How one engineering student and others like him realize their dreams by helping to change a small corner of the world

Ian Smith Builds a Bridge
Engineers Without Borders

by Alan S. Brown

E had first heard of Engineers Without Borders (EWB) in November 2002 on a flyer announcing a meeting of the University of Colorado at Boulder chapter. EWB, only in its second year, sought volunteers for an engineering project in a small village in Haiti. Ian Smith, then a senior civil engineering major with an emphasis on structural engineering, was facing an uncertain future. Growing up in New Jersey, he had admired the nearby Verrazano, George Washington, and Brooklyn bridges. But bridge design is highly specialized and offers few jobs to students without advanced degrees.

“There I was,” he recalls. “I was graduating soon and didn’t have a job and didn’t know what I was going to do. I was thinking about joining the Peace Corps, but I wasn’t sure I was up for the two-year commitment.”

So Smith went to the meeting. The chapter’s first team of four engineering students had just returned from Bayonnais in Haiti’s mountainous interior.

Bayonnais is one of many small villages scattered along the Petite River Valley, home to as many as 80,000 people. The valley does not have a bridge, and so residents must ford the 50-foot-wide Petite River to bring their products to market or attend school.

From May through October, daily thunderstorms can boost the river’s height by two to four feet. Most people wait a few hours for the Petite to subside before fording. Others venture across while the currents are still dangerous. A few years ago, a schoolgirl drowned.

Actionnel Fleurisma, who runs the local church and a school for 1,400 residents, asked Engineers Without Borders for help. A bridge, he said, would make the crossing safer. It would also help the hundreds of people who cross the river to sell their goods on market days.

As soon as the students mentioned building a bridge, Smith was hooked.
“When we returned, everyone thought it would be all over,” recalls Amadei. “But the students said, ‘That’s the work we want to do,’ and Engineers Without Borders was born.”

The fledgling organization learned a lot about the nature of its mission from San Pablo. To everyone’s surprise, EWB’s involvement with the small community did not end with the water system. Instead, it was the start of what Amadei calls “several years of trial and error.”

Shortly after the installation, a 10-year flood hammered the water system and destroyed the pump. A gasoline-powered replacement pump was destroyed by a hurricane the next year.

After several false starts, EWB decided that the only sustainable solution was to dig a well in town. It also installed photovoltaic cells so students can study at night after they return from their one-hour walk to the nearest high school. Today, the villagers enthusiastically talk about generating more power and drilling more wells.

**Definition: EWB in America**

EWB’s experience at San Pablo helped to define its mission. Instead of leaving after one project, EWB adopted the village. It returned at least five more times to learn what did and did not work and to revamp its designs. It learned to emphasize sustainability, a must in poor regions without skills, spare parts, or any way to call for help.

EWB’s mix of students with academic and professional engineers to provide quality control is also unique. “We see other groups that are out to save the world,” explains Mark Reiner, one of EWB’s two project directors.

“So they’ll drill a deep well. But will they test for arsenic or assess the likelihood of cross-aquifer contamination? Our approach is not to save the world right away, but to involve the community in planning and building and to make gradual improvements phase by phase.”

By helping the community improve itself, EWB transfers essential knowledge to its members. EWB engineers may design improvements, but local contractors and workers use local materials and methods to build them.

“We’re not talking about Peace Corps stuff, charity to help those poor little people,” says Amadei. “I’m not into charity. We help people to help themselves. We don’t teach them how to farm or build or do the things they already know how to do. Instead, we ask the community what changes it needs to create jobs and get back on its feet.”

This combination of idealism, professional engineering, and practical hands-on projects has spurred EWB growth. The group organized just five projects the year Ian Smith first heard about the bridge in Bayonnais and five projects the next year as well. As word of the organization spread, the number of projects jumped to 27 in 2004 and to 80 in 2005. Today, there are at least 66 student and 27 professional chapters, and many more in the works.

**The Survey: Ian Smith in Haiti**

Smith began working on the bridge in earnest after he graduated. “They didn’t really know whether to build a pedestrian bridge or make it big enough for cars and trucks,” he recalls.

“We ultimately decided to build a vehicular bridge out of concrete, since that’s what everybody builds with down there.”

Although Smith found a job engineering custom-designed homes, he continued to work on the bridge. Before they could begin to design, though, someone had to go down to survey the site. The survey was slated for the winter of 2004, but a political coup made the region too dangerous.

After the crisis passed, Smith took off to Haiti with Jessica McGowan, a professional engineer from Maryland. She had been designing bridges for the past year and had a strong background in hydraulics.

