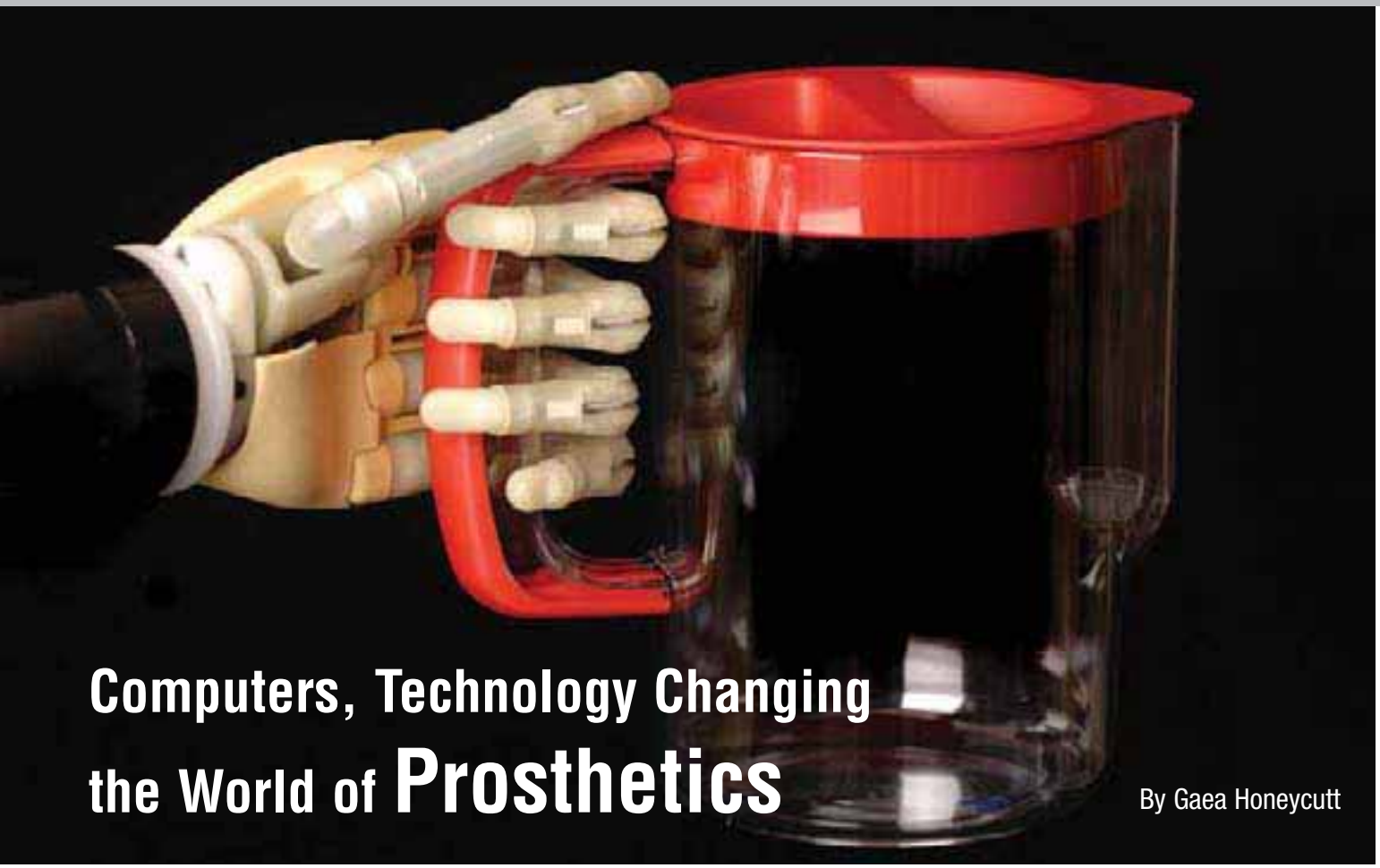

Computers, Technology Changing the World of Prosthetics

By Gaea Honeycutt

Touch Bionic's iLIMB bionic hand.

