

A PORTABLE AND SUSTAINABLE COMPUTER EDUCATION PROJECT FOR DEVELOPING COUNTRIES- PHASE I

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Abstract – Four members of Engineers without Borders – UCLA (EWB-UCLA), constituting the *Thinklab!* team, collected eleven laptops from various personal and corporate donors to establish the *Thinklab!* computer laboratory. The project aspired to provide an education resource to encourage learning and creativity for a small children's center called El Buen Samaritano, in Jocotenango, Guatemala. The team members tested each computer individually for functionality and installed Linux and OpenOffice, free alternatives to Microsoft Windows and Office. After setting up the units, approximately 25 students attended several weeks of typing, computing, and lab maintenance courses. Meanwhile, to address cultural impacts and logistical concerns, the *Thinklab!* team developed a close partnership with El Buen Samaritano directors. Design and implementation of the project covered eight main areas of focus: location, hardware and software, transportation, customs, Internet, classroom, benchmarking, and recycling. These main areas of focus, or modules, will be discussed in detail in this paper.

Index Terms – computers, education, Internet, portable, sustainable.

INTRODUCTION

In the summer of 2005, the *Thinklab!* team introduced an under-resourced region in Guatemala to technology by establishing a small computer laboratory at El Buen Samaritano (EBS), a center that functions as a home, family, and school for approximately 90 children of all ages. A volunteer and central hub in Antigua called Project Mosaic Guatemala provided several candidates for this project, and after meeting the dedicated directors of EBS, Magda Torres and Alice Lee, the team decided that EBS would be an optimal site for the computer laboratory. Additional considerations such as language, regional accessibility, and project potential given initial cultural, economic, and social status of the area also contributed to the final decision.

Preparation for project implementation spanned approximately 9-10 months. The most important duties involved acquiring computers and software and working with Alice and Magda to ensure the project feasibility and execution. Furthermore, because sustainability was also an important issue, the *Thinklab!* team considered additional factors: lab maintenance after the team departed from Guatemala, long-term funding for the Internet Service Provider (Telgua),

additional energy costs derived from the laptops, and the end-life processing of the units once they were no longer usable.

Also, organizing a team of people who were dedicated to project completion and future work at EBS was integral for project success. Engineers Without Borders – UCLA (EWB-UCLA), a humanitarian student group that strives to train and promote environmental and social responsibility among prospective engineers, provided the members. Being intimately involved in all aspects of the project, from planning to implementation, the team members learned how their efforts had a beneficial impact on the service community and the environment as a whole.

In designing the project, the *Thinklab!* team identified eight main areas of focus or modules: location, hardware and software, transportation, customs, Internet, classroom, benchmarking and recycling. The main purpose of this paper is to present the lessons learned through the implementation of *Thinklab!* for each of these modules. Also, due to an initial steep learning curve, the first implementation of any project typically incurs high fixed costs but can be reduced in future implementations. This is the case for the *Thinklab!* project in Guatemala. By presenting this paper, we hope that volunteer groups with similar projects in mind can also minimize their own fixed costs.

SPECIFIC AIMS OF *THINKLAB!*

- Identify the optimal candidate for a technology center.
- Collaborate with computer donors to assemble a small collection of computers for the center.
- Partner with local volunteers and directors to ensure project feasibility.
- Fundraise for at least 10 computers for the computer and technology center, *Thinklab!*
- Build a team of 3-4 students to plan and execute project.
- Train an “IT team” comprised of recipient students to oversee lab.
- Jump-start student interest in technology through basic computing theory and skills courses.
- Establish Phase II, as necessary, to ensure long-term funding:
 - Internet Service Provider contract with Telgua
 - Additional energy costs derived from computers
- Minimize negative environmental impacts through end-use recycling.
- Sustain relationship with recipient students by setting up a discussion group/community forum, survey, Yahoo group.
- Ensure responsibility to project on both ends (Engineers Without Borders and recipient school).
- Promote student creativity and provide “healthy” models and references such as the “Linux community model”.
- Document progress and challenges encountered throughout project development and implementation.

PROJECT MODULES

This section presents the eight project modules that represent the most fundamental components of *Thinklab!* (Figure 1). To present the ideas in a more systematic way, each

module is composed of two parts: *considerations* and *implementation*. The first exposes a set of important observations, and the second provides the actual steps to implement the module.

