ABSTRACT

WATER PURIFICATION IN HAITI
AN ENGINEERS WITHOUT BORDERS PROJECT

by
Melissa Valoura

The objective of this thesis was to present the necessary steps to help a town in Haiti develop an organization focused on improving their water quality. It goes through the technology needed to create the organization and explains the procedures for implementing a charitable project in a foreign country. A narrative of the student project in Milot, Haiti, where students from the New Jersey Institute of Technology's Engineers Without Borders Chapter implemented a water purification project, explains the course of action that was taken and gives an example of a successful project. A summary of Haiti and its history paints a picture of the environment and culture, where the project took place and gives some incite into the Haitian mindset to evaluate the potential success and failure of the implementation of a sustainable development project in Haiti.

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CHAPTER 1

INTRODUCTION

With poverty around every corner of the globe, it is the moral obligation of nations that are more economically stable to support nations that have been poverty-stricken. Throughout their history, third world countries have risen and fallen after being confronted by problem after problem. As the poorest country in the western hemisphere, Haiti has received a lot of aid from international organizations in vast forms such as money, clothes, food, and guidance. Their social and economic situation touches the hearts of many philanthropists who hope to make a change by way of their projects and financial donations. Unfortunately, these good intentions do not always prove to be the correct solutions to the problems that third world countries are facing. Situations like the one involving UNICEF and the donation of baby formula to thousands of mothers in Africa are perfect examples of charity gone wrong due to improper planning. Over one thousand children died after the donated formula ran out and the mothers were unable to breast feed their children because they had stopped lactating and couldn't afford more formula. (Freedman, 2000). Although they might have the best intentions, more often than not, they enter into a country flaunting their money and education, bright eyed with all the things they wish to change about the community and not thinking about what the residents want. Luckily, there are more successful projects then those failed. Because of right planning and technology, projects have the potential to significantly improve living standards of people in third world countries.

1.1 Sustainable Development

The key to supporting these nations is the introduction of sustainable technologies that can give them the opportunity to learn and succeed on their own. Unfortunately, sustainable development has only begun recently to impact development projects after decades of projects that "fostered dependency rather then development towards independent prosperity" (Reid, 1989). In my research about various charity projects and even more so during my travels to Haiti, I have found that sustainability was not always a part of the project-planning phase and therefore projects became "monuments of failure" rather than an asset to the community (Reid, 1989). In Milot, Haiti, a water reservoir built by the Brothers of the Sacred Heart proves to be such an example of the failed projects that litter Haiti. Lacking the education, finances and sense of ownership, none of the community members were able to repair the reservoir once the concrete started to wear. The "introduction of inappropriate technologies" has led to "developing countries [being] littered with the rusting good intentions of projects that did not achieve social or economic success" (Reid, 1989). Development projects have become a topic of controversy and debate due to the failed projects that have left countries in even worse condition. For this reason, it is important for charity projects to be solely in the interest of the recipients and be collaboration between the parties rather then an attempt to force one's ideas on another. Before entering into any country and attempting to put any type of project into action it is necessary to understand and respect the people and their cultures. Cultural boundaries are one of the many issues that affect economic development (Sachs, 2005). Understanding the history of the location you are trying to help is essential in order to be of any influence to the people you are working with and

will determine the longevity of your project. Thorough research needs to be completed in order to avoid affecting a culture negatively during the implementation phase of a project. Furthermore, making sure that the community wants/needs and approves the project will be the most important factor when entering into a community to implement a humanitarian project. Although there have been many successful developmental projects in third world countries, and especially in Haiti, many times these kind gestures are not congruent with what the Haitians need and in turn end up creating more damage than good. Most of the time, it is the politicians of first world countries who attempt to force their views on the weaker states thinking they are helping them. The National Democratic Institute for International Affairs (NDI) entered into Haiti in 1986 hoping to "strengthen democratic institutions and pluralistic values in new and emerging democracies" (Massing, 1987). Their method of fulfilling this goal was to establish the first election in Haiti but this was not carefully thought through. Many resisted change and on June 23, 1987, civil war broke out in Haiti (Massing, 1987). In third world countries such as Haiti, these types of situations have a fatal effect on society and leave the country in a worse state than they started. To avoid being another failed project, the New Jersey Institute of Technology's Engineers Without Borders (EWB) humanitarian project in Milot, Haiti, focused on engineering advancement through education. The students who planned the sustainable development project in Milot, Haiti developed a extensive Haiti Guide Book that new members could use to familiarize themselves with the country as well as and to take on trips to Haiti. Furthermore, by following current events in Haiti, they were able to stay up to date with the country's status and evaluate the current needs of the community prior to their departure. Their understanding of the country helped them tremendously

during the planning phases of the project as well as the implementation phase. A description of their successful project will chart the process and progress of the introduction of the Bio-Sand Filter to the citizens of Milot and show the importance of working with the community in developing projects.

1.2 Non-Profit Organizations

At the core of any humanitarian project is the organization that funds the efforts and coordinates all the logistics. The creation of the non-profit organization has increased the amount of aid provided to third world countries that have been affected by natural disasters, political unrest and disease. Most volunteers that you see working abroad on charitable projects are backed by non-profit organizations that focus on obtaining grants and donations to sustain their project. For the project in Milot, Haiti, the student members of the New Jersey Institute of Technology (NJIT) Chapter of Engineers Without Borders (EWB) raised money through various fundraising events and were backed by the national EWB organization. They were able to use this name to gain credibility as well as funding. One of the beginning steps to actually implementing any sustainable project is obtaining the money to do it. This could prove to be one the most time consuming efforts of the project because you have to convince people to give you their hard earned money. As the project proceeds and there is more evidence of the work you have done, this may become easier, but the most amount of money is needed in the beginning of the project and this is the hardest time to get funding.

1.2.1 Types

A non-profit can include many types of organizations so long as all profits go to running the efforts specified in their mission statement and not towards the personal financial benefits of any member. Since non-profit entities are organized under state law, many states have adopted policies contained in the Revised Model Non-Profit Corporation Act (a set of templates prepared by the American Bar Association), the Uniform Unincorporated Non-Profit Association Act (a set of templates prepared by the National Conference of Commissioners on Uniform State Laws) and similar generic documents to regulate non-profit organizations and to prevent the misuse of their benefits (Mercer, 2008).