They took with them a theodolite surveying instrument that a professor had in a closet. It was 40 years old and weighed 30 pounds. “It was the best thing we could have taken,” says Smith. “It didn’t require batteries, and you couldn’t break it unless you hit it with a hammer. It came in a big steel case and looked like a bomb. We had quite an adventure trying to get it through customs in Haiti, using body language to show that it was a telescope.”

Their host, Rev. Fleurisma, met them at the airport and drove them to his church and school. The trip lasted five hours, much of it along dirt roads. While the church ran its own 40 kilowatt generator, the small village of concrete block homes had no electricity. A network of four-inch steel pipes brought water from a mountain spring to a series of fountains, but the town had no sanitary facilities.
People and vehicles crossed the river near the school. Farther up the valley, conditions grow more primitive. As the road petered out, the concrete-block homes were replaced by wattle and daub.

Yet if Bayonnais was poor, it was also livelier than Smith expected. “Everyone seemed really happy and busy,” he recalls. “It didn’t feel like a needy place.”

Smith and McGowan’s survey lasted three days, including daily breaks for thunderstorms. In the afternoon, they went back to church and school to play with the youngsters and talk to teenagers learning English.

“Most everyone welcomed us,” says Smith. “Some people were suspicious, but that stems from being stubborn about change in the valley. Some of the older people don’t believe going to school is important. They believe their kids should grow up and farm. They were not happy about white people building roads to school.” In this case, any distrust was easily overcome because most residents wanted the road.

Just Trying to be Polite: Mark Reiner in Mali

Navigating the cultures isolated and primitive regions in the world is often more difficult than it looks. Mark Reiner learned this in Foutaka Zambougou, a village on the edge of the desert in Mali.

The village of 1,700 is isolated. It has no school. The nearest hospital is 10 hours away. Half of its children die by age five due to poor sanitation and hygiene. During the past 20 years, the transformation of the land north of the village into desert has steadily reduced the amount of rainfall reaching the village.

Ordinarily, Foutaka Zambougou gets about two feet of rainfall between May and September. In 2002, a drought caused the crops to fail. A Boulder resident, Karen Max, raised enough funds to keep the village from starving. She also asked Amadei if his fledgling organization could help. Amadei turned to Reiner, a civil engineer who worked on water-resource projects.

The villagers chose which dalas to deep and are now building the cisterns from concrete blocks made from local sand and gravel.

The cisterns will irrigate a one-acre garden. It may not sound like much, but it represents a dramatic break from the village’s diet of millet all day, every day. “Their goal is to grow vegetables and spices and put a portion of their profits towards funding the next cistern,” Reiner explains. “We’re seeding a microenterprise. After four or five cisterns, they’ll be able to fund their own growth, and we won’t need to be involved.”

It is not easy to gauge what people in remote parts of the world know, says Reiner. He once called some village elders together to explain...
evaporation. “I poured the same amount of water into a cup and a wide plate and the plate evaporated by noon,” he recalls. “I thought the demonstration was ingenious, but they all looked me like, ‘Thanks for wasting my morning.’”

Meanwhile, in the Turkana region of Kenya, Reiner’s sister, Elizabeth Gingerich, helped to install a drip-irrigation system with students from Valparaiso University. “When the first crops started coming up, some villagers could not make the connection,” she recalls. “They didn’t understand how you could have plants without rain.”

Designing Bridges: Ian Smith in Haiti

Smith knew that he had the community behind him when he returned from Haiti in June 2004. He immediately began compiling the survey data to generate a contour map of the site. Meanwhile, McGowan analyzed the river by scouring the Internet for free rainfall reports from nearby Florida. She then plugged them into river analysis software to determine flow rates and volumes.

That gave Smith the river height and hydraulic forces he needed to design the bridge. Before he could start, he needed to assess what kind of bridge the inhabitants could actually build. EWB planned to use a local builder. He was familiar with reinforced concrete, but had never built a bridge or worked from blueprints.

Reviewing the preliminary design with professional engineers led to several minor revisions, including changes in the number of supports, the depth of the structural members, and the amount of reinforcement.

The final design featured two supports on the river’s edge and two large piers spaced 20 feet apart in the river. The two central piers were 13 feet wide, 18 inches thick, and six feet high. They sat on the river’s sand and gravel, anchored by massive foundations. “The piers and foundations are over-designed,” says Smith. “We didn’t really need that much concrete, but we wanted to make sure.”

The bridge’s budget came to $8,000 in materials, $2,000 in labor, and $7,000 for periodic flights to Haiti to oversee the work. Colorado’s EWB chapter had to raise the money.

