The Sustainable Implementation of the Better Water Maker in Underdeveloped Kenyan Communities

May 3, 2012

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Mechanical Engineering

WPI 2013

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Abstract

The Better Water Maker (BWM) is a UV water purification device. From January to May of 2011 the first long term studies were conducted on the device. Data was collected around the usability and impact of the BWM in a variety of environments. The BWM adapted the best in the schools and faced the most challenges in the groups selling the water. It was found the most successful groups were the ones with an investment in the project.

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Needs

This year UNICEF reported the following statistics on the global water crisis,

> 783 million people live without access to safe water, which is around 11% of the world's population.
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> 2.5 billion people live without access to sanitation, around 35% of the world's population.
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> 1.4 million children die every year from diarrhea caused by unclean water and poor sanitation - 4,000 child deaths a day or one child every 20 seconds. This equates to 160 infant school classrooms lost every single day to an entirely preventable public health crisis. (Lamoyne)

It's not unknown to anyone that 90% of the population is suffering from a lack of clean water. In rural areas in developing countries many women and children spend hours each day walking miles to collect water from unprotected sources such as open wells, muddy dugouts or streams.

Carrying heavy water containers back home is an exhausting task, which takes up valuable time and energy. It often prevents women from doing vital domestic or income generating work and stops children from going to school.

In urban areas water is collected from polluted waterways or bought from vendors who obtain it from dubious sources. The water is often dirty and unsafe, but people have no alternative.

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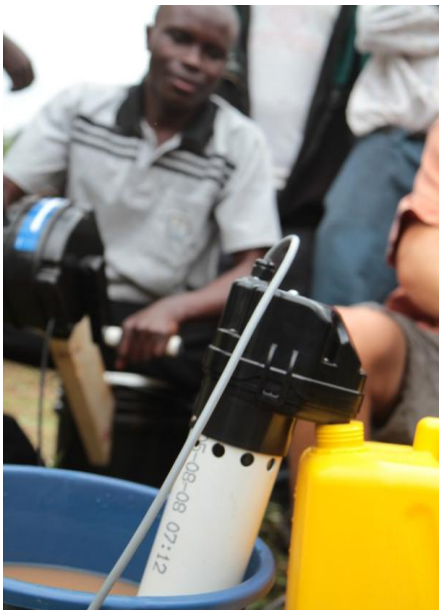
Diarrheal diseases caused by unsafe water and poor sanitation, such as cholera, typhoid and dysentery, are common across the developing world. People suffering from these diseases or caring for children who are ill from them are often unable to work to earn money, yet face large medical bills.

There is an urgent need for action, but too often water and sanitation are overlooked in global development agenda, despite being consistently cited as top priorities by communities themselves. (Lamoyne)

Background

The Better Water Solution

In 2005 Bob Bechtold invented the Better Water Maker UV water purifier. His goal was to help the women who were carrying contaminated water home each day to their sick children. Bechtold thought that by creating a device that could be sold for less than 100$, a woman could buy one with a loan. In this way, she would be able to supply her family with clean water and then pay back the loan by selling surplus water to her neighbors. Additionally, he founded “B9 plastics”, an NGO which oversees the distribution of the BWMs to NGOs and public institutions in the developing world.



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The Better Water Maker (BWM) uses ultra-violet (UV) light to inactivate E coli and other harmful microbes in water that cause water borne diseases like Cholera, typhoid, and Giardia. A manually turned crank generates 12v electricity to power the UV light and pump water through the cylindrical UV light chamber. Water flow is controlled to ensure sufficient

exposure to the UV light. An optional AC/DC converter is also available.

2 (Chamberlain)

The better water maker can be used in environments without electricity. The only replaceable part, the bulb, lasts for about 10,000 hours (which means the BWM can clean 250,000 gallons without the light needing to be replaced). Also, the bulb is a generic brand, allowing the owners to find replacement parts locally.

In theory, the BWM sounds like a great solution to many developing world water issues. Field tests were conducted in Malawi, Peru, Iraq, and Haiti. Each area had their own successes and shortfalls with the device. For example, the BWM cut the number of reported Cholera incidences in half in one region of Haiti, whilst in Iraq, one group set up a business selling the water to their community. On the other hand, a BWM was given to a school in Peru, and training on how to use the device was provided by a volunteer for two weeks. However, the BWM remained unused by the community. Other shortfalls include device malfunction, such as generator issues, due to poor assembly during manufacturing.

By the time I was introduced to the project, no one had done any long term field studies with the device. I wondered how the BWM would perform in a variety of locations besides the mama helping

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her family, such as a school, hospital, and business group. I wondered how easy it was to source parts locally, how frequently an owner would have to service the device, and if there was potential to manufacture the BWM within the country (versus shipping them from the US). Lastly, having researched many water aid projects in Kenya, I wondered how the BWM would rank among them. Through experimenting, I hoped to determine if the funding was well invested with the BWM or if it was better off funding one of the many other water projects in Kenya.

These questions drove me to Kenya where I worked with the BWM for four and a half months. Through my work with two schools, a hospital, and two business groups, I learned much about the BWM and how it can have a lasting impact in Kenya.

Location

The BWM field studies took place two hours from Kenya's capital, Nairobi, in the Gilgil district. The district of Gilgil has a population of 250,000 and is made up of the city Gilgil and surrounding villages. (A map highlighting Gilgil can be found in the appendix).

97% of Kenya's population is below the age of 64. Of this value, 42.2% are below the age of 14. (World Factbook). In Kenya 28% of the population does not have access to any form of sanitation and has the largest population using unimproved water sources. One child dies approximately every 20 seconds from diarrhea. About 90% of those deaths could be prevented through safer water, sanitation and hygiene practices, according to the WHO (Wakoli).