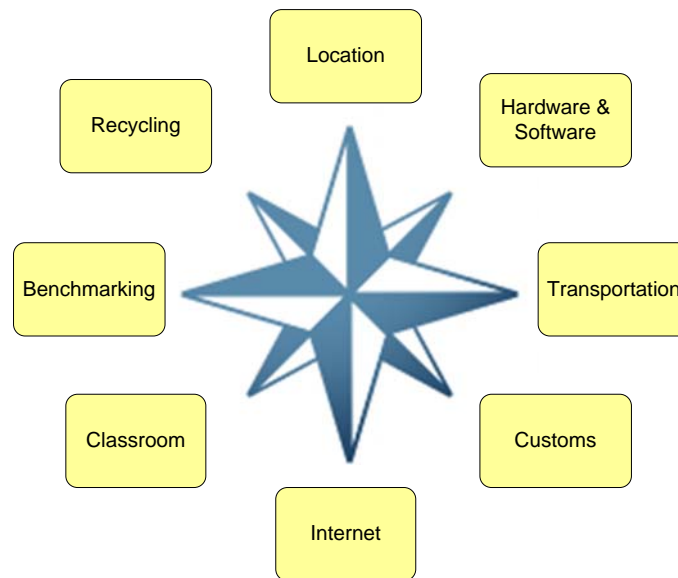


FIGURE 1
The Thinklab! project consists of 8 modules

Location

• *Considerations*

In determining a site location, the *Thinklab!* project considered its relative impact on a community given the its initial economic and social conditions. For instance, computers cannot help resolve the short-term problems of communities that do not have the ability to meet their most basic needsⁱ, such as food or shelter. On the other hand, the impact of such a project on a highly knowledgeable and technological community is minimal. Though most communities can benefit from technology, a computer center can teach more to a wider audience in an area where technology is less prevalent. This argument is similar to the well-known result in economic growth theory which states that poor countries should grow faster on average than rich countriesⁱⁱ. Summarizing, *Thinklab!* would be most effective and efficient in locations where:

- (1) the community is developed enough to meet its basic needs, and
- (2) the members have had little exposure to information technologies.

• *Implementation*

In our implementation, we use *GDP per capita* and *adult literacy rates* as proxies for “ability to meet the basic needs” and “level of exposure to information technologies” of a country, respectively. Consider Table I, where these proxies are presented for the three poorest countries in Central America (according to the United Nations Human Development Indexⁱⁱⁱ). We observe that:

- (1) Guatemala has a higher GDP per capita than Nicaragua and Honduras, but
- (2) Guatemala has a lower adult literacy rate than Nicaragua and Honduras.

The first indicates that Guatemala has a greater ability to meet its basic needs than Nicaragua and Honduras. However, Guatemala has a lower literacy rate or education level (in fact, the lowest Human Development Index in Central America, despite enjoying larger GDP per capita than its neighbor countries). These two factors comprise the macroeconomic argument that, according to our simple model, makes Guatemala an ideal candidate for *Thinklab!*.

TABLE I
GDP per capita and literacy rates of the three poorest countries in Central Americaⁱⁱⁱ

Country	Human development index	Adult literacy rate	GDP per capita	Education index	GDP index
Nicaragua	0.690	76.7	3,262	0.74	0.58
Honduras	0.667	80.0	2,665	0.74	0.55
Guatemala	0.663	69.1	4,148	0.66	0.62

Hardware and Software

• Considerations

Two questions arise when implementing the hardware (hw) and software (sw) module: what kind of hardware will be deployed? and what kind of software will run the hardware? To simplify the implementation, we limited our choices to:

- (1) a *desktop* or a *laptop* for hardware, and
- (2) be *open source* or be *closed source* for software.

This leads us to four possible configurations of hw and sw: (1) desktops and open source, (2) desktops and closed source, (3) laptops and open source, (4) laptops and closed source^{iv}.

The most suitable configuration will depend on the specific characteristics of the computer project and consideration of all possible pros and cons. Table II presents the analysis of these pros and cons.

• Implementation

First, we need to choose a suitable hardware and software configuration using the considerations in Table II. Once we made this decision, the implementation of the hw and sw module can be made in two stages:

- (1) *Computer fundraising*. In this stage, volunteers needed to collect donated computers. They employed creative methods of advertising to different donors: flyers “Call[ing] for

Laptops” posted on campus bulletin boards (Exhibit D), e-mails with similar messages distributed throughout various UCLA departments, and approaching local corporations for larger donations. As an incentive, each donor was given a receipt for the donation, reimbursing approximately 30% of its value (see Box I for a more detailed explanation of how tax-deductible donations work). Approaching local corporate donors proved to be the most suitable idea and was the method adopted. This ensured a long-term relationship and sustainable stream of computers that were uniform and highly functional.