1.2.2 Benefits

Most states have resolved to exempt non-profit organizations from state tax and state employment programs such as unemployment compensation contribution as well as to limit their tort liability. Some state laws also grant non-profit organizations solicitation privileges as well as accreditations, licenses and permits (Mercer, 2008).

1.2.3 Internal Revenue Service Requirements

A non-profit under Federal Section 501(c) (3) is obligated to fulfill the requirements in Form 1023, Application for Recognition of Exemption. Along with filling out Form 1023 and paying a fee of $300, Organization Bylaws and a basic business plan are required for an approved application. Furthermore, an Employer Identification Number (EIN) is necessary for financial purposes. This can easily be obtained by filing for incorporation with the State of New Jersey for a fee of $75.00. If the form is completed properly and

approved, the organization will receive a Determination Letter confirming its exempt status. To keep the letter valid, the organization is required to disclose information regarding its business yearly and thus prove its continued existence. The information required depends on the amount of revenue received that year. For this project's purpose, these requirements include Form 990, 990EZ or 990-PF to be filed annually. The form requires information on any changes to the general purpose and method of the operation and three lists which disclose members that have changed their names or addresses, members which are no longer with the organization and new members that joined within the year. The NJIT chapter of Engineers Without Border performs these requirements annually with the exception of filing the annual return and the initial paperwork required in becoming tax exempt.

CHAPTER 2

LITERATURE REVIEW

Since the 1940's and World War I, the number of organizations working in third world countries have been increasing significantly. In the 60's, it was estimated that there were approximately "between 2,500 to 3,000 transnational, non-profit organizations in the world" (Skjelsbaek, 1971). In 2006, there were 11,193 transnational non-profit organizations in the United States alone. These numbers show the increase in humanitarian interactions and even more so the increase in interest in helping third world countries. In the 1980's, sustainable development finally started impacting projects being implemented by these organizations. Since then organizations have been working towards higher standards of living in third world countries through the introduction of technologies that already exist in the developed world. William Easterly strongly believes that the government's global social engineering has failed to help the poor, and it will always fail (Easterly, 2006). He further expresses that private markets foster innovation and learn not to repeat prior mistakes whereas planners with no feedback keep doing the same failed plans (Easterly, 2006). Successful projects are scattered through every third world nation but the most influential projects work towards changes in incentive structures, particularly economic incentives that foster grassroots adoption of sustainable technologies (Reid, 1989). Examples of successful projects start as early at 1951 with the creation of World Neighbors. This organization was started by Dr. John L. Peters who believed in helping others by working from the bottom up, with no self-interest and an understanding of the dignity that every person has and deserves (World Neighbors,

2009). His first World Neighbors programs were launched in India in 1951 and focused on inspiring people and strengthening communities to find lasting solutions to hunger, poverty and disease through training and education (World Neighbors, 2009). Tamakoshi Sewa Samiti (TSS), a community-based organization located in the remote district of Ramechhap, Nepal is an example of one of their earlier projects that are still successful today. This voluntary grassroots organization grew to over 6,000 members in 40 villages, providing basic services in preventative and reproductive health care, sustainable agriculture, water supply and income generation through rural micro-enterprise (World Neighbors, 2009). Today, World Neighbors has moved out of that area proving this to be a true success story. World Neighbors projects were successful because [they] do not make decisions for the communities, but act as a catalyst for change, offering education and training (World Neighbors, 2009). Their focus in on having the community decide on which problem to address and how to make the changes themselves in order to instill self-confidence in all who are involved in the process and then educating them so that they can improve their situations themselves.

Trickle Up is another organization that focuses on advancement by providing third world residents with resources such as training, equipment and grants, necessary to build micro enterprises. The organization was started by Glen and Mildred Robbins Leet in 1979 and since then has helped start or expand over 11,000 businesses. They work in conjunction with local organizations to identify participants and then provide them with the training and an initial $100.00 grant to start work in their field. After some financial training and business plan preparations Trickle Up provides them with the necessities to open up their

business and then monitors their progress through frequent visits until they feel confident that the participants can run their business on their own. Currently, their statistics shows that 91% of the businesses they help start continues after the first year and are then able to qualify for micro-loans from local banks to further expand their businesses.

Street Kids International is another successful project that focuses on empowering children to explore opportunities for meeting their basic needs and realizing their potential (Street Kids International, 2009). During the past 20 years they have been working toward fostering a positive shift in the way [children] are regarded by the communities they live (Street Kids International, 2009). Peter Dalglish started this organization back in 1988 with the creation of the International Bicycle Courier Service in Khartoum, Sudan. From there, they developed educational material, such as movies and literature, for children regarding health issues, substance abuse, and even entrepreneurship. Their success is much attributed to their willingness to actively give away [their] methods and materials to anyone who is interested in child development (Street Kids International, 2009). They have worked with more than 2 million street kids in over 60 countries but also advocate and deliver innovative programs to other organizations around the world focused on building street kids' ability, knowledge and communities (Street Kids International, 2009). Today, Street Kids International has celebrated their 20-year anniversary by being recognized by the United Nations as a Global Best practice leader in youth work.

Some smaller organizations, which started as a single humanitarian project and grew into

successful organizations, include Friends of the Children of Haiti (F.O.T.C.O.H) and Sustainable Organic Integrated Livelihoods (S.O.I.L). These organizations are based in Haiti and started with one trip to Haiti. F.O.T.C.O.H was founded in 1985 by Richard Hammond and included yearly trips with a total of five volunteers at first. Since that mission trip, the Chicago-based non-profit organization runs six teams of 15 to 20 volunteer medical and non-medical personnel each year, providing medical care to thousands of Haitians at the 6,000-sq.-ft. clinic in Cyvadier, which was built by Haiti residents (FOTOCH, 2009). S.O.I.L was started by Sarah Brownell and Sasha Kramer who distribute dry toilets in several Haitian towns. The Kenyan Jiko Charcoal Stove project that started in 1981 by the Kenyan government and a couple of NGO's is a perfect example of the growth potential of a project if planned properly. In the late 70's Kenyans would use approximately $1/6^{th}$ of their earning on charcoal for their stoves. The introduction of the new and improved woodstove technology spawned a new industry in that country and by 1986 125,000 stoves were sold (Reid, 1989).

