From knee to neuron, offspring of Yale's 3D printers multiply

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The Yale Center for Engineering Innovation and Design has produced a model of a lone neuron (pictured) using its 3D printers. “We see a future in which 3D models of nerve cells will be an integral part of doing research and of teaching neurobiology,” said Gordon Shepherd, professor of neurobiology at the Yale School of Medicine.

(Phys.org) —Yale neuroscientist Gordon Shepherd has studied neurons for decades. But until recently he'd never had a neuron he could grasp with his own two hands: Neurons are much too small.

Now he's got his very own 3D neuron in all its spidery glory, a vastly

enlarged but precise replica that is the latest custom-made anatomical model to emerge from the Yale Center for Engineering Innovation and Design (CEID). The model neuron is believed to be the first made with a 3D printer.

"Brain microcircuits have a very complicated 3D architecture," said Shepherd, a professor of neurobiology at the Yale School of Medicine and author of "The Synaptic Organization of the Brain," a classic in the literature of neurobiology. "The model will give us unprecedented appreciation of this architecture. It's like being with someone versus having just a picture."

Last spring the CEID produced a model of a diseased human knee, along with the tumor eating it away. Inspired by that project (the brainchild of Yale radiology resident Mark Michalski) Shepherd inquired about the possibility of making a neuron.

Enter Joseph Zinter, the CEID's assistant director, and Yusuf Chauhan, a full-time design fellow there, who together produced the 3D knee. The neuron's tendril-like structure seemed to them a shape ideally suited for 3D printing.

"The wild, seemingly haphazard geometry of a neuron, with its cell body, delicate branches of dendrites, and long fibers make it nearly impossible to fabricate by conventional means," Zinter said. "But 3D printers can easily handle these types of complex geometries. They're the ideal technology for this kind of project."

Unlike drilling, cutting, and milling, which strip away raw material to create an object, 3D printers add material—exactly and exclusively where it's needed to form the desired object.

Shepherd's lab team prepared 3D digital images of a specific mouse

neuron—one among millions. Zinter and Chauhan then converted the data into a language readable by the CEID's printers and set them to work. Within a day Shepherd beheld a hugely magnified but otherwise precise replica of a murine mitral cell, or mouse olfactory neuron. Made of plastic, it measures 4.25 inches high by five inches wide, thousands of times larger than the real thing.

"We've been inspecting it from every angle and comparing it with experimental data, " said Shepherd, who has already presented it to groups of other scientists. As best he can tell, they seem awed, he said.

"There was a bit of a stunned silence when I pulled the model from its box and held it up for all to see," Shepherd said of a presentation at Yale. "There definitely seems to be something unexpected about seeing a nerve cell in this new guise for the first time."

That's what Zinter likes to hear.

"In addition to being used for the fabrication of models, prototypes, and usable parts, 3D printing allows for the visualization of information in new and exciting ways," he said. "This neuron is a perfect example. Professor Shepherd's neuron data is now a tangible three-dimensional object. The ability to interact with information in an additional dimension, whether it's a microscopic neuron or a patient's CT scan, will lead to new insights and discoveries. Researchers are still on the cusp of how to best use 3D printing technology."

Shepherd already has plans for 3D prints of more intricate neural networks. "We see a future in which 3D models of nerve cells will be an integral part of doing research and of teaching neurobiology," he said.

Scientists contributing to the 3D neuron project include Michele Migliore, a professor at the Institute of Biophysics, Palermo, and a

graduate student there, Francesco Cavarretta; and Michael Hines and Tom Morse, research scientists in Yale's Department of Neurobiology.

Provided by Yale University