feature article

engineering with a conscience

Volunteers are using low-tech engineering to have a high impact in developing communities.

by Gayle Ehrenman, Associate Editor

High impact doesn't have to mean a high-tech solution. Sometimes all it takes to effect a major change for the better is 3,000 feet of PVC pipe, hard work, and enthusiasm. Such was the case in San Pablo, Belize, where a volunteer team of civil and environmental engineering students from the University of Colorado at Boulder and their professor installed a water delivery system that used no electricity.

This project, which used a ram pump powered by a waterfall with 6 to 7 feet of head, was able to provide the small Mayan village with a steady flow of about one gallon per minute to the community storage tank. It was also the project that inspired Bernard Amadei, a professor of civil engineering at the university, to launch Engineers Without Borders-USA in 2000.

The organization, located in Longmont, Colo., was established to partner with developing countries and to train a new generation of engineers who can serve the developing world. To help provide this training, and to improve the quality of life for people in developing communities, Engineers Without Borders pairs professionals with volunteer engineering students to design and build an infrastructure project that a developing community has identified as a pressing need.

The group's projects, which typically involve the design and construction of water, wastewater, sanitation, or energy systems, are proposed by the community in need. Workers from that community help the volunteers build the systems, and are trained to operate and maintain them

after the volunteers go home.

This method of operating helps ensure that projects are culturally appropriate and sustainable. The projects are conducted by groups of student volunteers under the supervision of faculty and professional engineers from partnering engineering companies.

Engineers Without Borders-USA currently has about 75 student chapters based at universities across the United States, as well as a handful of professional chapters. Professional chapters consist of teams of engineers who typically work on projects in partnership with members of local student chapters.

The U.S. organization is a member of the Engineers Without Borders-International network. The network creates links between organizations around the world dedicated to helping disadvantaged communities improve their quality of life. Its projects are intended to be environmentally and economically sustainable. One of its goals is the development of internationally responsible engineering professionals.

The U.S. group's projects typically cost anywhere from $5,000 to $90,000, and are funded by the student chapters and corporate partners. They also benefit from donations of materials and services, according to Cathy Leslie, president of Engineers Without Borders-USA. Leslie works as the civil engineering manager for Tetra Tech RMC, a Longmont, Colo., engineering company.

"We haven't had any organizational funding to date," she said. "We've been able to accomplish a tremendous amount on a shoestring."

According to Leslie, the organization started with just one project in 2000-2001, expanded to 12 projects in the 2001-2002 timeframe, and has 40 to 60 projects under way at the current time. In 2003, more than 50 U.S. engineering students were involved in the group's activities in Mali, Mauritania, Senegal, Thailand, Haiti, Belize, Nicaragua, Afghanistan, and Peru.

Most of the projects carried out by the volunteers are "low tech, but very high impact," according to Leslie. "We

partner with developing communities on a ground-level basis. The people in these communities know what their problems are, but they may not know what's available to solve those problems. Once we show them what they can do, they really get it."

In Mali (top) and Thailand (middle) volunteers worked with the villagers to provide clean water. In Bir Moghrein, Mauritania (above), they installed solar panels to power a submersible water pump.

In one project Leslie was involved with, in Zambougou, Mali, in West Africa, 15 volunteers fixed a water pump that hadn't worked since 1986, installed a cement-lined water basin for reducing flooding hazards, and facilitated the drilling of two new water wells. The volunteers came from the University of Colorado student chapter, the Rice University student chapter, and the professional chapter at Tetra Tech RMC.

In another project, in May 2003, a team of six Colorado School of Mines students worked with the villagers of San Pablo, Belize, to install two 160-watt solar panels, to build a structure to house the electronics, and to wire up the village's elementary school, church, store, community pavilion, and woman's center. The project was part of the students' senior design class, and was partly funded by ASME.

Projects typically just "find" Engineers Without Borders, according to Leslie. Many projects are brought to the organization by universities with international exchange programs, or by nonprofit organizations that have funding, but not the expertise to get the engineering projects done.

All of the projects rely heavily on a non-governmental

organization to serve as a liaison with Engineers Without Borders-USA in the country where the project is located. And all projects require that the people from the community work alongside the volunteers.

Most of these low-tech, low-budget projects get knocked out in just a week or two in-country, after as much as one year of planning and design work, according to Dick Herring, executive director of Engineers Without Borders-USA. He is also in charge of mentoring the organization's Thailand projects. Herring, a chemical engineer who worked in aerospace until his retirement, accompanied volunteers to Thailand on behalf of Engineers Without Borders three times in 2003.

"It's a long process before we ever get on an airplane to Thailand," Herring said. "And it's a long trip there. But the experience of working with the students to improve a community in need is so exciting, I just can't say no."

In May 2003, a team of volunteers from the University of New Hampshire and University of Colorado chapters, and Herring set out to help the hill tribes of Santisuk, Thailand, remedy drinking water and sanitation problems.

According to Herring, the village needed to clean up the source of its drinking water, which was so contaminated with organics that about 40 percent of its population suffered from intestinal problems at any given time.

A spring in the hills approximately one mile from Santisuk provided all the drinking water for the village. That spring water was piped directly from a surface pool to an open reservoir. Both the spring and the reservoir were unprotected, and subject to algal growth, and to environmental and human contaminants.

The challenge for Herring and his team was to protect the natural water source from evaporation, contamination, and erosion. They needed to develop a water filtration system and a contained water tank, using a design that was appropriate to a rural community.

