Engineering with a Human Face

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Dr. Bernard Amadei is a co-recipient of the 2007 Heinz Award for the Environment, the recipient of the 2008 ENR Award of Excellence, an elected member of the U.S. National Academy of Engineering, and an Ashoka-Knight Fellow. In addition to creating Engineers Without Borders USA, Dr. Amadei is the co-founder of Engineers Without Borders International. In 2013 and 2014, he served as a science envoy for the U.S. Department of State. His overarching goal: to help shape a new generation of engineers with the education, training, and passion to change the world.

From the backyard to Belize and beyond

My interest in engineering for developing communities actually started in my own backyard in 1997. I was having some landscape work done, and the three young men who were doing the work were originally from Belize. As we talked in my backyard, they told me about the needs of young Mayan Indians in Belize, especially with regard to curriculum development. They wanted to start a vocational school. They asked me, "Since you are into teaching, would you be interested in helping?" I said yes, but I didn't hear from them for about two years.

Then, in 1999, I got an email inviting me to visit them in Belize. I was on sabbatical leave at the time. I went to Belize, where I fell in love with the land and the people. In the Mayan village of San Pablo, I met a little girl who carried water from the river up to the village every day. Because she had to do this, she couldn't go to school. The people of the village asked me if, as a civil engineer, there was anything I could do. Right away, I thought of installing a pump that could be used to pump water from the river to the village.

An enlightening experience

From a technical standpoint, the project was easy to design and implement. The challenge was to come up with a solution that was affordable for the local people, most of whom earned less than $1.00 a day. In the jungle, there is no electricity, and the community couldn't afford fuel for a pump. It was the first time in my life when an engineering problem was defined more by societal needs than by technological needs.

Back in Colorado, I talked to some engineering students about working on the project, and lo and behold, some 15 students volunteered to raise funds for it. A year later, we built a ram pump that relied on energy from a waterfall. It was an eye-opening experience for me and for the students, who wanted to do more of that kind of practical work, rather than learning solely from textbooks. And so Engineers Without Borders USA (EWB-USA) was born in 2001.

Today, we have around 14,000 members in the U.S. alone. Half of those members are professional engineers. The other half are engineering students who will eventually graduate and become professional engineers. We have over 300 chapters throughout the United States, and we're working in 47 countries around the world.

Working together to benefit the community

Typically, someone—a Peace Corps volunteer or someone from an NGO (non-governmental organization) or government agency—will contact us with a potential project. They submit an application they download from our website, which is then reviewed by professional engineers to determine whether it fits within the value system of EWB-USA: Can we do it? Is it going to benefit the community? If the project is accepted, it's put on the website and various chapters can bid on it. They have to show that they have the expertise as well as professional mentors, and that they can pull the project together and do fundraising. Based on

> "The challenge of improving the daily lives of people in developing communities calls for a new generation of global engineers who can operate in environments vastly different from those in the developed world.

—From *Engineering for Sustainable Human Development: A Guide to Successful Small Scale Community Projects* by Bernard Amadei

Dr. Bernard Amadei greets children in a village in Mali.

these criteria, we decide who gets the project. Then, an EWB team will visit the site to see what the community is like and determine the problems and needs of its people. Once a project is selected, a chapter makes a five-year commitment to the community.

Each chapter is responsible for raising funds for their respective projects. The typical per-project budget is around $30,000 to $50,000 per year. Most of that money goes to travel, but some goes into training, equipment, and resources.

Engineering for the people

In the developed world, engineers know how to build roads and bridges that don't collapse. We know how to build projects big and small. What we don't know much about is how to do projects in developing countries that not only are done well from an engineering point of view, but are also right for the community. How do we design good solutions for a community where people make $1.00 a day? How do we design solutions that are also accessible and reliable, and provide long-term benefits?

One of the greatest challenges in community development is the long-term performance of such things as pumps, buildings, and shelters. Often, charitable organizations go to these communities, build something, and leave. The fact is that about 60 percent of water pumps in the world installed by NGOs fail after six months. We're not dealing simply with concrete and steel. We have to remember that we're designing solutions for human beings. This is engineering with a human face. The solutions need to be technically sound but also appropriate to the communities who will benefit from them. Solutions can actually do harm if they are not well designed.

Cross-cultural challenges

We know how to build things. It's the non-engineering part that's the challenge. How do we train people to be leaders, and to deal with cultures that don't speak the same language, or that have different value systems? How do we teach student engineers to deal with issues of anthropology, sociology, language, conflict?

EWB-USA is pushing for its members to take classes in non-technical disciplines, including sociology, anthropology, conflict analysis and conflict management, and cultural sensitivity. We're working on an accreditation process that we want all of our members to complete. Our goal is to make sure that they're ready to go into the field, that they have the education and leadership skills to assess a community in order to address complex socio-technical problems.

Meeting complex needs

The number one problem in developing countries is water, whether it's drinking water, water for irrigation, wastewater, or the recycling of water. Closely aligned with that is energy. Water can be at the bottom of the well, but if you have no energy, the water stays at the bottom of the well. You need energy to pump, clean, store, and distribute the water. Food and agriculture are very important, too, as are safe and affordable shelter and transportation. Of course, health is very important, and we work on anything, such as clinics, that can provide for public health in communities.

Engineering diplomacy

Increasingly, we are talking about creating global citizen engineers, individuals who can play a leadership role and manage complex situations. Over time, EWB-USA has crept into the engineering curriculum. It's become a mature organization that has a place in engineering education and practice and in international development.

In 2012, I was appointed by Secretary of State Clinton as one of three U.S. science envoys. Over the past two years, I've served in various countries, including Pakistan and Nepal, to promote science and technology from a diplomatic perspective. We're dealing with the question of how engineers can help create a more civil society, one that brings people together and improves the well-being of the world.

It's very rewarding to be of service to humanity. When I see the villagers with water, smiling, I know it's a success story. Every time I see students coming back with a big smile on their face, completely changed, that's success. I've watched students who had never experienced work in developing communities come back completely transformed. We're creating a new generation of engineers, and I know that the engineering profession is in good hands. ■