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## Biomechatronic Man

By [Lance Ulanoff](#)

July 13, 2004

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The 1970s television shows *The Six Million Dollar Man* and *The Bionic Woman* hold nearly equal positions in the pantheon of pop culture, but their premises have been little more than pipe dreams. That pipe is blowing more than smoke these days, as scientists across the country work on human augmentation robotics technology, also known as *biomechatronics*—in other words, the merging of body and machine.

Following in the footsteps of household robots like the iRobot Roomba and the Sony AIBO entertainment robots, as well as battlefield robots like the iRobot Packbot, robots are now starting to show up on the human body. At MIT's Media Lab in Cambridge, Massachusetts, assistant professor Hugh Herr and his biomechatronics team have spent the past five years developing the Active Ankle-Foot Orthosis (AAFO). Made of plastics, a motor, a microprocessor, and a power supply, this robot can reanimate a paralyzed ankle.

Unlike a prosthesis, an orthosis doesn't replace missing limbs. Instead, it attaches to a paralyzed limb and may eventually enhance healthy ones. The 3-pound AAFO covers the leg from below the knee to the toes and restores natural motion.



The BLEEX project

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Across the country, a team at the University of California, Berkeley, Robotics and Human Engineering Laboratory is working on the Berkeley Lower Extremity Exoskeleton (BLEEX), which fits over the wearer's legs and assists in carrying heavy loads over long distances. It uses sensors, actuators, a network, and complex algorithms to compute the exoskeleton's motion. It's designed to imitate the torque, speed, and motion of a 165-pound person walking.

Homayoon Kazerooni, a Berkeley professor who invented the concept in the early 1990s, says that the prototype can support about 80 pounds in a special backpack. "You simply walk, and it walks with you," he says. The device, funded by the Defense Advanced Research Project Agency (DARPA), has applications in defense, firefighting, and rescue and recovery operations.

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Both devices are several years away from commercial use, and the AAFO will be costly to deploy. But as MIT's Herr sees it, human performance augmentation is the shape of the future:

"In the coming decade we will see body amplifiers that expand human endurance and strength. We will see novel transportation devices that do not rely on wheels, where our own limbs are augmented, where we can traverse very rough terrains with a very high metabolic economy or efficiency. I predict that people for certain situations will not want to use wheels anymore, because their legs, augmented by technology, far outperform wheeled vehicles."

Maybe Lee Majors and Lindsay Wagner were born just a little early.

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