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Group hopes prosthetics foster independence in Sierra Leone

01:25 PM CDT on Sunday, July 6, 2008

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FREETOWN, Sierra Leone – Ten years later, Gibrilla Sesay still trembles when he tells what happened.

Rebels raided his village and forced Mr. Sesay to carry the loot into the bush until he said he was tired. The rebels had him choose one of two slips of paper.

Mr. Sesay chose the slip that read "long sleeves." "You're lucky," a rebel said with a laugh. Mr. Sesay's hands were tied behind him, and his right leg was placed on a low tree branch. The rebel leader, called "Killer," used his machete to hack off Mr. Sesay's foot.

The "luck" of losing a foot instead of his whole leg ("short sleeves") disappeared after three days. When he finally got to a surgeon, Mr. Sesay had to have his infected leg amputated above the knee.

How Mr. Sesay got a new knee is a technology transfer story. It stretches from the hot streets of Ciudad Juárez, Mexico, to the piney woods of East Texas to a sweltering prosthetics workshop beside an amputee camp in West Africa.

Prosthetic legs for underdeveloped countries

A prosthetic leg can cost anywhere from \$10,000 to \$40,000, putting it out of reach for many in underdeveloped countries. Students from LeTourneau University in Longview, Texas, developed a prosthetic knee that can be made for less than \$30.

COMPONENTS OF A PROSTHETIC LEG



An artificial foot was designed to react like a normal foot while walking. A rubber covering adds additional durability.

THE KEY COMPONENT

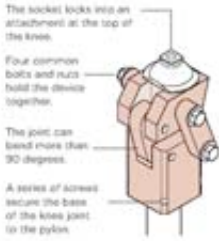
A tough, common plastic called Delrin was key to making the prosthetic leg affordable and durable. The knee was designed to be easily built with common tools.

The socket locks into an attachment at the top of the knee.

Four common bolts and nuts hold the device together.

The joint can bend more than 90 degrees.

A series of screws secure the base of the knee joint to the pylon.



WALKING WITH THE PROSTHETIC LEG



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It started when a kid from El Paso named Roger Gonzalez, on a visit to Juárez, made a wisecrack to his father about a child who was missing a leg. Roger's father admonished him that it was only by the grace of God that he had two legs, and the boy never forgot that lesson.

Roger Gonzalez is now a 45-year-old professor of biomedical and mechanical engineering at LeTourneau University, a small evangelical Christian school in Longview, Texas.

He has spent much of his career pondering limbs, joints and their frailties. Knee-replacement surgery is fairly common, but replacing a knee for a person with no lower limb of muscle, nerve and bone is a much greater biomechanical challenge. At LeTourneau, Dr. Gonzalez leads an effort to engineer solutions for poor countries in Africa and elsewhere.

Dr. Gonzalez's compassion draws on the New Testament – Christ's admonition to help those less fortunate – but it has an edge as well.

"What's happened in Africa over the years is we've created a culture of dependency," he said. "Africa's had billions and billions of dollars in aid, and some would argue it's no better off today than it was 50 years ago.

"The way to really help is to give them the tools to be independent," he said.

Dr. Gonzalez wants to teach Africans how to make a knee.

High function, low cost

Millions of people around the world have lost a leg to land mines, cluster bombs or accidents. Many get by on crutches. Others use prosthetics with a simple hinged knee. They often lock the knee in a stiff-leg position for walking, which puts damaging stress on the hip socket.

U.S. servicemen and -women who've lost a leg in Iraq or Afghanistan are often outfitted with prosthetics that have microprocessor knees to provide balance and anticipate the movements of a walking person. These

knees can cost as much as \$50,000.

Good mechanical joints for prosthetic legs, made with titanium and other advanced materials, allow an amputee to walk with a bending knee. Prosthetists in poor countries can't easily make these knees, however, and rely on an uncertain supply of donated joints.

In 2004, Dr. Gonzalez gave some of his best engineering students a task: Come up with a knee that could be made for less than \$50 using basic tools such as a table saw and an electric drill.

"We wanted the maximum achievable human functionality, low cost and locally available materials," Dr. Gonzalez said.

LeTourneau senior Eric Minelga of Soldotona, Alaska (who now works in [Boeing](#) Co.'s design group), gets credit for what's known as the M1 Knee.

The design uses five pieces of a tough DuPont plastic known as Delrin, held together with four bolts and nuts. The knee is fitted on a thigh socket and a lower-leg length of pipe attached to an artificial foot.

When the wearer stands, the knee locks to support the person's weight. It bends more than 90 degrees when the wearer squats. And it gives the wearer enough fluidity of movement to pull the foot forward when walking.

Dr. Gonzalez and his students next explored how to transfer the process for making the M1 Knee to workshops in Africa and Asia.

The first chance to try it out came at the Bethany Crippled Children's Clinic in Kenya, run by a Pennsylvania-based Christian charity called CURE International. In the summer of 2005, a LeTourneau team helped build prosthetic legs for 18 children and young adults at the clinic.

The next year, the group went to Bangladesh to help build six more prosthetic legs for patients, including farmers who spend much of their time standing in rice paddies. Dr. Gonzalez and two of his students came to Sierra Leone for a few days in January 2007 to see whether it would be a good site for a training workshop. Meagan Vaughan, a student from Dallas who's now pursuing a Ph.D. in engineering at the University of Texas at Austin, was one of those who made the trip.

