# Engineers strut their global stuff

By Trisha Gura
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Bioengineer Robert Malkin's career in global health began with a light bulb. The year was 2000, and he was traveling from his lab at the University of Memphis to Nicaragua, to aid a team of 15 American clinicians sponsored by the International Children's Heart Foundation. He was along to repair the devices that often broke during surgeries.

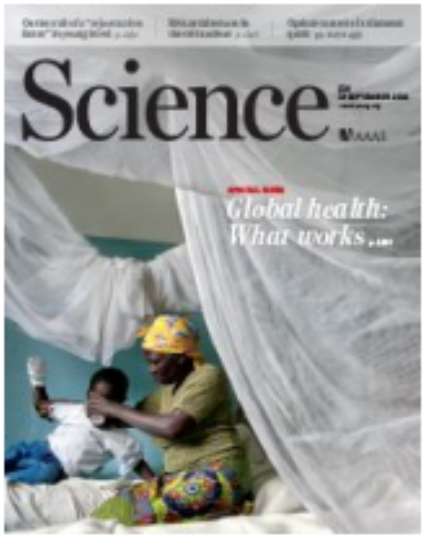
*"There's been a growing awareness of the need for appropriate design. It is a very exciting time." —Rebecca Richards-Kortum*

Malkin had just fixed the machine that suctions fluids from patients when the surgical lights burst into flames. Smoke filled the operating room, and debris flew about. A Nicaraguan nurse threw a blanket over the patient—splayed open on the table—and someone called the hospital's technician who calmly put out the fire.

"At this point, my jaw was scraping the floor," Malkin recalls. "There was a fire. There was no panic. The technician wasn't even surprised."

He was unruffled because this scenario had happened repeatedly. The reason, Malkin surmised, was that the technician was using everyday 100-watt light bulbs in a surgical fixture that called for special bulbs with an internal heat shield. The Nicaraguans understood the problem well enough; they just did not have access to the correct bulbs and couldn't afford them anyway.

"What I realized," Malkin says, "was that the kinds of repairs necessary here did not require a Ph.D. in biomedical engineering. They were quite within the reach of an engineering student."

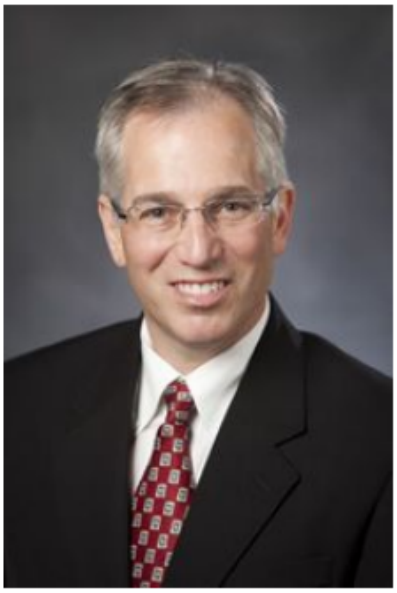



This story ties in with *Science*'s special issue on global health.

## Engineers go global

Thus, in 2001, Malkin and Mohammad Kiani, a colleague who has since moved to Temple University in Philadelphia, Pennsylvania, founded Engineering World Health (EWH), a nonprofit organization that sends college students to repair medical equipment in developing-world clinics. Malkin moved to Duke University in Durham, North Carolina, in 2004, and the organization moved with him. EWH grew quickly; thousands of undergraduates and graduate students have since been deployed to countries like Guatemala, Nicaragua, Tanzania, and Rwanda. So far, the students have fixed 6000 pieces of medical equipment worth about $12 million.

Seven years later, Malkin launched Global Public Service Academies, which trains high school students to perform 117 simple tasks such as changing batteries, replacing blown fuses, and swapping out faulty plugs. In Rwanda alone, these easy fixes have halved the amount of out-of-service equipment. That's a significant advance considering that 60% of the organizations that donate medical devices admit to shipping broken equipment, according to a 2011 report by the Catholic Health Association of the United States.



Courtesy of Robert Malkin and Engineering World Health

Robert Malkin

Global health had long been the domain of physicians, microbiologists, and “a handful of diseases found in warm places,” Malkin says. Now come the engineers.

Why engineers, and why now? The 1970s brought a boom of the medical device industry, Malkin says. Decades later, a lot of that old equipment was shipped out to the developing world.

In the late 1980s, organizations such as the World Health Organization (WHO) and the U.S. Agency for International Development (USAID) realized that those developed-world technologies were not improving health in their new setting because that first-wave equipment required intensive maintenance and expensive replacement parts—both unavailable in resource-poor settings. Myriad logistical and even cultural issues also hindered improvements in local public health. That insight prompted engineers like Malkin to set up a mosaic of efforts centered on three tactics: repair the old equipment; train local technicians to perform fixes; and design low cost, high reliability, easy-to-maintain equipment specifically for the developing world.

