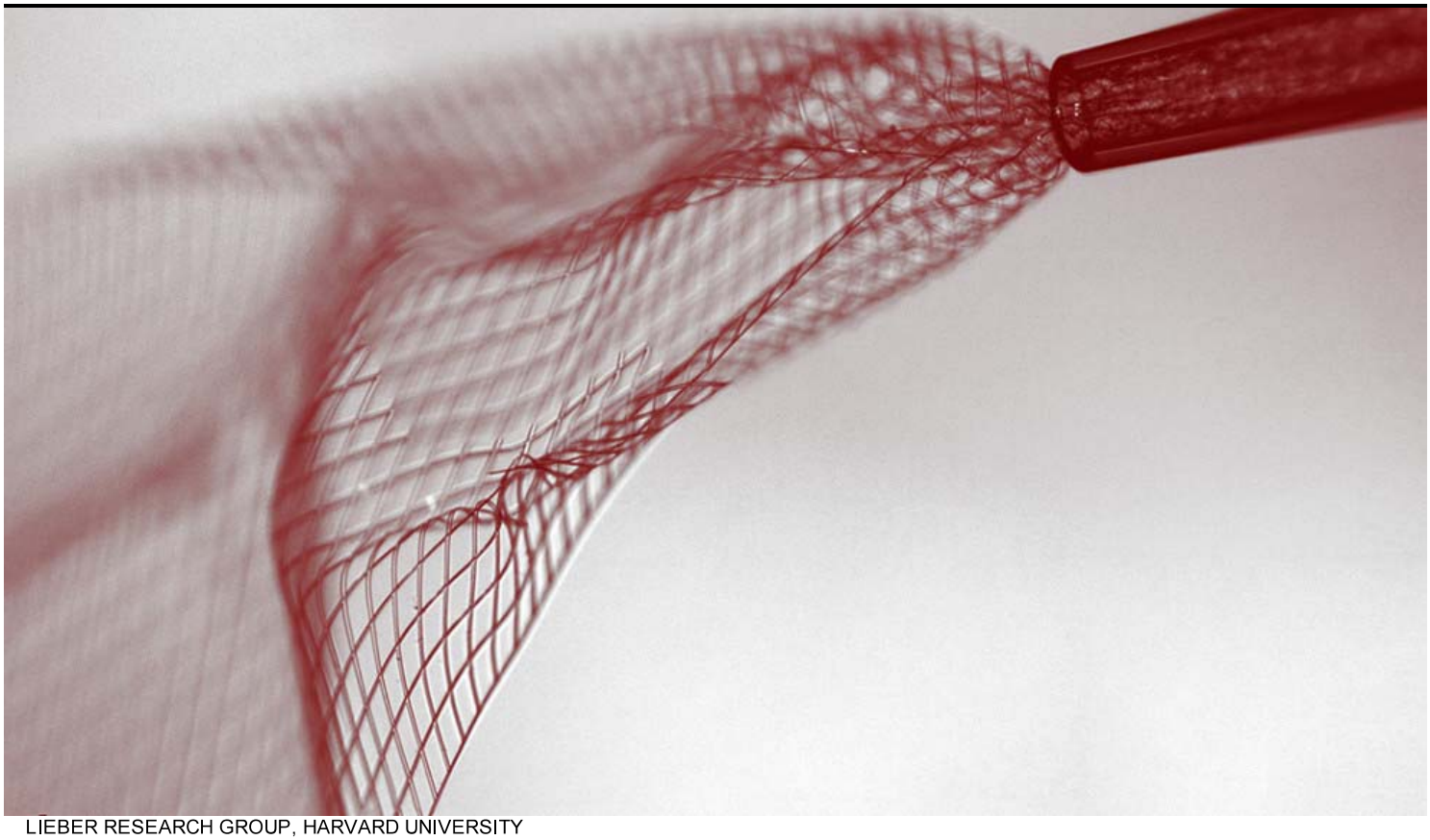

LIEBER RESEARCH GROUP, HARVARD UNIVERSITY
New mesh electronics, shown here emerging from the tip of a syringe, could one day be implanted directly into the brain.

GORY DETAILS: 1 day ago

Injecting Electronics Into Brain Not as Freaky as it Sounds

by Erika Engelhaupt

No need to wait for the cyborg future—it's already here. Adding to a growing list of electronics that can be implanted in the body, scientists are working to perfect the ultimate merger of mind and machine: devices fused directly to the brain.

