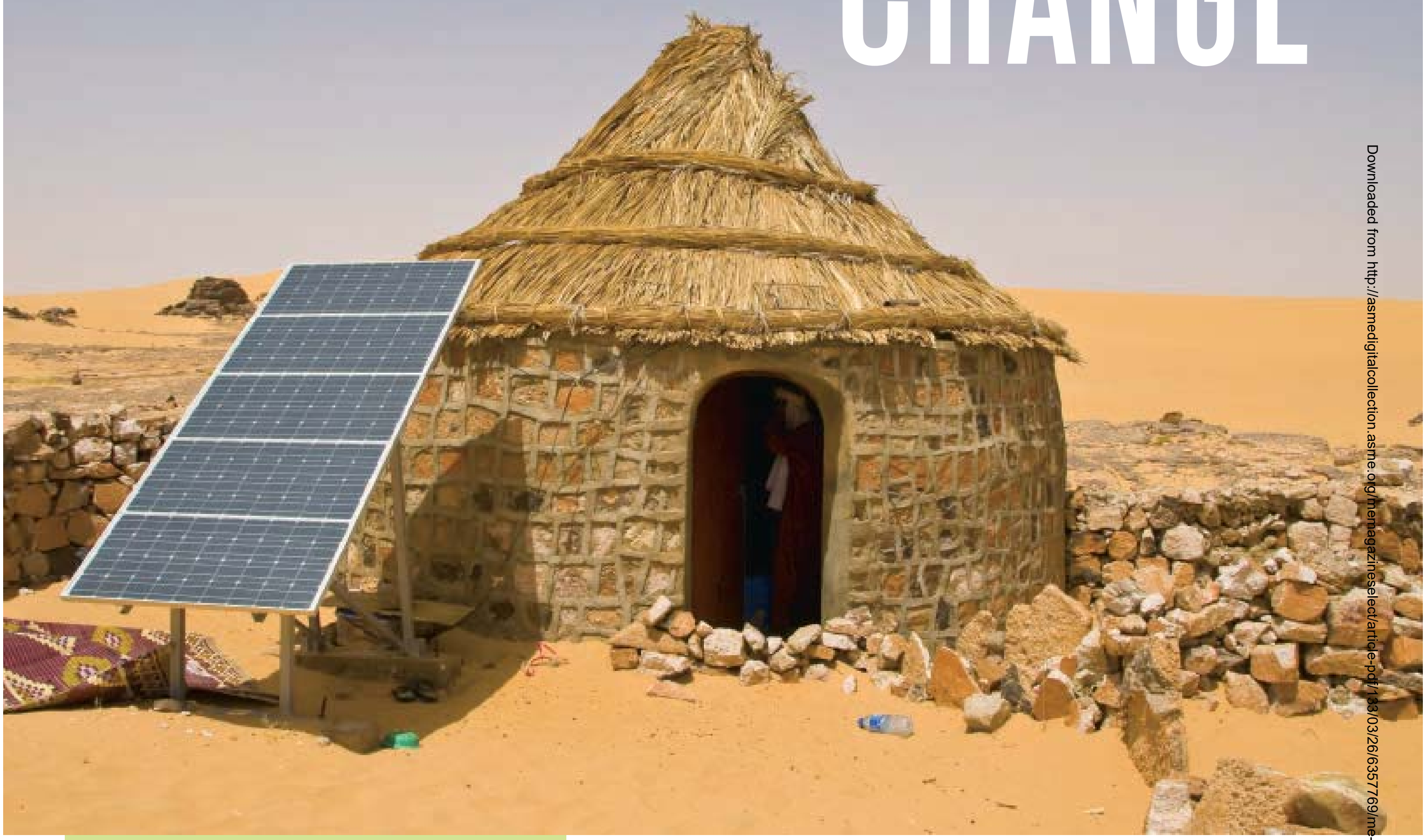
engineering FOR CHANGE



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New Web site seeks to connect engineers and humanitarian organizations to create smart, sustainable development projects

By Alan S. Brown
Associate Editor

Engineering for Change is out to transform the world, one small project at a time.

E4C's Web site, www.engineeringforchange.org, provides a space where engineers and humanitarian organizations can meet, share information, and collaborate with one another on development challenges throughout the world. Its focus includes projects on water, energy, health, infrastructure, agriculture, sanitation, and information technology. Its purpose is to serve the underserved populations of the world.

