A Global Approach to Engineering

Universities push their future engineers to study abroad, with limited success

By SCOTT CARLSON

Before she arrived in Namibia, Tarra Epstein had her trip planned out as precisely as a line plotted on a grid. She and three other engineering students from Worcester Polytechnic Institute had come to the South African country to help set up alternative-energy programs for poor villages, and Ms. Epstein had written up a daily schedule and plan of action for herself and her colleagues.

In time, all of that went out the window.

They arrived to find that they would have to cobble together some of their projects from scraps and that there was little in the way of an office or laboratory, and even less passing for a computer or Internet connection.

"By the end of the trip, I loosened up a lot," Ms. Epstein says. "Here we are on a truck, headed to a village where we don't know if they are expecting us or not. The four of us end up sleeping in a two-person tent in the middle of a cow field. It puts things into perspective. You're not in the lab. You're doing real work."

Within WPI's global-studies program for engineers, an experience like this is considered a grand success. The point of that program, and of many like it at colleges across the country, is to pull undergraduate engineers out of familiar campus environments and make them engage other cultures—in China, India, Thailand, Germany, Mexico, and other countries.

It is training for a profession that is becoming increasingly global. American manufacturing has largely moved overseas. Those manufacturing sites are also the homes of future customers. American companies forecast immense growth for their products in modernizing countries like India and China, and engineers need to understand those cultures before designing products for them, say supporters of international-engineering programs.

ABET, which accredits college engineering programs, has made a "broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context" part of its criteria.

Moreover, most American engineers will need better intercultural skills, as they will increasingly work with engineers from other countries. A recent study at Duke University showed that India and China are graduating large and growing numbers of students with engineering and technological degrees, outpacing U.S. growth. "The American engineer is going to be a minority on design teams in the future," says E. Daniel Hirleman, director of a global-engineering program at Purdue University.

Employers, most important, are hunting for graduates with international experience. Mr. Hirleman says that students who have participated in his program are in "ultrahigh demand" after they graduate, and that some land supervisory jobs.

But so far, American colleges have made few inroads in the global-engineering market. John Wall, a vice president at Cummins Inc., a major manufacturer of diesel engines that supports the international-engineering program at Purdue University, says he would like to hire more students with international experience. He says, however, that there just are not enough coming out of American colleges.

"Engineering is a social exercise, and being able to relate across cultural boundaries is getting very important," Mr. Wall says. In illustrating cross-cultural communication, he cites an example from his own experience working with engineers at offices in Asia: When asked to do an impossible task, Asian engineers will never say no, as an American might. "What you'll hear is, 'We'll try.' You have to be sensitive to that, how they will qualify it."

Constraints of Structure

Globalization affects not only engineers, of course. Many colleges are struggling to raise participation in study abroad across every field. Nationally the percentage of students who spend time abroad hovers around one percent. But engineering programs face particular challenges in encouraging students to go overseas. Undergraduate engineering programs are generally extremely rigorous and very rigid, and students have to follow a
strict sequence of courses to get a degree within four years. Engineering students—who, those in the field say, often come from working-class backgrounds—usually do not have the luxury of taking a semester off for a foreign excursion.

Last fall the Institute for the International Education of Students, a nonprofit study-abroad provider, announced that it was creating new programs tailored to engineering students and others with extremely structured majors. But Michael Steinberg, the institute’s executive vice president for academic programs, says the programs have had trouble getting off the ground, in part because of the heavy course loads of engineering students.

Jane F. Fines, who directs study-abroad programs for the engineering school at the University of Maryland at College Park, says that course load is less of a problem than poor marketing. Engineering students do not go overseas because foreign study has not traditionally been a focus for the field.

Whatever the reason, engineering students travel abroad in disproportionately small numbers. They make up 5.2 percent of all undergraduates, but account for less than 3 percent of students who go abroad. Students in the humanities, arts, and social sciences, by contrast, are overrepresented in those programs. They make up nearly 44 percent of all students who go overseas, even though they account for only 22 percent of undergraduates.

Many engineering deans aspire to push their numbers up. Lester A. Gerhardt, dean of engineering at Rensselaer Polytechnic Institute, is setting up partnerships with universities around the world. He would like to send overseas 25 percent of the class of 2010, or almost 200 students. Eventually, he says, all engineering students at RPI will study abroad.

He has some work ahead of him. Today only about a dozen engineering students at RPI study abroad in the Global Engineering Education Exchange, offered through the Institute of International Education. The program, which Mr. Gerhardt helped set up, serves about 300 students from 30 American and 70 international universities.

A Limited Audience
Others are skeptical that engineering schools will ever send overseas a critical mass of students. “It is impossible, literally, for every engineering student to go abroad for one semester in their career,” says Pradeep Khosla, dean of engineering at Carnegie Mellon University.

Most of the study-abroad programs in engineering are based on reciprocal arrangements with overseas universities, Mr. Khosla says, and American higher education could not absorb the number of students necessary to make these arrangements work. “If we sent 75,000 students abroad, are they going to send 75,000 students here, too? That ain’t gonna happen.”

Mr. Khosla would rather scale up international experiences by going online. Carnegie Mellon pairs teams of undergraduates with students in Brazil, Israel, and Turkey, and they collaborate on projects through videoconferencing, e-mail, and other Internet tools.

But Mr. Khosla’s is a minority viewpoint. Most observers say the only way to truly learn about a culture is to be immersed in it. The styles of global-engineering programs found at various colleges varies widely. But three engineering programs, at Purdue, the University of Rhode Island, and Worcester Polytechnic, have emerged as models of approaches to internationalizing engineering.