“This is a perfect time for engineers to get into this field,” says Malkin, who is deploying all three approaches. “It is exploding.”

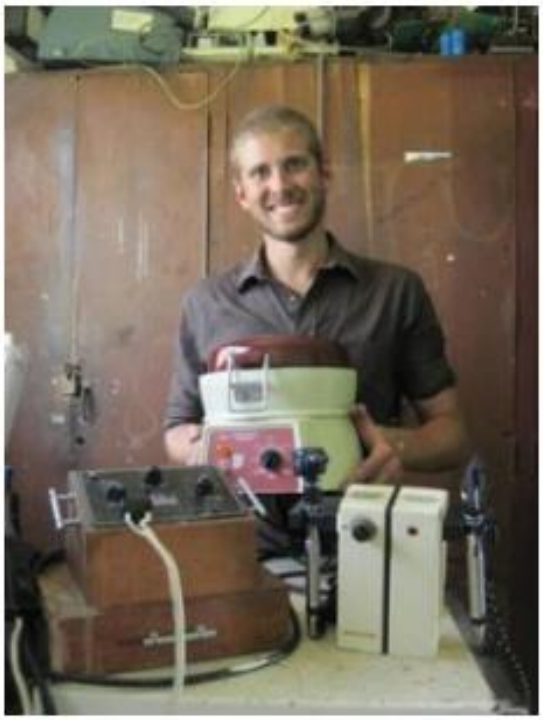
## The right stuff

What does it take to work in global health engineering? Travel experience in resource-poor regions can be a great start, Malkin says. That doesn’t mean a week at the beach in Jamaica, sucking down tropical punches. “I tell all my engineers, 'Take a year off and go live and work in the developing world,' ” he says. The stint will confer a perspective that cannot be garnered from books or classes—an understanding, for example, of how a light bulb can bring down a Nicaraguan operating room.

Courtesy of Robert Malkin and Engineering World Health.

Robert Malkin installs some new equipment at Good Shepherd Hospital in Sierra Leone.

Working in a resource-poor setting can enhance competitiveness for future jobs, even outside the field of global health. Not many engineering programs teach simple hands-on skills like soldering or rewiring circuits, says former bioengineering student Alex Dahinten, who now trains new recruits for EWH, among his other responsibilities there and at Duke University. “The curriculum is so dense and compact there is no real time for hands-on exercises,” he says. Working in remote places with simple tools and jury-rigged devices breeds a special kind of competence that can set a global-minded engineer apart.



Courtesy of Alex Dahinten/Duke University

Alex Dahinten

Languages are also an important part of the package for the aspiring global engineer. Akan, Khmer, K'iche', Spanish, Swahili: The list of languages that Malkin's team must communicate in grows ever longer. Malkin does not, of course, expect an engineer to be fluent in all of them. But he does expect his students to have studied at least one foreign language. The curiosity, passion, or interest that drives a student to learn another language points to a latent cultural sensitivity that can motivate an engineer to integrate better into a local community, he says.

## Design for the developing world

In 2007, bioengineer Rebecca Richards-Kortum founded Rice 360°: Institute for Global Health Technologies, which encourages graduate students to design medical devices to meet health needs in resource-poor settings. Richards-Kortum also launched Beyond Traditional Borders (BTB), Rice 360°'s component for undergraduates. Already, 80,000 people in 28 countries have benefited from 105 new technologies and programs designed by 450 students in the BTB initiative alone.

Furthermore, organizations such as USAID and the Bill and Melinda Gates Foundation have started sponsoring design competitions such as Saving Lives at Birth, which challenges innovators to protect the health of newborns and their mothers in the world's poorest places. These major players have been plunking down money for large-scale efforts (often framed as challenges) that engineer solutions to specific problems: Diagnose HIV at the point of care; prevent fatal, maternal bleeding after birth; help amputees get around tough terrain, and so on. The organizations are creating a market for developing-world medical technologies, and many organizations—including for-profit companies and private research institutions—are stepping up. Translation: jobs.

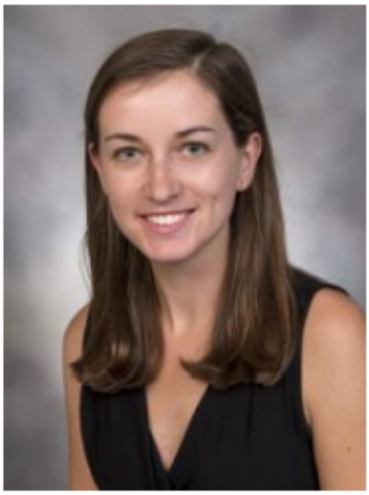
"There's been a growing awareness of the need for appropriate design," Richards-Kortum says, "It is a very exciting time."