These are some of the organizations that have succeeded their goals in developing countries. Through their humanitarian projects and education, they were able to surpass language and cultural barriers and improve the lives of millions of people as well as inspire other organizations to follow in their footsteps. The one thing that all these organizations have in common is that they worked with the community to establish a project that the community wanted. The key to all the above projects is education and showing people information and technology that they would not normally have access. The road to project failure is paved with those who only look at the surface of the problems that contribute to underdevelopment, and the underlying reason for that

project's failure is the thinking that any help would be better than nothing. This mindset and the lack of comprehension of the project as a whole lead to solutions that barely scratch the surface. Poor financial planning and lack of environmental planning have left projects unfinished and depleted resources available to the community (Parsons, 1996). The implementation of inappropriate technologies has also left many countries with useless machinery. Technology alone is not the answer to poverty, because if the users are not trained or if maintenance costs are too expensive, the project will never succeed (Parsons, 1996). The importance of including the local community as well as local NGO's has been ignored in many projects and subsequently these projects will not be sustained if the local residents do not support them. Walter Reid in his article titled *Sustainable Development: Lessons from Success*, states that, the projects most likely to be sustainable are those that have involved local residents from the outset and fostered grassroots support (Reid, 1989). The goal is for these projects to be institutionalized by the community and for them to solve the communities' problems, not the issues that the planners believe are problems. William Easterly feels that the smaller more organizations are, the more likely it is to succeed at their narrow goals than the Planners are to succeed at their more general goals (Easterly, 2006). The heart of the matter is that the education and involvement of local residents will be the deciding factor on the success of the project. As engineers we know the technology available to improve the lives of the citizens living in third world nations, but only those citizens can decide on the feasibility of these technologies.

CHAPTER 3

HAITI

This chapter provides a brief history of Haiti and its people to help describe the environment we will be working in and help set up the requirements for our initial project planning. After a thorough investigation of the situation in Haiti, it will be possible to decide what type of potential projects would be best for them and help in the preparation of the preliminary project scopes, which will be presented to the Haitian community for a decision and approval.

3.1 Geography

The Republic of Haiti is located in the Caribbean Sea and shares the island of Hispaniola with the Dominican Republic. It comprises of 27,560 sq km of land and 190km^2 of water adding up to approximately 27,750km^2 of area (CIA World Facts, 2009). Haiti is located directly in the middle of the hurricane belt and therefore between the months of June and October the rainy season brings in severe storms that are well known to cause flooding and take the lives of countless people. On the other hand, during the dry season droughts are very common as well as earthquakes, although a severe earthquake has not impacted Haiti since the mid 1900's (Dawicki, 2005). Most of Haitians live in a tropical climate where it is hot and humid but there are mountainous areas in the east were the climate is semi-arid. Haitian geography includes a mixture of rough mountainous terrain, beach areas and very little fertile farmland due to past depletion of nutrients in the soil. It has been suggested by John Kenneth Galbraith, among others, that there is a direct connection between poverty and climate. He states that in the tropics there are regions of

low income due to an easier life and greater consequent lassitude (Galbraith, 1979). He continues to point out that due to the climate, people in the tropics are more subject to endemic disease and directly infected through food and other resources, through parasites, and through their mode of life (Galbraith, 1979).

3.2 History

The Republic of Haiti was founded by Christopher Columbus in 1492 and was instantly occupied by the Spanish due to its many gold mines. They forced millions of Haitian natives into slavery, killing many with the diseases brought over by the Spaniards. In 1503, they had to resort to importing slaves from Africa, the future Haitians, as a means of ending native slavery on the island (*Synopsis of Haitian History*). By 1625 the French had settled in Haiti and began forcing out the Spanish. Spain eventually gave in and signed the Treaty of Ryswick with France in 1697 (*Synopsis of Haitian History*). France continued importing thousands of slaves from Africa and these slaves would soon start the Haitian Revolution. The slaves soon began to fight back in their own ways and would poison their masters, plan collective suicides, such as the Ibos, and even killed their own children to save them from slavery (*Synopsis of Haitian History*). After a century of slavery and years of fighting, on January 1st, 1804, Haiti became the first black independent republic and their revolution was the first successful black movement (*Synopsis of Haitian History*). Haiti would soon be seen as a threat to nearby countries due to their participation in other South American revolutions. Even after all these accomplishments, Haiti was still not identified as an independent republic and was shunned by Europe, consequently having no diplomatic relationships. France's refusal to recognize the new nation as an independent country would cause the Haitian president,

Jean Pierre Boyer to agree out of pride to pay the French 150 million Francs to be recognized as an independence nation. There was a revolt against Boyer and the country underwent decades of political instability while the British and French claimed interest on the country. As talk of world wars surfaced, the United States became interested in the Caribbean as a location to secure naval stations. The Haitians would not permit this intrusion, but in 1915 Haitian president Vilbrun Guillaume Sam executed 167 political prisoners and gave the US a reason to invade (*Synopsis of Haitian History*). The United States occupied Haiti until 1934 when the U.S. officially shifted authority to the Haitian government. With the US gone and Haiti in pieces, the country went through various leaders and many ups and downs. Between the various revolts and riots, and economic instability, the country struggles to this day.