The most common water purifiers in Kenya currently are the ceramic pot filter, the biosand filter, and the life straw. Combustible material lines the base of the ceramic pot filters, so when the pot is fired in a kiln, the combustible material burns out, leaving a network of fine pores through which the water is filtered through. Water leaves these pots at a rate of 1 to 3 liters per hour

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and costs between $18 and $30 (Ceramic Pot Filter). The Life Straw is another popular brand name in water filters. This straw uses a fine charcoal filter to remove sediments from water. The straw itself costs $3 (Vestergaard). Lastly, SODIS is used in developing areas to kill bacteria in water. SODIS stands for Solar Disinfection. By placing water in clear containers, after 6 hours enough UV radiation passes through the bottle to kill harmful bacteria (Sodis). These are just a few of the water purification devices in the portable water purification market.

Overarching Goals

The goals of the four month BWM field study were as follows,

To identify and place the BWM in a variety of locations.

To teach individuals in each group how to use the BWM, and guide them in creating goals and an action plan for how they will use it.

To collect data on its mechanical performance, frequency of use, and impact.

To determine if there was marketing and manufacturing potential for the BWM in Kenya

Approach

To accomplish these goals the following approach was taken.

Placing the BWM's:

A needs assessment was conducted to determine the best locations to place the BWM's.

> Before placing the BWM's, I interviewed a woman from Gilgil's Water Resources association. This women recommended visiting 4 schools, one youth group, and a hospital. The goal was to choose the 5 places most in need of the BWM.

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Questions were used to assess who needed the BWM the most. These questions were about the number of people sick at the location from the local water and the source of the water. Also, I wanted to assess if the person in charge seemed responsible enough to use the BWM to benefit the most people.

After choosing the location each group was given **instruction** on how to use the BWM, and resources if needed.

Data was then collected on **Mechanical Performance** and **how the BWM was used**.

This data was collected through survey, which were conducted weekly at each BWM site. The surveys determind the use and performance of each BWM. (They can be found in the appendix) Following are a few of the questions mentioned in the surveys.

- How often the BWM was used
- How many liters it purified / how long it was used for
- Number of people reported sick
- Problems using the device
- If they cleaned the device
- Who was receiving the cleaned water
- And how many people received water

BWM project coaching:

Each week oine would check in with the group to go over goals and overview their plans to achieve them.

Market and domestic manufacturing potential

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The following groups were interviewed to determine the potential for marketing and manufacturing the BWM within Kenya

- National Water and Sanitation Expo – Kisumu, Kenya
- The CEO of Pureflow – a leading UV water treatment group - Nairobi, Kenya
- The assistant director of the Gilgil Water Distribution Facility – Gilgil, Kenya.

Results

After completing the needs assessment described in the approach, the BWM's were placed in five different locations, two schools, a hospital, with a family, and with a youth group. Initially a lesson was given on how to use the BWM. Then, each week data was collected in each location on the mechanical performance of the BWM, how often it was used, and if it was creating an impact how it was being used. Each group made significant progress in reaching their BWM project goals over the course of four and a half months. Lastly, enough information was collected from interviews to accurately judge whether or not the BWM had marketing and manufacturing potential in Kenya.

As mentioned in the background, the BWM's were placed in five different locations, two schools, a hospital, with a family, and a youth group. The Location profiles give brief background on each location a BWM was placed and that locations goal for using the BWM.

Location Profiles

Kimbo Primary

Kimbo is located in a rural area right on the bank of the Malewa River. It has about 180 students in the school. The walls are made from mud in most buildings. Students going to Kimbo come from

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families making about a dollar a day off their small farms. Their clothes are torn, some don't have shoes. People living in the bush are not as fluent in English as those living closer to town.

Student's and faculty drink water from the Malewa river during the dry season (November to May). Then from May to November the school drinks water mainly from their water tanks.

There are about 9 students reported sick per week due to water borne illness. This number is just an estimate however – the school doesn't keep an official attendance. The water borne illnesses affecting the students are amoebic dysentery, typhoid, and cholera.

Goal: The school's goal was to organize a group of students that were responsible for using the BWM and distributing water to their peers. Moreover, the school strove to distribute the water to students under the age of 10, who were more susceptible to water-borne illnesses.

Ngumo Primary

Ngumo Primary is located on a hill overlooking the village, Langa Langa.
Ngumo is much more developed than Kimbo. The walls of the schools are made of cement, and the classrooms are well stocked. However, the school has no electricity.
Student's going to Ngumo come from a 5 mile radius. Those coming from Langa Langa receive chlorinated water, whereas the students other villages like Gatundu or Mwitumberia receive raw water

Existing water problems:

Because the school is located on top of a hill, they rely on their water collection tank. However, red worms have been seen coming from the tank. This water as well as water coming from homes leads to at least 9 students, out of 250, reporting absent per week

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Goal: The goal of the school was to organize a group of students to be responsible for the using the BWM and distributing the water to the students. Moreover, the school strove to distribute the water to students under the age of 10, who were more susceptible to water-borne illnesses.

Gilgil Hospital

Martin Mburu delivering water to a patient and explaining to hospital faculty how the BWM works.

Location

Gilgil Hospital is located in Gilgil city. Gilgil is a city that has many shops, supermarkets, and technology stores yet it is several steps below Nairobi (maximum 3 story building were built). It's stores are well stocked. The city also is heavily polluted.

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Description of the Hospital

Gilgil Hospital is central to the region. It's government funded. There are several wards including Maternity, Drug ward, psych ward, general medicine ward. It treats about 500 patients.

Current water problems

The hospital's water problems vary by season. During the dry season, the hospital relies on the water that fill the tanks from the wet season. When those run dry, more water is shipped to them from a nearby river.

Many children come to the hospital reporting sick from typhoid or amoebic diseases. The typical patients just take pain-killers before they decide to come to the hospital. Even at the hospital many patients cant afford the antibiotics necessary to eliminate the parasite causing them pain.

The youth group which runs health awareness campaigns through the hospital were responsible for overseeing the BWM project.