"The biggest issue [the Sierra Leone workers] have is that what is available has to be imported, and that costs too much in comparison to what they can afford," she said. "I don't think they deserve something less just because they're poor and live in Africa."

Lives changed

Mr. Sesay is now 36. When he was 19, in 1991, civil war broke out in Sierra Leone between corrupt rebels and a corrupt government. Calling themselves the Revolutionary United Front, the rebels invaded from neighboring Liberia and seized Sierra Leone's alluvial diamond mines.

The RUF kidnapped thousands of boys and girls and turned them into soldiers and concubines. Their signature terror tactic was amputation – hands, arms, feet, legs, lips, ears and noses. By the time the war ended in 2002, as many as 6,000 people had been mutilated.

Many of the men who had lost a limb were ostracized. They gathered in camps around Freetown and other cities. Charity organizations started prosthetics workshops to help the amputees.

The workshop next to the [Aberdeen](#) camp is called the National Rehabilitation Center. Dave Evans, an American prosthetist who lost both legs in the [Vietnam War](#), spent several months at the center and helped the Sierra Leonean craftsmen gain a sense of pride.

"When I first met Dave, I did not even know he was an amputee," said Nathaniel Kargbo, shop supervisor at the National Rehabilitation Center. "He taught us to do this work so that people would be able to take care of themselves."

After losing his leg, Mr. Sesay moved in with his parents in the northern city of Makeni. Craftsmen with the Seattle-based Prosthetics Outreach Foundation fitted him with a leg with a simple hinged knee. He learned to repair bicycles, then became a motorcycle mechanic. Using crutches, he played soccer and developed a lean, muscular body. He married, and has a son and a daughter.

'You need to teach us'

Dr. Gonzalez returned to Freetown in May to lead a workshop on the M1 Knee with LeTourneau graduating senior Micah Casteel of Tillamook, Ore. LeTourneau invited the charity organizations Prosthetics Outreach, Handicap International of Europe, and Mercy Ships of Garden Valley, Texas, each to send two prosthetists and one patient. Prosthetics Outreach chose Mr. Sesay as its patient.

The workshop started awkwardly. Dr. Gonzalez and Mr. Casteel passed around a finished knee and explained its history. Several of the prosthetists were skeptical.

"I don't think it will work," Mr. Kargbo said.

"Listen to me," Dr. Gonzalez said. "I like skeptical people. I want your questions. You need to teach us, too, on what you think will work better."

The invitation sharpened the interest of 37-year-old prosthetist Prince Kailie, who builds leg components at Handicap International's workshop in Bo, Sierra Leone.

"In six months, I'll have a better design," he said.

"If it is better, I'll fly you to Texas and you can show us," Dr. Gonzalez replied.

Despite the skepticism, by the end of the week each team had a knee joint and an assembled prosthetic leg for a patient.

Mr. Sesay walked tentatively at first but was soon pleased.

"It's very comfortable. It's a beautiful leg," he said. "I can walk faster. I can get down for my bicycle repair."

Two other men received new limbs.

Mohammed Kamara, 32, of Freetown lost his leg two years ago when a storm toppled a tree on him. Though

he'll need extensive training to walk again, the smile on his face when he was finally fitted with a new leg was dazzling.

Abu Bakar Jalloh lost his leg to RUF rebels in 1998, when he was 22 years old.

"With my new leg, I will go back to being a driver, and my children will go to school," he said as he paced back and forth.

No simple solution

The LeTourneau objective of transferring technology seemed complete.

Later, however, Mr. Kargbo explained that it won't be that simple. Like many charities working in Sierra Leone, Handicap International plans to leave. Other countries have pressing needs, and rebuilding after war isn't complete until Sierra Leone takes responsibility for its own people.

Mr. Kargbo may be the best-trained prosthetist in Sierra Leone. He's been making prosthetics since the early 1990s.

Handicap International pays him \$265 a month. When the Sierra Leone government takes over the workshop, Mr. Kargbo has been told that his salary will drop to \$40 a month.

"It's crystal clear that this workshop will be cut down completely," Mr. Kargbo said. "So if there is another opportunity outside Sierra Leone, I will go."

Alfred Lahai, an assistant secretary of the Ministry of Health and Sanitation, said the government doesn't have the money to pay more.

"We can't pay to keep the technicians," he said. "Our strategy is to seek other [charity] groups to come in" when Handicap International leaves.

That perpetuates the sort of dependency that Dr. Gonzalez hoped to break.

"If the world forgets about Sierra Leone," he said, "these people are going to be in trouble."

For more information

Prosthetics Outreach Foundation, Seattle; www.pofsea.org

Amputee Coalition of America, Knoxville, Tenn.; www.Amputee-Coalition.org

Project HOPE, Millwood, Va.; www.projecthope.org

Mercy Ships, Garden Valley, Texas; www.mercyships.org

LeTourneau University, Longview, Texas; www.letu.edu

American Academy of Orthotics and Prosthetists, Alexandria, Va.; www.oandp.org

U.S. Institute for Peace Washington; www.usip.org