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Ethical Issues Related to International Development Projects

Abstract

International service learning within engineering education is increasing in amount and visibility. There has been much work dealing with the legitimacy of service learning in engineering education. However, there has been less work dealing with ethical issues involved with engineering service learning. While there are ethical issues related to any engineering project, this paper concentrates on ethical issues inherent in the international service learning approach that has economic development as one of its goals.

One issue is how the design relates to the local community. In traditional engineering design the client is clearly identified and the engineer can work to make sure the client's wishes are carried out in the design. Often engineering service learning is done with a local non-profit agency or a local government agency. In both cases they claim to represent the needs and desires of the local community that will be served by the project. The lead professor needs to make sure that this project is really needed and wanted by the people it is designed to serve. Therefore, the project really has two clients, the local agency and the local population to be served. This complicates the design process and raises ethical issues if these two groups are not in total agreement.

A second major issue involves the creation of local businesses as an integral part of the project. Many service projects do not have a long term impact because they cannot be sustained by the local community. One way to deal with this is to help local people create an on-going, for-profit business that can maintain the project and provide jobs for the poor community that would not otherwise exist.

We will use as an example our current work in rural Honduras. Over the last several years teams of students and faculty members have installed several micro-hydroelectric systems. This past year we have made a key part of the project the creation of a local energy company that can provide cheap electricity to the villagers as well as jobs for the local community. Our goal is to use this as a springboard to franchise this to other villages, so that they also can have the benefits of cheap electricity and local jobs. One of the ethical issues we have faced is to make sure the business is not seen as a foreign project, but an indigenous one that meets the needs of the local people.

An Introduction to International Engineering Service Projects

Engineering service projects are becoming an increasingly common way to teach engineering. The growth of the EPICS (Engineering Projects in Community Service) program is an example of this[1]. EPICS was founded at Purdue University in 1995 and has now grown to involve 18 universities and some high schools. Other schools, like our own, are not formally members of EPICS but are doing many of the activities that the EPICS program promotes.

One of the issues related to engineering service learning is whether the course is mostly service and not enough engineering. This is, in itself, an ethical issue. If we are offering courses that get

engineering credit without doing real engineering, we are being deceitful to our students. This is an issue that many engineering programs have faced as some faculty are resistant to this new way of doing things.

Many engineering service learning courses have involved service projects within poor communities near the college campus. However, international service learning is increasing as well. Kelley[2] has written about service projects in East Africa. One of the authors has reported on a project in rural Western Kenya[3]. The group Engineers without Borders has grown dramatically in the last few years. Professors from Rice University[4] have written about their projects with Engineers without Borders. Part of the motive behind international service learning projects is to help our students develop a global perspective. Pines and Gallant have written about their work in this area at the University of Hartford[5].

There are many reasons why faculty and students might wish to do engineering service projects. From the students' perspective the opportunity to do a hands-on project where the results can be seen immediately is probably much more enjoyable than a traditional project might be. Many faculty are also drawn to these for the same reasons.

Many people have a desire to be of service to others. This can be done from a religious motive or a secular one. Our own university defines service to others as part of its basic mission. Our students have given up significant amounts of time, effort, and money to serve poor people in other parts of the world. This application of appropriate technology in a developing country is very consistent with Baylor University's mission, part of which is:

"to educate men and women for worldwide leadership and service."

At our university most of our service learning to date has been with international projects. These projects are an outgrowth of a student-created service organization. It is loosely patterned after Engineers Without Borders from whom we have learned a great deal.

Many approaches to poverty issues are from a top-down perspective, using governmental policies and spending to try to make changes. Engineering service learning can be part of a bottom-up approach, using technology and social entrepreneurship as tools to make a difference in poor communities. With a focus on service, technology can be an instrument of peace, community development, restoration of human dignity, and the alleviation of hunger and suffering. This happens as these endeavors and their practitioners orient their craft toward an end that has meaning as well as economic profit.

Engineers are not the only people who are trying this bottom-up approach. Non-engineering examples of such an approach to poverty are described in the excellent book[6] by Shannon Daley-Harris and Jeffrey Keenan.