TABLE II
Analysis of different implementations of the hw and sw module

Hardware		
Type	Pro	Contra
Desktop	<ul style="list-style-type: none"> - Easier to fundraise - Typically, more powerful 	<ul style="list-style-type: none"> - Shipping is more expensive. - Higher consumption (65-90 watts) - Needs larger room space
Laptop	<ul style="list-style-type: none"> - Easier to ship - Designed to resist harsh conditions - Lower consumption (15-45 watts) - Needs less room space 	<ul style="list-style-type: none"> - Slightly harder to fund raise - Maybe less powerful
Software		
Type	Pro	Contra
Open source	<ul style="list-style-type: none"> - No fundraising needed (free) - Source code is visible - Powerful message (open community, see also Box III) - Easier to migrate skills from open to close source - More creative - More powerful networking tools (ftp server, web server, gateway functions) 	<ul style="list-style-type: none"> - Today, many job openings in developing world only demand Windows skills
Closed source	<ul style="list-style-type: none"> - Today, many job openings in developing world only demand Windows skills 	<ul style="list-style-type: none"> - Fundraising needed (licenses) - No knowledge of source code - Less easy to migrate skills to open source - Less creative - Less powerful networking tools (ftp server, web server, gateway functions)

(2) *Software installation.* The second stage corresponds to the installation of the software. We can distinguish between two types of software: *operating systems* and *applications*. If the donated computer already has an operating system that suits our project needs, then we may not need to reinstall it. Otherwise, we need to reinstall a new operating system, either Linux or Windows. Notice, that Windows may increase the fixed cost of the project due to licensing. Becoming a Microsoft Authorized Refurbisher, however, allows the Windows

operating system at a reduced price if Windows is better suited for the project. The second type of software we need to consider is the set of applications that will run on top of the operating system. These are programs students will be using daily, such as a word processor, a spreadsheet program, and educational software. Again, open source software will avoid licensing costs. Costs and the creative learning environment open source led *Thinklab!* to adopt open source applications that can run on Linux that can be considered as a complete software suite. This software can be downloaded from the *Thinklab!* website^v.

Box I 501(c)(3) organizations and tax deductible donations: incentives for fundraising

Many developed countries have implemented laws that promote charity. A common mechanism is through the tax collection process: if a person makes a charitable contribution to a non-profit organization, then she has the right to deduct the value of her donation from her taxable income.

This box answers some of the common questions regarding tax deductible donations. Notice that we do not warrant or guarantee the accuracy of this information and that the reader should always consult a tax advisor or visit the IRS website for the latest information.

From a tax standpoint, what does it mean to be a 501(c)(3) organization? A charitable organization is generally defined as any nonprofit organization that is incorporated and identified by the IRS as a 501(c)(3) organization. These organizations have been given tax-exempt status and can accept contributions and offer donors a tax deduction for their gifts. For donors, this means that contributions are fully tax-deductible to the amount allowed by law.

What is the tax benefit for charitable donations? The table below provides an example of the deductions for a single person in each tax bracket making a cash donation of \$100. Notice that these numbers may not be the latest. For an updated table, please visit the IRS website. In general, the table shows that one should expect a benefit from 10% to 35% of the donation value.

Tax Bracket	Donation amount	Tax benefit	Actual cost of donation
10%	\$100	\$10	\$90
15%	\$100	\$15	\$85
25%	\$100	\$25	\$75
28%	\$100	\$28	\$72
33%	\$100	\$33	\$67
35%	\$100	\$35	\$65

What is the process? Upon making a donation, the donor should receive a receipt from the 501(c)(3) organization. This receipt should include the donation amount, the date the donation was made and the name and signature of the charity organization. When filling in the 1040 Tax Form, the donor can itemize the donation. The donor should always keep the receipt with her/him, in case the IRS asks for it.

Transportation

• *Considerations*

In general, there are two ways to transport equipment to a country: (1) using a *shipping company* or (2) *piggybacking* it as part of the team's luggage when traveling to the country.

Piggybacking is the most convenient because it involves only coordination of team members to carry the computers with them during travel. As we saw in Table II, an advantage of using laptop (as compared with desktops) is that they can be transported with relative ease. In fact, *piggybacking* would not be a feasible option had the project be implemented with desktops.

Partnering with a *shipping company* is another viable alternative, which requires more preparatory work in terms of establishing contact, agreements, and other logistics, but is more sustainable. For instance, Partners in Solidarity is an organization that specializes in moving technological-educational equipment to Guatemala, specifically^{vi}. For shipping companies in general, a partnership can be beneficial to themselves because:

- (1) philanthropic involvement promotes their organization name, and
- (2) the service they provide is tax-deductible, providing a positive impact to the company's "bottom line."

• *Implementation*

To leverage on this win-win situation, the volunteers need to approach a shipping company. Box II describes the steps required in doing so.

Box II Philanthropic accounts with shipping companies

Some shipping companies have philanthropic programs to support humanitarian projects. These programs are an example of a win-win situation: the (non-profit) solicitor receives cheaper or free shipping services while the shipping company builds its community reputation and improves its bottom line by deducting the service from its taxes (see Box I). The following provides a summary of the common requirements that the solicitor must meet as well as the process she needs to complete to receive a philanthropic account.