Funding: Elizabeth Gingerich in America

Raising money always poses a challenge. Because it is growing so fast, EWB frequently outstrips its ability to fund its projects. The group was lucky because Fleurisma’s mission is funded by the South Mecklenberg Presbyterian Church in North Carolina. Its 400 members helped pay for most of the materials and labor. Smith’s team was able to raise money for transportation through grants and campus fund-raising activities.

Others have found ways to tap professional engineers. The University of New Hampshire chapter received numerous donations for an irrigation project in Thailand says member Ben Nichols. BP p.l.c. donated money for airfare and the Uni-Bell PVC Pipe Association donated the system’s pipe. University alumni gave students $25,000 to seed a foundation to fund future missions, a nest egg swelled by donations from the school’s wealthiest alumni following a recent Engineers Without Borders presentation.

Elizabeth Gingerich, who doubles as a law professor at Valparaiso and a business lawyer, brings a different approach to fund-raising. “My dual career takes me out to the business community,” she says. The community has responded. In 2004, for example, Eli Lilly alone donated $14,000—followed by another $10,000 this year. She held auctions, including one where a business client bid $10,000 for a $150 golf basket.

She is a tireless ambassador, speaking at churches, civic groups, grade schools, and nonprofit organizations. Valparaiso lets her make an annual pitch for donations at one of its basketball games. The University Guild, a service organization founded by her maternal grandmother, donated $5,000.

“The best overall effect still comes from communicating our message one-on-one,” she says. Students who join the local chapter provide a list of family friends and relatives. “They’re usually a very good source of revenue, especially since students have to fork over $500 toward the $2,300 we spend to send them abroad.”
Money in hand, work began on the Bayonnais bridge in March 2005. Smith and two other engineers traveled two at a time to Haiti to oversee the initial work.

“We’re there to make sure everything is going okay,” says Smith. “We don’t want to tell them how to build because they already know how. They don’t really know how to read the drawings. The main thing we do is get the rebar in the right place and measure everything for them.”

The Haitians knew how to bend and cut rebar and build concrete formwork. “Our biggest concern was concrete quality,” Smith relates. “They mix concrete on the ground with shovels. So when we went down in March, we took some testing cylinders with us, filled them with concrete, and crushed them in a testing machine when we got back. While the concrete is weaker than anything you would get in the States, it’s still above the assumed designed strength.”

EWB hopes to complete the bridge before the rainy season begins in September. “They sent us some pictures, and one of the piers may be built too high,” says Smith. “We may have to knock off some of the top with sledgehammers.”

Smith’s ready. Like other EWB volunteers, he has learned to master chaos on the ground. So has Nichols’ New Hampshire team. Workers needed to complete three bridges to route irrigation pipe over a ravine in the upland village of Santisuk, Thailand, in a single week.

It took every ounce of their ingenuity. “They were supposed to turn off the water in the channel one week before we got there, but they had to water their crops so they left it running,” Nichols relates. “The first few days, we worked in mud up to our knees. The pipe arrived midweek, but the connectors did not show up in Chiang Mai until Friday afternoon. The team was slated to leave on Saturday. A late-night trip to the city and a very early work session enabled them to complete the bridges before they left.

The night before Smith left for Haiti, he and Hamel wondered whether they could pull it off. They had never done anything like it before, and neither had the builder.

“We knew it was designed it to AASHTO standards. It was reviewed by several professional engineers. We weren’t just a bunch of kids putting some concrete together.”

No, they weren’t. After three years, EWB had changed Smith in ways he finds hard to explain. “I’m more confident in my ability as an engineer and a project manager,” he says. “I’m comfortable in another culture. It’s so different from life in the States. It’s a shock. I mean, people actually function this way only 50 miles away from Miami. But when we’re done, I’ll feel like I’ve accomplished something. I’ll feel part of a community.”

Many of EWB’s volunteer share the same mix of feelings: Pride in their professional abilities. Awareness of cultures that tourists never see. Knowledge that they helped change the lives of people for the better.

EWB truly thinks globally but acts locally. Its incremental projects make life better in one village and then another. It embraces communities rather than quick fixes. It is an embrace that warms both parties.

“It changed my idea of what I wanted to do,” says Nichols. “I’ve learned that modesty is a virtue and that if you give what you have to give, you’ll be rewarded for that. I put in my time, but I felt like I got back so much more than I gave.”

**Alan S. Brown** has been an editor, contract editor, and freelance writer for more than 20 years and lives in Dayton, NJ (insight@comcast.net). A member of the National Association of Science Writers, he earned his B.A. magna cum laude at New College at Hofstra in 1974 and won a Phi Beta Kappa scholarship. He is executive editor of *Homeland Response*, contributing editor of NASA *Space Research* and *IEEE Spectrum*, and a regular contributor to *Mechanical Engineering*.