Machine Peels Brain, So Scientists Can Map Synapses

It slices, it dices and it heralds the arrival of a new era of neuroscience that focuses on industrializing the process of mapping the brain.

It's a neuroscience gadget called the automatic tape-collecting lathe ultramicrotome (ATLUM), and the name says it all. An ultramicrotome is a piece of laboratory equipment that cuts samples of flesh into very thin slices. The lathe allows the machine to cut continuously, which makes the process faster. Already, the prototype has collected more than a hundred half-centimeter-long sections of mouse brain.

Once the slices have been stuck onto a piece of transparent tape, the scientists use a scanning electron microscope to actually image the cells. Harvard molecular biology professor Jeff Lichtman's lab partnered with optical equipment company JEOL to automate the process of imaging and ordering those images.

"We will go to each section of tissue that the ATLUM has deposited and identify the region of that section that contains the important information, like the wiring of the neurons," said Charles Nielsen, a product manager and vice president at JEOL. "Then we'll do a series of montage maps on each section."

The technological hurdles of stitching together thousands of images (each 5,000 x 4,000 pixels) into a 3-D reconstruction of the brain is daunting. The team wants to complete the mouse-brain reconstruction in four years, but to hit that goal, Nielsen said the team would need up to 10 more electron microscopes to speed image taking.

"In the old days, we'd make an injection and see a few cells light up, and that was that," said Michael Huerta, associate director for scientific technology research at the National Institute of Mental Health. "But as areas in science mature, they get to the point where they are generating huge amounts of data: in this case, data about connectivity in tissues."

Better image-recognition technology, which turns photographic images into information that computers can use, could also increase the speed at which pictures of the brain are transformed into wiring diagrams.

"If our computers could automatically identify the synapses in the images, and trace axons and dendrites to their parent neurons, then they would be able to generate brain-wiring diagrams," said Sebastian Seung, a computational neuroscience professor at MIT. "Although we have made progress, we are still far from making computers 'smart' enough to do this reliably. This is a challenge at the frontier of computer science and artificial intelligence."

This article was written By Alexis Madrigal at www.wired.com.