As a testament, Devex—a Washington D.C.-based online clearinghouse for job listings, career advice, and news related to international development—currently lists 72 international aid and development jobs that include both "engineering" and "health" in the description and title. Those jobs must be filled in the next 2 months. (According to Forbes magazine, some 300 organizations, from the United Nations Children's Fund to Microsoft, use the site to learn about new contracts up for bid and to staff 35,000 development projects from China to Chile.) In addition, major U.S. health companies such as GE Healthcare and Johnson & Johnson are now saying they view resource-poor regions in Africa and South Asia as expansion opportunities. These companies are recruiting innovators of emerging technologies not for the companies' foundations or social-investment arms but as part of their mainstream technology-development efforts.

## Practical feedback

The push in part stems from the sense that technology development for the developing world requires a fresh perspective. To help acquire it, Richards-Kortum counsels students to partner with clinicians who work in those settings. For example, she taps the experience of pediatrician Elizabeth Molyneux at the University of Malawi to get ideas about what is needed, as well as honest, practical feedback on prototypes.

An example: After Molyneux mentioned the need for a simple, low-cost respirator that could help a sick or fragile newborn breathe, bioengineering student Jocelyn Brown and a team of Rice University seniors rose to the challenge, fashioning a breathing machine out a $30 aquarium pump and a water bottle. The part most likely to break costs just 25 cents to replace. For simplicity's sake, the device has few buttons; one has a picture of a baby (where the breathing tube would connect), and another has a graphic denoting a water bottle. "It was foolproof," Brown asserts.



Courtesy of Jocelyn Brown

Jocelyn Brown

## Focus on impact

That quest for simplicity is part of the kind of innovation that emerges from working on developing-world projects. The technology behind Brown's breathing machine was not cutting edge: The height of the water in the bottle determined the pressure of the air the patient will receive. The creativity was in how the team utilized that concept and how far they took it. After graduating from Rice, Brown joined BTB. She scored a $250,000 grant from Saving Lives at Birth and launched a year-long clinical trial at the Queen Elizabeth Central Hospital in Malawi, using the device to help infants in distress. The results were so positive that she netted $2 million more to introduce the device to all the government hospitals in Malawi. Now she has taken a job at 3rd Stone Design in San Rafael California, figuring out how to manufacture the device for commercialization.

Courtesy of Rice 360°

Nurses Florence Mwenifumbo and Isabella Mlambe flanking students Ariel Chen (2014) and Samantha Olvera (2015) at Queen Elizabeth Central Hospital in Malawi. Chen is now pursuing an M.D. at Baylor College of Medicine. Olvera is spending 2014 working at the World Health Organization in Geneva, Switzerland. Brown's breathing machine is on the shelf below the bassinet.

Brown's experience illustrates an important difference between traditional engineering and its counterpart in global health. "You can use science that is just as exciting, just as novel as something that you would use for a high-resource setting," Richards-Kortum says. But global health efforts are driven by resourcefulness and impact and not by how far you advance the high-tech frontier.

## Love the cause

It follows, Malkin says, that those who can improvise to maximize impact on the lives of those who have the least are the best equipped to make it in the global health field. The first step is to understand the new mindset propagated by Malkin, Richards-Kortum, and others. "There is a lot of the world that still thinks the solution to help the developing world is to ship them more stuff," Malkin says. "If you really believe that, all of us should quit our jobs and work for UPS."

Instead, Malkin ships his students to the developing world, where they may travel 5 hours down a dusty dirt road, immersed in a language they don't recognize, to find a hospital

and troubleshoot a piece of medical equipment. "You've got to have a certain level of passion," Malkin says. "And that will drive you through the inevitable problems that make this work really tough"—and, ultimately, rewarding.

# More information:

## Nonprofits

- Path, a Seattle, Washington, nongovernmental organization, develops technology for global health. PATH created a nonpneumatic antishock garment, based on NASA space station technology, that can keep a mother from hemorrhaging postpartum until she can be transported to a facility with a higher level of care.
- Medical Technology Transfer and Services, based in Hanoi, is an engineering design firm that designs technologies for pediatric health, especially newborn care. They have a LED phototherapy to treat jaundice.
- D-Rev, a nonprofit development company in San Francisco, California, delivers products to people living on less than $4 a day. D-Rev invented a low-cost, high-performance knee joint for amputees who have to navigate tough terrain in the developing world.
- Devex, in Washington, D.C.

## Nonprofit/Academia

- Rice 360°: Institute for Global Health Technologies
- Beyond Traditional Borders
- Developing World Healthcare Technologies Lab
- Engineering World Health
- Global Public Service Academies
- Stanford Global Biodesign Programs

## Multinational Companies

- IDEO, based in Palo Alto, California
- Laerdal, based in Stavanger, Norway

## Challenges

- Saving Lives at Birth