

Down from the Mountain

When they traveled to Rwanda to help restore a village's waning water supply, a group of UW engineering students confronted two problems. The waters running into the village weren't always crystal clear — and neither were the solutions.

BY JASON STEIN MA'03

Peter Bosscher came to bring the waters back to Muramba. It was July 2004, the dry season, the time of year when water runs short in this village in the mountainous western half of Rwanda. Bosscher, a UW-Madison professor of civil and geological engineering, had brought eight engineering students and a doctor to one of the poorest nations of a poor continent, a densely populated land coping with an

AIDS epidemic and the aftermath of the country's 1994 genocide. They had traveled half a world by plane and half a day by truck to reach a remote Catholic parish, some seven thousand feet above sea level and fifty miles west of the Rwandan capital of Kigali. The team had a goal that was as simple and idealistically pure as a glass of spring water — to restore the waning water system that is the life-thread of the village.

The day after their arrival in Muramba, the group hiked across the steep slopes and farm fields surrounding the village center, passing brilliantly clothed women, idle men, and children who would call out in excitement at the sight of the Americans. On their climb, the engineers studied the gravity-fed



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water system built by the country's Belgian colonizers more than seventy years ago. They measured the water at the high springs where it arose and flowed into pipes that ran down one mountain and halfway up another before emptying into several raised tanks in the village. The measurements surprised them. One liter of water was starting down the mountain each second, which should have sufficed for the roughly three thousand people in and around Muramba. And yet there was a shortage in the village below. What was happening?

"We don't have [enough] water," Bosscher remembers thinking. "We seem to be losing water."

The professor and his team soon made another startling discovery — one

that gave them their first sip, as it were, of the difficulties of engineering across borders. Down in the village, they found a series of outdated showers with the taps fully and inexplicably open, the shower heads spraying out the water they had come to restore.

Days later, Bosscher and two students met with John Bosco Musinguzi, a friendly, Ugandan priest who served as their community liaison. The Americans asked Musinguzi and another priest at

Facing page: Brilliantly clothed women hike through fields near Muramba, a village where some three thousand Rwandans come to collect water for their homes.

Above: UW student Perry Cabot talks with men from the village during a break from repairing a slope of land where a water line was unearthed accidentally.

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the meeting why they had not taken the crucial and seemingly obvious step of conserving water. The Americans received in turn a polite, but equally pointed question from the Africans: Would the engineers soon be bringing in heavy equipment and real resources, or were they nothing more than a group of college students?

“There was even a little bit of let-down on both sides,” Bosscher says. “There were tears that night.”

The professor’s students were finding that in international development, as in engineering itself, few things are simple and nothing is pure.

At fifty-one, Bosscher has both the receding silver hair of age and the idealism of the students he leads into the field. The son of an engineering professor, he inherited his father’s academic discipline, Christian faith, and commitment to volunteer work — threads that are woven into his beliefs about how engineering should be taught and practiced. Bosscher wants students to understand that service and learning go hand in hand, and two years ago, he found a new way to show them.

A leader in study-abroad programs and overseas involvement, UW-Madison already had plenty of alumni serving in groups such as the Peace Corps. But with some 7,700 volunteers rotating into and out of more than seventy countries, the Peace Corps is a huge operation, and follow-through on projects can be challenging. When Bosscher talked with former students who had returned from the corps, some shared doubts with him about how much they’d accomplished. They worried that the development projects they’d worked on might not last, either because locals couldn’t sustain them or because villagers hadn’t seemed to want them, Bosscher says.

Searching for other options, Bosscher learned of a fledgling organization called Engineers Without Borders, which had been formed in 2000 by University of Colorado engineering professor Bernard Amadei. The group’s mission — to foster sustainable development



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— resonated with Bosscher, who felt engineers obsessed over “high-tech, low-impact” projects in industrialized countries and failed to field the kinds of simple, elegant designs that might solve the problems of the developing world. Plus, while students typically entered the Peace Corps after they graduated, Engineers Without Borders offered them a chance to work on sustainable projects while they were in school.

In the spring of 2003, Bosscher organized a meeting to discuss forming an Engineers Without Borders chapter at UW-Madison. “I thought maybe ten or fifteen students would show up,” he says. When the day came, a crowd of more than seventy turned out.

Students came seeking experience in international engineering — skills that will be increasingly needed as the production of goods, and even design work itself, is shifted around the globe. But many also were looking for the human side of their discipline, a chance to step down out of “the ivory tower of technology,” as Bosscher calls it, and engage the problems that much of the world faces.