3.3 Economy

Although during the 1800's the Haitians were heavily involved in exporting, their supply quickly ran out, and today, the few goods that Haiti does produce on its own are almost exclusively used for domestic intake. Consequently, the country relies on imports of food and used goods. Through the years there have been some forms of major industry that employed thousands of Haitians but those quickly vanished with each episode of conflict. With an average income of $500 per year for a family of six, life is hard for the Haitian people (*Synopsis of Haitian History*). The citizens have not been offered the advantages of free enterprise, free competition and the market, and they are living in poverty as a result (Galbraith, 1979). With 6 out of 10 people being illiterate and an extremely high unemployment rate, what agriculture there is has become the underpinning of the economy. Although surrounded by erosion, Haiti is still a country of farmers who work

on the 30 percent of Haitian land that is considered suitable for agriculture. Most land is evenly distributed and privately held, although there is state land that is rented under a long-term lease to families for farming. Land is typically bought, sold, and inherited without official documentation, which has been the cause of much struggle between family members and neighbors. Work is scarce for all of Haiti, but there are white-collar professions too. Only a select few are lucky enough to be educated and as a result there has always been an economic gap between the poor, middle-class and wealthy. Most of Haiti's workforce includes female traders who specialize in domestic items such as produce, tobacco, dried fish, used clothing, and livestock and male laborers such as carpenters, masons, electricians, welders, mechanics, and tree sawyers. Due to the lack of work, people have been known to resort to breaking other people's tools or injuring them so that they would not be able to work. Although this seems crazy to someone from a first world country, when attempting to implement a project in a third world country it is very important to know that such things can happen as well as understand where these feelings of hostility are coming from so that you can prepare and react in a manner which would fit the culture.

3.4 Gender Roles and Family Life

The delineation of gender roles in Haiti has been set in stone throughout their culture. There are very specific responsibilities that are expected from males and females that have been embedded in their mindset for centuries and these responsibilities are very rarely shared or transferred. Although they are similar to the traditional gender roles found around the world, the lack of some people's acceptance in transposing those roles in necessary circumstances are what makes them differ from some cultures. Family life in

Haiti differs greatly from our society as a typical household has approximately 7 to 10 members, who include parents, children, adopted children, and any young relatives. Although marriage is common among the upper classes, less than forty percent of the non-elite population marries and therefore most rural partnerships are not legally binding. This in turn results in a lack of obligation to husbands and wives towards each other and for men, their children as well. To understand the culture of Haitian family life it is necessary to comprehend each gender and their typical responsibilities.

3.4.1 Males

Similar to many cultures, in an unbroken household, Haitian man are the breadwinners and are responsible for providing shelter and money to their families. Unfortunately, since marriages are usually not legally obtained, men have no actual legal obligation to their wives or children and often exercise their freedom. About 10 percent of men have multiple wives who would live with their children in separate houses that are provided for by the man and who are accepted by the community as legitimate wives. Sadly, because there is no reliable legal system to enforce any laws to prevent this type of behavior if a woman cannot find another family who will take her and her children, she must stay in these triangular relationships in order to be supported by her partner. Men are generally the only ones in the family who work since women tend to maintain households and children. Because of this, males hold the majority of power in the workforce since most of the work available is labor intensive. From my personal experiences in Haiti, I find that men would often gawk and laugh whenever they saw me doing construction related work. After asking one of our helpers in Haiti, Michel Myribel, why this was happening,

he informed me that it was because women are not supposed to be involved in construction and they don't typically see women doing physical labor. Some men would come over and try to do the work for me, but I found that this was not out of chivalry but because they were looking for work and expected to be paid. Since the unemployment rate is so high in Haiti, most men do not have jobs and therefore cannot do much throughout the day except scavenging for odd jobs. While in Milot, I would often see men sitting around socializing and occasionally playing dominoes or card games. Someone could make the assumption that these men are lazy and do not want to work, but to the contrary they are literally dying for work and there just is not any. Although some men are just lazy, there are many men that have been unemployed for months if not years and have been unsuccessful in finding work. This may be a result of not having the skills required for the jobs available or because they were injured and can no longer do physical labor, which happens very often. Although there is a great need for maintenance and repair work in Haiti, there is no one to fund these projects and since people do not work for free, this work is left undone while tens of thousands of people remain unemployed.

3.4.2 Women

Although some women have been able to climb Haiti's ladder of success, as previously stated, men generally control the job market. Women are responsible for the domestic activities such as cooking, cleaning, washing and tending to the children, which does not differ much from most traditional views. The few job opportunities available to women are in health care and teaching but this requires an education, which most women do not

possess. Retail sales are very popular among women because they are able to buy goods such as tobacco, garden produce, and fish in bulk at larger markets and redistribute the goods to smaller markets. In contrast, women in rural towns are severely repressed in comparison to more modern societies since women are often abused and disrespected by the males of their community. Of course this is not the situation in every instance, but it is known that men have the upper hand and often use it to their own benefit.

From my experiences in Milot, Haiti, I was astonished by the physical and emotional strength of the women in the community. The hardships many of these women have gone through due to being mistreated by the men in their lives from a young age would call for years of therapy for most women in our society. With no protection from authorities, women are beaten, raped and disrespected with no consequences for their assailant. Pregnant women and mothers very often find themselves abandoned by their husbands and male partners, leaving the men with no obligation to the children they fathered. This lack of obligation towards the mothers of their children as well as their children among men has led to many broken homes and countless fatherless children. The shortage of jobs for women in Haiti and the lack of help from their male partners have resulted in many women succumbing to promiscuity and all the negative consequences associated with it to support themselves and their children.

3.5 Education

The Haitian education system mimics that of the French and typically includes 10 years of instruction (*Haitians-Their History and Culture*, 2004). It is most often taught in French, and therefore has become an indicator for the educated and uneducated. Despite

many past attempts to develop an education system through out Haiti, the school systems are not successful in reaching the majority. Although education is of great importance, most rural parents are seldom able to send their children past primary school due to the financial issues they are combating. In the past, it was near impossible to find formally educated people within Haiti, but in the last couple of decades education among middle and upper class has increased. Unfortunately, the lower class has not latched on to this trend and their lack of education is confining them to their poverty. In Milot, Haiti there are 15 primary schools, 6 secondary schools and 1 technical school. According to an interview with Thony Mexil, a citizen of Milot, the numbers of students drops by the thousands as they move through each grade. This is a result of families not having the funds to send their children to school as well as them needing their children to work to support the family. Unlike our society, children are put to work doing household chores as early as seven years old and therefore become an important asset to the families. Thus, not only must a parent pay to have their children in school, they also lose out on the help they receive from the work their children can do. Most families must choose between school and work and more often then not, the latter becomes a necessity to the health and security of the family and thus the child is put to work.