Goal: The goal of the you groups was to collect, clean, and deliver water to "priority wards." The priority wards were designated by a head nurse as those most in need of clean water. They included the maternity ward, the general medicine ward, and the ward that would administer drugs to patients.

Joseph Kieri

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Joseph Kieri, leader of Gatundu Youth group, demonstrating the Better Water Maker to a women's group in his community.

Who is Joseph Kieri and why did he receive a BWM?

Joseph Kieri is a husband, father of two children, and subsistence farmer. His community receives raw water from a nearby river.

Goal: Joseph's goal was to sell water cleaned by the BWM to his neighbors, and use that money to pay off the $100 fee of the BWM.

Youth for Change

Location

Youth for Change (Y4C) operates in the Langa Langa village. People living in this village make from 5$ to 15$ a day.

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Water Problems in the area

The houses in Langa Langa receive chlorinated water piped to their homes. Those who can't afford the piped water may buy it from their neighbors for 2 kenyan shillings per 20 L (about $0.02). However, the community is well aware that even the chlorinated water can't be trusted. Sometime's there's too much or too little chlorine in the water to effectively kill the bacteria.

Youth for Change (Y4C) - Members

The group has youth members, ranging from 14 year olds to mid- 20's. They're focus is HIV/AIDS awareness. They're under the leadership of John Mbugua, 23. John grew up in Langa Langa, and attends Nairobi University part time.

Goal: the goal of this group was to sell water to the community members of Langa Langa. The money would be used to support group projects.

How did the BWM perform at each location?

Mechanical problems occurred with each of the five Better Water Maker's distributed. Following is a list of problems reported by each group.

Kimbo Primary

- 1-31-11: The BWM was given to the group.
- 2-2-11: (at the beginning of use). The hand crank could not power the BWM for periods longer than 20 seconds. One boy would use the crank for about 30 seconds, before needing to be

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replaced. Or sometimes two children would operate one hand crank by grabbing one arm each and circling at the same time.

- 2-28-11 : (after one month of use). There was a tear that formed down the side of the bucket used to sit on. This tear formed at the point where the wooden plank touches the bucket. This formed because the plank was not held securely into the bucket, the plank would constantly move up and down as the students turned the hand crank generator.
- 3-23-11: Received two new hand cranks. The hand cranks were both connected to one BWM with a y-plug (shown below). This would allow cranking on each hand crank to become significantly easier.

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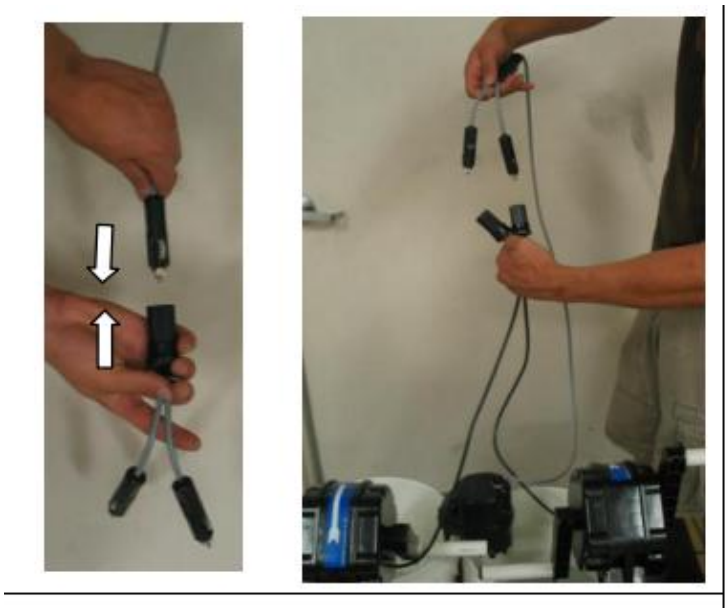

- When Kimbo placed the BWM's in the y- plug configuration, the bulb blew out.
- After inspection moisture was found inside the head circuit unit of the BWM

- Problem assessment
    - The bulb blew out because the positive and negative wires running from the hand cranks were soldered to the opposite poles. (So instead of the negative wire connecting to the negative pole, it connected to the positive one.) When the BWM was then connected to the hand cranks, the fuse in the bulb burst.

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- Once the wires were connected to the correct poles, the generators worked normally.

- Before the correction was made, tests were done to see how the reversed connection had an effect on how the BWM operated. One startling result was that water was able to run through the BWM even though the UV light was dead, causing dirty water to leave the device.
    - One tried to source the bulb locally. After weeks of searching, the electrician in Gilgil (the nearest city) was unable to source the bulb. A major producer of UV products in Nairobi was also unable to find this specific bulb that fit the BWM. His explanation was the BWM was a universal model. The UV company's in Nairobi sold bulb that could only fit their specific UV device, so the customers could only buy the bulb from them.
    - 3-31-11 Once the new generators were fixed, they were able to power the BWM long enough so the students could clean water for a minute and a half before stopping.

Ngumo Primary

- BWM problems
    - 3-1-11: Rust formed inside the female wal-wart that connects the BWM to the power source. At times the rust would prevent power flowing to the BWM. To fix this the students unscrewed the top, took out the fuse, and shook out rust filings from inside

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Figure 3 Female wal-wart

- There was rust on the male walwart which connects to hand crank generator. Once the female wal-wart was inside of it, it needed to be turned back and forth before power could flow between them.
    - During one dust cleaning the hand crank was suddenly became much easier to power

- How the students handled the BWM
    - Sometimes the students would place the BWM inside a small cooking pot to clean the water because they didn't have buckets readily available. The BWM can break if it's not submerged in enough water before being powered. Once this was pointed out later the teacher in charge bought two new buckets.
    - None of the five students in charge of operating the BWM handled it roughly.