One of the students was Audrey Miller ’04, who remembers seeing “a little, Xeroxed, mangy-looking flier” advertising an engineering group she’d never heard of. That was all it took for the



industrial engineering student, who after a stint volunteering in the Dominican Republic was looking to do more work abroad. “We have to start this,” she told Bosscher. “There’s no choice.”

Once the Madison chapter began, however, there were plenty of choices. Though much smaller than the Peace Corps, Engineers Without Borders chapters today run more than eighty projects in thirty-five countries, from managing a health clinic in Thailand to redesigning a well in the Mauritanian Sahara. With the help of an EWB chapter at the University of Colorado, Bosscher took a group on an exploratory trip to Rwanda in March 2004 to see how the UW group might help. Soon, Miller was gushing about books with titles like *Gravity-Fed Water Schemes* and preparing for the team’s return visit, which took place that summer — the second of four trips to Muramba that UW students have made



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Above: At a site near the path of the main water line, the UW team hired local workers to help shore up a hillside to prevent landslides, but they had plenty of unsolicited assistance from Muramba's ever-present children, including one tireless boy who hefted boulders nearly as large as he (above left).

Right: A stone pier that supported the pipes was close to collapsing into a river before students helped to reinforce it.



FERRY CABOT

in the past two years.

A few months later, Miller found herself in Kigali, looking for washers — not the modern appliances, but the little rubber rings that are used to seal a faucet. There were, seemingly, none in the entire capital, a city with a population in the hundreds of thousands.

Before they could work on Muramba's water system, the group needed tools and hardware: a sledgehammer, caulk, couplers. And so a few days after they arrived in the village, Miller and Bosscher returned to Kigali to buy

them. With a Rwandan interpreter, they entered one hardware store after another, finding a wire brush and caulk, but not the caulking gun. When the Americans showed a sample washer of the kind they needed to fix leaky taps in the village, the shopkeeper's answer was always the same: they could buy complete, but untrustworthy-looking Italian faucets, but there were absolutely no faucet washers to be had separately. Even in Kigali, the seat of Rwanda's politics and commerce, it seemed a whole project could be set back by a missing

part that cost mere pennies.

In Muramba, an administrative center for an area about the size of an American county, the students lived in a Catholic church compound built by the Belgians more than seventy years ago. Around the church lay the village's widely dispersed adobe dwellings with thatch and sheet metal roofs. The village has a bustling high school, and several thousand people from around the region fetch water from its taps. But reminders of Rwanda's hardships were never far away. The priest John Bosco Musinguzi had more than 3,500 orphans from the surrounding area under his care — children whose parents died from war and disease — and the number climbs steadily as AIDS ravages the region.

In their scant years, Muramba's youth have endured more suffering than whole lifetimes in the United States could have supplied. Much of it was squeezed into the vise grip of one hundred days that began on April 7, 1994, when Hutu soldiers and machete-armed militia began murdering members of Rwanda's ethnic minority, the Tutsis. In a nation of 8 million, they killed some eight hundred thousand so-called "Tutsi cockroaches," as well as Hutu moderates, before a force of Tutsi rebels took control of Rwanda in July of that year.

Bosscher and the students found that most people in Muramba would speak little of the days they call the Time of the Running. At least one Rwandan student at UW-Madison shares that reticence. Benjamin Twagira PhD'06, a twenty-nine-year-old doctoral candidate in international development, spent his childhood in a refugee camp in Uganda and returned to Rwanda around the time of the genocide. He won't say whether he is Hutu or Tutsi.

"I think that it would be better if people could become Rwandan," he says.

Some have. Near the center of the Muramba parish, there is a common grave for seventeen schoolgirls, and another for their teacher, a sixty-two-year-old Belgian nun, who were victims of a 1997 massacre. In his book *We wish*

to inform you that tomorrow we will be killed with our families, journalist Philip Gourevitch tells the story of how a group of ex-soldiers and militia reportedly ordered the students to separate into Hutu and Tutsi — an action that would have meant death for the Tutsi among them. The girls said instead that they were Rwandans, and they died as one.

Yet even without the scars of war, the obstacles to meaningful economic development in Rwanda are formidable. It is a landlocked and mountainous country, with poor soil, few mineral resources, no skilled labor pool, and the reality that much of its small economy is dependent on foreign aid. Jan Vansina, an emeritus professor of history and anthropology at UW-Madison and the author of the book *Antecedents to Modern Rwanda*, says that those conditions, even more than the nation's violent past, are to blame for all that is wanting in its infrastructure. "How can a country like that develop when it has very few resources?" he asks.