Lack of education is the crux of the majority of the issues Haitians face today. For this reason, education is one of the most important aspects of attempting to implement any type of project in a third world country. Educators dispatched by Europe and the Agency for International Development, attributed poverty to the absence of an educational system (Galbraith, 1979). Joseph E. Stiglitz states that education promotes the notion that change

is possible, that there are other ways of organizing production, as it teaches the basic principles of modern science and the elements of analytic reasoning and enhances the capability to learn (*Making Globalization Work,* 2006). The goal of any project should be to teach Haitians about the technical aspects of a project so that they can carry that information forward to future generations. Hopefully one day they may be able to create their own projects and help themselves rather than depend on outside aid.

3.6 Health

In addition to the many social and political crises, Haiti is battling diseases that could be cured with a simple pill in our society but that are killing Haitians by the thousands. Although the average life expectancy in the 90's was under 50 years and has increased to be close to 60 years during the past couple of years, Joseph E. Stiglitz states that today, there is more concern in the development community about the importance of health (*Making Globalization Work*, 2006). Unfortunately, the life expectancy in Haiti is still significantly lower than the surrounding countries in the Caribbean (World Health Organization, 2009). Children are especially susceptible to these diseases and consequently, approximately 2 out of every 10 children will die before reaching the age of 5 (World Health Organization, 2009). Some of the more serious diseases include Malaria, typhoid, tuberculosis, intestinal parasites, and sexually transmitted diseases but very often, simple illnesses go untreated due to the shortage of hospitals, and eventually result in death. Since medical facilities are poorly funded and understaffed, many health care workers are not properly educated and therefore, incapable of properly diagnosing sicknesses. Unfortunately, due to the absence of modern medical care, people have turned to indigenous healers and have put their faith in the informal healing practices of these

so-called healers. Consequently, many people believe that diseases are a result of spells, curses and bad luck, and this feeds into the horrible trend of diseases being treated by spiritual healers rather then medical professionals. William Easterly quotes a man in *The White Man's Burden* who lost his wife despite trying to cure her with tebel [holy water] and woukabi [spirits], for these were the only things a poor person could afford (Easterly, 2006). As a result of these types of situations, the cause of the outbreak is never known and the cycle continues as more people get sick and die. The truth of the matter is that many of the diseases in Haiti are a direct outcome of the lack of sanitation and hygiene standards throughout the country. The concept of a lavatory is very new to Haiti, although there are non-profit organizations such as Sustainable Organic Integrated Livelihoods (S.O.I.L.) who are developing and distributing waterless toilets due to the lack of running water throughout the country, Haitians are not accustomed to using toilets and have trouble understanding why they are relieving themselves in any type of containers. I can recall a conversation with an elderly man where after trying to explain the harms of depositing their excrements outside, especially near their homes and water source, the man asked what would his animals eat. This is a perfect example of improper education being transferred from generation to generation and illustrates the urgent need for health education throughout rural areas in Haiti. In addition to the scarcity of bathroom facilities, there is also no garbage depository and consequently, the streets and waterways are littered with waste. In our society this seems ludicrous but in Haiti this is all they have known and it has become natural to them. After one of my training sessions in Milot, I gave each student a granola bar in appreciation of the work they had completed and as I finished passing them out I saw that they had thrown the wrappers on

the floor of our shop. Trying to set an example, I went around and picked up all the wrappers and placed them in a bag. As I did this I noticed that the students were looking at me as if I was crazy, so I explained to them that where I came from no one threw garbage on the floor and that there are fines for people who litter. Almost instantaneously, everyone erupted in laughter at what I said and soon I found that the idea of not being able to throw garbage out and even more so of getting in trouble for throwing out garbage was not the reason, but in their minds they were imagining having to hold on to their garbage in bags like the one I put the wrappers. I continued to teach them about our waste management system and explained what they would need to implement a system similar to that in the US. Unfortunately, when I reached the part about having to pay taxes to fund such a project, everyone lost interest rather quickly.

CHAPTER 4

ENGINEERS WITHOUT BORDERS

NEW JERSEY INSTITUTE OF TECHNOLOGY

During the past three years much time has been devoted to the preparation of the EWB-NJIT sustainable development project in Milot, Haiti. The planning and preparation involved in implementing a project such as this is very extensive and increases once the project has started. Today there are over 200 non-governmental organizations operating in Haiti and although the number sounds wonderful, not all the projects that have been implemented by these organizations have been successful due to improper planning and community involvement (The Haiti NGO Connection, 2007). Obviously, more aid will lead to more career and education opportunities, which could then lead to a higher standard of living, but getting from here to there is a matter of routine planning (Sachs, 2005).

4.1 Location

Our advisor, Professor Jay Meegoda knew a Doctor who volunteered every year at a hospital in Milot, Haiti. Dr. Lewis Ladosci among many other doctors and nurses would travel to Milot to volunteer at the local hospital, Hospital Sacre Coeur. Dr. Ladosci informed us of the large number of patient cases that were directly related to the poor quality of the water and unsanitary conditions in the community. He was confident that if we found a way to provide people with clean water and improve sanitation standards the number of cases at the hospital would drop exponentially. Since we already had a connection to volunteers in Haiti, Milot proved to be the best project location for us.

Through Dr. Ladosci we contacted the Sisters who ran the Hospital as well as the compound that housed the volunteers during their visits and coordinated our visits with them. The compound provided us with cheap and safe housing and the proximity of the hospital guaranteed immediate assistance if anyone was hurt or become sick. This relationship with other volunteers in Milot would be a large determining factor in the acceptance of our project by Engineers Without Borders and would later prove to be a major reason for the success of our project.