E4C is an initiative of ASME and two founding partners, IEEE and Engineers Without Borders–USA, whose volunteer engineers build development projects in underserved communities around the world. Together, the three groups have half a million members.

The need for such a platform is clear to Noha El-Ghobashy, president of Engineering for Change, as well as ASME's director of technical programming and an engineer herself.

According to El-Ghobashy, thousands of humanitarian organizations are planning or building development projects around the world. Many of those endeavors will run into problems without engineering support. While thousands of engineers already volunteer their knowledge and skills, most organizations don't know where to turn to access engineering help when they need it. Nor do they have an open, easily accessible way to look at potential solutions to common development projects.

E4C's Web site makes it easy for engineers to volunteer their time and skills, and for humanitarian groups to find the engineering help they need. The site will also help them discover what others have done, so each new project does not have to re-invent past innovations—or repeat mistakes.

This type of transparency is critical, El-Ghobashy said. "Today, you could have an organization in one part of the world working on an issue, and another 10 miles down the road working on the same problem, and neither one knows what the other is doing," she said. "Neither one knows what has worked or has failed before.

"There's no central humanitarian body that tracks this information. Lots of organizations are trying to fix problems like water, sanitation, or energy. There's power in learning and partnering with one another where appropriate," she said.

"What we want to do is create an infrastructure that lets engineers and humanitarian organizations leverage everything that is going on. We want to break down communications barriers, so people know who is doing what, what resources are available, and what approaches have succeeded or failed," she said.

That approach is exactly what someone like Farhad Abdolian could have used when he decided to build a schoolhouse in Ghana.

>> 'What Is Dinner?'

Like many people who get involved with humanitarian projects, Abdolian's reasons were personal. Abdolian is an Iranian-born electrical engineer who lives in France and works for a U.S. consulting firm. Two years ago, he and his wife journeyed to Ghana to adopt a young girl. While the Abdolians were there, a family left three girls at the orphanage, Orphans' Heroes, because they could no longer feed them.

The Abdolians spent a day helping one of the three, a nine-year-old, adjust.

"In the evening, the kids were lining up washing their hands to eat dinner, and she asked me why they were doing so," Abdolian recounted. "I replied, 'They are getting ready for dinner.' She looked at me with surprise and asked me, 'What is dinner?'"

After Abdolian had explained the idea of an evening meal, she asked, "You eat before going to sleep?"

According to Abdolian, "When I said, 'Yes,' and explained it a bit more, she went to her two younger sisters and explained to them that they were about to have some food. The three kids jumped and danced with joy. They never had dinner before and for them it was an amazing luxury."

Abdolian heard that before the orphanage opened in Hohoe, a poor rural town near Lake Volta, starving families in the region sometimes sold their children into slavery. The combined orphanage and school provided an alternative. It would feed and educate their children.

Orphan's Heroes wanted to expand its efforts to help Andokope,

FROM THE E4C WEB SITE

↗ Mashavu project is developing low-cost medical instruments from plastic pipe, cardboard, and Velcro.

↖ OpenBTS creates cheap cellphone networks using PC Internet connections.

↗ Adapt solar powered refrigerators, so camels could carry chilled vaccines to clinics.

↙ The Lebone organization uses microbes in dirt to generate electrical current.

a town of 800 people several miles from Hohoe. In 2010, it helped completed a well to provide safe drinking water. The villagers also set aside a plot of land to build a schoolhouse.

The villagers understood that education could help lift them out of poverty. Some of their children attend school seven miles away, even though they are needed badly in the fields. A school in Andokope would enable students to study and work the fields.

Building that schoolhouse presented significant challenges. This is not just because Abdolian, an electrical engineer, describes himself as "mechanically handicapped." The real problem is that building any project in such a remote, poor village imposes strict constraints on any design.

In fact, Andokope is the type of community envisioned in a 2009 study, *Engineering Solutions for the Base of the Pyramid,* prepared for ASME's Strategic Issues Committee. It identified the base of the economic pyramid as the nearly 4 billion people who live on a per capita income of less than $4 per day. More than 1 billion do not have safe, dependable drinking water; 1.2 billion lack adequate housing; 2.4 billion live without tolerable sanitation.

To put this into perspective, the fortunes of the world's two richest people are greater than the annual gross domestic product of the world's 45 poorest nations combined.