In Muramba, John Bosco Musinguzi is answering that question by strengthening the schools, adding vocational programs where villagers can learn trades such as carpentry. "If I could give my people one thing, it would be wisdom. I would give them education so they could provide for themselves," the priest told a newspaper on a U.S. trip.

But contaminated drinking water means students often miss classes because of dysentery. The priest's good works depend on good water.

The system that delivers it begins on a mountain on the other side of a valley from the village. There, spring water is collected in concrete boxes, which are connected by a series of pipes to conduits that feed the village's holding tanks. From those raised tanks, water flows down into the taps from which the families of Muramba take what they need to drink, cook, and irrigate their crops. Over decades, the area's population and its need for water have increased, but roots and debris have clogged pipes and lowered output. An open stream, piped into the system to boost supply, brought the contamination of *E. coli* bacteria from



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Above: Jean Paul Eyadema Bazansanga shows off a water bottle that the UW team brought to Muramba. When the sun heats the water sufficiently to kill off bacteria, a wax seal melts, letting the user know the water is safe to drink.

Right: The taps in Muramba's central village provide a cool break from the heat.

livestock manure that washed into the water. Villagers lack the means to boil or otherwise treat all the bad water they use and often get sick from drinking it.

The Americans set to work restoring the system with the help of the parish's head repairman, Innocent Kambanda, who wore rubber boots, a constant smile, and, occasionally, aviator sunglasses. Jean Paul Eyadema Bazansanga, a twenty-two-year-old volunteer who taught French and English at the vocational school, translated for the engineers and the villagers, most of whom speak the national language of Kinyarwanda.

When the students examined the water system before the trip, they saw one of the first things they would have to do was repair a column that held up the main water pipe, which a river at the bottom of the valley had been slowly eroding. The river threatened to wash away the rock-and-mortar pier and snap the tube it supported. Responsibility for preserving the pier was assigned to Andrew Lockman MS'04, a geological engineer by training. He says he spent a month in Madison devising complicated systems of walls that could safely divert the river, but when he saw the site for the



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first time, he knew that a simple wall set into the riverbank was all that was needed.

Bosscher says he's seen that pattern repeated as students arrive in Africa and ditch their complicated plans, recognizing that simpler is better — that in a land of scarce resources, simpler is often the only option. "They soon realize that what they did over here [in the United States], it's not going to fly," he says.

Working as a volunteer gives students an idea of how much messier real-life problems can be compared to those in a textbook, says Fred Bradley, an associate professor of materials science and engineering at UW-Madison. Bradley helps run the university's Engineering Projects in Community Service (EPICS) program, which since 2000 has matched more than six hundred students



ANDRE STEELE/WR-UK

Villagers sell produce at a farmers' market in Muramba, which depends on a steady water supply to help crops endure the region's dry season.

with community groups in Madison such as the Salvation Army and the Boys and Girls Club. As part of a four-credit course, teams of students from several disciplines help nonprofits design equipment, Web sites, and databases.

"One of the most important things is the ability to deal with ambiguity and complexity," says Bradley, who thinks universities should offer students more of these service-learning opportunities. "This is what really opens their eyes to what they're going to do when they leave here."

As it turned out, Lockman and Kambanda were able to build the retaining wall for some four hundred U.S. dollars — money that paid for twelve bags of cement and aggregate and eleven days of work by twenty villagers. As he worked

alongside the men of Muramba, Lockman noticed Kambanda telling the workers to place plastic tubing crosswise in the wall. Lockman had forgotten these "weep holes" — a crucial element to allow rainwater to drain out of the earth above the wall and relieve pressure that could have toppled it.

"It was something I'd completely neglected — it was Engineering 101," he says. "They one-upped me on that. It was very humbling."

Over four visits to Muramba, the last in May, Engineers Without Borders teams and the villagers have boosted the parish's water supply by tapping more springs and clearing blockages from the pipes; shored up crumbling supports; and cleared the water of at least some

harmful bacteria by forcing the dirty stream to run underground, using the earth to filter it. They've fixed some of the leaky village taps that were letting water escape and have even met with Rwandan president Paul Kagame in Kigali to lobby him to improve the dirt road leading to Muramba. In May, the project received the prestigious Mondialogo Engineering Award, a prize sponsored by UNESCO honoring work in the service of development.