Requirements. Most of the shipping companies only accept applications from 501(c)(3) organizations, with good financial and public standing, and a competent management.

Process. Typically, the solicitor will need to write a 2-5 pages memo describing the project and how the shipping company donation can help in the project's implementation. A few weeks after the submission of the application, the solicitor should get an answer from the shipping company.

More resources on shipping companies with philanthropic programs can be found in:

<http://www.fedex.com/us/about/responsibility/>

<http://www.community.ups.com/philanthropy/main.html>

<http://www.dhl.com/publish/se/en/about/citizenship.high.html>

Customs

• Considerations

Customs adds another degree of uncertainty to the project. Most customs laws, especially those in developed countries, accept the clearance of goods that are both used and for non-commercial purposes. However, lack of regulation or lack of strict implementation of legislation in developing countries makes the process of customs clearance a complex one. To minimize uncertainties, the team needs to be prepared to face any number of potential interferences.

As we have already seen in the transportation module, there are two ways to bring equipment to a country: (1) by using a *shipping company* or (2) by *piggybacking* it as part of the team's luggage.

Experience seems to indicate that one may have a better chance to clear customs when piggybacking the equipment because volunteers can provide explanations to with customs officers in person^{vii}. Furthermore, at the time of clearing customs, it is important that volunteers (1) have a way to prove that all the equipment is used (i.e. by presenting the donors receipts) and (2) carry a letter from the recipient entity indicating that the equipment will be used in a non-profit project to promote education.

• Implementation

The implementation of these modules consists of three actions:

- (1) Obtain documents proving that the equipment is not new. This document can be, for instance, the donors' receipts, or the actual invoice receipt of the computers. For an example of a donor's receipt, see Exhibit C.

- (2) Obtain documents proving the non-commercial objectives of the project. This document can be a letter from the recipient indicating that the equipment will be used for non-profit purposes. A sample of the letter that was used for *Thinklab!* is presented in **Error! Reference source not found.**
- (3) Contact the corresponding authorities. The volunteers should contact the local embassy of the recipient country and ask about the process of clearing customs. The group should also contact the recipient country's government (e.g. immigration or the ministry of education) and ask for advice. In our previous experiences, the information provided by the authorities may not be very helpful (as previously mentioned, the difficulty lies in the knowledge of customs rules in developing countries as well as the given response of customs officials despite the rules). However, it is still important that volunteers maximize the amount of information using local sources.

Internet

• Considerations

Having access to the Internet is a crucial component of *Thinklab!* because it facilitates a *sustainable learning experience*. These are some of the points that justify this observation:

- *Spillover effects of Internet*. Internet virtually removes the barriers between countries, making knowledge available to anybody who is connected to it. While in the past, the library may have acted as the primary source for receiving information. Today, the internet can provide the same information through simple online^{viii}.
- *Creativity*. At school, students are typically accustomed to obeying instructions given by the teacher (teacher-driven process). When using Internet, however, students are responsible to research topics of interest (student-driven process), to use judgment about reliable sources, and finally to find suitable methods to apply the knowledge to test the knowledge that the Internet provides. Overall, the *Thinklab!* team believes that this process develops the general creative process and critical thinking skills involved in the overall scientific method^{ix} to communities that may lack access to textbooks and resources such as libraries.
- *Community*. Internet teaches the students a new sense of Community. Through Internet, they can learn about and sympathize with new cultures, languages, people and traditions around the globe. Furthermore, students in the developing world using Internet get exposed to the "success stories" of the developed world (e.g. Silicon Valley, Linux, the first man in the moon, technology breakthrough, sports...), which can serve as references and bring a positive message to them. See Box III for an example of a powerful success story.

It is very important to understand that as the world becomes virtually flatter, both positive and negative messages are easily conveyed across countries^x. The role of the teacher is therefore still needed, maybe not as much as the source of knowledge but more as a figure of guidance who helps students decode and understand messages sent through the Internet.

Box III The Linux message: its lessons for development

In August 25 1991, Linus Benedict Torvalds sent out an email to the Internet community: "Hello everybody out there using Minix - I'm doing a (free) operating system...". He was referring to Linux, and it was the beginning of what is now regarded as one of the most important computer technologies ever developed. But probably as important, it was also the beginning of a new attitude towards the problem of (technology) development. This new attitude can bring a new message to developing countries.

An operating system is the piece of software that runs our computer hardware. Examples of well-known operating systems are: Windows XP, DOS, Mac OS, Unix, BSD, or Linux itself. Back in 1991, DOS was still the dominant operating system in the PC market. PC users had basically no other choice. Alternatives such as Apple Macs and Unix were superior but with astronomical prices that not many could afford. It seemed that the free market forces of capitalism had lead the computer community into a deadlock situation: the big vendors of Mac OS and Unix were doing good business selling their products to big corporations that could afford them, leaving Microsoft without any serious competition in the large PC market.