The model for addressing such widespread privation has changed dramatically over the past two decades. Most agencies have abandoned charity, except in the face of such catastrophes as the Haitian earthquake. After all, if an outside agency provides free rice or efficient stoves, why would anyone plant rice or manufacture stoves for local consumption?

Instead of charity, today's development projects seek to involve the community in selecting, funding, and building projects that might help them pull themselves out of poverty. People who buy into a project with sweat equity are committed to making it work.

The right project can have enormous leverage. A simple latrine can prevent diarrhea, the world's second leading cause of infant deaths. An irrigation system might allow farmers to grow surplus crops for sale. A pedal-powered generator to recharge cell phones could let villagers check prices before bringing products to market.

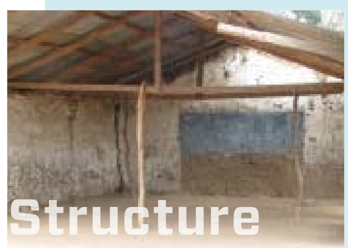
Climate Healers, a group focused on sustainable practices, distributed solar-powered LED flashlights in India. Not only did the lights let children study at night, but also they helped women avoid snakebites when they foraged for fuel in the morning.

Such projects could tip the balance in many communities, moving them from subsistence to market economies. While individual incomes are low, the cumulative buying power of the base of the pyramid is $5 trillion per year, according to landmark studies by University of Michigan's C.K. Prahalad and Cornell University's Stuart L. Hart. This includes large markets for water ($20 billion), information and communication technology ($51 billion), health ($158 billion), transportation ($179 billion), housing ($332 billion), and energy ($433 billion).

Right now, such markets are mostly unrealized dreams. Jump-starting market economies could generate surplus dollars at the base of the pyramid and unleash these large and growing markets. Yet it will take solid engineering—often sophisticated in its simplicity and ability to slash costs to the absolute minimum—to tip the balance.

Getting Started With Engineering for Change

It is easy to get started on the E4C Web site. Just don't think of it as a Web site. Instead, think of it as a community. Then you can walk into a workspace to work on a specific challenge, or create one yourself and ask the community for thoughts and suggestions. Or you can check the library for solutions implemented by various organizations. The site is divided into areas of interest (development topics) and resources.



Areas of Interest

There are seven topic areas:

WATER. The focus is on safe, clean drinking water and solutions to waterborne disease.

ENERGY. Alternative off-grid energy solutions demonstrate promise to improve living conditions for one quarter of the world's population.

HEALTH. From diarrhea to tuberculosis, many killer diseases are treatable if we can deliver medicine where it is needed.

STRUCTURES. Innovative technologies can help overcome scarcity of resources and materials for construction.

AGRICULTURE. More efficient farming can help feed more than one billion undernourished people.

SANITATION. Improved sanitation can rein in the world's most common cause of infection.

INFORMATION SYSTEMS. New technologies can help link the rural poor to a world of information and empower communities.

Each topic area links to workspaces where topic-related projects are under way. Users can see who is doing what and download relevant documents.

The topic areas also include case studies, publications, blogs and Web sites from humanitarian organizations focused on this problem, news, and tools and references.

Resources

E4C's resources enable engineers and organiztions to team with the community to solve development problems. The Web site has several features:

WORKSPACES contain all project-related information. They are where members post and respond to challenges. Users can start or join a discussion, contribute to a whiteboard, post documents or engineering files, and propose solutions for review.

The **BULLETIN BOARD** is just what it sounds like, a place to post requests or offers for help on projects or technologies. Both the request and offer pages are divided into five sections: materials, expertise, funding, tools, and other.

The E4C **SOLUTIONS LIBRARY** library archives past projects. If you want to see how others handled a similar challenge, the library is full of ideas that you can use or modify. Users can browse solutions by topic or use the search tool.

Pages contain the latest **NEWS** about how engineers and humanitarian organizations are responding to challenges around the world. Another great place to troll for ideas.

The **LEARNING CENTER** introduces appropriate technology development principles, and explains how to use the Web site. The "Education" tab features top academic programs in development and identifies relevant publications and online training.

A space lists **MEMBERS** and their profiles. You can see where they are and what workspaces they have started or joined.

>> A Question of Sustainability

Affordability is probably the most imposing barrier engineers face in underserved regions. The very concept takes on entirely new meanings in villages where most people must work hard to survive and have very little time or money to invest in infrastructure that can improve their lives.

