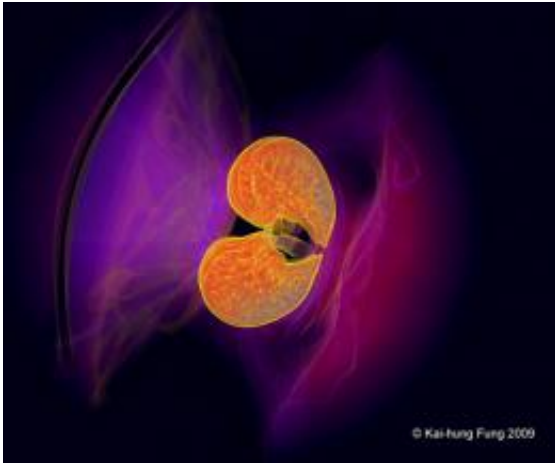


DigiMorph: Bringing fossils to life (w/ Video)

February 1 2011, By Miles O'Brien and Marsha Walton



This artistically rendered 3-D computed tomography (CT) scan shows the human lungs in the center with the viewer looking from the top. The rest of the body is digitally removed. The cushion on the CT table (left) and the blankets covering the subject (right) represent the cosmic clouds. Credit: Kai-hung Fung 2009, Pamela Youde Nethersole Eastern Hospital, Hong Kong

For hundreds of years, scientists who wanted to examine a rare fossil might have had to travel halfway around the world. And that is not the only challenge when viewing a small, unique or priceless specimen.

"When we're looking at these precious things under the microscope, we're distracted because we might break them," says vertebrate paleontologist Timothy Rowe. "You might hit it against the [microscope](#) and break it."

Now a new range of tools provides a chance for researchers anywhere in the world to see a one-of-a-kind specimen, with no fear of damaging it.

At the University of Texas at Austin, Rowe and his team use high-resolution X-ray computed tomography (CT) to scan valuable and unusual scientific specimens. And once scanned, the objects can be safely put away, while thousands of different [digital images](#) of it can be studied and compared by students and researchers everywhere.

"Science is about natural objects. It's about plants and it's about animals and it's about things that you can see and hold and touch and feel, or at least you want to, and that's the immediate goal. It's just been that the access to that has been very, very difficult, and this changes everything," he says.

The [High Resolution](#) X-ray CT facility is part of the National Science Foundation (NSF) Digital Libraries Initiative, and was funded by the agency's Earth Sciences Instrumentation and Facilities program. It's a resource for scientists all over the world.

Computed tomography works by shooting [X-rays](#) through an object. Doctors use the same technology when scanning patients. But when the object being scanned is not alive, the scans can use more powerful, higher energy x-rays for longer periods of time, to get often dazzling images.

Rowe remembers the first scans he showed to a meeting of vertebrate paleontologists in Toronto back in 1992.

"It was marvelous to step back and listen to the audience 'ooh' and 'aah,' and immediately thereafter, many in the audience said, 'I have this precious specimen, I want to see inside the brain case or see inside the nose, what would it take to scan it?' And they started shipping us their

specimens," he recalls.

After working briefly with a commercial firm, Rowe realized that in order to really innovate with CT, he and his colleagues would need their own machines. The High Resolution X-ray CT Facility was established in 1997.

Now with three industrial scanners, they can scan specimens that range in size from less than a millimeter to as big as half a meter.

"We're making voxels, which are three dimensional pixels," says Rowe, who is director of the Vertebrate Paleontology Lab at the Jackson School of Geosciences, as well as co-director of the UT-CT facility. "We're doing this at very, very high resolution."

So, for example, they were able to scan the skull of *Herrerasaurus*, the world's oldest dinosaur.

"I can cut open that specimen digitally, I can open it up and I can answer one of the questions that I was after with *Herrerasaurus* which is, 'what was its brain like?'"

Another remarkable option with these scans is the ability to make precise 3-D models of the originals in any size.

"I saw things in this model that I couldn't see in the original," says Rowe, holding up a model of a mammal's jaw. The model is several inches across and much larger than the jaw, which is the size of a fingertip.