Yet, the computer community regarded Microsoft products as poor in quality. Some attempts were made from private initiatives to compete against Microsoft (for instance, during the 1990s Netscape tried to compete in the Internet browser market against it) but they were all shut down by aggressive marketing (and some times regarded as monopolistic) strategies. Then what market forces and antitrust legislation failed to resolve in a prompt manner, was overcome by a change of attitude in the computer community. First, in search of fun and computer knowledge, Linus Torvalds decided to write a simplified operating system on his own. Then, he posted the source code (the blueprints of the operating system that explain how it works) online so that others could use it, learn from it and improve it. Linus started receiving feedback and contributions of a few computer programmers. Then, a few hundred, then thousands... today, Linux is used by all types of consumers, schools, large corporations, start-ups, governments and, what is more important, because the source code is freely available, each of them can use it, modify it, improve it and contribute back to the Linux community.

The Linux story cannot be explained using modern economic theories of capitalism, which assume that agents act rationally to maximize their individual economic profit. Neither Linus nor the first contributors had an economic incentive to develop Linux. Instead, they were pushed by a new set of values and attitudes: in essence, the Linux message shows that knowledge, curiosity and community work can be, for development, great substitutes of money and power.

• Implementation

In developing countries with limited infrastructure, connecting to the Internet can be challenging work. Table III presents an analysis of pros and cons for the most common access technologies.

The implementation of the Internet module requires two considerations:

- (1) *Installation.* This requires contacting an Internet Service Provider in the recipient country and negotiating a contract. Volunteers should leverage their non-profit organization endorsements to arrange a favorable contract, with lower monthly fees. In this regard, it is helpful to contact the government (e.g. ministry of education) to receive further advice. By using influential channels (such as NGOs and governments), ISP's will be more willing to cooperate. For instance, in our *Thinklab!* project in Guatemala, the local ISP provided a DSL service at 50% discount and free of all installation charges because we were endorsed

by EWB-USA. Furthermore, the ISP committed to provide a service in the remote area of Jocotenango, where no service available originally.

- (2) *Sustainability*. This is in fact the most critical component of this module: how to make an Internet connection sustainable? More specifically, how is the recipient going to finance the monthly fee costs year after year? Box IV presents some proposals.

TABLE III
Internet access technologies

Access	Pro	Contra
Dial-up	<ul style="list-style-type: none"> - Usually the less expensive solution - Most laptops have a dial-up modem - It requires a telephone line, but most urban areas have it 	<ul style="list-style-type: none"> - It requires a telephone line, and most rural areas don't have any - Slow transmission rate: ~50 kbps (insufficient to handle multiple laptops at the same time) - Does not permit to use Internet and make phone calls at the same time
DSL	<ul style="list-style-type: none"> - Fast transmission, ~128 to 2000 kbps - It requires a telephone line, but most urban areas have it - Can use Internet and make phone calls at the same time 	<ul style="list-style-type: none"> - May be more expensive than dial-up - It requires a telephone line, and most rural areas don't have any - Even in urban areas, some telephone lines don't have enough quality to support DSL
Satellite	<ul style="list-style-type: none"> - Fast transmission, ~128 to 2000 kbps - It does not require any telephone line, it can be installed almost anywhere, urban or rural. 	<ul style="list-style-type: none"> - Fees are more expensive than DSL - Expensive equipment
Cable	<ul style="list-style-type: none"> - Fast transmission, ~128 to 2000 kbps 	<ul style="list-style-type: none"> - Most developing countries do not have a cable network developed yet. - In developing countries, it may be more expensive than DSL.

Classroom

• Considerations

In this module, volunteers need to consider the content taught in their classes. While this module is flexible in that any academic subject can be taught with the help of computers and Internet (e.g. history, geography, arts, science, math ...), not all the subjects contribute to maintaining the sustainability of the project. Naturally, without the ability to use and manage their equipment, the students will not be able to efficiently learn any other subject of interest. For instance, if the network deteriorates and the students do not know how to repair it, then the sustainability of the whole project will be in jeopardy. Therefore, volunteers should teach at least a basic course in computers and networking maintenance. In the next implementation section we develop this idea in more detail and present a few more mechanisms to implement a sustainable teaching environment.

Box IV Some Proposals to Make an Internet Connection Sustainable

Internet connectivity is an important part of the project because it facilitates a sustainable learning experience. On the other hand, its implementation poses a new sustainability issue: in the long run, how do we pay the Internet Service Provider (ISP) monthly fee? We propose a few possible solutions.

