Designing for Developing Countries

The challenging design process of Soundspray

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Abstract: The purpose of this study is to perform the social responsibility as a designer through product development to contribute and improve the quality of life in developing countries. KAIST ID+IM Laboratory has emphasized on the designers social participation and contribution through a charity design project called Nanum (Means sharing in Korean) since 2005 under Professor Sangmin Bea's supervision. Until now, all the profits (approx. 1.7M USD) from the sales of the products have been donated as children's education scholarships to low-income families within South Korea [6]. The Nanum project has also won numerous global design awards and as known as a successful example of social contribution through design. Since 2011, project Seed has been launched to extend the project beyond boarders. Our design team ID+IM has visited sites in Kenya to investigate and develop products to continuously conduct social contribution through design.

In this paper, we discuss the social and cultural context of the developing world regarding malaria infection and our design solution Soundspray, which is an eco-friendly ultrasonic anti-mosquito device that repels mosquitoes by emitting an ultrasonic sound that simulates the sound of the mosquito's natural predator. We will also be discussing the design process of Soundspary and important insights when designing for the developing world.

Key words: Developing Countries, Design Process, Soundspray, Malaria, Mosquito Repellent, Observation Research, Sustainability, Social Design, Nanum Project, Seed Project, Kenya, Africa

1. Introduction

Design has become an essential element to the key success of our socio-economy system. Nonetheless, design exists and benefits only for 10 percent of the world's population who have the power to consume. The rest 90 percent still cannot fulfill their basic needs such as fresh water, housing, food, transportation, education, medical treatment, and information [3]. In recent years, there has been an extensive growth and effort on supporting the developing world through funds, relief goods, and humanitarian aids. Nonetheless, there is still a lack of help and in many cases the end results tend to bring negative impacts to the developing societies. Due to this movement, the growth of social responsibility has changed many designers to shift their perspectives to help relive poverty in the developing world as well. Currently, there are many ongoing design projects in the developing world, but most of the design outcomes are not viable to meet the current market and fail to sustain within the community.

Therefore, innovative design solutions that can relieve the encountering problems and sustain within the community is needed.

2. Problem

From all the health related issues of the developing world, malaria is one of the most serious diseases spread through mosquito bites. The World Health Organization estimates that around 250 million malaria episodes occurred in 2006, resulting in nearly 1 million deaths. About 90 percent of all malaria deaths occur in Sub-Saharan Africa, mostly among children under age 5 [1]. Despite the fact that the cause of malaria was discovered in 1892, it is no longer seen in developed countries, but still is seen as a common disease in the developing world.

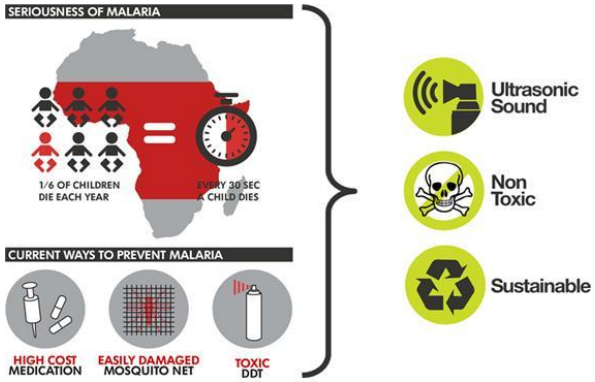

Figure.1 The seriousness on malaria in Africa

Currently the most common method to prevent malaria in Africa is by medication treatment, DDT (Dichlorodiphenyltrichloroethane) and sleeping under an insecticide-treated mosquito net [4]. However, our field research in Kenya indicated that these approaches were not ecofriendly, caused other health issues due to the toxic chemicals, and was not a sustainable solution. This signified that an innovative solution was urgently needed.

3. Objective

An innovative design solution was needed to prevent newborns and pregnant woman getting infected by malaria. For this study, our team used a product design process to develop the eco-friendly ultrasonic anti-mosquito device Soundspray. We hope that designers who are interested in social design can refer to our design process when designing for the developing world. Last year Soundspray has proven its sustainable and social value by winning one of the most prestigious design awards from 2012 IDEA (International Design Excellence Award) from the social impact category [2]. Currently, final tests on the prototype and mass production is in preparation.