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Youth 4 Change (Y4C)

- BWM Problems
    - Like Kimbo, the hand crank given Y4C proved too difficult to use. After about 20 seconds of cranking, the user was too tired to carry on. As a result, the group bought a car battery, which they connected to the BWM.
    - The BWM performed relatively well throughout the course of its use. Y4C only encountered one problem with it. Once they dropped the BWM and it stopped working completely. After further inspection, it was found that one of the two wires that connects to the motor, which pushes the water up and out of the BWM, had come lose. Once it was attached back on the device worked normally again.
- How it was handled
    - This group often needed to carry the BWM to different communities to clean and sell their water. To do this, wooden plannk that the hand crank sit on was stored in a backpack, while the BWM and the hand crank sat in the two buckets (one bucket used to collect the clean water, the other used as a seat the hand crank generator extends from), then the buckets sat on the knee of the person riding the motorbike.

Joseph Kieri

- BWM Problems
    - 2-11-11 Joseph's hand crank generator was about 6 months older than the ones given to the other groups, because he received his the previous May. At first his hand crank was performing much better than the ones in the other groups. It could power the BWM for several minutes before the user chose to stop (versus the users of the generators in the

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other groups would stop when they were too tired to continue, which was usually after about 2 minutes)

- 3-1-11, One arm broke off the hand crank.
- 3-30-11, Joseph received a new working generator to replace the broken one.
- Joseph did not report any problems with the BWM pump unit itself.

- How it was used
  - The BWM was never used roughly and was only carried from location to location.

Hospital

- BWM unit
  - No problems were reported with the BWM.
  - This group did not use the hand crank generator. They relied on the hospital's electricity.
  - An extension cord was purchased so the group could clean water closer to the hospital's water catchment tank.
- How it was being used
  - The BWM was never used roughly and was only carried from ward to ward.

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Was it used effectively?

How effectively the BWM was used was based on, how often the water was cleaned per week, how many people received the water, the number of liters cleaned, and if the water was going to people in need of it.

The following chart shows how the BWM was used changed overtime.

	Kimbo		Ngumo		Hospital	
	Before	**After**	**Before**	**After**	**Before**	**After**
Times Cleaned Per Week	**3**	**3**	**4**	**5**	**3**	**3**
# People Receiving Water	**15-20**	**200 students**	**15-20**	**150**	**Uknown**	**Uknown**
# Liters Cleaned	**18**	**510**	**40**	**100**	**60**	**80 – 100**
Distributed to those in need	**75% to Teachers 25% to Students**	**All Students**	**75% to Teachers 25% to Students**	**All Students**	**Psychiatric Ward, and Youth Group Offices**	**Maternity, General Medicine, and Drug Wards (considered high priority)**

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Kimbo

The mechanical issues with Kimbo's BWM effected it's performance initially. The numbers changed over time due to the organizational issues at the school, as well as issues with the BWM. Initially, the students were only capable of cleaning 6 liters of water in 30 minutes. There was also an issue with the bulb burning out at the school. Even when it appeared the hand crank generators were working well, and that they were cleaning a lot of water, as shown by the sheet, the water was not actually clean. This occurred for roughly a week. Afterwards, the students left for vacation in April. During break a working generator was received. At this time, they were cleaning 170 liters and were able to distribute it to 100s of students each day for several weeks. When the wet season began, the school transitioned over to using water tanks and set the BWM aside for later use.

Ngumo Primary

Initially, the school was cleaning the water 4 times per week for 30 minutes at a time. During each cleaning roughly 10 L was being cleaned. Additionally, the teachers (considering there wasn't enough to go to all the students) they were using for their lunches and tea in the kitchen. They understood that boiling the water would have the same effect as the UV cleaned water, but they felt that he UV water would be somewhat cleaner so they used it in the kitchen. The buckets the school was using was also too small—the BWM must be completely submerged to work. These were solely setbacks to attempts to mass distribute the BWM. As mentioned in the mechanical performance section, there were issues with powering the BWM due to rust problems. One of the students at the school discovered a method of improving the efficiency of the generator. Since that time, more water was cleaned per week . It is not clear exactly what was done, however the program for water cleaning improved in consequence. A

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group of five students were responsible for the cleaning, which allowed the students overall to increase the water output. Eventually, roughly 100L of water was being cleaned each day and being distributed to about 150 students.

Youth 4 change

Youth4 Change's primary aim was to sell water to individuals, families and groups within and on the outskirts of the town. To achieve this goal, they conducted numerous demonstrations, until a local market was established. Initially, the group was met with limited to no success. At first they didn't have the materials to give the demonstrations. To help market the BWM, the group was given: handouts, reading materials. Though not all material was used, after a few months of demonstrating the group finally found a community to sell the water to on the outskirts of Langa Langa. They were selling house to house. People would have a bucket of water ready for them to clean – and they would go door to door to do so. In addition to this, the Secretary of Youth for Change, Yvonne, found another potential market for the BWM. Her mother was a nurse, and she said that the patients were willing to buy the water from us. She had a plan to visit them twice a week use their local water tank and deliver the water. This was the first hopeful move made from youth for change.

Soon after both projects were underway, the rainy season struck and people stopped purchasing water. Rather, the majority of homeowners would rely on water from their tanks. During the rainy season the majority of homeowners drink water from their water tanks.

Materials were passed out during their demonstrations, as well as a different BWM booklets that talked about the advantages of the BWM compared to other water improving means. I tried to source them a few water testers, which posed it's own set of challenges.

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We went through different people, and didn't end up with any water testers. Once someone said they had testers that only took 2 minutes to yield results. This man worked at one of the nearby water treatment facilities, and he would only talk to John - he thought I could be someone out to get him fired because he's selling to people behind the company's back. Regardless, we didn't end up needing his tester's because we found out once we were finally able to obtain them that they solely tested for chlorine. Eventually we got some powder E. Coli tester's in the mail from B9

I also gave this group reading material to prepare for the community meetings where they pitched the BWM, and fliers to hand out during them. I'm not sure how much this material even helped the group in the end.