- *Solar panels.* In some cases, computers are installed in schools that are connected to the electricity grid. These schools may need to pay their own monthly bills for electricity used in lights, the heating system, washing machines and others. In average, this monthly bill may be similar to the ISP charges for Internet connectivity. Therefore, a solar panel implementation that provides enough energy to satisfy all electricity demands from the school can be enough to offset the costs of the ISP contract.
- *Internet café.* Another alternative is to build an Internet café to provide public access to the network. With the revenues obtained from this service, the recipient can auto-finance the ISP fee. This solution poses another issue though: classes cannot be taught to students while the public uses the computers. To overcome this problem, the group can set up two rooms, one for the public and another for the students. Then, with the help of a wireless router, the same Internet connection can be used to connect both rooms. Notice that this solution provides a way to leverage the fix-cost nature (flat rate) of the ISP contract.
- *Selling used laptops.* If the group has a surplus of laptops, a third alternative to finance the ISP fee is to sell the extra laptops. Typically, the selling of one laptop can finance one year of Internet connection. This solution is only sustainable if the group has a surplus of laptops in a yearly basis.

• Implementation

As previously mentioned, two subjects will need to be taught, computers and networking, which requires that volunteers possess a certain level of understanding and mastery in these areas. Next, we provide a basic list of items that should be included in these two classes.

- *Class of Computers.* The students will need to learn how to use, manage and in some instances repair their computers. A possible list of items that would achieve this objective follows:

- *Typewriting.* How to correctly type using the computer keyboard.
- *Windows interface.* How to manage the computer through the windows system.
- *File system.* How to manage files using the file system.
- *Office suite.* How to create files, spreadsheets, or graphs using an office suite.
- *OS installation.* How to reinstall the OS in case the system breaks.

- *Class of Networking.* Another potential hindrance to the computer center is the possibility of network failures: if it goes down, then the students will not be able to use Internet, limiting the benefits of the project. To avoid this, the students should learn the following networking subjects:

- *Local Area Network (LAN) management.* How to manage the TCP/IP settings, the gateway, the firewall and NAT if using local IP addresses.
- *Internet browsing.* How to browse the Internet using an Internet browser.
- *FTP and Telnet.* How to use FTP to transfer files and Telnet to open remote sessions.

In addition to the above crucial classes, we propose two more mechanisms to enhance the sustainability of the project:

- *Forward teaching.* Many volunteers alternate their volunteering work with a professional life. Their available time as instructors in the recipient country is in general limited, which makes the teaching resource a scarce one. In this regard, *forward teaching* is a technique which permits an effective increase in the amount of teaching resources without increasing the actual number of volunteers. It works as follows. Suppose a class needs to be taught to a group of 40 students but volunteers only have a teaching capacity for ten. First, the volunteers separate the students in two groups: a group A with 10 students and a group B with 30 students. The most experienced, mature and responsible students (for instance, as a simple proxy for these qualifications volunteers can use age) should be in group A. Then, the volunteers dedicate their time to teach the class to group A. In addition, each of the students in group A is assigned to three exclusive students from group B. Finally, students from group A teach the class to students in group B.
- *Yahoo Groups.* Some of the volunteers may have the time and determination to continue their work from their home country. In this case, technology can help to bridge the distance. The idea is simple: to set-up a Yahoo Group account (or any similar online tool) for the project, where students can post messages and files. Through this mechanism, volunteers can continue to work with the project, for instance, by answering on-line questions to students (e.g. technical questions about the equipment, online troubleshooting), give assignments to students who later can upload their work and make them available to the same volunteers for correction, or simply have a forum of discussion. Our group used this technique for the *Thinklab!* project in Guatemala. The Yahoo Group can be visited at: <http://groups.yahoo.com/group/thinklab-ebs/>

Benchmarking

• Considerations

Benchmarking is included as a mechanism to enhance the sustainability of *Thinklab!*. Through benchmarking, volunteers can monitor the long-term impact of the project. This information can then be used to learn and correct positions in order to make the project more efficient. For instance, *Thinklab!* in Guatemala was implemented using open source Linux, but the effectiveness of this strategy is currently unknown. Through benchmarking, the volunteers have the opportunity to observe and survey whether or not the students find Linux user friendly. With this information, the volunteers can then tune the project to make it more sustainable.

- *Implementation*

To benchmark the impact of *Thinklab!* we chose the package “Instruments for Assessing Educator Progress in Technology Integration” from the Institute for the Integration of Technology into Teaching and Learning (IITTL). This package provides a set of questionnaires for both the students and teachers that have been carefully designed to understand the impact of technology on education. The answers to the questionnaires can be processed to obtain a set of statistics that characterize the progress of the students.

