COGENCE OF THE RODENTS

"This is Your Captain Squeaking..."

Rat brain cells can be programmed to fly planes and sense epileptic seizures. Here's a look at how they might influence software development.

By **Michael Behar**

Illustration by **John Ueland**

EVEN WITH THEIR mounting financial issues, it's unlikely the airlines will be replacing their pilots' unions with hordes of rats anytime soon. Still, that possibility took a tiny step closer to reality recently in University of Florida biomedical engineering professor Thomas DeMarse's lab when he trained rat brains to fly a plane.

Only DeMarse went one step better: He did it without a corporeal rat. Instead he cultivated brain cells from rats in a petri dish lined with a multi-electrode array. About the size of a quarter, the array consists of 25,000 rat neurons germinating from electrodes that can send and receive data to an F-22 Stealth Raptor flight simulator. By stimulating certain sequences of neurons and muting others, DeMarse was able to "teach" the brain cells to maneuver the fighter and react to minute changes in the F-22's pitch, roll, and yaw as it cruised through virtual airspace.

Perhaps sensing the salivation from Pentagon officials, DeMarse is quick to point out that his experiment has nothing to do with training rats to carry out bombing raids over Baghdad. "Of course you'd never have

living neurons doing this," he says. "You have to feed them, they get infected, and they are very temperamental." The purpose, he continues, is to unravel the complex mechanisms that govern how neurons—rat or human, which are essentially the same—record, analyze, and relay information. "Once you learn how these computations work," says DeMarse, "you can extract the rules and apply them to a hardware or software system."

One such application might be to implant a matrix of electrodes into the brain of an epileptic patient to help control seizures. To that end, DeMarse has induced epilepsy in a live rat (by making tiny incisions in its brain) and implanted electrodes beneath its skull to watch how neurons behave during a seizure. Eventually DeMarse will have enough data to create a software algorithm that could instantly neutralize the epileptic signals the moment they appear. "You could use the electrode arrays with a [software] system that recognizes when the brain is about to seize and send in a stimulus before the seizure ever happens," he says.

DeMarse's software approach to tackling epilepsy someday could become one of many tasks relegated to computers. In the meantime, scientists are making use of brain-computer interfaces to help those with disabilities. John Chapin, a professor of physiology at State University of New York, has trained rats to operate a robotic arm via brain implants. The intent is to build a device that lets paraplegics maneuver a prosthetic with their own brainwaves—or even control their own arms by using the implant to stimulate paralyzed muscles.

At the New York State Department of Health, Jonathan Wolpaw and his team have developed a system that uses an external scalp-recorder to harness the brainwaves of a person with spinal-cord injuries to control a computer cursor. For the most severely paralyzed, Wolpaw foresees an increasing demand for brain-computer interface technologies "because life-support technology is keeping alive [people] who, in the past, would have died," he says.

The intent is to build a device that lets a paraplegic maneuver limbs with their own brainwaves.

Hurdles remain. "There are a whole host of things the brain is great at doing that computer algorithms right now aren't good at," notes DeMarse. The trick, he says, is to translate neural missives into a language that computers can understand and reproduce.

"We're still at a pretty early stage," says Wolpaw. Yet he's optimistic: "We now have very powerful, fast, real-time software and hardware that can handle the analysis and the feedback necessary for these devices. That equipment didn't exist—or was really expensive—10 or 20 years ago. And we know a lot more about the brain than we did several decades ago, so we understand better how to design such devices."