4.2 Schematic Planning Phase

We started the planning process by developing a comprehensive list of objectives for the project. For this, functional objectives, budgetary restriction, and usability had to be considered. The functional objectives for a project include supporting the community's needs at a low cost but high efficiency rate, and having a large focus on education and health. The budget should include half of the donations that were obtained through fundraising in order to leave money for future trips in case contributions decreased. Our budget included an initial $10,000.00 donation from the Dean and any money we were able to obtain through fundraising. Therefore, our first trip for the project would have a budget restriction of $4,000.00 to leave money for our future trips in case we were unable to raise enough money through our fundraisers. Usability would be the most significant part of the project since longevity is an important goal to be met. For projects to be carried forward into future generations and become part of the local culture, one cannot just show up, leave there some technology and let the locals fend for themselves. The ability to teach the community about the technology that will be implemented would ascertain that the project would remain a success and therefore would be a deciding factor

in the choice of technologies.

4.2.1 Learning the Ground Rules

Before considering concepts for a project it is necessary to conduct extensive research on Haiti, especially the community where the project is to be implemented. Learning background information on Haiti and studying geographical information such as populations, terrain data, and environmental data including weather, ecological data and phytology data will leave an organization better prepared. Moreover, investigating the history of issues involving violence, health, education, and the economy in Haiti will increase the chances of implementing a successful project. This would help in traveling to Haiti and would help volunteers better understand the Haitians.

4.2.2 Learn the Site

After determining the objectives of the project and researching the lay of the land, in order to proceed with planning, it was necessary to verify the information found through our research. To accurately plan the project, we needed to base it on verified information of the actual location and we needed to get the recipients involved. This information will influence the technology options considered and will help us when we conduct our feasibility study in the future. Therefore, an assessment trip to the project location is required to ensure an accurate project plan. One of the most important aspects of a project such as this is assessing the needs of the community you are trying to help. The goal of our pre-assessment trip to Milot, Haiti was to investigate the needs of the community, perform a Community Health Assessment, assess the resources available and obtain a GPS survey of the land.

4.2.3 Areas of Need

For a country like Haiti, a list of necessary improvements can be extensive and therefore it is critical to stay focused on the project you went there to accomplish and not lose track of your goals. For our project, we focused on the needs revolving around health, sanitation and education. Through Community Health Assessment Surveys, we narrowed down the actual problems the community is facing and found that most of the problems boil down to the lack of jobs and education. This creates a domino affect that reaches all aspects of the community members' lives and leaves them unable to rise from their current standings. Engineers Without Borders found that the community problem was not that there was no food or clean water; the problem was that these things cost money and this was something most people did not have. Therefore, people would eat and drink contaminated food and water, which would send them to the hospital to spend money they did not have or lead to their death because they could not afford hospital care. Furthermore, the lack of education among the community's members prevented them from understanding what was making them sick and even more so of developing a solution to their problem. After speaking with the local hospital, we were informed that the major problems they see daily are directly related to contaminated water. We met with the local water committee and discussed their needs and feelings regarding a potential water purification project. The community emphasized that they were not taught the mechanics of previous projects and therefore these projects did not provide enough change to the community. Based on this information, it was clear that education was the most important aspect of a project and therefore whatever technology was implemented would be paired with an educational plan as well as a possible business plan for future

development within the community.

4.2.4 Available Construction Resources

The available resources in a community plays a large role in deciding which technology would best suit the area you are working. In Haiti, a variety of resources are available but it is important not to deplete the community's valuable and limited resources. The material options available for the Engineers Without Borders project were wood, clay and concrete. Concrete proved to be the best alternative since it is the building material of choice in Haiti and many people know how to work with concrete. It is important to understand that in countries like Haiti, construction standards are less then satisfactory and projects should be used as an opportunity to educate the community workers on the proper methods of construction.

4.3 Design Development Phase

Upon returning home from our assessment trip, we began to research different technologies that have been implemented in other countries in the past. The students involved in Engineers Without Borders decided that the Bio-Sand Filter was the best alternative because of the efficiency of the process and the low cost of construction. Additionally, there were other projects in Haiti involving the Bio-Sand Filter, which would facilitate implementation of the project. Hence, the next step of EWB would be to learn about Bio-Sand Filter construction and figure out how to accomplish this in Haiti. NJIT EWB sent two members to an organization called Center for Affordable Water and Sanitation Technology (CAWST) where they were taught how to construct, troubleshoot and test Bio-Sand Filters. This training also included information about starting projects

and the proper planning that was needed prior to the implementation trip. This training is very important as it ensures that the organization is providing the proper information to the communities it serves, and that the organization is prepared to implement a project.

4.3.1 Technology

It is no secret that 1.1 billion people in the world do not have access to clean drinking water and 2.6 billion do not have adequate sanitation (World Water Council). The introduction of technologies in Haiti will improve these statistics and drastically improve the quality of life for many Haitian residents. Joseph E. Stiglitz states in *Globalization and its Discontents* that the fruits of research can be of benefit to anyone, anywhere, at essentially no additional cost (Stiglitz, 2002). Since the technology to solve these problems already exists, considerable success can be achieved now by incorporating [these] developed strategies (Reid, 1989). Therefore, the Bio-Sand Filter proves to be the perfect technology for this project. These Bio-Sand Filters are small, household sized, slow sand filters that can be run intermittently in a household or small group (Clean Water for Haiti, 2002). The filter consists of a layer of gravel overlaid with prepared sand media contained within a filter body, usually constructed in concrete. As water pours into the top of the filter, it travels through the layers and is collected in another [clean] bucket or container at the base of the spout (Clean Water for Haiti, 2002). A shallow layer of water sits at the top of the sand developing a biological layer in the sand consisting of slime, mud and microorganisms. This bio-layer or "Schmutzdeke" as it is technically called removes 98% of bacteria in the water as it passes through to the spout (Clean Water for Haiti, 2002). The Bio-Sand Filters to be built and distributed during this project will allow Haitian residents to have a continuous stream of clean water that they can use

for drinking, cooking and cleaning. According to a study in 2005 where 105 families that had filter for 1-5 years were interviewed, 99% of the users agreed that the water tasted, smelled and appeared better then before. Furthermore, a unanimous 100% felt that the filters were easy to use by adults and children and that they generally liked them. Also, 95% of the people interviewed said they had seen an increase in health after starting to use the filters (Clean Water for Haiti, 2002). Based on this information, one can expect that most families will be receptive to the introduction of the Bio-Sand Filter.

