Interfacing the Brain with the Computer
By Jonathan Kurowski

Brain-Machine Interfacing (BMI) is a collaboration in which the brain accepts and controls a mechanical device as a natural part of its representation of the body. By reading signals from an array of neurons and using computer chips and programs to translate the signals into action, scientists hope it will be possible for a person suffering from paralysis to control a motorized wheelchair or a prosthetic limb just b thinking about it.

Cyberkinetics of Foxborough, Mass has developed an effective and unobtrusive universal operating system allowing disabled people to control devices using their thoughts. BrainGate uses an implanted neural signal sensor and external processors to allow users to control machinery. The sensor is about the size of a baby aspirin, and contains 100 electrode probes thinner than a human hair. It is implanted in part of the brain responsible for movement, the primary motor cortex. The probes detect the electrical activity of brain cells and relay this through a small wire exiting the scalp to a pedestal on the skull. A cable runs from the pedestal to a cart with computer, signal processors, and monitors, allowing operators to study how well users can control their neural output. Using this product, an unidentified quadriplegic person with a 3 year old spinal cord injury had the sensor implanted in a 3 hour operation at Rhode Island Hospital. The patient experienced no side-effects or problems healing. The study ran for over 2 months, allowing for 20 sessions. The study found that the recipient could immediately adjust neural output in response to commands, and that the computer interface allowed the subject to perform tasks and operate basic computer functions including controlling a cursor, playing Pong with 70% accuracy, and performing multiple tasks simultaneously (controlling a TV while speaking). While these results are preliminary, Cyberkinetics aims to enroll a total of 5 patients between the ages of 18 and 60, each being expected to participate for 13 months, and upon finishing, can undergo surgery to remove the device or choose to participate in future studies, which the first patient opted to do. Their ultimate goal is to link BrainGate to medical devices such as muscle stimulators to give the patient the ability to interact with the world around them.

Another study of BMI is being done at Duke University's Center for Neuroengineering by Dennis Turner, M.D. and Miguel Nicolelis, M.D. In the mid-90's, the duo had begun to insert electrodes into the brains of living rats. After some time, they found that instead of needing to find a specific cluster of neurons that controls a certain motion, they could listen to a small fraction of neurons in the brain, which generate enough information to recognize many different commands. By 2000, the duo had moved to a lab in Duke University, and had invented a system to recognize patterns in monkey brains well enough to let the animals swing a robot arm to the left or to the right with their thoughts, and even squeeze the hand in order to grip something. As the monkey trained, neurons in its brain began to alter their firing patters, and more and more were involved in producing commands. This shows that the brain is assimilating the robot, creating a representation of it in different areas of the motor cortex. Scientists speculate that it is possible that the robot arm begins to feel as much a part of the body as the monkey's own arm.

- Carmena, Jose M., "Learning to control a brain-machine interface for reaching and grabbing by primates." *PloS Biology*, Volume 1, 1-16. 2003.
- Millan, Jdel R. "Noninvasive brain-actuated control of a mobile robot by human EEG." *IEEE Trans Biomed Eng.* 2004 Jun;51(6):1026-33.
- Friehs, GM. "Brain-machine and brain-computer interfaces." *Stroke*. 2004 Nov;35(11 Suppl 1):2702-5. Epub 2004 Oct 14.