Recycling

- *Considerations*

In its 2002 report, the Basel Action Network (BAN) showed that “*electronic waste is currently the most rapidly growing waste problem in the world*”^{xi}. The report describes how some U.S. recyclers exported the material they received to countries where wages were lower and environmental laws were essentially non-existent. In order to tackle the *e-junk problem*, countries like the European Union, Japan and China have passed laws. To avoid the same problem, the project must guarantee that the recipient has the necessary infrastructure and competencies to properly dispose of computers. One can consider two possible options in doing so:

- (1) identify a recycler of electronic components at the destination site, where equipment can be disposed, or
- (2) bring the equipment back to a developed country (e.g. the U.S.) and recycle the equipment there.

- *Implementation*

Some infrastructure needs to be in place in order to implement the recycling module:

- (1) A tracking system that enables a way to identify and track each laptop. This can be as simple as giving a unique name to each piece of equipment and keeping track of their current location using a database. For instance, each *Thinklab!* laptop was given the name of a Star Wars character (see Exhibit B for a copy of some stickers that were attached to the laptops).
- (2) A memorandum of understanding (MOU) between the volunteers and the recipient defining the required steps when a piece of equipment needs to be recycled (see **Error! Reference source not found.** for a sample MOU). This agreement can include:
 - a. That the recipient will promptly communicate to the volunteers when a piece of equipment stops functioning.

- b. That the recipient will either recycle the equipment to a local recycler or, in case there is no local recycler, that the recipient will ship the equipment back to the volunteers, who will then recycle it in their own country.
- (3) If the recipient has no local recycler and needs to ship the equipment back to the volunteers, then the transportation module previously described can be invoked. As in that case, there are two options: to piggyback the equipment with some other volunteer's luggage or to use a shipping company (see the transportation module for more details).

CONCLUSION

This is the first international education and technologically-oriented project conducted by EWB-UCLA. We have found the experience to be extremely rewarding, both on a technical and practical level as well as on a personal level. In documenting the diverse considerations required for implementation, in addition to other important factors that were overlooked in our first approach, we hope to continuously improve and optimize the project design and execution in future processes for our organization and for others.

ACKNOWLEDGMENT

Team EWB-UCLA would like to thank General Motors and the UCLA Henry Samueli School of Engineering and Applied Science, for their financial sponsorship of this project, all of the donors who supplied the laptops for the *Thinklab!* Center, and faculty advisor Dr. Michael Stenstrom (Civil and Environmental Engineering, UCLA). The authors are also grateful to EBS managers, Alice Lee and Magda Torres for, their hard work.

EXHIBIT A. Meaning of the *Thinklab!* logo



The *Thinklab!* logo corresponds to the line drawing picture of the actual garage where Hewlett and Packard developed their first HP product, in Silicon Valley, California, in 1939.

EXHIBIT B. Labeling System



EXHIBIT C. Sample: donor's receipt


	<p>Engineers without Borders - UCLA Regents of the University of California 5732 Boelter Hall, Mailcode 159310 Los Angeles, CA 90095</p>
	<p>Club TaxID: 95-6006143</p>
<p>Date of Donation:</p>	<p>_____</p>
<p>Item(s) Donated:</p>	<p>_____</p>
<p>Donation Amount:</p>	<p>\$ _____</p>
<p>Donor Information:</p>	<p>_____</p>
<p>Club Representative:</p>	
<p>Printed Name and Title</p>	<p>Signature</p>
<p>I,(name of donor) _____, have agreed to give up all rights to the item(s) that have been donated to Engineers without Borders – UCLA. I agree not to ask for any item(s) back for any reason after the exchange has been made.</p>	
<p>_____ Signature of Donor</p>	

EXHIBIT D. Call for Laptops Flier



www.seas.ucla.edu/ewb/

ThinkLab

Central America needs your used laptop!


Do you have a used laptop? Now you can donate it to a group of disadvantaged students in Central America.

Who are we? We are a group of students from Engineers Without Borders - UCLA. ThinkLab is a non-profit project that fosters technological education in the developing world.

To donate your used laptop: call **(949)232-5852** or email **jros@ucla.edu**



EXHIBIT E. Customs Letter from the Recipient

Asociación Centro de Cuidado Diario
El Buen Samaritano 
Calle Real de Jocotenango Casa 59, Jocotenango, Sacatepéquez, Guatemala

Guatemala, 27.07.2005

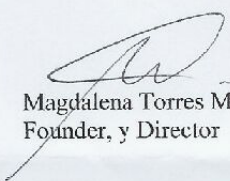
To Whom It May Concern:


This letter is to confirm that Mr. Jordi ROS GIRALT, with Spanish passport no. A7731665300 is volunteer of our project, "**Association El Buen Samaritano**". The computers and the other equipment that he brings is a donation for our project. This material will be used in our computer laboratory.