4. Design Concept

Soundspray is an eco-friendly ultrasonic mosquito repellent device that repels mosquitoes by emitting a ultrasonic sound that simulates the sound of the mosquito's natural predator. The power to emit the high-pitched noise is self-generated by simply shaking the can, which is how most conventional mosquito replant sprays are used. Shaking Soundspray for one minute recharges the battery and emits an ultrasonic sound for an hour. Since

Soundspray can self-generate electricity, it can also be easily used in areas where electricity is out of range. It can work effectively in rural places in the developing world where mosquitos are the number one infector of malaria. Also Soundspray does not diffuse any chemical substances into the air, which prevents endangering people from inhaling it. This makes Soundspray an ecological and healthy solution.

Figure.2 How Soundspray works

5. Design Process

To understand and investigate the social and cultural context of the developing world we investigated the users environment and the appropriateness of our design solutions. We also considered the users safety, convenience of use and asked the locals on their thoughts to check the public interest. From the proposed designed solution, we designed a prototype at site and conducted a user test. The user test confirmed that the users were able to use the prototype easily and that they were satisfied with the results. Based on the results we were able to refine the mechanical components and derived to our final design.

5.1 Preliminary Research

Prior to the field research in Kenya, preliminary research was conducted to understand the seriousness of malaria through literature and interviewing experts regarding the problem. Also to understand the user's society, economy, culture, life style, etc. an overall investigation was conducted to gain comprehensive knowledge. Through this, we tried to avoid any presumptions beforehand.

5.2 Site Research

The site research was conducted in Kenya on August 2011, with a total of six designers including Professor Bae and three graduate students from KAIST ID+IM laboratory along with two students from KDM (Korea Design Membership). The plans on visiting the site were prepared with the help of World Vision Korea and World Vision Kenya. The selected site was the Osiligi region of Kenya, where the most indigenous and traditional Massai tribe lives.

5.3 Site Research Methods

At site we paired two members as a team and concentrated on observing not only the problems related to malaria but their overall life style. During user observation and experiencing their day at first hand, we asked problems, questions, and possible solutions as we went along. Cameras, camcorders and personal journals were used to gather information from the site. The information was later shared with other team members at the end of each day for clarification. The organized information was later verified with the locals to confirm the information was reliable and accurate. By this we were able to suppress our presumptions.

Figure.3 Verifying information with the locals

5.4 Site Research and Results

1) Current methods for repelling mosquitoes and problems

Form the interviews with the locals we found that during the dry seasons mosquitoes did not breed, but during the monsoon season mosquitoes bred in puddles or tall grass around the housing areas increasing the threat for malaria. Since most wells were far in distance, people tend to drink water from these puddles, which led them directly to malaria. During the wet seasons they would continuously cut downed any growing grass and covered puddles with dirt to prevent the disease to spread. Our preliminary research indicated that medication, DDT, and sleeping under insecticide-treated mosquito nets were the most common methods used to prevent mosquito bites. However our field research in Kenya indicated that there were many problems regarding these approaches.

-Problem with medication

Through our research, we learned that the medication could only be taken at a hospital or by a certified trained health worker, which most of the rural area people had very little access too. Also giving medication to a child or pregnant women when their immunity system was weakened prevented the malaria infection, but caused other serious side effects. Moreover we found that many died due to the difficulties of identifying the symptoms at an early stage when one was infected. On top this problem, there were also cost issues when patients had to take laboratory diagnosis for malaria symptoms and continuous medical treatment.

-Problem with DDT usage

The use of DDT was a common way that was recommended and sponsored by many NGO's. This approach was very effective and showed if all the shelters in a village were DDT treated, the malaria infection rates

dramatically dropped until the substance lasted. The biggest problem with this method is that the indoor residual spraying and chemicals released into the air caused serious health issues. Research shows that DDT can cause pregnant woman to give birth prematurely, which could eventually affect the state of the child. Also the chemical shows serious effects on male fertility [5].

-Problems with insecticide-treated mosquito nets

Another common solution was using insecticide-treated mosquito nets, which were given to a family through charity when a baby was born. This approach seamed ideal, but was not effective in many shelters due to its construction. From our research we found that most shelters in rural areas were built using traditional construction methods depending on their tribes. However the materials used for construction were similar and could be locally found. Most shelters used wood branches for the main structure and mud for exterior finishing along with insulation. The living space inside the shelter was small, cramped and impossible to stand up in a straight position. Also there were no windows or chimneys, which showed that they had no intention for air circulation when building the shelter. In this situation, the insecticide-treated mosquito net was made out of light and thin material that was nearly impossible to properly install inside the shelter. The mosquito net kept being torn by the wood branch twigs that supported the shelter and people who were trying to move around inside. Another problem was that the mosquito net was insecticide-treated, which could cause health-related issues. Also the net had to be treated with insecticide again after a period of use, but no one knew when to do so. It clearly showed that the net could not last long enough to be treated with insecticides again. Since mosquito nets where only distributed a limited number of times (once in most cases), most people had to purchase and treat with insecticides their own nets. The net came with a dissolvable insecticide powder that the user had to dissolve into water and soak the mosquito net. This process caused health-related issues and the used insecticide water was dumped straight in to the ground, which caused environmental issues as well.

