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Making Computers Based on the Human Brain

How the biology of gray matter is having an increasing influence on computer design

By Steve Hamm

When Lloyd Watts was growing up in Kingston, Ont., in the 1970s he had a knack for listening to songs by Billy Joel and Elton John and plunking out the melodies on the family piano. But he wondered, wouldn't it be great to have a machine that could "listen" to songs and immediately transcribe them into musical notation? Watts never built the gizmo, but his decades-long quest to engineer such a machine has finally resulted in one of the first commercial technologies based on the biology of the brain.

Microchips designed by Audience, the Silicon Valley company Watts launched, are now being used by mobile handset makers in Asia to improve dramatically the quality of conversations in noisy places. Even a truck passing right by someone using the technology won't be heard at the other end of the phone line. The chip is modeled on functions of the inner ear and part of the cerebral cortex. "We have reverse-engineered this piece of the brain," declares Watts.

The 47-year-old neuroscientist is on the leading edge of what some believe will be a fundamental shift in the way certain types of computers are designed. Today's computers are essentially really fast abacuses. They're good at math but can't process complex streams of information in real time, as humans do. Now, thanks to advances in our understanding of biology, scientists believe they can model a new generation of computers on how the brain actually works—the microscopic chemical interactions and electrical impulses that translate sensations into knowledge and knowledge into decisions and actions. It's a successor to the old ideas about artificial intelligence, and a handful of companies have initiatives under way, among them IBM (IBM) and Numenta, a Silicon Valley startup.

Scientists caution that the changes won't come quickly. "The nervous system is very sophisticated, but I applaud what they're doing. Eventually we'll figure it out," says Carver Mead, a microelectronics pioneer and professor emeritus at the California Institute of Technology.

In one of the most ambitious efforts along this track, IBM was scheduled to announce on Nov. 20 a $4.9 million grant from the Pentagon's Defense Advanced Research Projects Agency for research into creating intelligent computers. The money funds the first phase of a multiyear effort to engineer computing systems that simulate the brain's activities while rivaling its compact size.

SMARTER CIRCUITRY

The government says it will use the results to design battlefield monitoring systems that detect threats and warn troops. Dharmendra Modha, manager of cognitive computing at IBM Almaden Research Center in San Jose, foresees a wide variety of applications, from security monitoring to detecting worrisome climate changes or predicting disastrous storms. "We're creating a planet that is covered with sensors," he says. "We need a global brain-like device to aggregate, integrate, and make sense of all this data—and respond if appropriate."

The mind behind Numenta, Jeff Hawkins, has a long record of inventions, including the first successful handheld computer, the PalmPilot, and the first successful smartphone, the Handspring Treo. But for more than two decades his real passion has been figuring out how the cerebral cortex works and applying that knowledge to computers. Hawkins hopes to produce a software toolkit for product developers next year that will allow them to mimic the way humans process visual imagery. Uses could include medical imaging, security monitoring, and Web search. "We're laying the

foundation for a second wave of computing," says Hawkins.

Hamm is a senior writer for BusinessWeek in New York and author of the Globespotting blog.