

Not Your Ordinary 'Toons

Developing interactive science animations, a scientist at Bowdoin shows that innovations in teaching can be used in research—instead of the other way around.

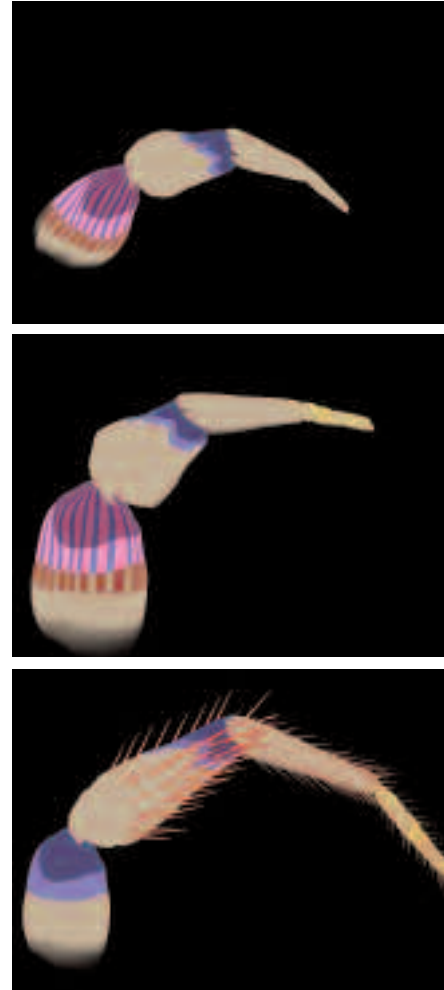
MIDWAY THROUGH THE ANIMATION, Carey R. Phillips points to his computer screen. “There,” he says, as flecks of yellow appear at the tip of an insect’s developing leg. “These areas show where genes for limb formation are being expressed at this point in time.”

What started as a flat disc of single cells has divided, multiplied, and rearranged itself to create the likeness of a three-dimensional leg bud. As yellow splotches appear briefly, a second segment sprouts from the tip of the growing limb. And as the object telescopes outward to form an eerily lifelike, multi-segmented leg, other colored patterns—red, blue, green—emerge and fade. The colorful stains illustrate carefully orchestrated patterns of gene expression, part of the process of ensuring that each segment of the limb develops properly. Students can rotate the developing model, fly through it, or even “meet” other students within the model and discuss it, all in real time.

This virtual reality model is just one of several interactive programs created by Phillips and his students at Bowdoin College that take viewers—via animation and virtual reality—through the insides of organs and cells, as a way to help them

visualize biology in action. Based on real-world data that students have gathered during long hours peering through a microscope or from reviewing the scientific literature, the animations simulate complex biological processes such as cell division and cell signaling. The animations help students to visualize difficult-to-grasp scientific constructs.

But viewing these animations is no passive experience. With funding from HHMI, Phillips has been developing new ways to use virtual reality to create worlds in which students interact with the objects under study. In one virtual world, for example, students enhance the virtual model by “painting” new information on it, adding data gathered from their own research or from published findings. With such tools, Phillips says, students can readily experiment with modeled processes under various conditions and can view com-



RIGHT _ ANIMATION CAN BE AN EFFECTIVE TOOL FOR VISUALIZING BIOLOGY IN ACTION. THIS SERIES OF STILLS, TAKEN FROM A STUDENT-GENERATED VIRTUAL REALITY MODEL, SHOWS A SNAPSHOT ALONG THE DEVELOPMENTAL TIMELINE OF AN INSECT'S LEG. BANDS OF COLOR MARK THE CHOREOGRAPHED CHANGES IN GENE EXPRESSION AS THE LEG DEVELOPS FROM A FLAT DISC OF CELLS TO A THREE-DIMENSIONAL LIMB.

COURTESY OF KRISTINE FURIC / CAREY PHILLIPS LAB

HUMAN BRAIN PROJECT



CAREY PHILLIPS

Carey Phillips is in the process of translating his animation techniques to a larger scale. This past year, Phillips and collaborators at the University of Tennessee and the University of Florida received a \$4 million grant from the National Institutes of Health to create a visualization tool for the Human Brain Project. They plan to do magnetic-resonance-imaging scans of mama mouse throughout her pups’ development, using motion sensor-type technology to track key points in their brains as they grow. The team will then apply the acquired data to build a three-dimensional model of the developing mouse brain, ultimately allowing viewers to observe its tissue layers as they grow. “We will then use the same technology we developed for teaching,” Phillips says, “creating tools allowing researchers to log their gene expression data and interactively visualize any combinations of spatial/temporal data stored in the database.”

“The NIH award demonstrates very directly,” Phillips says, “how innovations in teaching can be used in research, instead of always thinking about it the other way around.”

Ultimately, Phillips plans to create a framework that would allow researchers to contribute new findings to the model of how genes, proteins, and other molecules interact in the developing brain. “We’ll set up an interface so that people from anywhere in the world can enter their data,” he says. “Ideally, it could become a national archive as well as a research tool.” —S.G.

FOR MORE INFORMATION

www.bowdoin.edu/news/archives/1/bowdoincampus/001189.shtml

COURTESY OF CAREY PHILLIPS



ABOVE_ SEEING HOW TISSUES MOVE THROUGH SPACE AND TIME THROUGH VIRTUAL REALITY MODELS AND ANIMATIONS GIVES STUDENTS A BETTER GRASP OF HOW THE BODY DEVELOPS. EVEN IN THIS CAPTURED FRAME, THE RED BLOOD CELLS APPEAR POISED TO TUMBLE THROUGH A VESSEL.

plex sets of databases in ways that even scientists previously couldn't do.

Phillips discovered a new use for art while doing graduate work in embryology. In a study of RNA in developing eggs, he struggled to understand how the concentrations changed over time. "The concept was difficult for me to grasp, and then, one day, I suddenly got it. By visualizing the development in three dimensions, and then adding a fourth dimension for time, I

could see exactly what was happening in my mind's eye from any perspective in the developing embryo."

Phillips built on this revelation when he began teaching embryology and tissue development at Bowdoin. He used animation to help students better understand how tissues move through space and time, not only to change shape but to position themselves to signal each other. Otherwise, "students had a difficult time visualizing that," he says.

Always innovating, Phillips now has a grant from the National Endowment for the Arts to build virtual environments that allow students from any location to create online virtual reality models of Zen gardens, enabling others to log on and experience the spaces. ■

-Susan Gaidos-