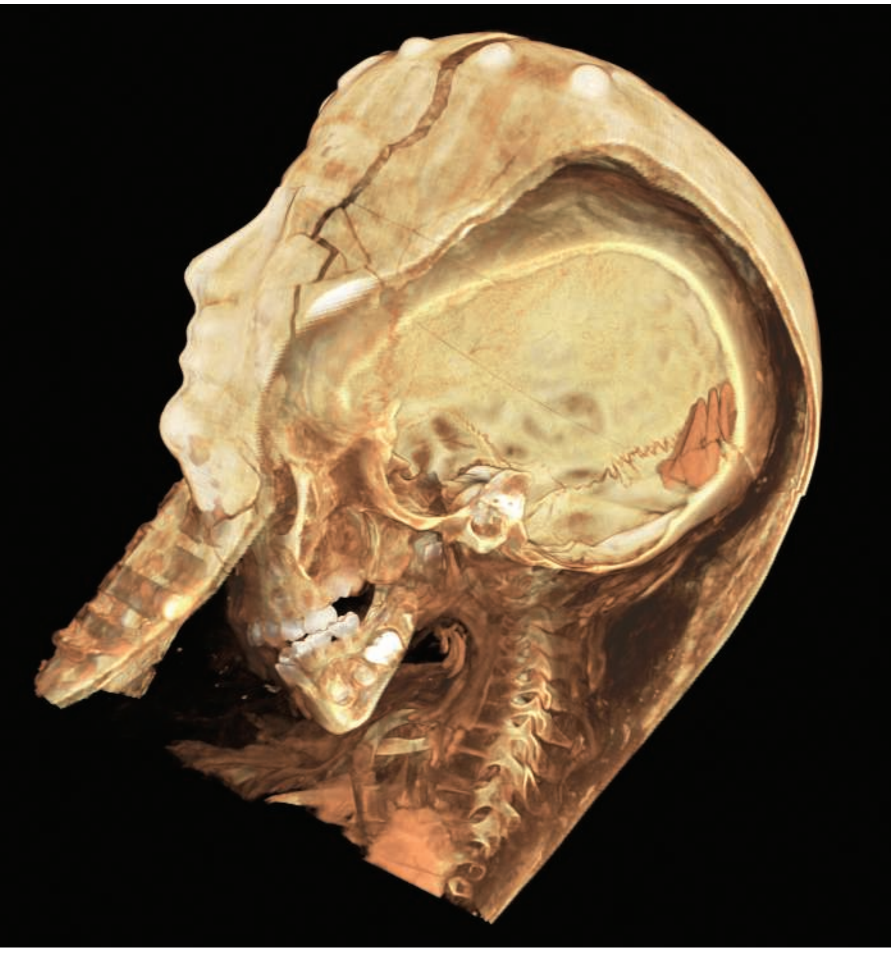
2006 Visualization Challenge



FIRST PLACE

An Egyptian Child Mummy

Robert Cheng, W. Paul Brown, and Rebecca Fahrig, Stanford University, and Christof Reinhart, Volume Graphics

For 75 years, this child mummy resided in the Rosicrucian Egyptian Museum in San Jose, California, its body unseen by human eyes, its story a mystery. Then, in early 2005, a team of researchers and computer engineers led by W. Paul Brown of Stanford University began to unravel the threads of this mystery using the latest imaging technology.

Radiologists at Stanford University used a high-resolution C-arm computed tomography (CT) scanner from Siemens Medical Solutions to generate 60,000 2D scans of the unopened, intact mummy. Computers running the latest 3D computer graphics at Silicon Graphics used these scans to create a 3D model of the mummy and its interior.

Analysis of the data revealed that the 2000-year-old mummy is the remains of a 4- or 5-year-old girl from a well-to-do family. The Rosicrucian museum has since named her Sherit, ancient Egyptian for "Little One." Her body showed no telltale signs of trauma or long-term disease, and so the researchers believe Sherit died unexpectedly. "She must have died from an infectious disease," says Brown, nicknamed "Mummy Daddy" by his team members. "We want to put together a CD to send it to different museums."