At the University of Rhode Island, the focus is on language. “There are those who say that English is the global language, but I see that as a handicap for Americans,” says John M. Grandin, executive director of the international-engineering program, who is a professor of German. “Those who do not learn a language do not get exposure to a culture in any kind of depth.”

He says he and an engineering dean started the program two decades ago, when Mr. Grandin saw that globalization was inevitable. Naturally, Mr. Grandin formed the university’s first partnership with a German institution, the Technical University of Braunschweig, but the program has expanded to France, Mexico, Spain, and, most recently, China.

From freshman year on, students study a language along with their engineering requirements. In their fourth year, students travel to one of the four countries to study language and engineering at universities that have formed partnerships with Rhode Island, such as the University of Cantabria, in Spain, or Monterrey Tech, in Mexico. After their studies, they
spend six months working at a company in one of those countries. Siemens, Mercedes-Benz, and the chemical company BASF have been among the companies training students in Germany.

Over the years, Rhode Island has sent about 250 students abroad through the program, and now 20 percent of engineering students take part in the program, Mr. Grandin says. To manage the extra workload and time overseas, Rhode Island students do what might be unthinkable to other engineering students: They take an extra year to finish their degree.

At Purdue's global-engineering program, Mr. Hirleman did everything he could to avoid adding an extra year. He found that cost and graduation time were two barriers to getting more students to sign up for overseas programs. So his program plays down the role of language (each student takes 12 credit hours, but fluency is not necessarily a goal) and limits the number of partner universities, to ease the scheduling and transfer of courses.

More than 90 percent of Purdue's engineering undergraduates get well-paying summer jobs with corporations before they graduate. Some make as much as $3,000 a month. Students in the exchange program in a place like China might make as little as $10 a day. So Mr. Hirleman found corporate sponsors like Cummins, John Deere, Siemens, and General Motors to supplement student pay — they cover about $250,000 for more than 20 students every year, and might recruit the students after they graduate. (When Mr. Hirleman met with Mr. Wall, of Cummins, he barely got his pitch out before Mr. Wall interrupted him: “I’m in,” he said.)

Another barrier to students joining the program was the threat of losing a sense of community, Mr. Hirleman says. So Purdue's program is based on international design teams — Purdue students are matched up with those in Germany, China, India, and Mexico, and they work on projects and take classes in the United States for a semester, then go overseas for a semester during their junior year. To help nurture a sense of community, they are introduced as freshmen.

About 10 percent of Purdue's engineering students participate in the program, and Mr. Hirleman says he wants to raise that number to 20 percent. “There are so many things going on for students, so many opportunities, and so many barriers, that I am happy to be at 10 percent,” he says. “It'll be tough to get to 20.”

Some of the enduring lessons of the overseas experience come from foreign students, he says. In Asia, Purdue students will encounter highly competitive Indian and Chinese peers who had to be among the very top students at their schools to get into universities, and who are thrilled to make $10 a day. German students surprised some of the Americans when they put environmental issues as a top concern of their projects. “American students are concerned with cost and performance, not sustainability,” Mr. Hirleman says.

Risk-Averse Students
Sustainability is one of the main themes of Worcester Polytechnic's program, which sends about half of each graduating class overseas to more than a dozen locations. Worcester Polytechnic is able to attract so many students to the program because the trips are a short seven weeks and terms at WPI are on a modified quarter system, designed to accommodate the trips and other projects.

Female students are disproportionately attracted to the global-engineering program. Thirty-five percent of participants are women, although they make up only a quarter of WPI's student body. Among programs set in developing countries, almost half of the participating students are women.

Still, says Richard F. Vaz, dean of the global-studies program, many factors keep “risk averse” engineering students in Worcester: participation in sports, a double major, a
girlfriend or boyfriend, or tight finances. Students also have to cover travel costs, which vary.

Many of WPI’s global-studies locations are in poorer nations such as Namibia, Thailand, and Morocco, where students work with nongovernmental organizations on projects that don’t necessarily have an intense engineering focus. In Ifrane, Morocco, for example, students might help artisan woodcarvers market their wares on the Internet. In Bangkok, they might develop a computer-literacy program for refugees. Faculty members organize the trips and supervise the students, but local organizations come up with ideas for the projects.

The point is to teach students how to “solve problems in the real world with messy constraints,” Mr. Vaz says. “Students do a lot of research before they leave, and they come up with a plan,” Mr. Vaz says. “Then they get there, and the plan disintegrates before their eyes, as they find that there are all these political and logistical hurdles that they couldn’t have learned about until they arrived on site.”

In Namibia, which is experiencing energy shortages and deforestation, Ms. Epstein and Steven Feroli traveled from village to village, educating people about energy-saving technologies. They found that success was a matter of politics — finding a young villager who spoke English, explaining the technology to him, and then getting him to persuade one of the village elders to try the technology.

Mr. Feroli, whose voice can be as commanding as his linebacker build, discovered that he could not push high-efficiency woodstoves onto villagers using loud, high-pressure tactics, American style. Instead, he found that he garnered interest by cooking dinner alongside the villagers and waiting for them to become curious and ask questions.

“One of the biggest things our group learned is that it’s not about going in and telling people what to do,” he said. “It’s about explaining the options and letting people figure it out on their own.”

Mr. Feroli returned from Africa with a new awareness about energy and sustainability. As he drove away from Boston’s gleaming airport, he couldn’t help but notice all the wasted energy around him. He made his family buy compact-fluorescent light bulbs. He gets excited when talking about solar energy.

That kind of epiphany is not uncommon after students return, Mr. Vaz says. “This is an eye-opener,” he says, “and for some students, it’s not what they expected engineering to be.”