Figure.4 Traditional Massai house

-Problems with folk remedies to treat malaria

Minimizing windows and air vents (Most traditional houses do not have either of them) to prevent any possibility for mosquitoes to enter the house. This somewhat prevented for mosquitoes to enter, but caused deaths to children inhaling carbon monoxide from indoor cooking and heating.

2) Other things to consider

Most suburbs and rural areas outside the city have no access to electricity. Most of these areas have requested for electricity to the government over 20 years ago and yet do not have it. Therefore the use of electricity is very limited to products such as light fixtures or mobile phones. Most of these lighting fixtures are solar powered and donated by NGO's. There were a few tribal members who had mobile phones, but to charge these phones they had to walk for a few hours to get them charged at a store by paying 20 Kenya shillings (25 cents USD). Therefore designing product that uses electricity is not viable and appropriate.

5.5 Ideation

The collected information led us to find a solution that was not harmful to their health, did not use electricity, was eco-friendly, and above all repelled mosquitoes. While searching for possible ways to repel mosquitoes, we found that ultrasonic waves were used to repel mosquitoes and applied this to develop our final design.. The ultrasonic mosquito repellant works as follows. The malaria disease is carried by the female mosquito and avoids contact with the male after fertilization. The ultrasonic mosquito repellant produces a sound that mimics the male mosquitoes wing beat frequency (12000~17000Hz), which chases away the female mosquito. However, depending on the climate and mosquito type the frequency varies, therefore producing a broad range of different wavelength frequencies can be more efficient rather than focusing on a particular frequency. Ultrasonic frequencies are not audible to human ears so it can be used comfortably indoors and also since the size of traditional housings are small in size, the ultrasonic sound does not have to reach out which means it can be used with less energy. Since the ultrasonic mosquito repellant needs to generate sound, it is inevitable that it needs to use an external energy source. However, using electricity or fossil fuels is difficult due to access and price, therefore using eco-friendly energy sources such as solar, wind, kinetic energy, etc. seemed appropriate for usage. While searching available energy sources in Kenya, we learned that people used spray type insect repellants and were very familiar with it. Therefore, using this familiar form and behavior of use would make the users use the product more comfortably without any additional training.

Figure.5 Spray type insect repellents in Kenya

Soundspray follows a similar form language as most spray type repellents and uses the same shaking behavior to generate electricity to charge the battery inside. This shaking movement to generate electricity is not only an eco-friendly solution, but is also an intuitive design solution. Soundspray also does not spray chemical substances through the nozzle, but sprays ultrasonic sounds to repel mosquitoes.

5.6 Prototyping and Testing

For the prototype, we had to design a new self-generating mechanism along with an ultrasonic generator circuit. The mechanism of Soundspray works as follows. By shaking Soundspray it will move the coil of wire through a magnetic rod that generates an electrical current. This electrical current is then stored in the rechargeable battery.

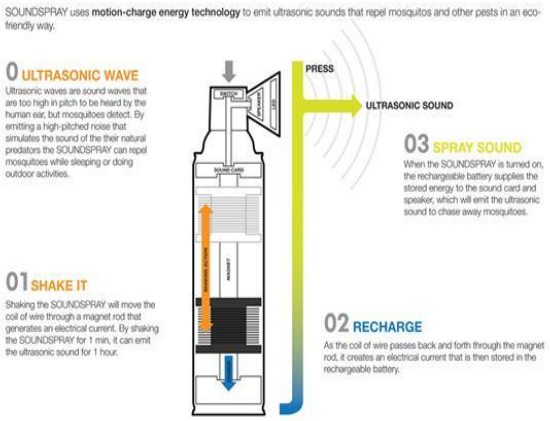

Figure.6 Mechanism of Soundspray

Through our prototype experiments, we found shaking Soundspray for 1 minute can emit ultrasonic sound for one hour. This means the users can shake Soundspray for 8 minutes to be mosquito-free for one night. By pressing the nozzle just like in any other spray repellent product, will emit an ultrasonic sound to chase away any mosquitoes for malaria infection, which is intuitive and well acceptable by the users. A working prototype was built and tested at site with the locals to see whether the form and function was appropriate for usage.