Felice Frankel, a member of the panel of judges, says that the panel's decision was undeterred by the fact that CT scanning and computer imaging, rather than traditional photography, produced the "stunningly beautiful" image. It shows how "the definition of photography in science has expanded," she says.

Photography

SECOND PLACE

Cockroach Portrait

David Yager, University of Maryland

Cockroach haters, look your enemy in the eye! Photographing small animals like this 2-centimeter-long Cuban banana cockroach, *Panchlora nivea*, has its challenges: You can focus on only a small part of the tiny animal in one shot. To overcome this drawback, David Yager of the University of Maryland, College Park, relied on technologies old and new. He laid the dead roach on its back on a bed of glass beads and took multiple snapshots at different depths of field through a regular dissecting microscope. Each frame focused on different parts of the roach's head. With three light tubes, he lit the roach's face from various angles and peeked into its head. Next, he merged 12 separate frames using image-processing software called Automontage to create a clear and detailed "Cockroach Portrait."

Published by AAAS

Illustration

FIRST PLACE

Still Life: Five Glass Surfaces on a Tabletop

Richard Palais, University of California, Irvine, and Luc Benard

To most of us, a surface is something we can touch and attribute a shape to—the spherical surface of a ball or the toroidal surface of a doughnut. But there are innumerable surfaces that we cannot touch, or see, or even know of, because they are representations of mathematical functions. Mathematicians have long relied on their own powers of imagination to picture these abstract surfaces. Now, mathematicians such as Richard Palais of the University of California, Irvine, and graphic artists such as Luc Benard are exploiting the magic of computer graphics to recreate these abstract mathematical surfaces in familiar yet intriguing settings.

This illustration presents five well-known mathematical surfaces, rendered as glass objects in a highly realistic "Still Life." To create their chosen surfaces, Benard relied on the computer program 3D-XplorMath, developed by Palais for visualizing many of the most famous mathematical surfaces. He then exported these surfaces into a 3D-rendering program, using it to give the objects a glassy texture and place them on a virtual glass-covered wooden tabletop.

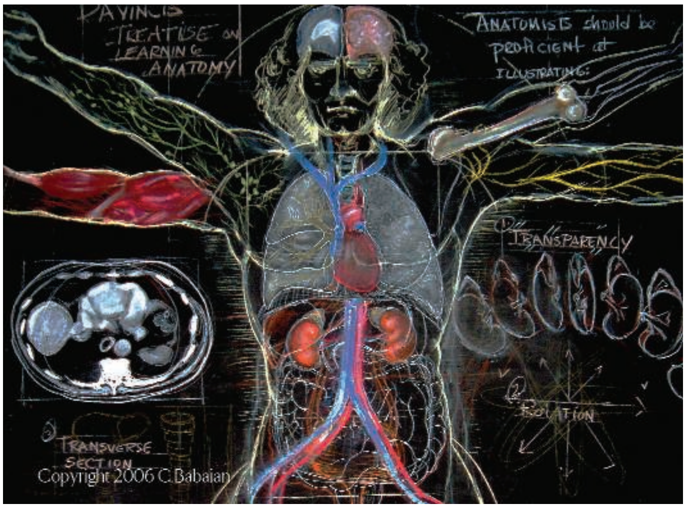
Panel of judges member Felice Frankel was impressed by the image's ability to engage viewers and trigger their curiosity. "That is what we strive for in any visual experiment, that we are creating curiosity, by engaging each other [visually]," she says. "That is how we can learn from one another."