El Buen Samaritano is a daycare center in Jocotenango, for children of disadvantaged families which have limited economic resources and confront many problems such as inadequate housing, broken homes, domestic violence, alcoholism, drug addiction and prostitution. EBS provides these children with education, food, clothing and a safe, caring environment.


For more information, please contact our association.

Respectfully yours,


Magdalena Torres M.
Founder, y Director


Alicia Lee
Coordinator



Asociación Centro de Cuidado Diario
El Buen Samaritano
Calle Real de Jocotenango Casa 59, Sacatepéquez,
Tel: (00902) 811 1249
NIT: 3485334-0
Guatemala C.A. 

¡EBS, un lugar mágico que transforma las lágrimas en sonrisas!

www.ebs-guatemala.net

EXHIBIT F. Memorandum of Understanding

EWB UCLA

5732 Boelter Hall

Los Angeles, CA 90095

EL BUEN SAMARITANO

Calle Real de Jocotenango # 59

Sacatepequez, Guatemala

Tel: +502- 831- 1249

+502- 295- 5462, +502 5993 1633

Dear Sir or Madam:

We are delighted with the arrangement between El Buen Samaritano and Engineers Without Borders – UCLA that has been established this year. Before we complete the computer center at El Buen Samaritano, allow me to confirm the major details of the project:

1. This project, which EWB has named IP4CA (Internet Protocol for Central America), will be done as a completely voluntary service.
2. The center will be completed in 2-3 weeks in August, 2005. Should this time be insufficient, we will work together to schedule another visit.
3. EWB-UCLA will require a solid contact with EBS to execute a questionnaire every two months and provide a brief update report to monitor the impact of technology and computers for use in future considerations.
4. EWB-UCLA will establish a contact and support system to discuss any questions students or local users may have through a Yahoo Groups forum.
5. EWB-UCLA agrees to collaborate with EBS regarding funding issues for the IP4CA project.
6. EBS will hereafter be responsible for correspondence and maintenance of contract with internet service provider, Telgua.
7. EBS will be responsible for reporting any problems to EWB-UCLA to ensure speedy address of the issue. EBS will be responsible for designating the appropriate person(s) to complete the aforementioned tasks.
8. EBS will guarantee the proper recycling of waste electronics and track the computers (whether problematic or not) to ensure improper disposal and loss does not occur.

In signing below, EBS agrees to the previous listed terms and conditions.

Please feel free to discuss these conditions at any time. We look forward to working together soon and hope to sustain this relationship.

Date: _____

EBS Representative _____

Printed Name

Signature

EWB Representative _____

Printed Name

Signature

ENDNOTES AND REFERENCES

Charles I. Jones, "Introduction to Economic Growth," Norton, 2nd edition, 2002.

United Nations Development Programme, "Human Development Report 2005," 2005.

Pradip K. Ghosh, "Third World Development: A Basic Needs Approach," Greenwood Press, 1984.

BBC News UK Edition, "Google to scan famous libraries," 14 December 2004.

Jim Puckett et al., "Exporting Harm, The High-Tech Trashing of Asia," The Basel Action Network, February 25, 2002.

ⁱ By basic needs we mean those without which life would be impossible, for instance, food, shelter, and health. For a description of basic needs, see Pradip K. Ghosh 1984.

ⁱⁱ This catch-up phenomenon is known by economists as *convergence*. For a detailed description of this argument refer for instance to Jones, "Introductions to Economic Growth," 63-72.

ⁱⁱⁱ Refer to "Human Development Report 2005," United Nations, 2005. See the complete report for an explanation of education and GDP indexes.

^{iv} While this is not the only manner to partition the set of possible implementations, we find this to be a useful way to analyze the advantages and inconveniences of different approaches. Notice also that a hybrid project is also possible, that is, a combination of a few laptops with a few desktops and some with open source and others with close source.

^v You can find the Thinklab resources at <http://www.ewb-ucla.org/>.

^{vi} You can find the Partners in Solidarity resources at <http://www.partnersinsolidarity.com/>.

^{vii} While no formal evidence is provided to support this argument, this seems to be in agreement with different experiences shared among several members of EWB-USA.

^{viii} As this article is being written, the libraries of five of the world's most important academic institutions (libraries of Michigan and Stanford Universities, archives at Harvard, Oxford and the New York Public Library) are being digitized by Google, with the intention of making them available online, see "Google to scan famous libraries," BBC News.

^{ix} Basic principles of scientific method and investigation reintroduced at http://en.wikipedia.org/wiki/Scientific_method.

^x Thomas L Friedman, "The World is Flat: A Brief History of the Twenty-first Century," Farrar, Straus and Giroux, 2005.

^{xi} Jim Puckett, 2002.