Ethical Issues in International Engineering Service Learning

There are some ethical issues that must be faced in any international engineering service learning project, whether or not there are economic development goals. Three critical ones are safety, liability, and community involvement. The safety discussion is adopted from a previous paper

by the first author[7]. Additional ethical issues that are inherent to projects that include economic development goals will be discussed in a later section of this paper.

Safety

Nothing that is made can be guaranteed not to fail. Everything that is designed and built has some finite probability of failure. This is because our knowledge is not perfect. Our capability to build to a specific design is not perfect.

As a result of this, an engineer must be very careful to design according to the most recent knowledge and practice in her field. Even if a design is based on the most current knowledge, there is still a chance that not enough is truly known about the situation, and the part/structure may still fail. An ethical engineer should take into consideration the likelihood of failure during the design phase. This process is called risk analysis. Risk analysis concepts should be used in some form in engineering service learning projects.

There are two separate issues that must be examined. The first one is the **probability** of failure. This is the likelihood that the structure will fail during use. A second issue is the **severity** of the failure. If the structure does fail, how hurtful will that failure be? In many situations the actual calculations of the probability of failure and severity of failure may be rather difficult.

This does not mean that high probability of failure will always mean the design should not be made. For example, when a man shaves with a razor blade, there is a high probability of failure (meaning he cuts himself shaving). For many, this probability is somewhere between five and ten percent. Does that mean the blade was designed or built poorly—not necessarily. It means that the user is not always as careful as he should be. Men who shave with razor blades tolerate this high probability of failure, because the severity of failure is so low. In the case of the razor blade, the failure is a small cut that the user has probably forgotten about by the time he leaves for work.

What probability of failure is acceptable depends upon the severity of the failure. The five percent failure rate in shaving (which is willingly accepted) is much higher than the probability of failure a car's axle. If an automobile's axle failed five percent of the time, most owners would be very upset. This is because the severity of the axle failure is so high. [It could result in loss of human life, probably will result in damage to property, and certainly would result in a lot of time wasted trying to get it repaired.] If the severity of the failure is very high, the designer must make sure the probability of failure is very low.

Once the probability and severity of failure have been determined (or estimated), then the decision as to whether to make the part needs to be made. There may be honest differences of opinion as to what is acceptable risk. However, some risk decisions appear to be based solely on financial risk rather than taking into consideration the value of human life. For example, the Ford Pinto was known by Ford to have a design flaw that could result in a disastrous fire during some types of rear end collisions. They estimated the probability of failure to be rather low, and decided it was cheaper to not make the design changes but be willing to pay off any claims that

might occur from the accidents. For details of the Pinto case, read the article in Johnson's engineering ethics book[8].

Liability

Liability for design is not something that is always carefully thought through when doing an engineering service design for a non-profit agency. However, our recent experience on a bridge project illustrates the potential for a problem. A group of faculty and students from our university worked on a design of a pedestrian bridge to be built in south eastern Kenya. We have reported on our preliminary work at a 2007 conference[9]. About the time we finished our preliminary design a pedestrian bridge failed in Nepal[10]. This bridge was built by a non-profit agency that uses many volunteers to do their design and building. A photograph of the failed bridge is shown below.

Figure 1—Failed bridge in Nepal that had been built by a non-profit agency[13]

This bridge failure shows the importance of ensuring safety in whatever the students design. While the bridge in this example was not the result of a student design, its length is not much longer than the largely student designed bridge that was designed at our university.

It is important that the student engineering service projects be given adequate supervision so that failures do not occur. Some student designs seem relatively simple. However, even something as simple as playground equipment could fail if not designed or built properly.

Community Involvement

Even if the probability and severity of an accident can be estimated, problems can still develop if the public does not have the same perception of risk that the engineer has calculated. At the very minimum, our designs need to be acceptable to the local community. Even if we are confident they are safe, the local community needs to be confident they are safe was well.