Chris Berger hadn't expected that fixing his grandmother's prosthetic as a kid would turn into a career 20 years later.

"My grandmother was an upper-limb amputee," says Beger, now a certified prosthetist orthotist and the clinical director at East Coast Orthotics and Prosthetics Corporation in New York City. His path to the profession is actually a common story, he says. "A lot of the folks that go into this either know someone who's an amputee or it's a family business."

But that path is changing as the field of prosthetics becomes an increasingly high-technology industry and increasingly professionalized. Today, entry into the field requires specialized education.

Twenty years ago, it was "just guys working in a lab through trial and error," Berger says. "Now, there's a lot of education that goes into it. There's graduate work and graduate degrees."

In just 25 years, prosthetic and bionic limb development has advanced exponentially. Much of the early advancement was due to the advent of plastics, which resulted in more durable, lightweight, better fitting prosthetics. Over the past 10 years, advances in technology have improved not only the quality of the products but the quality of life for patients. And with these advances, amputees experience improved gait and movement and less exhaustion due to reduced energy consumption.

The demands on prosthetic devices have never been greater. Vincent Benenati, certified orthotist and CEO of East Coast Orthotics and Prosthetics, cites a growing trend—younger prosthetic patients. It's easy to assume it stems from war, with veterans surviving combat at higher rates and retiring with full lives ahead of them. Yet, approximately 60-70 percent of amputees are people who lose limbs from diabetes. These patients are also more active. They run marathons, hike, climb mountains and live active domestic lives as well. The lifestyles of patients help drive the innovation.

Benenati points to the newest prosthetic products as evidence of sophistication and innovation of the technology. "In the last few years, they've come up with ankles. If you're on an incline, a rigid foot is not going to work well." For example, when a person sits, the foot and leg are not positioned at a perfect 90-degree angle and the lower leg must be able to tilt forward in order to create the leverage and momentum to stand.

Previously, orthotists used hydraulics to enhance prosthetic feet, employing little springs. But now computers expand capabilities of the limbs. "Your foot moves in many different planes, so they invented a computer foot to move up, down, side-to-side and in different angles," Benenati explains. Much of this is accomplished through microprocessors placed in the socket that fits over the residual limb. The microprocessors sense firing from nerves and pressure from the artificial limb.

"The other part is the upper extremity, which is also difficult," says Benenati, "when you lose your arm, your hand, touch and everything else." Upper extremities have a lot more movement—from twisting at an elbow to opening and closing digits. "To do that, we put different sensors on a body and train the patient to fire certain muscles all the way up the shoulder, which includes the neck."

Touch Bionic's iLIMB hand makes everyday activities easy for amputees.

One device East Coast Orthotics and Prosthetics commonly uses is Touch Bionic's iLIMB Hand, the world's first commercially available multi-articulating bionic hand. The Scottish company's myoelectric device features ProDigits, self-contained, individually powered fingers, as well as a rotating wrist. "[The iLIMB Hand moved] bionic hand technology from the research and development phase into the real world," says Touch Bionics CEO Stuart Mead.

The hand provides a range of grip patterns not available with other products. Most bionic hands only grip objects between thumb and forefinger. The iLIMB Hand allows amputees to grip objects using all digits. Born without the lower part of her left arm, Lindsay Block of Oklahoma City, Okla., says the range of motion makes a difference.

"[You] don't have to strategize so much about what you do with it because you realize it's not limited and will adjust depending on what it's gripping on to," she says.

Robotic Suits and Bone Implants

As with other prosthetics, patients are taught to fire specific muscles to trigger microsensors in the device and activate the hand though batteries power the bionic device. The industry has come even further with devices that connect sensors directly to nerve endings or the brain itself to control movement with thought. Japan's Cyberdyne® has developed the Hybrid Assistive Limb (HAL)™, a robotic suit that's both voluntary and autonomous. HAL reads the electrical signals sent by the brain to muscles through the skin, generating movement. Each of these movements is then stored as series in the system's database to be generated later as more autonomous motion. Its applications stretch beyond prosthetics to patients with more extensive physical damage, such as spinal cord injuries, ADL, multiple sclerosis or other extremely debilitating conditions.