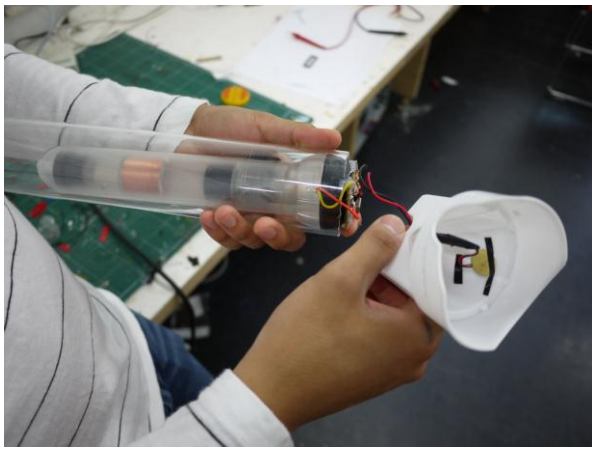

Figure.7 Soundspray Prototype

We were able to observe all user groups regardless of gender and age found the prototype intuitive to use and learn. Also we were able to see that most users found it fun to use the product as well. When designing a product for the developing country it is vital to provide them with a good product, educate the usage, and a product that can sustain in the community. By designing an intuitive product for the users, we were able to achieve these goals.

Figure.8 User test with the locals

5.7 Manufacture

By demonstrating the usefulness of the product through user testing, the process for mass production was initiated. The final prototype was 3D modeled using CAD to find appropriate and aesthetical pleasing ratios, which resembles the conventional spray type repellant products. By the similar morphological form it gives a metaphorical message on how to use the product. Also by giving design detail on the nozzle we were able to represent the main function of the product as well as differentiate it with other conventional products. A number of prototypes where designed to visualize the form and usability before selecting the final mechanism of the design.

Figure.9 Final CAD design of Soundspray

After manufacturing and assembling all parts, Soundspray was ready for its final test. From the final user test, we were able to find that it needed a visual indicator on the status (on/off) of the product. We decided to embed a LED at the end of the sound nozzle, which will light up to visually indicate that the Soundspray was activated. Visual indication was needed since the human ear cannot hear ultrasonic sounds, but also since most indoors were very dark and hard to indicate if the product was working.

Figure.10 Final design of Soundspray

5.8 Distribution

Unlike most products designed for the developing world, Soundspray can be used in both developed and developing countries. For those who like outdoor activities and demand sustainable and healthy solutions to repel mosquitoes in the developing world can use the product as well. The profit from the sales in the developing world can be used to send Soundspray to those countries in need (matching gift).

6. Problems and Solutions

Out last visit to Kenya was during the dry season, therefore we have not experimented Soundspray in the monsoon season. Our nest visit will be during the monsoon season to experiment the performance of Soundspray and to conduct more user tests. Also during the manufacture of Soundspray, we found it difficult to use all local materials found at site. More local market research will need to be conducted to find materials that can replace the ones obtained outside Kenya. Additionally, we found that many designers and engineers did not take into account the local aesthetic standards when design for the developing world. Form our field research it was very clear that they had standards for aesthetics and implementing these standards was necessary, since it is proven that beautiful objects tend to have longer life span than the ones that do not. Currently the aesthetical standards and design consideration for the developing world is in research and will soon be published.

7. Conclusions

Soundspray is an eco-friendly ultrasonic anti-mosquito device that repels mosquitoes by emitting ultrasonic sound that simulates the sound of the mosquito's natural predator. It can work effectively in rural places in the developing world where mosquitos are the number one infector of malaria. Since Soundspray does not diffuse any chemical substances into the air, it prevents endangering people from inhaling it. This makes it an ecological and healthy solution. Also the intuitive way of generating electricity can ensure its sustainable use in the developing world. Above all, it is important to acknowledge that Soundspray has considered the users environment, ethics, culture, society, economy from the finding s from the field research. Also it is vital to prevent any presumptions when designing for the developing world. An overall understanding of the society is crucial, because in most cases the design affects the lives of the users. Therefore designers should attend with responsibility when designing for the developing world.

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