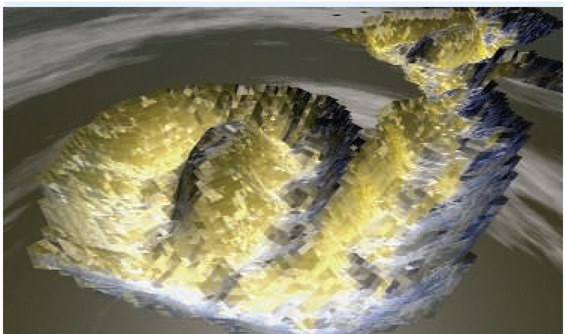
SECOND PLACE

A Da Vinci Blackboard Lesson in Multi-Conceptual Anatomy

Caryn Babaian, Bucks County Community College, Newtown, Pennsylvania

Some things never grow old. Leonardo da Vinci's *Vitruvian Man*, first drawn more than 500 years ago, is still teaching people about the intricacies of the human body. Biology teacher Caryn Babaian of Bucks County Community College in Newtown, Pennsylvania, uses the iconic sketch as a "multi-conceptual image" in her introductory anatomy class to illustrate three crucial anatomical concepts: rotation, transparency, and transverse section. Babaian requires her students to draw the image in their notebooks as they watch it take shape on the blackboard. Panel of judges member Thomas Lucas says even though the use of the image "gave inspiration to a few people, the effect on them might have been more powerful than something that went over the mass media."



