The MHET

Team Pat (Group 1)
Alex Hanks
Tomas Alonso Valverde
Patrick Clements
David Lopez
Mission Statement

Our mission is to create a renewable energy source that is; portable, inexpensive, durable, compact, easy to use, and also that has multiple functions of use. We will do so by coming up with various ideas and collaborating collectively to come up with a product that works. This product will be aimed to be sold to consumers in developing countries as they do not have the means of efficiently and inexpensively charging their cell phones. Our product will aim to fix this problem in developing countries.

Concept Development Summary

Location/Context Research:

Kenya has had a rough start from the beginning. Kenya was once a British colony gaining its independence in 1960. It then became a single-party state from 1969 to 1982 when the Kenya African National Union made itself the sole legal party of Kenya. A lot of conflict since then, for example the U.S embassy was bombed in 1998 by Al-Qaeda. Kenya is in Eastern Africa, bordering the Indian Ocean, between Somalia and Tanzania. It has a varying climate, near the coast it has a tropical climate, however as you go inward it becomes more arid. There are many languages spoken in Kenya, such as English, Kiswahili and numerous indigenous languages. Kenya has very little natural hazards, one that always affects Kenya is recurring drought; flooding during rainy seasons as well as volcanic activity, but the last time there was a volcano warning was in 1921 when a volcanic eruption occurred.

The country of Kenya has one of the most successful agricultural production regions in Africa, it mainly consists of tea, coffee, corn, wheat, sugarcane, fruit, vegetables; dairy products, beef, fish, pork, poultry and eggs. The agricultural sector is the backbone of the Kenya’s
economy. This sector directly contributes 24% to the GDP and 27% GDP indirectly through linkages with manufacturing, distribution, and other services related sectors. Over 80% of Kenya’s 42 million population works at least part-time in the agricultural sector.

Out of the nation’s GDP only 2.4% is invested in its health care system. With a population of more than 43 million kids under the age of 15 the lack of investment has serious implications for the country’s urgent health care problems. Currently Kenya’s health care cannot meet the vast needs of the people. Tropical diseases, especially malaria and tuberculosis, have long been a public health problem in Kenya. In recent years, infection with the human immunodeficiency virus, which causes acquired immune deficiency syndrome, also has become a severe problem.

Kenya is a low-income food-deficit country. A possible solution to rising food prices is to increase rural food production. Agriculture in Kenya currently does not meet its productive potential, therefore it may be possible to reduce the prices of domestically-grown crops by increasing agronomic capacity. According to the Joint Monitoring Program’s 2012 report, access to safe water supplies throughout Kenya is 59% and access to improved sanitation is 32%. There is still an unmet need in rural and urban areas for both water and sanitation. Kenya faces challenges in water provision with erratic weather patterns in the past few years causing droughts and water shortages. Kenya also has a limited renewable water supply and is classified as a water scarce country. Due to lack of access to water and sanitation, diarrhea is second to pneumonia in deaths in children under five years of age. Water, sanitation and hygiene related illnesses and conditions are the number one cause of hospitalization in children under age five. Access to water and sanitation also contribute to time savings for women, more hours in school for girls, and fewer health costs.
In 2010, the US gave $7 million of funding towards education. Kenya spends 6.6% of its GDP on education. One million children are still out of school in Kenya. While this is almost half the number in 1999, it is still the ninth highest of any country in the world. Primary education is not of sufficient quality to ensure that all children can learn the basics. Among young men aged 15-29 years who had left school after six years of schooling, 6% were illiterate and 26% were semi-literate. The figures are even worse for young women, with 9% illiterate and 30% semi-literate after being in school for six years. The numbers have worsened over time for illiteracy in young women, in 2003 there was a 24% illiteracy rate, in 2008 it has gone up to 36%.

Our case study surrounds a small coffee farming family, the Obamas. The Obamas are a small family in rural Kenya. The Obama family is a fairly nuclear family. The father, Barrack, is 54 years old and is the head of the family. Michelle is his wife and is slightly younger at 51 years old. They have three children, Natasha, who is 14, Malia is his oldest daughter at 17 years old, and their one son Bo is only 5 years old. They all work hard on the Obama family coffee farm but only make about one to two dollars a day. They own a small flip phone but they have a major problem with charging it due to the fact that their farm is relatively remote. They are lucky enough to have access to a source clean water in a nearby stream. They also have access to basic education and Natasha and Malia have both finished their schooling, with Bo just starting his. Based on the fact that they have gone to school Natasha and Malia are decently literate and their parents have very basic skills when it comes to reading. They live about two hours by foot away from the nearest charging station so they rarely use their phone and try to conserve battery.
Desired Features/Criteria:

Firstly we started by outlining some design features and criteria that our product had to have. We all collaborated and came to the conclusion of 6 important design criteria, which at first were vague, as listed below:

- Portable
- Inexpensive
- Durable
- Compact
- Easy to use
- Multiuse

With these ideas of customer needs in hand we were able to start thinking of ideas for the product, knowing what our mission was, and with a rough idea on how to make our goals possible.

