BY BILL SNYDER

LED Lamps Light the Way for Social Entrepreneurs

The lamp itself is a small part of the class project, which requires developing a business plan to spread and sustain the technology.

These solar-powered LED lights were designed by a team of business and engineering students with input from industry experts and potential users in other countries.

Turn on the light. For most of us, it's second nature. Electric lighting is clean, safe, and relatively cheap. But for more than 1 billion people in underdeveloped countries, turning on the light, if it's possible at all, means lighting a smoky, dangerous kerosene lamp.

A groundbreaking partnership between Stanford University's *Social Entrepreneurship Startup* and the nonprofit Light Up the World Foundation (LUTW) is working to bring safe, affordable lighting to people in China, India, and Mexico. And in the process, 21 students in business and engineering are learning invaluable lessons about product development, market research, and applied engineering that would be hard to duplicate in a traditional classroom.

In 10 short weeks, a team of Stanford students, helped by volunteer advisors from private industry, developed three business plans (one for each country) and prototypes of three LED-based lamps bright enough to read or work by at a fraction of the cost of conventional incandescent lighting or kerosene lamps.

All the prototypes are inexpensive to manufacture and maintain, durable, and, most significantly, ultraefficient. That's because LEDs, or light-emitting diodes, produce nearly 50 times the amount of useful light per dollar of a conventional bulb and up to 200 times more useful light than a kerosene lamp, according to Evan Mills of the Lawrence Berkeley National Laboratory, who acted as an advisor to the project.

Looked at another way, 90 percent of the energy used to power a standard bulb produces heat and 5 percent produces light. An LED works roughly the opposite. Moreover, LEDs, which are solid-state circuits made of semiconductor material, are durable—able to last for as long as 40 years. And it is much easier to use inexpensive lenses to focus light produced by an LED (think point source) than a standard or fluorescent bulb.

Headed by professors Bill Behrman and David Kelley of the School of Engineering and James Patell of the Graduate School of Business, the *Social Entrepreneurship Startup* course was inspired by and builds on the work of David Irvine-Halliday, the founder of LUTW. Irvine-Halliday, a Scottish-born Canadian electrical engineer, hit on the idea of using LED technology to replace kerosene lamps while trekking in the Himalayas in 1997.

Within three years, 134 homes in four regions of the mountainous country were lit using battery-powered LEDs recharged by a mix of solar, pedal, and hydroelectric power. And because Irvine-Halliday believes that economic development projects will spread and sustain lighting technology more efficiently than giveaways, he helped start Pico Power Nepal, which now builds LED lamps in a small factory in the countryside.

The problem Irvine-Halliday, and then the team at Stanford, set out to solve is rather like an iceberg. The most visible part of the solution, the lamp itself, turns out to be only a relatively small part of the whole. Consider the power source: Is the community on the electric grid at least part of the time—if so, a battery and a conventional recharger might do the trick. If not, pedal-powered generators might work—but only if there are enough people in each user community to justify the expense and share the labor.

Solar power works in some communities, but the stu-

KURT ANDERSON

dents who were developing a solution for Mexico found that earlier attempts by the government to bring solar-powered lighting to the countryside had failed and tarnished residents' image of solar power.

What shape should the lamp be? Should it hang from the ceiling or sit on a table? Should it be a task light—a reading lamp, for example—or should it provide more diffused light across a larger space? Settle all those questions and that still leaves the question of price, including the bill for materials and the cost of assembling them into a finished product.

To make the job manageable, the spring quarter class was divided into teams for each country. Some students concentrated on engineering tasks, others on business- or market- oriented tasks, but "there was a tremendous amount of cross-fertilization," said Patell. And a tremendous amount of preparatory research.

Like students in any university class, project members spent countless hours on the Internet and in the library to ferret out basic information about conditions in the three target countries. Consider India, the second most populous country in the world: Between 150 million and 300 million people are without electricity; as many as 80,000 rural villages are not connected to the power grid; many areas on the grid have power for just six to seven hours a day.

> At times the class resembled nothing so much as a Silicon Valley startup, with students pulling pizza-fueled all-nighters while they struggled to finish an iteration.

But this project needed significant amounts of primary research as well, and Stanford's position as a preeminent institution of learning opened many doors.

Behrman contacted the Indian government and was able to arrange a meeting with a cabinet-level official, who in turn introduced the project to a number of nongovernmental organizations and local academics. And those contacts enabled the students to work with villagers who became vital sources of information and feedback.

One Indian, Bharatsinh Patel, is an agricultural worker in semirural Gujarat. Patel, who has 11 people in his family, is on the grid, but power is off much of every day. Although kerosene costs only 30 cents a liter, his average fuel expenditure for backup lighting accounts for as much as 4 percent of his monthly budget—a serious problem for a man who only earns $300 to $600 a year. What's more, Patel spends more precious cash buying disposable flashlight batteries.

The solution: the $20 Mighty Light. Looking a bit like an iron, the LED-based Mighty Light can be carried like a flashlight, hung by its handle to light a room, or set on a table. It runs on two AA batteries that provide around four hours of light when fully charged. It has a built in photovoltaic (solar power) panel that will charge the batteries in a little more than seven hours and costs about $10 to build.

The business plan: Light Up the World initially will act as a virtual manufacturer, subcontracting manufacture to a third party. Once the product and business concept has been proven, LUTW will throw the design open to competing manufacturers to produce and distribute the product.

The foundation initially will support the sales channel with marketing and promotion activity and handle inventory. But in the long run, LUTW's goal is the creation of a self-sustaining local infrastructure that will build, distribute, and sell the lamps.

At times the class resembled nothing so much as a Silicon Valley startup, with students pulling pizza-fueled all-nighters while they struggled to finish an iteration (each prototype had about 10) for the next day's critique. Their audience was a tough one: experts from companies including IDEO, the Palo Alto, Calif., industrial design company whose credits include the first mass-produced computer mouse and the Palm VII; and Solectron, one of the world's largest contract manufacturers, plus designers and engineers from other firms and universities.

The advisors heeded the advice of the project leaders to be supportive but critical. "Eventually, we established a rule that the experts had to say one nice thing for every nasty thing," said Stanford's Patell. Actually, the critiques were a lot less bruising than those in the real world. Nevertheless, they were taken very seriously. "It's a lot better for us to find mistakes here than to have something fail in the field 6,000 miles away," Patell added.

Prototypes of lamps and business plans were sent regularly to the target countries for feedback. Villagers used the lights for several days and were then debriefed by LUTW representatives who sent the information back to Stanford for incorporation into the next round of product development.

By mid-June, the team had settled upon two light designs, the MightyLight and the MightyTorch. At about $7.30, the MightyTorch looks like a flashlight, contains three small LEDs, and is powered by one AA NIMH battery, recharged by a photovoltaic panel on the side. Its intended use? Task lighting for poor people without electricity in any country.

Neither of the solutions is perfect. "They don't have to be," said Patell. "What we want to do is produce something that a nonprofit can show to a group of investors and get their attention." Similarly, the business plans are closer to proposals than economic blueprints.

Five students spent two weeks of the summer deepening their research in India. "The experience has been too inspiring to let go," said Matthew Scott, MBA '03. Students are continuing to work with the Foundation to develop plans for a full-scale pilot project beginning spring 2004.

Others will move on—to jobs or new academic challenges. For all, it was a memorable 10 weeks. "I got to combine my interest in technology and business with social entrepreneurship," said Scott. "It opened my eyes to the world of development." ■

ANNE KNUDSEN

Industry and design experts worked with students from initial concept to demonstration models of several different LED light designs.