A new type of flexible electronics can be injected through a syringe to unfurl and implant directly into the brains of mice, shows a study published Monday in *Nature Nanotechnology*. Researchers injected a fine electronic mesh and were able to monitor brain activity in the mice.

"You're blurring the living and the nonliving," says Charles Lieber, a nanoscientist at Harvard and co-author of the study. One day, he says, electronics might not only monitor brain activity but also deliver therapeutic treatments for Parkinson's disease, or even act as a bridge over damaged areas of the brain. Deep brain stimulation is already used for Parkinson's, but uses relatively large probes, which can cause formation of scar tissue around the probe.

The tiny size (just a couple of millimeters unfurled) of the new devices allow them to be placed precisely in the brain while minimizing damage, a separate team of Korean researchers note in an accompanying article. Ultimately, the goal is to interweave the electronics so finely with brain cells that communication between the two becomes seamless.

And that's just the latest in the merging of electronics into the human body. While Lieber envisions using the implants in science and medicine—for example, to monitor brain activity and improve deep-brain stimulation treatment for Parkinson's disease—others are already using non-medical electronic implants to become the first generation of cyborgs. These do-it-yourselfers call themselves biohackers, and they aren't waiting for clinical trials or FDA approval to launch the cybernetic future.

At the website Dangerous Things, you can buy a kit—complete with syringe, surgical gloves and Band-Aid—to inject a small electronic device into your own body. The kits use a radio-frequency ID tag, or RFID, similar to the chips implanted to identify lost dogs and cats. These can be scanned to communicate with other devices. The site warns that implanting the chips should be done with medical supervision and "is strictly at your own risk."

An X-ray image of Amal Graafstra's hands shows the two electronic tags he had implanted. Image: Dangerous Things

The website's charismatic founder, Amal Graafstra, has RFID implants in each hand, and can use them to unlock doors and phones, log into computers, and start his car by waving a hand.

"One of the holy grails of biohacking is the brain-computer interface," Graafstra says. He likens brain-wiring efforts so far to eavesdropping on neural activity with a glass to our ears and then shouting back with a bullhorn; electronics simply overwhelm the subtle communication between brain cells. "The ultimate goal, I think, would be a synthetic synapse," he says, in which nanomaterials would function much like living brain cells, allowing far more nuanced communication between mind and machine.

An article in the *Telegraph* in October 2014 sums up today's state of the art in brain-hacking:

> "Quietly, almost without anyone really noticing, we have entered the age of the cyborg, or cybernetic organism: a living thing both natural and artificial. Artificial retinas and cochlear implants (which connect directly to the brain through the auditory nerve system) restore sight to the blind and hearing to the deaf. Deep-brain implants, known as "brain pacemakers," alleviate the symptoms of 30,000 Parkinson's sufferers worldwide. The Wellcome Trust is now trialling a silicon chip that sits directly on the brains of Alzheimer's patients, stimulating them and warning of dangerous episodes."

The goal of a complete merger of biology and technology is exciting to champions of transhumanism, which aims to enhance human intelligence, abilities, and longevity through technology.

But not everyone is thrilled about a future filled with genetic engineering, artificial intelligence, and cyborg technology. Implanting electronics in the brain, more so than in the hands or even the eye, goes directly to one of the biggest fear about cyborgs: a threat to free will. Could someone hijack an implant to control its user's thoughts or actions? Or to read their minds?

That's unrealistic, at least with current technology. The kinds of electronics that Lieber and others are working on have inherently limited use—such as delivering a small electric pulse to a particular spot—and would be useful only to people with a serious medical condition.

"Some people think we're going to implant a microprocessor in people's heads," Lieber says, "but that has to interface to something." And a tiny electronic device attached to one part of the brain simply cannot take over a person's thoughts. "There's always going to be someone interested in doing something bad," he adds, so it's important to monitor the technology as it becomes more sophisticated.

Graafstra says biohacking has "some maturing to do," and studies like Lieber's are a good step in bringing scientific rigor to what has at times been a Wild West.

"I think the biohacker understands that we are our brains," he says. "You are your mind, and the body is the life support system for the mind. And like an SUV, it's upgradeable now."

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