Nor can engineers count on an infrastructure with access to modern power machinery and building materials. Concrete is available, but costly relative to income. Steel is often economically out of reach. It is not common outside large cities, nor are people who can work it. Many designs rely instead on such local materials as wood, clay, thatch, and textiles, with plant or animal fats for lubrication of machinery.

Designs must be simple and robust, capable of lasting years with minimal maintenance. While humanitarian organizations are doing a better job training villagers in maintenance, they may not have the specialized equipment needed to analyze circuit failures or rebuild complex mechanical devices. Spare parts are often difficult to find. A torn seal could put a pump out of commission for months.

Designs must also mesh with the culture and routines of the communities that will use them. Solar cookers, which focus sunlight to heat food, have had a mixed history. Despite their advantage—eliminating the need for fuel—they never caught traction. This is because they require people to cook in an entirely new way, and because they are ineffective at the end of the day when people return from the fields to cook the evening meal.

Climate Healers, whose solar flashlights succeeded so well, is one of many groups that stumbled when it distributed solar cookers. It is now looking for engineers through E4C to help it design a solar cooker that stores midday heat so villagers can cook in the evening. This is one reason that Engineering for Change's design principles emphasize solutions rather than technologies, and call for working with local populations to design these solutions.

Even something as basic as a latrine needs a careful introduction. In 2005, the Princeton University chapter of Engineers Without Borders-USA built a latrine in Huamanzaña, a village of 160 perched 6,000 feet up the Peruvian Andes. Before they could reduce the incidence of diarrhea, they had to explain the link between bacteria and disease, and how soap and handwashing could prevent its spread. They posted pictures and taught children a song to sing while they washed so they would lave their hands long enough to kill germs.

Not all development projects are so simple. Many take advantage of enormous changes in the developing world, such as the growth of renewable wind and solar power, cell phones that provide cheap communication, the Internet's ability to transfer knowledge, and microfinancing to support new ventures in poor regions.

Many development projects involve sophisticated engineering that could serve as platforms for future advances. Some highlights mentioned on E4C's Web site:

> A team of telecom veterans has developed OpenBTS, open-source software that creates cheap cellphone networks using PC Internet connections. It promises to slash the cost of service in rural areas to as low as $1 to $2 per month.

A salad spinner-based centrifuge for rural medical clinics to use in tests for anemia.

A Listeroid diesel engine that runs on local vegetable oils to mill grain and generate electricity.

Engineers Without Borders taught children to sing while they washed so they would wash long enough to kill germs.

> Columbia University's student chapter of Engineers Without Borders-USA developed a Listeroid diesel engine that runs on local vegetable oils. The group teamed with Makerere University in Uganda to install the 6 hp engines to mill grain and generate electricity.

> At the Pennsylvania State University, the Mashavu (Swahili for "chubby cheeks") project is developing low-cost medical instruments from plastic pipe, cardboard, and Velcro. The instruments send medical data by phone from rural clinics to city doctors who suggest treatment.

> Princeton aerospace engineers teamed with local communities to adapt solar powered refrigerators, so camels could carry chilled vaccines to clinics in Kenya, Nigeria, and Ethiopia.

> Students at Rice University developed a salad spinner-based centrifuge for rural medical clinics to use in tests for anemia. The students are now looking for ways to standardize spinning speed for better results.

> Lebone, an organization formed by a South African engineering fellow at Harvard, uses microbes in dirt to generate enough electrical current to run a low-powered light bulb or charge a cell phone.

>> Building Blocks

Abdolian's schoolhouse shows how these factors come together to turn a simple project like a schoolhouse into a major engineering task. Consider, for example, materials of construction. Andokope's homes consist of mud bricks, but the rainy season forces villagers to rebuild their walls every few years.

Abdolian wanted permanent walls for his school. "Some new houses use concrete bricks, but they are very expensive," Abdolian said. "Most people here live on $2 per day and a concrete block costs 45 cents. For the schoolhouse, it's out of the question."

If E4C had been up and running when Abdolian began looking for alternatives, he might have begun there. Instead, he searched the Internet and queried friends. Eventually, an architect pointed him towards compressed earth blocks.

The blocks, which are similar to adobe bricks, are made by compressing dirt and clay with a small amount of concrete. Their low cost and ability to stand up to rain have made them a hit in such fast-developing nations as India and Brazil.