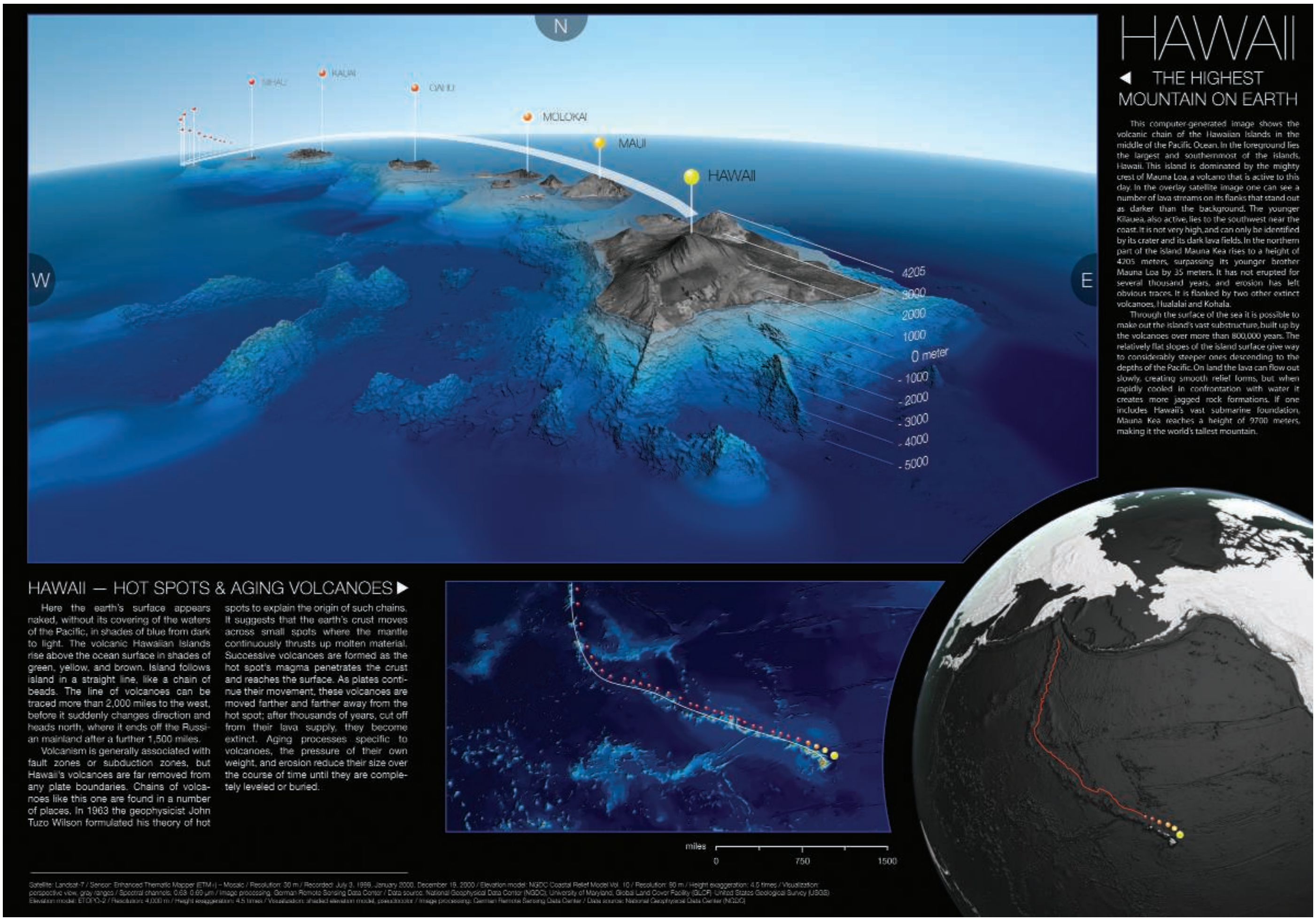


HONORABLE MENTION

The Handwritten Letter "e"

Curtis DuBois

This landscape began as an effort to aid handwriting analysts. According to independent media artist Curtis DuBois, who is based in Lummi Island, Washington, "every individual has a characteristic way of using pressure in their writing," resulting in a unique pattern of pressure points. He used a 3D ray-tracing program to convert the shades of gray in a digitally scanned image of the handwritten letter "e" into variations in virtual altitude. By turning the darker spots into deeper areas in the image, DuBois was able to highlight the "hot spots" or pressure points and thus increase the amount of information available in the writing. He then added color and "atmospheric effects" for "aesthetic impact" of the image.



FIRST PLACE

Hawaii, the Highest Mountain on Earth

Nils Sparwasser, Thorsten Andresen, Stephan Reiniger, and Robert Meisner, German Aerospace Center

Informational Graphics

Mount Everest is the highest mountain on Earth above sea level, but it's not the world's tallest. That honor goes to the Hawaiian volcano Mauna Kea. When measured from its base on the Pacific Ocean floor, it is about 1000 meters taller than Mount Everest. Mauna Kea is part of a 5600-kilometer-long string of volcanoes stretching westward from the main Hawaiian island.

Geographer Nils Sparwasser and his colleagues at the German Aerospace Center in Oberpfaffenhofen introduce us to the Hawaiian volcanoes with this panoramic view across the Pacific Ocean. The illustration combines data gathered by satellites and ships with the latest in computer-modeling technology.

The image shows the five volcanoes on the main Hawaiian island, including Mauna Kea, with the smaller islands stretching westward behind them. The jagged submarine surfaces of the volcanoes are formed by the rapid cooling of hot lava under water.

The volcanic chain spanning the Pacific (inset) is formed by small convection streams called "hot spots," just below Earth's crust, where magma rises from the hotter parts of the mantle. These hot spots melt the tectonic plates moving above them, causing magma and bits of the molten plate to erupt onto the sea floor. Over time, the lava accumulates, forming a mountain that rises above sea level. The moving tectonic plates carry the newly formed mountain away from the original location, as newer volcanoes continue to form in the same spot.

Panel of judges member Donna Cox says she found the image "compelling" because it conveys information with ease without the viewer having "to read too much of the text."

