Mind Over Matter

Basic science is the underpinning of neurobiologist Andrew Schwartz's breakthrough robotic arm research.

IT'S DIFFICULT TO AVOID HYPERBOLE when describing the work that goes on in Andrew Schwartz's lab. Simply put, he hopes one day to create a robotic arm that people with limited or no movement in their own limbs can control through thought. In the case of the monkeys used in Schwartz's research, their reach no longer exceeds their grasp.

For nearly a quarter of a century, Schwartz—an unassuming but highly respected professor of neurobiology at the School of Medicine—has studied the ways in which the brain and central nervous system control motor movement. To date, that research has led Schwartz to what he calls "a good idea" of how many variables forming the reaching movement are represented in the motor cortex section of the brain.

"In fact, it's so good that we think we can extract the path of the arm as it moves through space through these neuro-signals," he says.

It's a breakthrough that, if perfected, could one day radically change the lives of people afflicted with paralysis or the loss of a limb.

By translating the neurosignals into a command that moves a robotic arm, Schwartz's team has been able to train monkeys with restrained limbs to use the robotic arm to reach successfully for a piece of food and grab it. This breakthrough, along with a video demonstration of the activity, received international media attention this past year.

"He modulates the activity through his brain the same way as if he was moving his own arm, but we intercept that," says Schwartz of the monkey.

As the neurons in the primary motor cortex fire, they sense movements in different directions. For each arm movement, for instance, thousands of motor cortical cells change their firing rate. That signal, together with signals from other brain structures, then travels through the spinal cord to reach the muscles and prompts the movement.

In Schwartz's research, tiny probes are inserted into the motor cortex to pick up these signals, which are interpreted through computer software using a specific algorithm and then sent to the robotic arm, which carries out the actions that the monkey wants to perform.

Pieces of the technology—specifically, the math that supports the interpretation—have been patented with the help of the Office of Technology Management (OTM). As the research continues to develop, Schwartz says he hopes commercialization will play a greater role.

He currently is writing a proposal for a neuroengineering center with the objective of overcoming the obstacles that currently block the use of the technology in humans. Toward that end, Schwartz says he would like to collaborate with industry partners and modify existing devices for human use, something that he acknowledges the OTM will help him to do.

"Right now, people are working all over the world on this problem," he says. "It's a pretty hot field right now—actually, explosive. A lot of people are entering the field, and there is a major investment by universities in neuro-engineering programs."

Schwartz is the senior researcher on the project, which is conducted with the help of several grants, including those from the National Institutes of Health, Defense Advanced Research Projects Agency (DARPA), and the Whitaker Foundation. Though the team must overcome a number of hurdles before it produces a practical medical device, human trials for a simplified version are under way.

"The idea is to build infrastructure at Pitt for more elaborate experiments as the technology becomes more mature," explains Schwartz. "We're one of the leading places for it right now, so I'm pretty optimistic. And we have a good reputation for doing things in a rigorous way; we try to deliver on what we say."

Though the project itself may seem futuristic, Schwartz says the basic science behind the problem initially sparked his attention. "I look at the brain and nervous system as a complex system," he explains. "The brain hasn't really been approached that way, but I'm fascinated by how things come together to work. If you look at the way movements are produced, there is a certain structure to the movement."

Once those characteristics are studied, Schwartz says, "You ask: How does the brain make that happen? It's scientific discovery. To anyone who likes to solve puzzles, it's the same thing—it's just a lot slower."

He laughs and then adds, "Before, we sort of did this in obscurity. It's somewhat satisfying to see that people think it's as exciting as we do."