No success

For a while the Y4C group wasn't getting anywhere in selling BWM water. They were giving demonstrations to a variety of groups , like women's groups, church groups, and other youth groups, but no one was contacting them to buy water.

Y4C found one group to sell to on the outskirts of Langa Langa. They were selling house to house. People would have a bucket of water ready for them to clean – and they would go door to door to do so. But the whole project was very unsustainable. They were traveling too far and making too little money. Eventually the rainy season struck and no one was buying water because they would rely on water from their tanks. After I left I got reports that John had stopped the project. It was still the rainy season, and people still weren't buying from them.

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Joseph Kieri

Joseph Kieri's case was the most unsuccessful of all the groups. He was unable to sell water to any of his neighbors. He did clean about 20L of water a week for his own family, however.

Hospital

Though a approximately 300 patients were treated daily, the hospital was only able to attain 2 buckets to purify water with the BWM. A total of 11 unpaid students worked to clean and distribute the water in the hospital, during a few hours of the week. Students cleaned about 60 liters/week and distributed the water to the psychiatry ward. Knowing that psychiatric patients drank contaminated water daily, an adjustment was made in the distribution methods so that the water could be provided to a group where an impact could be more easily made. Thus, the hospital began giving the water to the maternity and general medicine wards. At this time, students were providing roughly 80L/week of clean water to patients. Due to a high percentage of outpatient care, and short term in-patient care, the clean water reached a greater number of people. Water obtained from the local the river and from water tanks—both originally contaminated.

Does it have marketing and manufacturing potential?

To assess whether the BWM had marketing and manufacturing potential, interviews were conducted with the Gilgil Water Treatment Association, groups attending the National Water Expo in Kisumu, the CEO of a popular UV water treatment company, and the Kenya Bureau of Standards. Below is a list of relevant information gleaned from each group to help assess if the BWM had either of these potentials.

From an employee in the offices of the Gilgil Water Treatment and Distribution Group:

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- The Water treatment facilities in the district only have the capacity to clean and distribute water to 35% of it's residents. The water group relies on the help of foreign aid to reach the remaining 75%.
- There are four water kiosks set up throughout the Gilgil district. They provide chlorinated water to residents either for 2 ksh ($0.02) per 20L or simply for free.

At a National Water Expo held in Kisumu, about six other groups displayed their water purification equipment. None of the products on display were at all similar to the BWM. The products ranged from high quality water purifiers that cost about $100 - $300, to slow gravity fed filters priced at $5. A list of each product and price can be found in the appendix.

Through discussions with PureFlow CEO David Maina I also learned that there was great manufacturing potential for the BWM. PureFlow, a top UV water purification producer, had invented a device very similar to the BWM, but the device was too expensive for the company to manufacture. After noting the similarities between the two devices, Mr. Maina shared details about how the company uses their devices and a survey system to build capacity within each community they work. He provided details about how to set up preliminary water kiosks, which lead into community-run water kiosks. Furthermore, he shared information about how to keep the system sustainable, such as price changes based on kiosk location, as well as other methods for how to better integrate the BWM in communities for a sustainable and long-lasting impact.

Conclusions and Recommendations

Placing the Better Water Maker at each site enabled the identification of locations where the BWM would be of greatest use. Though the project was met with varying degrees of success in each area, this assessment provided detailed information about how to improve the BWM so that it can be integrated in a wider variety of settings. Overall, the greatest success was observed in the schools, as they were easily able to adapt to using the BWM. In such environments, the BWM was considered both

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fun for the students to use and a form of exercise. Additionally, the school's ability to organize a group of students to manage and distribute the water, further showed that schools are a worthwhile investment.

Kimbo Primary School

After three months of using the BWM, the students and staff at Kimbo were carrying out a plan that allowed 160 students to receive water at least three times a week. At the start of the study, the staff was using the water for themselves, and not distributing it to the students. Once the staff understood more about waterborne diseases and its effect on young children they became more willing to distribute the water to students. Though the school attained its goal of giving clean water to the majority of school attendees, many younger students were still denied water by their older peers. Also, once the wet season struck, students and teachers stopped using the BWM and the river water, and began relying on solely water tanks.

To address these issues, first, more water education lessons need to be taught to students and faculty. The more teachers know about the bacteria that contaminates their water tanks, the more likely they are to continue using the BWM through the wet season. During these lessons, it may also be beneficial to use the water testers as a visual aid. To the majority of Kenyans, seeing is believing. Thus, visuals would be highly effective in helping adults and children understand the detrimental effects of poor water quality. Only two water testers were allotted for use at Kimbo during my four months on-site.

In order to help the younger students gain access to clean water, Kimbo's water distribution routine must become more structured. Greater supervision by teachers would also help create the order. Additionally, if a small group of students took charge of the water distribution process, as done in Ngumo, more order could arise.

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The school would also benefit from increasing the number of containers at the school, so as to augment the impact of the BWM. If more water could be stored, the student's would need to spend less time during the day to clean it. Lastly, it would be helpful to have a source of power that could be generated by multiple students at once**,** such as a device similar to the Play Pump Merri-go-round. The Play pump merry-go-round pumps water from a bore hole as children play. It would be useful to create a merry-go-round that could generate the energy necessary to power the BWM. This way the students' energy could be used toward cleaning more water, and there would be less fighting to play with the BWM hand crank.