But more work remains. The team has raised some thirty thousand dollars to support ongoing projects in Rwanda, and Bosscher returned again this summer to make more improvements and gauge progress.

He also took with him a device that represents the kind of elegant design that could change lives in developing nations. He had been thinking about the problem of purifying water. The simplest way to kill bacteria in contaminated water is to heat it, but boiling water consumes precious fuel. Solar energy — one thing Rwanda has in abundance — can also do the trick, but the problem comes in knowing if water left out in the sun has heated enough to eliminate contamination.

To solve that dilemma, Bosscher had located a simple, clear tube with a daub of wax at one end. The tube hangs on a string inside a water jar with the wax end up, and once the water around it becomes hot enough to kill the bacteria — about 150 degrees Fahrenheit — the wax melts, running from the top part of the tube to the lower end. All villagers have to do is look at the tube to be sure the water is safe to drink. To use it again, they simply invert it.

Students have learned that in engineering, the toughest parts of a system to change are sometimes the human ones. The engineers, for instance, are still struggling to understand why villagers don't turn off the taps that are pouring out precious water. Sometimes the running water can be explained by a broken spigot, Bosscher says. As for the other kinds of waste, the professor sees an analogy to the way Americans can be

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both fearful of oil shortages and yet seemingly fearless at the gas pump.

"I don't think we know why it's a problem because our mindset is just too Western," he says.

After seeing for themselves how difficult it can be for villagers to find parts to fix leaky water taps, Bosscher's group has considered designing spigots that have spare washers stored inside them. The Americans and priests are also looking for ways to teach villagers to conserve water and to make small contributions that would pay for maintaining the water system. Accomplishing these tasks will take a much greater commitment than repairing a few pipes.

"Everybody wants change, but it's so hard. It takes patience," says Miller. "It's like a constant sense of excitement about it — that's what it takes."

One afternoon Lockman and Miller went with Bazansanga to visit his home. The young teacher's family was of the sort all too common in Rwanda today: Bazansanga lived with his sister Christine, a single mother with a young baby, and together these two siblings, orphans themselves, cared for another orphan, eleven-year-old Diane Uwamahoro.

Bazansanga's concrete house lay on a hillside in a field of banana plants. The first thing the teacher pointed out to the Americans was his goat, tethered among the banana trees; the next was the garden plot that held the remains of his mother, killed by soldiers during the civil unrest, and his father, a victim of disease. With the help of Miller and Lockman, Bazansanga did something he had never been able to do — photograph the graves. The trio went into the teacher's bare house, where the concrete walls were decorated with a stylized painting



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At the vocational school, student Andrea Khouropour entertains an entourage of children, who followed the American contingent virtually everywhere.

of a snake, outlined in dark black with maroon zigzags across it, and an image of Jesus Christ on the cross. The hosts set out a bowl with four hard-boiled eggs and Fanta sodas.

"I've never felt like such an honored guest," Lockman says.

Neighbors joined them, and for three hours, they talked light-heartedly with the help of Bazansanga's translation. Evening came, and a young woman, a stranger to the Americans, said something to them in Kinyarwanda.

"I wish," the stranger's words came through in translation, "that this moment would never end."

When the two weeks did end and it was time to go home, Lockman says he cried to leave Bazansanga and Muramba. Back in Wisconsin, he and Miller raised some \$1,500 to help the teacher go to college while supporting

his family. Bazansanga is now at the University of Ruhengeri, where he is studying linguistics and language. He has agreed to go back to Muramba for a time to work when he's finished.

Miller has graduated and taken a job at the Milwaukee industrial equipment firm Rockwell Automation. It's a position that may one day take her to Rockwell's factory in Tecate, Mexico, providing another bit of proof to Bosscher's argument that the next generation of engineers needs experience working outside their own culture.

In Muramba, the taps are still routinely left on, wasting water. But Musinguzi says he's seen improvements. "There is more education [and] awareness on water conservation, maintenance of the system, and use," he writes in an e-mail.

Those changes started with that evening meeting in July 2004, when both sides — Musinguzi, his colleague, and

the American engineers — began to come to terms with one another. The conversation was courteous but wrenching; Miller, one of the two students present, still tears up remembering it. The engineers had to admit they weren't the saviors that villagers had anticipated. They had neither the money nor the ability to take on more than a few of Muramba's most basic problems. For their part, the priests acknowledged that some of the solutions lay within the villagers' own hands.

"It was a profound coming together and a moment of humility," Bosscher says. "We've been growing together since that moment." 🌿

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