Early Designs/Concepts:

As a group, we decided to come up with a few ideas each and then collaborated on which ideas we deemed to be best. Each of us had at least one idea from each other. Below are a few images of ideas that we deemed as promising but did not make it to the prototyping stage:
<table>
<thead>
<tr>
<th>Idea</th>
<th>Portable</th>
<th>Inexpensive</th>
<th>Durable</th>
<th>Compact</th>
<th>Ease Of Use</th>
<th>Multiuse</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea 1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>70</td>
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<td>Idea 2</td>
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<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>Idea 3 (chosen idea)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>111</td>
</tr>
</tbody>
</table>

**Test Report Summary for Prototype #1**

<table>
<thead>
<tr>
<th>User Need</th>
<th>Test Description</th>
<th>Goal</th>
<th>Meet Goal?</th>
<th>Materials Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable</td>
<td>Weigh the prototype</td>
<td>Weigh less than 5lbs</td>
<td>Yes</td>
<td>Scale</td>
</tr>
<tr>
<td>Inexpensive</td>
<td>Find cost of each material used</td>
<td>Total cost of under $10</td>
<td>Yes</td>
<td>Internet</td>
</tr>
<tr>
<td>Durable</td>
<td>Drop test from 10ft</td>
<td>Does not break, remains in one piece</td>
<td>Yes</td>
<td>Chair, Tape Measure</td>
</tr>
</tbody>
</table>
Portability:

- We need our product to be portable because the use requires one to bring it to a moving body of water. Seeing as many individuals in developing countries have to walk a great distance to get water, we wanted to make sure our product is lightweight. We wanted to make it weigh less than 5lbs because that would mean very little strain on the user but also it is a reasonable weight taking into consideration the different parts needed.

Inexpensive:

- The product needed to be very inexpensive to make because it has to be sold at a low price. Individuals in Kenya have on average a GDP per Capita of only $1358.30. This is barely enough to live off of so buying a product to charge a cell phone has to be very inexpensive. Based on this information we decided to make the product have a goal to be under $10 to buy which means it has to be under $6 to make in order for this to possible (with transportation and production costs). We researched how much the materials would cost to make the product, they are listed below.
  - Battery: $3.50 (when purchased in bulk)
  - Plastic and cost of shaping: $0.30
Fans: free, taken from old computers and unwanted machinery

Wiring: $0.13 per ft. (for high quality wiring, Cerrowire)

- Total Cost: $3.93

This means that there is $6.07 available for production and transportation. Let’s say we aim to make $2 profit, this still leaves $4.07 to production and transportation. This is obviously an ideal cost, but when buying products in bulk this is an attainable goal.

Durable:

- We needed to make sure the product is durable because when individuals remove the product from the water it may become slippery. This could lead to an issue of the product breaking and a replacement needing to be sent. We made sure the prototype was durable by dropping it from 10ft. This is because it is unlikely that it would ever reach heights greater than 10ft. This was a success, the internal parts remained in place and the external parts were all still in place. This was most likely due to the quality of the plastic used in the prototype.

Compact:

- Going along-side the idea that it has to be portable, it also has to be compact. This is not only for convenience when carrying purposes, but also for storage purposes. Houses in Kenya aren’t very spacious as it is, so there isn’t much room for a large charging devise to be stored. We decided that 1 cubic foot was a good size in maximizing effectiveness but also for convenience of transport and storage. We tested this with a ruler and found that the prototype was indeed less than 1 cubic foot.

Ease of Use:
We understand that individuals in developing countries do not have the same technological experiences and knowledge as us here in the United States, and also that there would be some language barriers so we decided to see how well diagrams would explain how to use our product. We went around the class and asked individuals if they understood how the product worked just from the pictures. Over 75% of people we asked understood how to use the product and also the different uses for the product. This was a success in our eyes because we came to the conclusion that if even 1 in every 2 people understand the product then the knowledge could be passed on.

