the benefits of moving the light outweigh the costs; it may be that if we move it, many will suggest that it should be moved back.

Improving Aesthetics

Both families indicated that the aesthetics of the system could be improved to provide a more finished and modern look. Specific suggestions included painting the table and replacing the bucket with a container similar to the *garrafon*. In addition, participants suggested that the table could be made out of a different material than wood, such as modern looking plastics, since the wood could possibly warp if it got wet. Another solution is to provide a protective and decorative plastic table cloth that would cover the system.

Adding a Filter

One of the most interesting findings from the interviews was the way in which water treatment systems were viewed. The families understood water treatment to be the physical removal of contaminants such as particulates or insects. Though we had explained that the system worked through UV light, they continued to refer to the apparatus as a filter. After we had explained that the UV light killed the bacteria, one participant expressed concern that the remains of the dead bacteria would still be in the water, maintaining its polluted quality. From this observation, we realized that it might be beneficial to incorporate a rudimentary filter, such as a piece of cloth for the water to flow through. This might provide peace of mind to the users and increase the likelihood of adoption in rural Mexican communities.

Changing the Outlet

Our original design of the table had the mouth of the *garrafon* placed as close to the outlet as possible, while still allowing the user to slide the *garrafon* in and out from underneath the table. During the installations, we discovered that this distance still provided problems, as a little bit of water still spilled out along the outside. To temporarily fix this problem for our test users, we provided a smaller sliding tube. This tube remained up when the *garrafon* was inserted and then came down once the water started to flow. While this solved the problem of water spillage, it also introduced the possibility of more contamination since users would touch the sliding tube with their hands. The next design iteration should include a better solution to this problem, such as a flexible hose outlet.

Facilitating Transport of Water

The most inconvenient part of using the UV tube system seemed to be transporting the dirty water into the bucket in preparation to be cleaned. One participant noted that it would be helpful if there was a way in which piped water flowed directly into the bucket.

Adding a Protective Cover

One participant expressed a concern about the amount of dust in rural Mexico. This dust could settle into the open bucket of water and any crevices, contaminating the water further. To solve this problem, it would be advisable to use a protective cover over the bucket and any other open water containers to prevent dust from settling.

Setting Appropriate Costs

An important factor to consider during implementation in Mexico is setting appropriate costs for the UV tube system. We asked both families how much they thought a family in Mexico would be able to pay for this system. They indicated that while city dwellers would be able to pay much more than those who lived on the ranches and needed it most. One participant remarked that some families have difficulty paying for shoes, much less a water treatment device. While we were unable to pin down an exact cost, both families seemed to believe that US$40 was an acceptable cost for the system.

Future Work

This summer, work on the improved UV tube design will continue in BCS, Mexico. Three members of our team will be traveling to Mexico to continue with this project. One of the main tasks we will pursue will be adapting materials of our current design to those materials available in Mexico. Even in the Bay Area, we had difficulty finding all of the components of the UV tube and had to search several different hardware stores. We are unsure which components are readily available at a typical hardware store in rural Mexico. In addition, we don't know the standard type and size of certain components. While many of the components are sold in English units in the United States, they are sold in metric units in Mexico. After determining which materials are available in Mexico, we must adapt our design to accommodate available resources. Additionally, we would like to incorporate a rudimentary filter into the UV tube design. This will increase performance and make people in rural Mexico more likely to adopt the system. While in Mexico, we will conduct another study to test the new design in households in rural BCS, California. We will conduct interviews with our true end users to gain further insight on how successful our design is and learn of further modifications that we can implement. The next step will be to consider plans for large scale dissemination in Mexico. We will consider if any modifications should be made to the design to make it easier to manufacture on a large scale. In addition, we will work on an appropriate business plan for determining cost, how to distribute the systems, and how to spread the word about this new technology.