4.4 Implementation Phase

During our Pre-implementation trip, we found how we were going to get and transport material, who would be making the filters and where they would be constructed and stored. Furthermore, we tested several water sources and introduced the Bio-Sand Filter to the community. We brought all the tools necessary to construct a Bio-Sand Filter and contacted an organization called Clean Water for Haiti, which had been selling Bio-Sand Filters in Haiti since 2001, for some advice in planning our trip. We purchased two filter molds and some material required for 25 filters from Clean Water for Haiti and had them delivered to Milot. We had a meeting with some of the local residents as well as NGOs and were offered an old abandoned building at the back of the compound that we could use to start constructing filters. Moreover, the principal of the technical school located in the compound volunteered his students to build 25 filters as part of their education. We held a community meeting and we disclosed the water testing results and reviewed our Bio-Sand Filter plan with the community. During this meeting we explained the agreement we had made with the Sister in charge of the compound and the Technical School principal and reviewed each party's responsibility. To create a sense of pride in

the project, we made it clear that if accepted, this was to be the community's project and that we would only be here to support the students with filter education and provide them with initial funding. They were responsible for choosing the 25 recipients that would receive the filters, making sure that the students were working on the filters and ensuring that our material and tools would not be stolen. We advised them that we would return in three months and that these requirements had to be met in order for us to continue our efforts to help them. When January came, we returned to Haiti to check inventory, inspect the 22 filters that were built, inspect and test the 3 filters that were installed during the previous trip and meet with the Water Committee to develop a plan for installation of the remaining filters. Another very important aspect of our trip was to keep our promise of coming back since we had gained everyone's trust during the previous trip and not keeping our promise could potentially damage our relationship. We brought some replacement tools and educational material to distribute to local schools and community centers. After the Water Committee meeting and working with the students again, I felt confident that our next trip would be the beginning of transferring the project to the community members.

4.5 Project Transfer

Finally, during the implementation trip we installed 23 filters and finalized the remainder of the project. We continued training the students on how to install the filters and the community on how to maintain the filters. At this stage, the Water Committee requested that they would like to take responsibility of the project so that they can make additional filters on their own. Since they have the necessary tools and a place to work, all they need is to get the money to fund their project. This is outlined in the remainder of the paper.

CHAPTER 5

UNIT COST ANALYSIS

One of the major goals of our trips to Haiti was to obtain as much cost information as possible. The reason for this was so that we could calculate and evaluate the costs of this project. Since funding is one of the most arduous tasks of this project, figuring out the cheapest method to implement this project would be very important for the students at NJIT as well as to the community in Milot.

5.1 Material and Cost

The first thing would be to collect data on the cost for various materials. From our four trips we created Table 5.1, which will be used to determine the approximate cost of the construction of one filter.

We provided the community with two molds and tools but they would be required to pay the rent for the location that they would use to construct the filters. The fixed costs for our individual project would include the items listed in the Table 5.2.

To develop a unit cost per filter we would need to calculate the man-hours required in building a filter. We used the information shown in Table 5.3 that lists all steps needed for filter construction and the amount of time it would take to complete those tasks to figure out the length of time required for 2 people to construct a filter.

Based on a pay rate of $0.63 per hour, it would cost approximately $1.88 for labor for the

construction of one filter.

Table 5.1 Cost Data from Haiti Trips

Materials:	
Gravel (truckload)	$50.00
Sand (1 truckload=5 c.y)	$10.00
Cement:	$9/bag, 1 bag = 97 lbs.
Rebar (1")	$8/Bar, 1 bar = 30ft.
Plywood	$15/ 4x8 sheet
Lumber (1"x12")	$58-$72/12 pcs.
Paint	$13.30
Nails	$1/lb.
Tubing	.70/ft
Clear plastic board	$100/ 1/8" thick 3x6 sheet
Tools:	
Wheelbarrow	$91.25
Shovel	$6.25
Hammer	$5 ea.
1.5 inch Wrench	$60.00
Bucket (5 gal.)	$10 ea.
Saw	$80-90 ea.
Generator (5000W)	$1000-2000 new, $600 used
Pump (1.5 HP)	$400 ea.
Labor:	
1 day	$5 / day
Michelle- Navigator	$20.00
Miscellaneous:	
Copy of Key	$2.75
Cell Phone	$20.00
5 Gallon Bucket	$9.38
4 Gallon Bucket	$6.09
1 Gallon Bucket	$4.57
Fine Sieve Material	$25.00
Wheelbarrow- Sieve	$10.00
Transportation (Cap Haitian)	$37.50
Tarp	$40.00
Vegetable Oil	$10.00
Rent for Shop	$25.00
Generator	$1,000.00

Table 5.2 Fixed Costs associated with this project

Fixed Costs	
Mold	$125.00
Tools	$80.00
Rent	$5.00
Total	$210.00

Table 5.3 Labor Information

Person-Hours required for 2 people to build and install a Bio-Sand Filter		
TASK	TIME	
Cutting and installation of 34" of tubing	5	min
Preparation of molds	5	min
Preparation of concrete	10	min
Pouring filter and lid	10	min
De-molding	5	min
Cleaning molds	3	min
Painting filter and lid	10	min
Preparing media	20	min
Preparing diffuser plate	10	min
Filter Installation	10	min
Total	1.5	Hours

Table 5.4 shows the unit variable cost computation. Based on this analysis, the Bio-Sand Filters would cost approximately $10.00, but through donations, grants, and other funding, filters will be provided to families for $5.00.

The recommended amount of water a person should drink daily is 64 oz and this amount increases with prolonged activity. Since the average price for an 8 oz bag of water is

$0.10 it would cost a person $0.80 per day to drink the amount of water suggested. The average cost for a 5-gallon jug of water is a little under $3.00, which calculates to $0.30 per day for the suggested water consumption amount. Therefore, a 5-gallon jug of water would last a little over 1 day for a family of 8 and would average out to approximately $9.00 a month and $108.00 per year spent on clean drinking water. With an average annual income of $500.00, this is more than 20% of their yearly earnings. Taking into account that this number excludes the water required for cooking and bathing, the price a family spends on water yearly would nearly double. Unfortunately, most families do not have the money to spend on the luxury of clean water and therefore resort to drinking contaminated water.