"I could see the tooth roots, I could see the canal that runs through here, it tells me what kind of nerves, whether this thing has special sensor systems on its face. It's this whole new world of information that comes out of the volume, where before, we could only study the surfaces,"

explains Rowe.

"We've scanned things you might not imagine, everything from fossils to meteorites to human remains to oboe reeds, potato chips, all sorts of antique books," says Jessica Maisano, paleontologist and facility manager.

Maisano came to the University of Texas lab 10 years ago, right out of graduate school. She says there's an 'aha moment' just about every day in the facility. "Every time we scan something for the first time, we are seeing something that no one has ever seen before," she explains.

Her experience as manager of the CT facility is different from what she imagined of her scientific career. "Like most kids who want to be a paleontologist when they grow up, I envisioned myself out in the field, digging up fossils then photographing them," she says.

Now, the 'x-ray vision' of the CT scans enables her to see things she never could using standard methods. Maisano is an expert in lizards, and the CT scans have helped break new ground on one rare species, *Lanthanotus borneensis*, a nocturnal, semi-aquatic lizard found on the island of Borneo.

"It's closely related to monitor lizards but it is the only living representative of its entire branch of the lizard tree of life." "So it's just one of those holy grails for us lizard biologists," says Maisano. "This is a great way to see things that you normally couldn't see in a skeletonized bone, because things don't hold together."

The Digital Morphology or DigiMorph website is a powerful teaching tool, whether in a college lecture or an elementary school. It shows unique 2-D and 3-D visualizations of the internal and external structure of living and extinct vertebrates, and invertebrates.

"These visualizations are a marvelous way to represent knowledge," says Rowe. For example, instead of writing a long, difficult Latin name on a blackboard, Rowe can put up an image on a computer screen for a group of youngsters.

"They go, 'Oh, that's really cool. Wow. It looks like a bat.' Or, 'Oh, it's a bird, I see feathers.' And then, I can tell them, by the way, its name is Archaeopteryx."

Amy Balanoff began work in the lab as an undergraduate. She spent two years meticulously uncovering the secrets of one of DigiMorph's most precious scans, the egg of *Aepyornis maximus*: the extinct elephant bird. A relative of the ostrich and emu, the elephant bird once thrived on the island of Madagascar. The birds could grow to 1,000 pounds.

The egg was collected in 1967 by Luis Marden, a photographer for National Geographic Magazine. It is a completely intact egg, with an embryonic skeleton of an embryo that died shortly before it should have hatched. After it was scanned in 1999, the specimen was returned to the National Geographic Society's Explorer's Hall in Washington, D.C.

"It took a year's worth of image processing work, isolating each bone, and another year or so to write it up," says Balanoff, now working on her doctorate at Columbia University and working at the American Museum of Natural History in New York.

Balanoff used the emerging tools of the DigiMorph website, and Photoshop software to understand each bone in the egg.

"It was fun to be on the front lines of the new technology, doing things no one else had done," she recalls. Now, Balanoff says it's standard practice among paleontologists to do a CT scan of a [fossil](#).

"Eighty thousand unique visitors now have come and seen the inside of this egg," says Rowe. "Even though the egg is intact, nobody's ever really seen the inside, but through our digital imagery, they can come and look at this."

Rowe says there's another step in making this vast amount of information available: to make it easy to create 3D models of the scanned specimens.

"The last step in this, to make this revolution happen, is to build the voxel bank, put this stuff in the public domain," he says. "We want to convert them to files that can be printed, so that, if you're in Cape Town, in your dormitory studying for an exam at 3 o'clock in the morning, trying to figure out, what a worm lizard looks like, you get on DigiMorph and print one of these things out."

The CT scans are not just for scientists studying living, or once-living things. The technology can also delve into the secrets of ancient books, papers and art works.

"And so we can digitally unroll papyrus scrolls," says Rowe. "We're starting to see more and more archeologists, anthropologists, curators of art museums come through, [asking us] to help with quality control or conservation issues on some of their materials."

More information: www.digimorph.org/

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