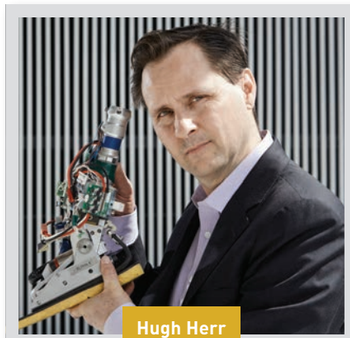
BIONIC LEG PROSTHESES

INNOVATOR Biomechatronics group, MIT Media Lab. Hugh Herr, group leader.

INNOVATION Powered foot-ankle prostheses with multiple tendon-like actuators controlled by multiple onboard computers.

IMPACT Advanced prosthetic limbs may one day enable people to exceed the capabilities of their natural body parts.



Hugh Herr

BIOENGINEERING

POWER PROSTHETICS

Hugh Herr designs bionic legs—including his own.

STORY BY SARA GOUDARZI • ILLUSTRATION BY THOMAS ROMER

Hugh Herr was already a top technical rock climber at age 17 when he set out with a partner to scale Mount Washington in New Hampshire. The two were caught in a blizzard and Herr suffered severe frostbite to his lower legs. Surgeons eventually had to amputate both of his legs below the knee.

"I was fitted with conventional prostheses that were wholly inadequate," Herr recalled, "and I really dedicated my life at that time to improving technology for people with disabilities."

Herr didn't have a rigorous engineering background but he knew his way around the machine shop. After a little tinkering, he designed prostheses especially for ice climbing. Each one weighed as little as a carbon tennis racket—that enabled Herr to pull up less weight and to do more work before experiencing fatigue.

"I was able to climb better after the accident," Herr said. "That experience was really inspirational and led me back to school, into a new realm where I was studying mathematics, science, engineering and loving that."

Today, Herr heads the Biomechatronics group at the MIT Media Lab, where he works to create improved prostheses—both to aid the more than 20 million worldwide who experience limb amputations and to extend human physicality beyond natural innate levels.

Herr has developed bionic limbs, specifically powered foot and ankle prostheses with multiple tendon-like actuators that stiffen and power gait. Each ankle holds three computers that perform various computations enabling one to walk at different speeds across different terrains. They're distinct in the prostheses world because these bionic limbs are powered, while all other foot ankle prostheses are energetically passive.

"You can say that conventional mechanical prostheses are like a bicycle and what I'm wearing is like a motorcycle—the motors actually inject mechanical energy into my walking gait, enabling me to move more efficiently," Herr said.

In effect, he's tried to mimic the mechanism of a natural limb: The human spinal cord receives sensory information from all the muscles and tendons. Then computation is performed on the spinal cord level and muscles are activated based on the sensing and calculation information. The bionic limb is running these spinal-like reflexes on a computer chip.

A commercial product—called emPOWER—is sold through Herr's startup called BioneX Medical Technologies. In the lab, Herr and his colleagues are working on developing neural interfaces, essentially connecting the bionic limbs to muscles and nerves so a person can think and move the limbs and also feel the movement as a feedback into the nervous system.

"The units that I wear day to day is the emPOWER foot ankle system," Herr said. "It is all intrinsic intelligence without the neural control but just in a year or two I'll be neurally linked to my limbs fulltime inside and outside the lab."

Currently, computer-controlled prostheses are more expensive than passive prostheses and run a few tens of thousands of dollars. However, Herr hopes that as they scale the product, manufacturing will become more efficient and the costs will go down, making smart prostheses available to the millions in need. ME

SARA GOUDARZI is a writer based in Brooklyn, N.Y.