Table 5.4 Unit Cost Variable Computation

Variable Costs per Filter

Material	Amount	Unit	Price/Unit	Total
Cement	0.25	Bag	$9.00	$2.25
Sand	0.024	Cubic Yard	$2.00	$0.05
Gravel	0.04	Cubic Yard	$10.00	$0.40
Diffusion Plate	1	Square Feet	$3.00	$3.00
Tube	2.83	Feet	$0.70	$1.98
Labor	2	People	$0.94	$1.88
Total				**$9.56**

CHAPTER 6

BUSINESS START UP

Jeffrey D. Sachs, among others, agrees and believes that the main challenge now is not to show what works in a single village or district...but rather to scale up what works to encompass a whole country and even the world (Sachs, 2005). Since the technology that was introduced in Milot, Haiti was accepted and is working very well, the next step is to try to evaluate a method by which the community can run this project successfully and grow it to include other communities. We provided them with the tools to construct the filters and taught them how to build, install and maintain them. The only issue left would be figuring out how they would find the funds necessary to provide the filter to the community at an appropriate price. Currently, residents would be forced to buy drinking water at approximately $9.00 per month. Therefore spending the money to have an unlimited supply of clean water is a great alternative. With approximately $42.00 per month to spend on a family's necessities, very little money can be paid towards the purchase of a filter. Therefore, payment options would greatly facilitate to acquisition of a filter for a family. Options could be accommodated for each recipient depending on the amount of money they could pay per month and would include a minimal interest rate.

6.1 Funding

In an effort to end poverty from the bottom up, the idea of Micro-financing arose. These micro-finance programs offer loans to individuals from third world countries that have a good business idea and some ambition. Loans and qualifications vary depending on the organization and the business idea, but all share the same goal of business training and

education. One bank in particular, Fonkoze, which has 40 branches in Haiti, one of which is located in Milot, Haiti is the largest microfinance organization in Haiti. Their Business Development loans start as low as $1,300 and can reach as high as $25,000. Interest rates vary with the economy and are accrued based on the balance of the loan. With a thorough business plan, an aspiring individual can pitch their idea to a Fonkoze representative and apply for a loan. If they are given the loan, they will be trained and monitored by individuals from Fonkoze for the duration of the loan to assure that they have the help they need and are running a successful business. With our help in developing a business plan and the training we have already provided, the students in Milot will be able start a venture of their own providing the community of Milot with Bio-Sand Filters and one day moving on to other communities and maybe even other countries.

6.2 Business Plan

Beyond the funding aspects of starting a business are the internal developments of a business steered towards success. The most important aspect of starting any business is creating a business plan because it outlines your goals, the methods you will use to reach your goals and the timeline you will follow. Reviewing your plan periodically can help keep your organization focused and organized through the years. Furthermore, it may help in proving your legitimacy and commitment and assist in the development of marketing strategies. Having a line of approach for matters such as technologies to be introduced, marketing strategies, financial plans and operation plans can break down the project to ease the planning and implementation stages. Since most families will not be able to pay for the full cost of the filter and the business owners will have a hard time

subsidizing the cost of the filter, developing payment plans will facilitate the entire process. For this project to be worthwhile for the business owner, he or she must make a profit. Therefore, based on the amount of money a person would spend on clean water per day mentioned in Chapter 5, it would be advisable for the owner to rent the systems at $1.25 per month for a period of one year. After one year or 12 payments, families would own their filters and would only be required to pay a small fee for maintenance and repair, if required. This would result in 50% final profit for the owner and $8.75 savings on clean water for each family per month. If the rent is reduced to $1.00 a month for 12 months, the owner would receive a 20% profit and the families would save $8.00 per month. Depending on the amount of profit the business owner is looking to make as well as the length of the loan, the monthly payment may be reduced or increased according to the agreement made by the business owner and the customer. Either way, the Bio-Sand Filter will prove to save families money in the long run on clean water and medical bills resulting from the consumption of contaminated water.

CHAPTER 7

SUMMARY AND CONCLUSIONS

Starting a non-profit organization goes far beyond government forms and fees, Business Plans and Mission Statements. Although these are necessary items to be recognized as a non-profit, the true core of a non-profit organization is the projects it is working towards and the people it is trying to benefit through hard work. The education it provides and the technology it introduces to these third world countries will be handed down to several generations and outlast any formal document that was ever drafted up for its cause. The logistics of the organization are important to work efficiently, and should be carefully planned to ensure the longevity of the organization, but it is the community members who will ascertain the success of the projects. It is the organization's responsibility to take the necessary actions throughout the duration of its involvement with the project to ensure that everything runs smoothly after the project transfer. This need to involve a thorough research on the country and other projects in that area prior to visiting the area, and most importantly, the understanding that the community must be involved in every step of the way. Every interaction with community members should be educational both for the community as well as the project managers. A complete understanding of everyone's intention must be put out in the open in order for trust to be developed between all parties. In the end, if these general steps are followed there is a high possibility that the project will continue long after the organization has left the area.

The students of New Jersey Institute of Technology's Engineers Without Borders Chapter have been developing their project in Milot, Haiti for the past three years and is a perfect example of the steps to take in developing a charitable project in a third world country. Moreover, they stand to prove that anyone can help a community in need with a well thought-out plan and a kind heart. Through my research I found that Haitians are paying close to $9.00 per month on clean water or just drinking contaminated water, which causes a variety of sicknesses throughout the country. I also calculated the costs to construct a Bio-Sand Filter and found that it would cost approximately $10.00 to construct one filter. Based on these numbers, it is obvious that an organization cannot only make money in the construction and distribution of filters, but more importantly, it can significantly improve the health of families in Haiti. With a Fonkoze bank right in Milot, it would be easy for an ambitious individual to be approved for a loan of $1,300.00 to start the business. Based on this, I am positive that this organization can become successful and be accepted by the community. Furthermore, with the demand that exists ever since Engineers Without Borders introduced the Bio-Sand Filter, I am confident that this venture could expand to include other cities besides Milot and potentially help towards the goal of providing clean water to all third world countries.

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