"Let's say you have a stroke," says Benenati. "You'll have foot drop." Foot drop is the condition where the foot doesn't raise completely and might get caught or drag, which results in self-tripping. People with illness or other conditions that result in foot drop attempt to accommodate the situation by hiking their hips. A device such as HAL can support and help the muscles accomplish everyday motions.

However, the trend that is more likely to be widely adopted first is the use of Osseo implants—prosthetic limbs attached directly to bone. "They are actually implanting hardware within the bone to attach whatever bone [the patient] has left," explains Berger. It's something he believes may replace traditional prosthetist orthotists because Osseo implants require surgery by qualified medical doctors.

Scandinavian countries have had some success but the procedure is not approved for use in the United States due to complications such as device deterioration. German-based Eska Implants may be the first company to enter the American market. The U.S. division, Eska America, recently introduced its Endo-Exo Prosthesis for above the knee amputees at the prestigious American Association for Hip and Knee Surgeons conference, a leading annual meeting for U.S. orthopedic surgeons.

Under development for nine years, the Endo-Exo Prosthesis combines both osseo implants and external prosthesis. Having conducted the first implant surgery seven years ago, Eska Implants now has 48 post-operative patients sporting the Endo-Exo Prosthesis. "No other major orthopedic company has this Endo-Exo prosthesis. It's a unique product," says Uli Henssge, president and CEO of Eska America.

One key to the success of the implant is Eska's patented Spongiosa Metal cast, which is made of a 70% porous cobalt chrome matrix that is electro-magnetically coated with Titanium. Invented 30 years ago by Eska Implants founder Dr. Hans Grundei along with Henssge, the Spongiosa Metal cast doesn't have the same

deterioration issues as other osseo prostheses and is cast out of one piece.

The other key to success is the two-step surgical process. Through experimentation, Eska learned that implanting the device during one surgery was less successful. "The two-step surgery helps prevent infection and other complications," says Henssge. The endo implant surgery is first and then the prosthesis is added 4–6 weeks later, when the surgeon creates the attachment part of the rod. "A patient can literally walk within days of second surgery," Henssge says.

George Stanley, Eska America's director of sales and marketing, believes this is the most significant advance during his 20-year career in the industry.

Cyberdyne's Hybrid Assistive Limb robotic suit allows anyone to become a champion weightlifter.

"One other thing that deserves mention is that orthotic surgeons have done artificial hips, knees and other things for years," he says. "But this is the first thing of its type for amputees. The number of amputees out there that could be candidates could make the hip and knee implants look like nothing."

With amputees able to do so much with traditional prosthetics, one has to wonder if something so invasive is necessary. But the Endo-Exo takes some of the ongoing maintenance out of the equation. "After the surgery, the limb is larger. It's swollen. As you walk and move, the residual limb shrinks. Over three to five months, you'll need a new one," says Benenati. "If you are active, the more active you are, the more you'll need a new prosthesis."

Henssge contends that the Endo-Exo represents a marked improvement in amputees' quality of life.

"It activates and reactivates the muscle in the stump. It actually heals what he's walking on. It allows a patent to feel what he's walking on at every angle—whether it's sideways or at an angle." And, because the device is completely integrated, there's a full range of motion without the bulky encumbrance of a rigid prosthetic socket.

Regardless of the branch of the industry, the doctors and practitioners are inspired by their patients.

"Honestly, what I see is the spirit of people. They have such fantastic attitudes that losing a limb is not going to stop them," says Benenati.

Henssge agrees, reflecting on a patient that accompanied him to a demonstration. "After a 30-hour flight from Germany, they asked him to join them on a hike," he says. "He left many behind."

Gaea Honeycutt is president of G.L. Honeycutt Consulting LLC and a freelance writer.