William Oakes and Marybeth Lima have written an excellent book on engineering service learning[11]. In chapter one of their book, they make the following recommendations concerning the interaction of an engineering service project with a local community[14]. We would like to interact with several of these concepts in this paper

- Think hard about how your problems are defined or framed
- Realize that engineering and technology decisions are value laden
- Realize that engineering itself is value laden
- In engineering, use systems thinking instead of linear thinking
- Engineering and technical systems should be democratic

Engineers and engineering students frequently do not seriously think about how their design might impact a community. The social implications of their designs are not one of the criteria that is used to assess its success. This is in contradiction to what ABET requires schools to teach concerning engineering design. Criterion 3(h) states that[12]:

> "Engineering programs must demonstrate that their students attain the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context."

Ignoring societal impacts is also a violation of most engineering codes of conduct. For example, the National Society of Professional Engineers (N.S.P.E.) states in their code as the first fundamental canon of engineering practice[13]:

> "Engineers shall hold paramount the safety, health, and welfare of the public."

The practice of engineering is value laden. This is an important point in Oakes' discussion, but this perspective is not unique to him. Steven VanderLeest has also written about this[14] topic. Engineers use computers to do much of their work. This has led many engineers to only solve problems that can be solved using computers. Problems that are not easy to solve using computers may be ignored. This may be good for many of the specific technical portions of the design, but computers are not able to analyze the needs and wishes of the local community.

Oakes suggests[14] that the practice of engineering service learning should be done in a democratic way. This does not mean that everyone votes on everything. It does mean that the local community gets input into the decision making process. This includes not only what projects to design but also how the design works. If the design works in a culturally offensive manner, it will not be used.

Another local involvement issue is that the project is frequently done for a local non-profit group which is acting in the name of the community. The faculty member must make sure the community itself really wants this project to be completed.

Our experience in creating a company in the developing world

The basic issues of safety and liability still play a role with development related international projects. Given the different legal systems around the world, the legal liabilities for the same design may be very different in different countries.

Community involvement is also critical when working in a developing country. The design project needs to be desired by the local community, not just the national government. In authoritarian countries the government may support projects that serve their national goals, but which are not supported by the local people. How to determine whether the local community really wants a project is not always a simple task. Some have suggested that the local people get to vote on a project. This is not realistic in many places, particularly in countries where the people have never voted in a free election. It is also hard to do in countries with high illiteracy rates.

Several examples from international projects at our university will be used to illustrate this point. The pedestrian bridge in Africa was designed with a non-profit called Bridging the Gap Africa[15]. Before they will work on building a bridge it must first be requested by the local community. The local community must also commit to help build the bridge and agree to maintain the bridge. This ensures that the bridge is something that the local community wants to have.

Another example of involving the local community is in the projects we plan to do in 2009. In early January 2008 the first author visited with several groups in Rwanda. We identified several projects where the local people have already requested our help. One example of this is the Sonrise School near Musanze, Rwanda. This is an excellent school that was originally created to teach kids who were orphaned in the 1994 genocide. At the school they now teach many other children as well. They have needs for purifying their water. Currently the workers boil it in wood charcoal based stoves, which takes a lot of work and pollutes the kitchen area. There are also problems with electricity. The school's source is not stable and very expensive. Teachers and students are trying to use computer labs and need a better source of cheap electricity that is also stable. Our work for the above project will be based upon specific requests from the people who need help. There would not be any issue of community buy-in to this project. We still will need to work to make sure our designs are safe and sustainable by the local people.

Traditionally development work has been done by good hearted people who desire to help the poor. Their typical mode of development is to enter into an area and try to give aid by building hospitals, clinics, schools and churches that are funded entirely through foreign monies. Although it is never their intention, what they most often succeed in developing is a culture of dependency that relies on the incoming gift monies from developed nations.[16] Most often the poor are seen as being incapable of taking care of themselves and must therefore be provided for, rather than taking a positive approach of helping them develop business opportunities that will benefit their communities.

Our recent projects in Honduras illustrate a number of the ethical issues developmental projects can have. Our university has sent several teams around the world to do engineering projects that help the poor. Recently our student group has started focusing on the country of Honduras. In order to make sure we have community support we have worked through a network of local indigenous churches.