"Instead of 40 percent cement and 60 percent gravel or sand for a concrete brick, we can use 10 percent cement and dirt instead of gravel," Abdolian said. "If the earth has clay, the brick is perfect. Otherwise, we have to find clay or add lime."

Compressed earth blocks slash the cost of building blocks to pennies. The problem is finding an inexpensive way to compact the blocks. Commercial machines cost $16,000 plus shipping. Abdolian found a Polish team, Cohabitat Group, that developed a simpler and less expensive design, but it wanted to make the equipment in Poland.

To fit his budget, Abdolian needs a design he can build in Andokope. He remains optimistic. "I believe we can make 80 percent of it from local materials, such as I-beams, which are commercially available eveywhere," he said.

"Just think, if we can build the machine, Andokope can use it to make blocks it can sell for other buildings," Abdolian said. "We could use a machine like this to rebuild Haiti." He listed the project with Engineering for Change, and is recruiting engineers to help with the design.

More and more organizations are likely to follow his lead. In less than three years, E4C has gone from a germ of an idea through several prototypes to a fully functioning online platform. ASME and IEEE have devoted substantial resources to launching the project. Engineers Without Borders-USA has contributed valuable content. The Web site is now ready to begin linking engineers, individuals, and humanitarian organizations with one another.

E4C already lists projects from a number of well regarded organizations. These include Appropedia, a development wiki; Appropriate Infrastructure Development Group (AIDG), a humanitarian organization; Catapult Design, an innovative development design firm; D-Lab, Massachusetts Institute of Technology's sustainable development laboratory; Honeybee Network, India's largest humanitarian organization; and India Institute of Technology's Center for Technology Alternatives for Rural Areas.

The initiative also receives support from the ASME Foundation, United Engineering Foundation, and Autodesk Inc. El-Ghobashy is also reaching out to other engineering societies, and to corporate and development organizations.

"We think it's going to be very big," said Iana Aranda, an ASME manager of Technical Programming and Development, who supports content development on E4C. An engineering graduate of University of Toronto, Aranda joined the New York professional chapter of Engineers Without Borders-USA when she moved to New York City six years ago to work on biomedical instrumentation at Memorial Sloan-Kettering Cancer Center. She took a position at ASME specifically to work on E4C.

As part of Engineers Without Borders-USA, Aranda has seen thousands of engineers respond to development challenges, anxious to use their skills to benefit the world's less privileged.

El-Ghobashy is not surprised. She has spent the past two years talking to engineers about how to make Engineering for Change more useful. "As we talked, I could see that what they cared about, what attracted them to engineering in the first place, was not the equations and mathematics," she said.

"No, what attracted them to engineering is that they wanted meaningful work. They wanted to work on projects that improve the quality of people's lives.

"For students, it is the most dynamic and profound experience they could have in college," El-Ghobashy said. "It exposes them to life and real engineering. For established engineers, it is a way to use what they have learned in their career to make the world a better place.

"Those engineers want to give something back," El-Ghobashy said. Engineering for Change is there to help them do it, one project at a time. ■

E4C DESIGN PRINCIPLES

↖ *engineeringforchange.org Web site*

Over the past decades, development practices have evolved from the charity model to working with communities to co-create sustainable, affordable and reliable technology solutions. Engineering for Change embraces these design principles:

DEVELOP SOLUTIONS, NOT TECHNOLOGIES.
Designing "in" rather than "for" underserved countries enables engineers to understand truly the cultural, social, and economic context of a problem. It is one thing to say a village is poor, another to live with the tradeoffs people make when they must survive on $4 per day.

CONSIDER THE CONTEXT.
Many societies at the base of the pyramid are very traditional. They may reject solutions that do not mesh with traditional practices. As Ethan Zuckerman, founder of Global Voices, said, "If people cook by stirring their stews, they're not going to use a solar oven, no matter what you do to market it."

CREATE TRANSPARENT TECHNOLOGY.
Create products that are easy to make, use, and understand. If possible, stick with open-source design so others can improve or re-purpose your work.

EMBRACE THE MARKET.
Design solutions for price, so they are affordable relative to the local economy. Remove unnecessary materials and source locally.

DESIGN FOR DO-IT-YOURSELF.
Involving the community in the design process yields the most successful designs. It also builds local skills, knowledge, and experience so societies can better meet their own needs.