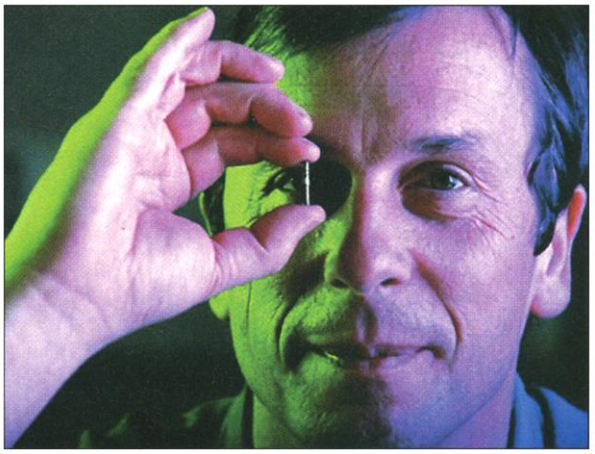
NEWS

Part Man, Part Computer: Researcher Tests the Limits

Kevin Warwick plans to connect a computer chip to the nerves in his arm to see if a computer can read and communicate signals directly from his nervous system. Are computer-controlled humans next?

By the end of this month, Kevin Warwick hopes to be a cyborg. If all goes as planned, in late February the University of Reading, U.K., professor of cybernetics will have surgery to connect nerves in his arm with wires leading to a "smart card"–sized collection of microprocessors. The wires will pick up signals from his central nervous system and relay them via a radio transmitter to an external computer that will record the patterns. Warwick hopes the device will pick up discrete signals from the nerves depending on his movements, his sense of touch, and even his mood, and then send those signals back to his nerves to see if they can mimic the movement or the sensation. Warwick's wife plans to have a similar implant so the two can try to communicate through computer-mediated signals.



One small step? Kevin Warwick, here with his first computer chip implant, plans to become the first computer-enhanced person.

For decades, science fiction writers have imagined beings who are part human, part machine—Robocop, for instance. In the nonfiction realm, cochlear implants have restored hearing to deaf patients, and computers that sense brain waves have enabled paralyzed patients to communicate (*Science*, 29 October 1999, p. 888). But as far as Warwick knows, this is the first time anyone has attempted to computer-enhance the nervous system of a healthy human. Some scientists doubt Warwick will succeed, and others call the effort unethical. But Warwick says the potential benefits of computer enhancement outweigh the risks, and he is eager to debate just how far the technology should go.

Warwick first made headlines in 1998 when he had a much simpler device implanted into his arm. Like a built-in security badge, this computer chip allowed sensors in his lab building to detect his location and movements. With the new device, Warwick is aiming for much more. He hopes the computer will detect patterns of electrical signals that correspond to movements or sensations: the bending of his index finger or the pain of a pinprick, for example. In one experiment, Warwick hopes to send those signals to a robot. By trial and error, he hopes he can learn to remotely control the robot by simply moving his finger.

Animal experiments suggest that goal is realistic. Several groups, including those of neuroscientist Miguel Nicolelis at Duke University in Durham, North Carolina, and Andrew Schwartz at the Neurosciences Institute in San Diego, have been able to program robot arms to crudely mimic the movement of a monkey's arm based on patterns in the animal's brain waves. Warwick is curious to see whether the computer chip can "play back" such signals, triggering his arm to move involuntarily or tricking him into thinking his finger has been stuck.

The bundle of nerves that runs down the arm, called the median nerve, also communicates with the body's limbic system—for example, making our palms sweat when we're nervous. Warwick will attempt to record the signals produced by shock or anger, then have a colleague try to send them back to the implant when he is calm—and unsuspecting—to see if they have an effect.

If the initial experiments go well, Warwick's wife, Irena, will receive her own implant a few weeks later. The pair will then attempt to send nerve-mediated messages—emotional or otherwise—through their computer connection. If Warwick cuts his finger while slicing a bagel, for instance, the chip should record the signal from his medial nerve and then send it to a computer that communicates with his wife's implant, adding new meaning to the phrase "I feel your pain."

Warwick and others in the cybernetics community envision a world in which humans are able to expand their senses to hear ultrasonic sounds or see infrared wavelengths. "It's tremendously exciting. Can we in the future link extra memory into our brains? Why shouldn't we do something like that?" he asks.

Such questions are premature, says Peter Fromherz of the Max Planck Institute for Biochemistry in Martinsried, Germany. "Warwick is a very interesting person. But what he's doing is scientifically crazy," he says.

For 15 years, Fromherz has been working on experiments that join single neurons and computer chips, with the goal of enabling researchers to build better computer-enhanced prosthetic devices. In a paper published 1 November in the *Proceedings of the National Academy of Sciences*, his team described a nerve-computer circuit consisting of snail neurons and a computer chip. The circuit was able to send a discrete signal from a computer chip to a neuron, from that neuron to a second neuron in a network, and from the second neuron back to the computer chip. On a cellular scale, Fromherz's work is state of the art, but it is a long way from computer-synthesized emotions, he notes.

Others think Warwick's experiment should not be allowed to proceed. (It does not require permission from a formal ethics board, as Warwick is experimenting on himself.) Political scientist Langdon Winner of Rensselaer Polytechnic Institute in Troy, New York, for one, calls the experiment "profoundly amoral. Enhancing one's information-processing ability by connecting chips to the nervous system marks a very fundamental change in what human beings are." Should it become possible, he says, "then it is a matter for theologians, politicians, and citizens to address."

And that's the debate Warwick hopes to spark, much as the birth of Dolly fueled the debate over cloning. Although he sees great benefits from computer enhancement, left unchecked, the technology also has great potential for harm, he says. For example, if the computer is able to prompt Warwick to move his arm involuntarily, then that suggests that a computer could someday remotely control a person instead of the other way around—a troubling prospect, he concedes. "If you're creating superhumans," Warwick says, "that could mean the end of humanity." And even this cyborg hopeful thinks that's a question that humans, not computers, should decide.

—GRETCHEN VOGEL

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