During this first trip and a following trip the students did site survey work, design, construction and installation of a battery charging station. However, there was a failure to leave behind a

completed business structure that resulted in a lack of accountability that would have ensured that the business and operational objectives of the project where continued. This resulted in a nearly complete "business" failure, in part because the technology was not really what they wanted, and that resulted in a lack of societal uptake and therefore a lack of societal acceptance of the battery charging station. Also during this trip, we did not have the vision or plans to try and spread the technology around to other towns in similar situations.

While we have learned from our mistakes, this lack of foresight has ethical implications. It is not ethical to start something that cannot be sustained. The local peoples' hopes are raised as they anticipate an improved life, and then it is shattered by the failure of the project to continue to work.

Our second try at developing an electrical system in Honduras has a very different base. We have learned a lot from our first try and from further research in the area, and although we have a similar purpose, this time we have a totally different set of directions, goals and methodologies. This time around we want to make the system sustainable in as many ways as possible, and we do want to spread this technology around to affect as many people as possible.

It is important that the project improve the life of the people it was designed to serve. Equally important it must be seen as an improvement by the local people themselves. If the local population does not see this as an improvement, most people will not bother participate after the project team has left the country.

Presently the people in the targeted rural villages use a combination of disposable D-cell flashlight batteries and homemade kerosene lamps to light their houses. The kerosene lamps pollute the air in their houses and are very hazardous, because they are only an accident away from having them break and burn much like a Molotov cocktail. The batteries that they purchase for their flashlights are very low quality alkaline batteries that do not last long and once they are dead, are thrown out the back door like all the other trash. Although alkaline batteries are less toxic that other forms they do contain potassium hydroxide and may contain small amounts of mercury, which can leak out and leach into the ground and water.[17]

All of these dangers disappear when people switch to electric lights; they no longer have fumes in their homes, they no longer have toxic chemicals leaching into their fields, and there is no longer a constant danger of fire from bottles of kerosene sitting around the home.

Another great benefit is in the quality and cost of light. The people's present kerosene lamps are expensive to operate and produce very little light. The unit of light output is the lumen and a kerosene lamp produces 90 lux-hours of light for one dollar, where as a 15 watt compact florescent lamp produces 2310 lux-hours for the same dollar when running off of power generated from our grid.[18] This results in a 25 times increase in the quantity of light per dollar that a villager receives.

When people switch over to electric lights they receive not only better quality light, but they also receive an important increase in their social status. When a village goes from lacking electricity, to having electricity, it helps to generate a sense of self worth. Also when people have electricity

made available to them they are able to utilize it for many other purposes, something that is impossible with kerosene.

Design, whether in engineering or in business, is about filling an unmet need. In this situation we have a physical need that can only be sustainability filled with a combination of business and engineering. Without the engineering we would not have the ability to design the power generation and distribution systems in the villages. Without the business we would not have the ability to determine what is needed financially to build, support and sustain the operations over a period of time. In this project we are utilizing many off-the-shelf engineering components, and many common business concepts to operate effectively. We are, however, applying the engineering components and business concepts in slightly novel ways.

For example, hydro power is commonly done around the world, but we are operating in the micro-hydro segment of the market that has not received a lot of attention from the large commercial vendors. On the business side of things we are using the very familiar concept of a franchise in a new way, by applying it to the very small scale as a micro-franchise model, which allows local people to potentially own the electric grid in their village.

Our system will utilize these modified common design principles to fix the problems that we have observed in Honduras that are keeping people from being connected to the national grid. The solution we are presenting will produce power locally to be delivered to local people. We are utilizing natural resources that are abundant and non-polluting to generate our power and that have very low costs of operation. We are utilizing local people to build and maintain the system, which keeps costs down. We have also built in checks and balances in our paper work system to prevent theft and corruption. And finally and most importantly we are set up to serve small customers with small amounts of power.