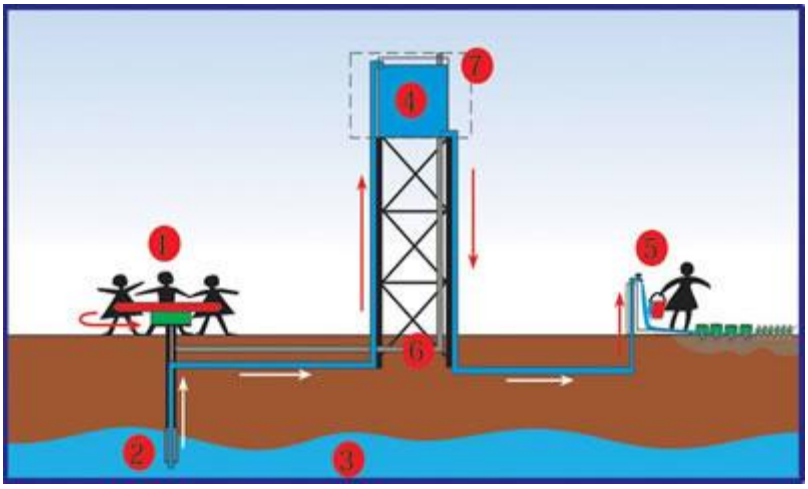

Figure 4 (Play Pump)

Ngumo Primary School

Ngumo's goal was to distribute water to as many students as possible, as frequently as possible, and to make sure younger students, under the age of 10, had access to the water. Ngumo made significant progress in reaching their goals. They went from cleaning 20 L of water per day and giving the water to solely teachers, to a student group cleaning at least 50L and day and distributing it to other students. Also, the student group not only cleaned water for the school, but they were would spread awareness of

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water borne diseases across the school. However, like Kimbo, it was difficult to get clean water to the students under age 10, as older students tended to keep the water for themselves.

If more than one BWM could be brought to the school, more water could be cleaned, and it would likely create a measureable impact. As with Kimbo, if the school purchased a water tank, clean water from the BWM could be stored inside it and made readily available to all the students.

Hospital

Bringing the BWM to this group was very successful. The BWM was used by a group of highly-motivated individuals that provided 200L of water to the hospital per week. Furthermore, through its use the community, hospital staff and administration became more familiar with the machine. The youth group introduced the BWM to each ward, and with time the heads of each ward showed support for the BWM project. As a result, the hospital staff began showing interest in getting all of the hospital's water improved by the BWM. To achieve this goal, the staff plans purchase more buckets and a central tank that the BWM can be connected to.

Though the hospital appears to be the best example of the need for an investment, the time needed to get administrative support and funding from the hospital far outweighed the youth group's ability to rally community *and* hospital support in just four months. Due to the hospital's inability to make decisions quickly, It is not likely the administration would have created such an impact in such a short period of time.

In order to receive funding for the BWM project, the BWM would need to be advertised to the Ministry of Health. It is recommended that the BWM be placed in a second hospital to gather more data on it's impact (Pureflow, 2011). Also, if work was to be done with a hospital group again, some form of

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commitment to the project would be required from the responsible party before receiving a BWM. For example, a draft of a scheme for using the BWM and necessary monetary investments would be necessary. A series of incentives should also be included to keep administrative officials accountable throughout the implementation process. I recommend making progress indicators with the group. These could motivate the group to progress, and it will help them understand how significant their work is to the overall BWM global project.

In order for the BWM to make an impact, the hospital must invest in storage containers. If the hospital cannot afford both the BWM and containers, then it would be worth sitting down with them to re-evaluate their goals for the BWM use. The evaluation would include an assessment of how many people they need the water to go to, and how much time they have to put into the project. The ultimate goal of this assessment is to help the hospital focus their objectives, so they can accurately assess how many BWMs and/or containers they need. From here, the initial investment cost would be calculated and an investment timeline developed.

The business groups: Youth for Change

Though the Youth for Change group was unable to sell the water to a large populace, they were the first group to try to sell water in the Langa Langa region. As a result of their work, we know what materials are required for demonstrations and the challenge the wet season brings.

During demonstrations, the customers needed a way to validate that the BWM was producing clean water. Certificates and testers would be helpful toward this end. If the BWM had a filter that changed the appearance of the water coming from it, this would help the BWM most. It takes a great deal of effort to get the community to adapt to the BWM technology, but less effort if the technology adapts to them. Lastly, packaging the water in a bottle with a sealed lid would also serve as a sign that

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the water's clean. Thus, investing in a BWM filter, bottles, and bottle sealers would be useful to such groups.

In addition to these suggestions, setting up a small kiosk to sell the water from would also be helpful. The company PureFlow had two different kiosks that could be used as models to base the BWM kiosk off of. Their kiosks provided containers people could make deposits on and use for their own water. They had a station where they could clean the water from as well as seals that they would blow dry to fit the shape of the bottle cap. Pureflow has a uniform logo for their treatment centers and their members had matching shirts. Lastly, they had a kiosk that was different in a rural setting versus a sub-urban. In the rural setting, again, people need visual validation that their water is being treated. So the rural water kiosk, the Pure Flow's UV treatment is visible. However, in the sub-urban setting people believe that purifying water is a complex process, so if they see simple equipment they don't believe it's getting treated enough – so in that setting the treatment system is placed out of site.

Another recommendation for the group would be to invest in containers for water storage. In John's case they went door to door cleaning people's water – or just cleaned it directly from the water tank. But again, if we want people collecting water in one location, it's important that the water is being stored somewhere, and is always readily available for people to take with them.

Joseph Kieri

Based on this experiment we saw that it was extremely challenging for Joseph to sell water in Gatundu. Similar to the Langa Langa community, Gatundu also held high expectations for water the water they would buy. Joseph faced a greater challenge than John's group because Joseph was trying to sell water to people who lived their whole lives drinking free raw water. The community members pointed out to Joseph that if they were going to buy water it had to look, taste, and smell cleaner than what they were

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used to. If the water is clear, sealed with a plastic cover, and has a flashy logo, they are much more willing to trust and buy the product. However, again the BWM water looked the same as before it entered the device, and Joseph's only proof that the water was clean, was from water testers that took three days to show results. In effect, the people in Gatundu continued drinking water from their nearby stream or water tank.