In addition, we will work on establishing a needs assessment methodology, in order to determine where in Mexico the UV tube is an appropriate technology, and where it is not. Appropriate here means that it is culturally acceptable, technically effective in removing bacteria and viruses from the source water, and economically feasible for people to purchase. For places where the UV tube is not appropriate, we will work on determining what other options for water treatment are feasible.

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Attachment A

Sample Interview Form:

HOUSEHOLD AQUATUVO USE FORM

Quisiéramos hacerles algunas preguntas relacionadas con el uso del AquatUVo. Para nosotros es muy importante que nos respondan las cosas como son. Nosotros no los vamos a juzgar de ninguna forma, solo estamos interesados en aprender como se usa el AquatUVo en las casas para poder realizar las mejorías necesarias. ¿Les parece bien? ¿Entonces, podemos hacerles unas breves preguntas?

Main Steps:

a) switch on b) light on c) water into bucket d) rinse garrafon e) fill garrafon f) drain g) switch off

#	Step	Comments
		Washed Hands
		Use regular little cups of water to fill bucket from sink (though usually fills it up with a hose)
		Carried bucket back on top of table and inserted hose
		Placed garaffon under table and inserted adaptor to outlet spout.
		Turned switch on
		checked light
		opened bucket valve
		Once filled lifted the garafon to the top of the UV tube table
		Placed the PVC outlet adptor in the opening of the tube so the kids would not loose it.

TEST OF HOW IT WORKS		
1. ¿Tiene un idea en general de cómo funciona el AquatUVo? - Yes (good that we are getting feed back to implement improvements for rural communities)		
2. ¿Sabe para que es el tubo de drenaje? Thinks the water that has to come out	**Si**	No
3. ¿Nos puede mostrar como se usa el AquatUVo? yes		

GENERAL REACTION		
1. ¿Cree que el AquatUVo beneficiaría alguna persona o comunidad que usted conoce en Mexico?	**Si**	No
2. ¿Usted recomendería el AquatUVo? A quien?	**Si**	No
"Mi gente" (mexicanos)		
3. ¿Que piensan sus familiares del AquatUVo? (have they used it?) A tenido visitas que le han comentado algo del AquatUVo? Que han dicho?		
They think that it's good 1st day of instillation thought it was good. Good because it killed all pathogens. Oregon Relative even wanted on to take back with him to Oregon.		
USER FRIENDLINESS		
1. ¿Si le ha funcionado el AquatUVo? ¿Ha tenido algún problema?		
Light didn't go on for 2 days		
2. ¿Le cambiaría algo para hacer el AquatUVo más facil de utilizar?		
tubing on bucket to inlet was bent use better tubing, a way to connect a water source hose to the UV tube so you don't have to remove the bucket and make it easier to use.		
3. ¿Qué le gusta más del sistema? Everything…really likes the idea.		
4. ¿Cuales aspectos no le gustó del sistema? NIcer looking table. Not well made sand and Paint it. Use plastics instead of Wood. Not everyone will have enough		

COMMUNITY/ RELEVANCE	
1. ¿Hace cuanto vive en los Estados Unidos? Since 1961	
2. ¿Tiene parientes en Mexico? Con cuanta frecuencia los visita? Sister in México uncles he's from baja	
3. ¿Cuantas personas viven en su domicilio? 3 wife him and a kid	

Side notes

Would like to change the design. He doesn't think it takes too much time to clean water.

He would like to see the design change to a fancier version. He think the bucket is ugly would like it to use 2 garaffones one inserted on top like a regular water cooler (upside down) He likes the fancy look of the blue garaffon.

Thinks It's good we are getting feed back
When Light did not go on he tried using a new extension cord then called the group

Has a sister in baja
In Mexico just drank right out of natural water source with animal excrement's

Would like to give it to someone who needs it more with more family members with children.

He felt bad because the thought that we thought he didn't like it when he asked us to take it back

Maniadero city in baja where his sister lives and 4 uncles and a few cousins.

Use a sliding scale to have people to pay for system.