What we have attempted to do is to create a local village for-profit energy company. The company must be profitable to be sustainable. This local company will service the needs of the people in the village, and collect the monthly electric bills. They will use the hydroelectric system provided by the franchiser company and pay fees so that can eventually buy the system. Money received from these franchisees will be used to start additional franchises. More details about this business plan are in a separate paper presented at this conference[19]. The franchiser company is being created as a Triple Bottom Line company. It will have goals to (1) make a profit so it is sustainable, (2) provide incomes to the local people who work with it, and (3) create a social good as the lives of the people who are served are improved.

One of the major things that we have been pushing for is self-sustainability in everything we do. Although this phrase has now become a major buzzword, it is truly one of the major changes that has occurred in recent years that has allowed many people to go from one time short lived successes to long term maintainable ventures within the development community. This venture is going to be a for-profit company, but at its heart is a non-profit purpose: we wish to help the poor via providing them with resources to improve their lives. We desire to develop this method of deploying electric systems so that we can rapidly scale these installations to as many people as possible around the world.

Another major issue facing us is that of proving that our financial models are correct and will "pan out" once we start implementing them. We need to prove to ourselves and to potential investors that we are financially viable, that we can get our costs down, that we can replicate this quickly in other villages. This will allow us to get the investment money we need to continue the project and succeed in the long run.

The idea of installing small electric grid power plants utilizing locally generated hydro power has many promising aspects and potentials. There are obviously many difficulties to overcome before we are able to reliably and cost effectively install these systems but we are excited about the possibility of moving forward with this project.

With our company having a Triple Bottom Line perspective from the very beginning we hope that some of the ethical issues other groups have faced can be avoided. When making major decisions, there will always be a need to make a profit so the business can be sustained and continue to grow. However, by keeping the social goals uppermost at all times, we believe we can avoid some of the problems created by companies that only pursue a maximum profit perspective.

Additional Ethical Issues when Development Goals are added to International Service Learning Projects.

There are several ethical issues that are faced by development projects that are not seen in most pure service projects. There are needs to treat the workers fairly, to avoid designs that are dangerous to the workers and the community, and to avoid damaging the environment.

While the company must make a profit to be sustainable, the workers need to be treated fairly and paid fairly. While they should be paid a fair wage, this fair wage is often determined by local conditions. If we pay too little then the workers may feel exploited or just not work for our company. If we pay them too much (by local standards) then we may damage the local economy as other companies cannot compete. Doing so will also make it harder for the company to stay profitable. We should work to ensure that what we do will qualify us to legitimately claim our products were produced under fair trade conditions.

One of the tensions we face is if the company has both U.S. and local employees. The U.S. people are used to higher salaries and nice living conditions. They may not be willing to come to this country and this job position without being paid much more than the local people. This could cause problems with the local workers. Ideally there would be no U.S. workers needed. However, at the start of a company, there will likely need to be U.S. employees. This is referred to by some as using "borrowed talent" until enough local people are able to take over the job.

If the company is to provide a social good for the community, it must not pollute the environment. While everyone would probably agree that polluting the environment is bad, it is not always easy to set the appropriate pollution standards for a given situation. The U.S. has very strict environmental standards, which our prosperous economy can support. However, some countries have allowed more pollution to allow economic development to occur more

rapidly. When local standards are much more lax than in the U.S., companies may face a dilemma as they have to decide for themselves how much pollution is too much pollution. Many people who make less than $2 per day may be quite willing to take some health risks to avoid the problems of malnourishment because they cannot afford enough food.

Conclusions and Recommendations

There are some ethical issues common to all international engineering service projects. Among them are issues related to safety, liability, and community involvement. These three issues must be dealt with before a project can be safely and ethically implemented.

These are additional issues present when economic development is also a major part of the goal. Among these are the needs to treat workers fairly, to make sure the project is sustainable (by being profitable), and to not pollute the environment around the business.

We would encourage developers to create businesses that have a Triple Bottom Line. When the company's fundamental goals include more than just making a profit the company's leaders are more likely to make ethical decisions that will be to the benefit of the local people. The company still needs to be profitable to be sustainable, but profitability is not the only goal.

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