interior to be able to fabricate reinforcing beams and other structures that can be assembled robotically.

"The main challenge is building the robot so that it can withstand high radiation and navigate irregular terrain," says Tim Denmeade of Red Zone Robotics, a Pittsburgh-based firm collaborating on the project.* The warren of rooms beneath the reactor hall is littered with at least 10 tons of equipment-fouling dust and 2000 tons of twisted steel, concrete, and plumbing debris. But the thorniest problem is radioactivity: In room 305, radiation levels exceed 3500 rads per hour, enough to deliver a lethal dose in minutes. Most materials, lubricants, and electronics will succumb in short order when exposed to such intense radiation. Indeed, says Holliday, after the explosion "the West sent over robots that just weren't made for that environment, and they failed."

Pioneer is designed to fare better. Chernobyl engineers will steer the 450-kilogram robot, which resembles a small bulldozer, through the rubble by remote control. Along the way, Pioneer will bore into the concrete walls and floors of the reactor rooms to measure their structural integrity, using a sensor to measure resistance to the drill bit and thus calculate the material's hardness. Other sensors will generate three-dimensional (3D) profiles of temperature, humidity, neutron flux, and gamma radiation flux. And a digital 3D imaging system, using three radiation-hardened video cameras aimed by a remote computer, will create range maps using algorithms originally developed for NASA's Mars Lander.

"We're going to be at the very edge of what we can do," says Geb Thomas, an industrial engineer at the University of Iowa, Iowa City, who oversees the image processing system. If the imaging system performs well, he says, it will be used in NASA's Mars 2001 mission.

Pioneer's first test will come in August, when it runs through a mock-up of the Chernobyl reactor hall, sans radioactivity, that Red Zone is building. If that simulation goes well, Pioneer could be plumbing the heart of the sarcophagus by November.

–Joseph Alper

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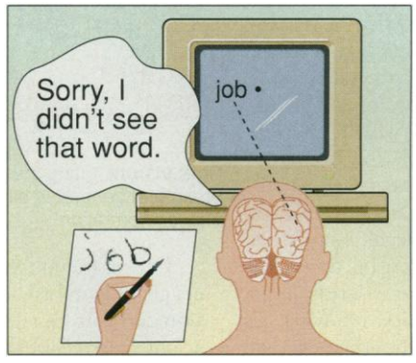
* Other participants include Silicon Graphics and NASA's Ames Research Center, both in Mountain View, California; the Jet Propulsion Laboratory in Pasadena, California; Carnegie Mellon University's Robotics Engineering Consortium in Pittsburgh; the University of Iowa, Iowa City; and the Ukrainian National Academy of Sciences.

NEUROSCIENCE

Writing, Speech Separated in Split Brain

Like unruly children in a noisy classroom who shout answers and pass notes from one side to the other, neurons in the brain are constantly chattering. When it comes time to see just who can do what, it helps to stop the cross talk and test individuals. Neuroscientists can't yet examine single neurons in living people, but on page 902 researchers describe a case where they have in effect isolated one side of the "classroom" from another—and made some surprising discoveries about how the brain organizes the components of language.

By studying an epileptic patient whose brain was surgically divided to control her seizures, Kathleen Baynes, a cognitive neuroscientist at the University of California, Davis, and her colleagues found that the centers for speech and writing, long thought to be in the same side of the brain, can reside in different hemispheres. It's hard to generalize from this single case. But the findings suggest that spoken and written language can develop separately, and may lead to a new understanding of learning disorders.



Reader's block. V.J.'s left brain didn't see the word, so she couldn't name it.

"The typical view is that all the components of language hang together on the same side of the brain," says Alfonso Caramazza, a cognitive neuropsychologist at Harvard University. "This shows that you can take them apart."

The patient, V.J., had suffered severe seizures. By cutting her corpus callosum, the fibrous portion of the brain that carries messages between the hemispheres, surgeons hoped to create a firebreak to prevent the seizures from spreading. The operation did decrease the frequency and severity of V.J.'s attacks. But V.J. developed an unexpected side effect: She lost the ability to write at will, although she could read and spell words aloud.

To explore what had happened, the researchers tested which skills each side of her brain could perform. For example, when they showed words and pictures to V.J.'s left hemisphere (by flashing them in her right visual field), she could read and name them aloud, but she couldn't write the corresponding words. The researchers concluded that her left hemisphere controls speech and reading, but not writing.

In contrast, when words were displayed to V.J.'s right hemisphere, she could write them—although not as well as before surgery—but she couldn't read them aloud. Nor could she write or name the word for a picture. Thus it seems that her right hemisphere controls writing, but not reading, speech, or the neural functions that allow people to find the right word for an object.

"Here's someone whose right hemisphere has all the motor information for controlling writing, but it's useless to her even for simple activities like making a grocery list," says Baynes. "She can't look at an empty butter dish and write 'butter' because her right hemisphere can't make the connection between butter itself and the word. Her left hemisphere might know that she needs butter, but it can't write that down."

It's difficult to know how far to extrapolate from one person, particularly someone with a history of seizures, cautions Baynes. Indeed, the brain organization of V.J., who is left-handed, differs markedly from that of the few other split-brain patients studied; they retained the ability to write and speak in one hemisphere and completely lost it in the other.

Still, neuroscientists are intrigued. "The fact that it's possible [to separate speech and writing] means that the brain is made up of a mosaic of autonomous parts," says Caramazza. "If it were a completely integrated system, you couldn't move writing from one hemisphere to the other—even in one person."

This insight has implications for learning disorders and language development. "To understand dyslexia, people want to figure out the connection between oral and written language skills," says Richard Ivry, a cognitive neuroscientist at the University of California, Berkeley. This work shows that "the writing system is not necessarily scaffolded on top of the phonological system." Moreover, the fact that spoken and written language are not linked supports the idea that they evolved independently, says Baynes. Indeed, in V.J.'s brain at least, the side passing notes carries on independently from the side calling out the answers.

–Evelyn Strauss

Evelyn Strauss is a free-lance writer in San Francisco.