If more work was done in Gatundu, it should be around more water disease education. Though Joseph tried his best to teach his neighbors about the severity of water diseases in their region, he wasn't consistent in following up with a group. He would talk to one group and if they weren't interested in the product he would move on to the next. If Joseph met with one group twice a week for four weeks, his odds may have increased around selling his water.

Marketing and Manufacturing Potential

Based on the information gleaned from the water distribution plant, the national water expo, and from Pureflow there is potential to market and manufacture the BWM in Kenya. The devices that cleaned water as fast or faster than the BWM were much more expansive than it (again the BWM sells for 100$, whereas the UV devices at the conference were of professional grade and at least $100 more expensive.) The devices that were as cheap or cheaper than the BWM were not able to clean water as fast. This includes devices like gravity fed ceramic and charcoal filters. Also, the CEO of Pureflow was excited and interested in testing out the BWM to see if it's something their company may want to take on. Lastly, many of the people to whome the youth for change and Joseph presented the BWM, wanted to buy the BWM itself (not the water coming from it, to Y4C's and Joseph's dismay). If more than five BWM's were brought to Kenya, they would have sold easily.

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From these results, one could conclude that there is a niche for the BWM in Kenya and it can be marketed in the country.

Final Recommendations

If B9, again the NGO manufacturing and distributing the BWM in NY, wanted to seriously consider mass manufacturing the BWM's in Kenya, the following steps would be recommended. (These steps were told to me by the CEO of Pureflow)

First, more BWMs would need to be tested in similar settings to those where they already existed – meaning, a second school, hospital, and business group. The goal being to collect more data on how the BWM is used to present to the Ministry of Health. If, for instance, they see that the BWM can decrease the number of sick students reporting absent from school, they may choose to fund the project.

Second, the leader of any BWM project must be invested in the project in some form, but especially through money. This way they experience the consequence of not being responsible for the success of the project.

Lastly, a steadfast action plan must be created from the beginning. Also part of this action plan will include how the operator will obtain the tools necessary to succeed, even if it means taking out a loan from the distributing NGO.

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Acknowledgements

I would like to thank the following individuals for their help in guidance in making this project possible.

Dr. Diran Apelian - *Howmet Professor of Mechanical Engineering, Director, Metal Processing Institute (MPI).* Thank you for advising this project from the freshman "Great Problem's Seminar Project" in 2008 to the Inter-Qualifying Project in 2012. Thank you for lighting the spark that grew into this five month field study.

Karin Nunan - *IHSAN(Industry's Humanitarian Support Alliance NGO) board of directors*. Thank you for connecting me to the Better Water Maker Project, B9 Plastics, and my new Kenyan family.

Kate Chamberlain and Bob Bechtold, with B9 Plastics. Thank you for giving me the opportunity to field test your product. I hope this data has helped guide the BWM's future.

Chris and Christine Campbell Clause – with the Malewa Trust, GilGil Kenya. Thank you for providing me free accommodation and the office space where I worked with the project.

To Naomi Mumbi, John Mbugua, and Joseph Kieri – thank you for being great teammates. You've helped move the BWM on it's journey.

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Appendix


KENYA
Administrative Boundary
SUDAN
ETHIOPIA
UGANDA
SOMALIA
UNITED REPUBLIC OF TANZANIA
INDIAN OCEAN
Konso
Negêlê
Yabelo
Houdat
Kelem
Ch'ew Bahir
Todenyang
Lolimi
Banya
Sabarei
Mega
Dolo Odo
Banissa
Ramu
Mandera
Lokichokio
Kakuma
Lokwa
Kangole
Lake Turkana
(Lake Rudolf)
Kaabong
North Horr
Moyale
Takaba
Lodwar
Loiyangalani
Buna
El Wak
El Beru Hagia
Moroto
Lokichar
Marsabit
Girito
Tarbaj
Lokori
Wajir
Baragoi
Laisamis
RIFT VALLEY
EASTERN
NORTH-EASTERN
Mbale
Kitale
Maralal
Kisima
Archer's Post
Habaswein
Dif
Tororo
WESTERN
Lorule
Mado Gashi
Busia
Webuye
Eldoret
Butere
Marigat
Nyahururu (Thomson's Falls)
Isiolo
Kinna
Liboi
Kakamega
Nanyuki
Meru
Hagadera
Bilis Qooqaani
Kisumu
Londiani
Solai
Nakuru
Mt. Kenya
5199 m
Molo
Nyeri
Garissa
NYANZA
Kericho
CENTRAL
Embu
Homa Bay
Kisii
Gilgil
Naivasha
Murang'a
Nguni
Migori
Narok
Thika
Mwingi
Bura
Kolbio
Buur Gaabo
Nairobi
NAIROBI AREA
Kitui
Hola
Kaambooni
Musoma
Machakos
Kajiado
Sultan-Hamud
Magadi
Lamu
Garsen
Kibwezi
Namanga
Mtito Andei
COAST
Kilimanjaro
5895 m
Tsavo East National Park
Tsavo West
Arusha
Moshi
Voi
Malindi
Taveta
Kilifi
Mariakani
Same
Mombasa
Moa
Wete
Korogwe
Tanga
Pemba I.
National capital
Provincional capital
Town, village
Airports
International boundary
Provincional boundary
Main road
Secondary road
Other road or track
Railroad
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
0 50 100 150 200 km
0 25 50 75 100 mi

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BWM Survey Questions

Name: Date:

Company/Association:

Your information is incredibly valuable to us and towards improving our product. We would appreciate your response every 3 to 6 months.

Forms can be electronically submitted through our website- http://www.b9plastics.org/evaluation.html

*please call or email info@b9plastics.org , any time, with questions, concerns, or comments.

1. When and how did you begin using the Better Water Maker?

2. How often do you use it?

† a. Daily: Approximately _____ times

† b. Weekly: Approximately _____ times

† c. Less than once a week: Approximately _____ times

*if you answered “C” please explain why:

3. How easy was it for you to set up the device?

† a. Very easy- no problems.

