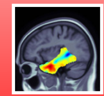
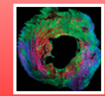
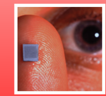
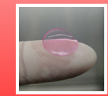
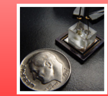
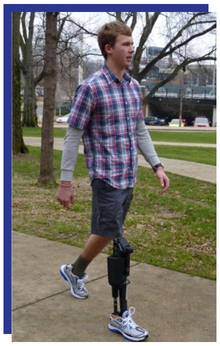
NATIONAL INSTITUTE OF BIOMEDICAL IMAGING AND BIOENGINEERING

Rehabilitation Engineering

National Institutes of Health

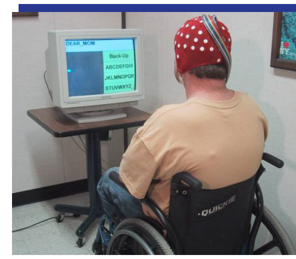
What is rehabilitation engineering?



Source: Michael Goldfarb, Vanderbilt University

Rehabilitation engineering is the use of engineering science and principles to 1) develop technological solutions and devices to assist individuals with disabilities, and 2) aid the recovery of physical and cognitive functions lost because of disease or injury.

Rehabilitation engineers design and build devices and systems to meet a wide range of needs that can assist individuals with mobility, communication, hearing, vision, and cognition. These tools help people with day-to-day activities and tasks related to employment, independent living, and education.



An individual writes sentences with his thoughts using a brain-computer interface system.
Source: The Wadsworth Center, New York State Department of Health

Rehabilitation engineering may involve relatively simple observations of how workers perform tasks, and then making accommodations to eliminate further injuries and discomfort. On the other end of the spectrum, more complex rehabilitation engineering is the design of sophisticated brain computer interfaces that allow a severely disabled individual to operate computers, and other assistive devices simply by thinking about the task they want to perform.

Rehabilitation engineers also develop and improve rehabilitation methods used by individuals to regain functions lost due to disease or injury, such as limb (arm and or leg) mobility following a stroke or a joint replacement.

What types of assistive devices have been developed through rehabilitation engineering?

The following are examples of the many types of assistive devices.

RUPERT: a device for robotic upper extremity repetitive therapy.
Source: Jiping He, Arizona State University

- Wheelchairs; scooters; and prosthetic devices, such as artificial limbs that provide mobility for people with physical disabilities that affect movement.
- Kitchen implements with large, cushioned grips to help people with weakness or arthritis in their hands with everyday living tasks.
- Automatic page-turners, book holders, and adapted pencil grips, that allow participation in educational activities in school and at home.
- Medication dispensers with alarms that can help people remember to take their medicine on time.
- Specially engineered computer programs that provide voice recognition to help people with sensory impairments use computer technology.

How can future rehabilitation engineering research improve the quality of life for individuals?

Robotic training enhances arm motor recovery after stroke.
Source: David Reinkensmeyer, UC Irvine

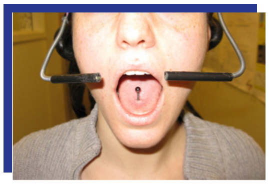
Ongoing research in rehabilitation engineering involves the design and development of new, innovative assistive devices. An important research area focuses on the development of new technologies and techniques for improved therapies that help people regain physical or cognitive functions lost because of disease or injury. For example:

- **Rehabilitation robotics** that involves the use of robots as therapy aids instead of solely as assistive devices. Intelligent rehabilitation robotics aids mobility training in individuals suffering from impaired movement, such as following a stroke.
- **Virtual rehabilitation**, which uses virtual reality simulation exercises for physical and cognitive rehabilitation. Compared to conventional therapies, virtual rehabilitation can offer several advantages. It is entertaining and motivates patients. It provides objective measures such as range of motion or game scores that can be stored on the computer operating the simulation. The virtual exercises can be performed at home by a patient and monitored by a therapist over the Internet (known as tele-rehabilitation), which offers convenience as well as reduced costs.
- **Improved prosthetics**, such as smarter artificial legs. This is an area where researchers continue to make advances in design and function to better mimic natural limb movement and user intent.

- **Increasingly sophisticated use of computers** as the interface between the user and various devices to enable severely impaired individuals increased independence and integration into the community. For example, brain computer interfaces that use the brain's electrical impulses to allow individuals to learn to move a computer cursor or a robotic arm that can reach and grab items.
- **Development of new technologies** to analyze human motion, to better understand the electrophysiology of muscle and brain activity, and to more accurately monitor human functions. These technologies will continue to drive innovation in assistive devices and rehabilitation strategies.

What are NIBIB-funded researchers developing in the area of rehabilitation engineering?

Promising research currently supported by NIBIB includes a wide range of approaches and technological development. Several examples are described below.



The tongue magnet and headset allow an individual to move a computer cursor and operate other devices with the tongue.
Source: M. Ghovanloo, Georgia Institute of Technology

Wireless Tongue Drive System for Paralyzed Patients: NIBIB-funded researchers are developing an assistive technology called the Tongue Drive System (TDS). The core TDS technology exploits the fact that even individuals with severe paralysis that impairs limb movement, breathing, and speech can still move their tongue. Simple tongue movements send commands to the computer allowing users to steer their wheelchairs, operate their computers, and generally control their environment in an independent fashion.

A man guides his wheelchair around an obstacle course using the tongue magnet and headset system.
Source: M. Ghovanloo, Georgia Institute of Technology

Neurostimulation in Individuals with Spinal Cord Injury (SCI) for Recovery of Voluntary Control of Standing and Movement, and Involuntary Control of Blood Pressure, Bladder and Sexual Function: Through the NIBIB Rehabilitation Engineering program, researchers are developing the next generation of high density electrode arrays for stimulation of the spinal cord. The first patient received a current generation electrical stimulator implant in his lower back. The electrical stimulation and locomotor training resulted in the ability to stand independently for several minutes, some voluntary leg control, and regained blood pressure control, bladder, bowel, and sexual function. Three more patients have received this treatment and had similar results.

Smart Environment Technologies: As the population ages, increasing numbers of Americans are unable to live independently. NIBIB-funded researchers are working on creating smart environments that aid with home health monitoring and intervention allowing individuals with health issues to remain safely at home. For example, researchers are analyzing the needs and limitations of Alzheimer's patients to develop automated and reminder-based technologies that can be integrated into the home to help with everyday tasks.

Artificial Hands Capable of Complex Movements and Sensation: Persons with hand amputations expect modern hand prostheses to function like intact hands. Current state-of-the-art prosthetic hands simply control two movements "open" and "close." As a result, NIBIB researchers are developing new artificial hand systems that would perform complex hand motions based on measurements of the residual electrical signals from the remaining muscles of an amputee's forearm. Signals from the muscles (in one project) and nerves (from another project) have the potential to result in much finer control of the fingers in the artificial hand. In addition, one of the teams is working on capturing the sense of touch, so in the future the users will be able to also "feel" what they are holding with their artificial hand.

NIBIB Contacts

National Institute of Biomedical Imaging and Bioengineering
6707 Democracy Blvd.
Suite 200
Bethesda, MD 20892
Phone: 301-496-8859
info@nibib.nih.gov
www.nibib.nih.gov

Office of Science Policy and Communications
Press Office:
Phone: 301-496-3500
Fax: 301-480-1613
nibibpress@mail.nih.gov