Multiuse:

We realized that not everyone will have the same devices that they want to charge. Knowing this we wanted to make the product available to use across many devices. We researched and found that almost all cellular devices are, or can be, charged using a USB connection. Also we found that many other devices such as navigation systems and torches can be charged using USB connections. We found over 25 devices can be charged using a USB connection.
**Confinement Refinement Summary**

The Team decided on the final prototype by consulting our professor, as well as by using our own ideas. What we learned from prototype one is that it was very aerodynamic, we tested this by throwing it out a three story window. One idea we thought of was to make our prototype more aerodynamic. We did this by giving more of a curve to the frame of the prototype. Another change was we added an indicator to be able to tell how much energy is stored in the generator. One change our professor suggested was to put a grid on our prototype in order to protect the inside and the animal itself in case plants or fishes go inside the prototype and could get hurt with the turbines on the inside.

**Test Report Summary for Prototype #2**

In this case we would actually test it in the water in order to see if the turbines actually spin. Prototype two performance be improved from prototype one by checking on the fin size, as well as comparing prototypes to see if we can improve how aerodynamic our second prototype can be. We can also check our turbine placement to see how far apart or how close together they have to be to generate as much energy as quickly as they can. Prototype 2 would be more
streamline than prototype 1 meaning more stability and efficiency. Also the more stable handles would mean more efficiency.

**Cost Analysis**

Like we discussed before, making the product inexpensive was very important. We decided to make the product have a goal to be under $10 to buy. This means that the cost of manufacturing has to be $6 so that there can still be some money for the transportation, possible taxes, production costs and damages. After doing some research, we were able to come with an estimate of how much the product was going to cost, and what would be the price of each of the materials needed. The battery that is stored in the hull costs approximately $3.50; when purchased in bulk. The cost for the main product (the plastic) and doing the shape of it is from $0.30-$0.50. The reason the plastic is so cheap is because we would try to use recycled materials whenever available. The propellers that go inside of the turbine would be free, because we would take the fans of old computers and unwanted machinery. The only products left that are necessary are the wire that connects the propellers, which costs $0.13-0.20 per ft. (for high quality wiring, Cerrowire) and the net, which would cost no more than $0.10 (for high quality wiring, Cerrowire). At the end, the final price of the product, excluding production and transportation cost would be between $3.93 and $4.5. This means that there is approximately $6 left for production and transportation. We would like to make $2 profit, so this would leave us with approximately $4 for production and transportation. This is obviously an ideal cost, but when buying products in bulk this is an attainable goal.
User guide:

How the prototype works:

1) If the family live near a river or stream of water, the person puts the turbine in the water, attached to something, then the water flows through the turbine making the blades move and producing electricity (first drawing in the picture)

2) If there is no stream of water near the house, the person can go to a lake or water well, put the turbine upwards and pull it in and out as fast as he/she can (second drawing). (About 20 times)

3) At the end, you can look at the indicator (above the USB port) to see how much battery is stored. If there is sufficient battery, you can plug the cell phone with the USB cord (as shown in the image).

4) After 1 or 2 hours approximately, your phone should be charged and ready to use.
**Final thoughts**

**HESE feedback:** We had the great opportunity of listening to experienced people in the field and hearing about how we could improve our prototype what was good about it, what we could eliminate, what else we could add, and how efficient would the prototype be for these people. After talking with two of the judges, they gave some very good constructive criticism. The first thing they recommended us was to make sure the plastic was hard to avoid being broken very easily. Also to make it survive severe weather conditions because the heat in Kenya is very high. Also, they recommended us to make more sturdy handles so that when it is submerged in the water, it wouldn’t move about too much. This increase in stability would mean an increase in efficiency. Other than these few need improvements, they seemed to like the idea, and enjoyed that it was different from everyone else’s hydroelectric ideas.

**How would look prototype 3:** After doing prototype 2 and doing the research about how would we test it, we realized there was no much else we could do to improve it. The wire could be of a different material, maybe one more stable so it lasts more. We concluded this because the wire itself is going to suffer a lot when it is hanging in a tree or when the person pull it in and out of the water sink. Also, we would do the net of a solid material, so that it does not break so easily with the water flow. At the end, the product would look practically the same, just with the variation of the solid net and maybe some little changes in measurements, depending on the needs of the family. Also, the wire would change so it can last more and reduce costs in the future. Finally, the product would be ready to use and the Obama family would have an excellent source of energy to charge their phones in a daily basis.
How DEM could be improved: The project is an excellent way to introduce to the people how many live in our world. All of us were impressed after seeing how people really live in a lot of countries in Africa. The project is a great opportunity for us to be creative and put our brain to work in creative ways. It is incredible how one person’s idea can be the base to create a new awesome idea. The whole process, since the beginning to the end, doing the research and creating the prototypes was very entertaining and gave us the opportunity to think outside of what we are used to. After all, there are some things that we as a group found that would be very interesting to integrate into the project. Put the prototype to work or at least try it would be an amazing task. Also, Making the contact with one of the families via internet or cell phone would be awesome, because would give us a real approach of what the family really wants, and what are their current resources.

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