† b. Somewhat easy-a few problems.

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† c. Very difficult/confusing

*if you answered “B” or “C”, please explain ANY problems:

4. What was your power source?

† a. Hand crank

† b. Wall plug

† c. Other_____(please describe)

5. Did you encounter any problems using the device?

† a. No problems.

† b. A few problems.

† c. Very difficult/confusing

*if you answered “B” or “C”, please explain ANY problems you had:

6. On average, how long did you use the device each time?

† a. 30 minutes or less

† b. 30-60 minutes

† c. 60 minutes or more

*if “C” what was your average time?

7. Did you test the water before treatment?

† Yes

.

† No

If yes, please explain your procedure and the results:

8. Did you test the water after treatment?

† Yes

† No

If yes, please explain your procedure and the results:

9. Approximately how many people have drunk treated water from the device?_____

Please describe the general population:

10. Did anyone who drank treated water have any adverse reactions?

† Yes

† No

If yes, please explain

11. Did the device ever malfunction?

† Yes

† No

If yes, please explain

12. How often did you clean the device?

† a. Daily

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† b. Weekly

† c. Monthly

† d. Every_____ uses

13. What was your cleaning procedure?

14. Please include a brief narrative about your experience that we could potentially use when telling the story of The Better Water Maker. If possible, photos/video of the device in use, people drinking the water, and/or the local environment would also be appreciated.

Records Sheets

Gilgil Hospital WATER PURIFICATION RECORDS

PLACE	DATE	AMOUNT IN LITRES	PERSON IN CHARGE	COMMENTS
WARD 4	2/03/2011	20LTRS	DENNIS ONKARI	*DO THIS DAILY*
WARD 11	4/03/2011	40LTRS	MARTIN MBURU	*NEED OF MORE BUCKETS*
MARTENITY WARD	9/03/2011	120 LTRS	AMU EKENO	*MOST OF BWM NEEDED*
LAB	16/03/2011	25 LTRS	MARTIN MBURU	*GOOD START*
MARTENITY WARD	18/03/2011	80 LTRS	MARTIN MBURU	*MACHINE IS SLOW*

.

			AMU EKENO	
WARD 11	23/03/2011	60 LTRS	MARTIN MBURU	*PERFECT*
C.C.C	25/03/2011	25 LTRS	MARTIN MBURU	*NEED OF MORE MACHINES*
Y.F.C	30/03/2011	60 LTRS	MIKE GICHUKI	*ABOVE AVARAGE*
PSYCHIATRIST	1/04/2011	150 LTRS	AMOS BERE	*KEEP IT UP*
MARTENITY WARD	06/04/2011	80 LTRS	AMU EKENO	*GOOD JOB*
CCC	08/04/2011	40 LTRS	MARTIN MBURU	*FAIR*
PSYCHIATRIST	13/04/2011	100 LTRS	AMU EKENO	*ECONOMICAL*
MARTENITY WARD	15/04/2011	80 LTRS	MARTIN MBURU	*EASY TO USE*
LAB	20/04/2011	45 LTRS	MARTIN MBURU	*UPGRADE*
MARTENITY WARD	22/04/2011	80 LTRS	AMOS BERE	*FAIR*
WARD 11	27/04/2011	40 LTRS	AMU EKENO	*COME AGAIN*
Y.F.C	29/04/2011	25 LTRS	MIKE GICHUKI	*GOOD*
C.C.C	04/05/2005	40 LTRS	MARTIN MBURU	*MORE MACHINES*
WARD 4	6/05/2011	40 LTRS	MIKE GICHUKI	*ISSUES OF BUCKET*
MARTENITY WARD	11/05/2011	80 LTRS	AMOS BERE MARTIN MBURU	*BETTER*
MARTENITY WARD	13/05/2011	25 LTRS	AMOS BERE AMU EKENO MARTIN MBURU	*NO HOPE OF BUCKETS*

A POSITIVE START FOR A SUCCESFULL CONCLUSION

.

BY :-

MARTIN MBURU

Ngumo

Date	Time Start	Time End	Litres	Water Source	Number Pupils given water	Number Absences	
29-3-11	1:00pm	2:00pm	25	Tanks	20	5	
30-3-11	1:00pm	2:00pm	54	Tanks	195	7	
4-4-11	1:00pm	2:00pm	48	Tanks	157	6	
5-4-11	1:00pm	2:00pm	60	Tanks	199	5	
6-4-11	1:00pm	2:00pm	58	Tanks	190	4	
7-4-11	9:30pm	10:40am	70	Tanks	198	5	
9-5-11	11:00	11:30am	35	Tanks	25	200	
10-5-11	11:00	11:30am	38	Tanks	30	150	
11-5-11	11:00	11:30am	50	Tanks	70	100	
12-5-11	11:00	11:30am	100	Tanks	150	50	

Kimbo

.

Date	Time Start	Time End	Litres	Water Source	Number Pupils given water	Number Absences
22-3-11	10am	10:15	6L	River	20	
23-3-11	11:42	12:02	20L	River	100	
23-3-11	1:05	1:45	40L	River	130	
24-3-11	3:20	4:15	70L	River	163	7
25-3-11	1:06	1:54	50L	River	167	3
28-3-11	1:14	1:45	60L	River	168	2

Products on display at the Kisumu National Water Expo (1ksh ~ $0.012 USD)

1. David and shirtliff products
    a. Podrollo , 5,500 ksh
    b. Hydrofresh and Pump , 20,000 ksh
    c. Generator ksh94,000
    d. Reverse Osmosis for water treatment – ksh36,000
2. SAHA
    a. Filtration tube
    b. Eco-toilet ksh12,000/ 13,000
3. Safe water and AID's project
    a. Pot, ksh450
    b. Water filter – ksh1,150

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c. Home washing bucket (sp?) ksh 600

d. The taps – ksh150

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