The solution the team came up with was a covered spring box for the current drinking water supply; a roughing filter to remove large particulates from the water; a slow-

sand filtration system to remove viruses, bacteria, and organic contaminants, and a contained storage reservoir that the slow-sand filters feed into. The clean water was delivered to the village in a separate piping system.

In Santisuk, Thailand, EWB-USA volunteers installed a multipart filtration system (top), a covered spring box (above).

The water filtration system delivers about 1,000 liters per day to the village. This supply, along with the water from the storage tank, provides sufficient clean drinking water for the village of 150. The team did all this in just four days, at a cost of $8,000 for materials.

"It's amazing what you can get done with a determined, hard-working team," Herring said. "Nothing we did was high-tech. Heck, it was so far from state of the art, that you couldn't set the radar low enough to pick it up."

Of course, it took a lot of planning—and a lot of flexibility—to pull off such an ambitious project in such a short period of time. For more than six months before the students arrived in Thailand, they were working out their design with Herring. He gave the students the requirements for the project, and guided them through two to three iterations of design and engineering plans.

Once the design was set, the students generated a bill of materials. The organization tries to buy as much of the materials for a project as possible in-country, to make sure they're appropriate for that environment, and in the case of mechanical systems, can be serviced locally, according to Herring. A non-governmental organization (in this case, The Foundation for the Advancement and Integration of Traditional Hill-Tribes) helped out with logistics.

Typically, Engineers Without Borders has contact with the village before the volunteers touch down. This involves spending a couple of days talking with the village elders and other residents, to make sure that the project is culturally appropriate and sustainable, according to Leslie.

Still, all the planning in the world didn't quite prepare the students for what they found when they got to Santisuk. "It's real-time engineering, no matter how prepared you are or how good your design is," Herring said. "The students tend to get a little frustrated their first couple of days with all the changes they have to make, but then they start going with the flow."

According to Erin Stanisewski, a graduate student in environmental engineering at the University of New Hampshire who participated in the Santisuk project, there's a world of difference between the design created back in the States and the project as built in Thailand. Stanisewski is the president of her university's chapter.

"We thought we left home with a pretty good design, but we had to redo everything once we got out into the field," Stanisewski said. "On the spot, we were doing real-time troubleshooting."

Part of the need to make so many changes to the team's original design stemmed from the inability to make a site inspection before the arrival in Santisuk.

"We had no pictures of the area, and no idea what materials would be available to us," Stanisewski said. "If we had done a site assessment, it would have been easier to create a valid design the first time around."

In Santisuk, Engineers Without Borders volunteers installed new leach fields to clean up the contaminated water supply.

Indeed, even with the "extreme engineering" that occurred on site, the spring box the students built proved to be flawed. When the box was built, the water it shielded tested negative for contaminants. But, after one monsoon season, the box collapsed and ceased to adequately protect the water supply, according to Herring.

"We didn't know how bad the monsoons were," Stanisewski said. "We didn't know the slope of the hill or how the water rushes down the hill."

With this hard lesson under their belts, the students are better prepared for their return trip to Santisuk, which is planned for this May.

"We're redesigning the spring box and designing water diversion techniques, so we won't have any more problems," Stanisewski said. "We can't wait to go back to Thailand," she said. "It's such hard work, but it's so rewarding to work alongside the villagers. We were trying to teach people who didn't speak English how to put

systems together that we were still figuring out."

But, the hard work paid off. The Santisuk villagers were able to fix the spring box system when it caved in, Stanisewski said. They also are able to clean the slow-sand filters whenever the filters become clogged.

While in Santisuk, the team will also work on a drip irrigation system for the village. In preparation, the students have started designing a similar system on the University of New Hampshire campus. The hope is that this will help them work out any kinks in the design before they get to Thailand.

According to Herring, this irrigation project will enable the villagers to increase their yield from two crops a year to three, which should greatly improve their quality of life. Currently, the villagers need to get water across a series of small ravines that cut across the current irrigation ditch. The engineering team will be building a water delivery system capable of spanning those ravines to provide an adequate supply of water for farming.

So why do the volunteers do it? Because it "satisfies the soul," a phrase echoed by Leslie, Herring, and Stanisewski.

Leslie said, "It's a great opportunity for the professionals to help train engineering students to be humanitarian."

According to Herring, "We're teaching the new generation to be socially responsible in their designs, outlook, and work."

Stanisewski said, "The Thailand project reached out to me in a way nothing ever has before. I feel changed, smarter, and like a better person for having worked alongside the villagers to make such a big change in their quality of life. As a chemistry major undergrad, I never got to leave the lab. Now, I have a great opportunity to use what I've learned and make a difference."

That desire is what fuels the volunteers to return, usually to the same area. "We made friends with the villagers by working alongside them," Stanisewski said. "We want to fix what we didn't get quite right the first time, and help

the villagers make more progress."

Making more progress on the organizational level is the current goal of Engineers Without Borders-USA. The nonprofit enterprise is working on getting a baseline organization in place that's funded, so it can adequately control the quality of its projects, Leslie said. The goal is to be able to qualify projects to make sure they perform properly. Toward that end, the group is seeking more corporate and professional partners to help the students in the field.

With those partners in place, Engineers Without Borders-USA will be able to reach out to more developing communities, and effect more change in the quality of life for the people who live there. All it takes is a small amount of materials, and some engineers with a social conscience.

Editor's note: For more information on Engineers Without Borders-USA, visit the organization's Web site at www.ewb-usa.org.