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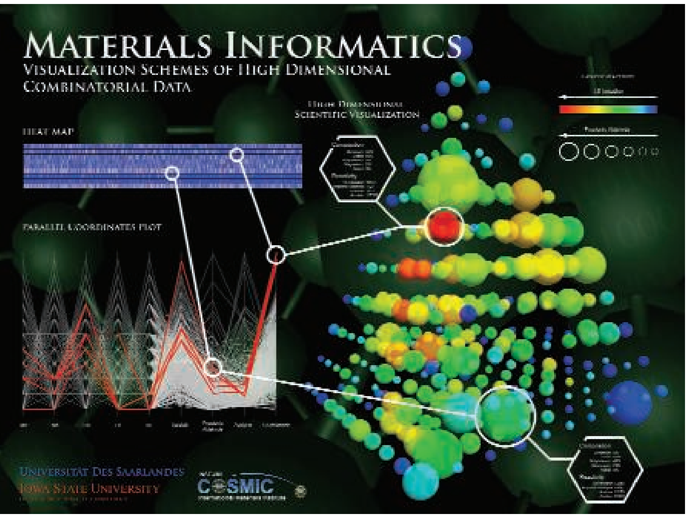


HONORABLE MENTION

Materials Informatics

Matt Heying, Changwon Suh, and Krishna Rajan, Iowa State University, and Simone Seig, Universität de Saarland

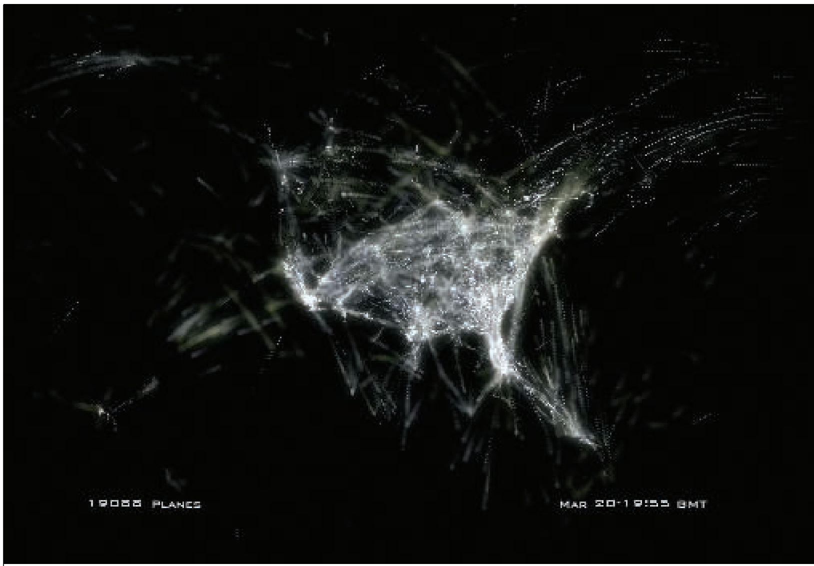
Chemists are forever hunting for newer and more efficient catalysts. The task can require sifting through enormous amounts of data on the chemistry of potential candidates. Materials scientist Krishna Rajan and his colleagues at Iowa State University and the University of Saarland in Germany have made the job easier with this visually captivating yet comprehensible informational graphic. In a glance, a catalyst researcher can get information on the composition of thousands of catalysts and their chemical reactivity.

SECOND PLACE

Mona Lisa Montage

Louis Borgeat, François Blais, and John Taylor of the National Research Council of Canada, and Christian Lahanier of the Centre de Recherche et de Restauration des Museés de France

It may not be the prettiest Mona Lisa image you have seen, but it is certain to be the most informative. This "montage," jointly produced by the National Research Council of Canada and the Center for Research and Restoration of the Museums of France, depicts the information obtained by analyzing Leonardo da Vinci's painting using the latest scientific imaging technologies, such as a high-resolution 3D scanner and a polychromatic 13-band multispectral camera. Not only can such analyses help museum curators and conservation experts study the condition and authenticity of old paintings, but they also reveal the artists' techniques. This project filled in details of the unique pattern of cracks on the Mona Lisa, provided an estimation of its original color, and demonstrated da Vinci's sfumato painting technique.



Noninteractive Multimedia

FIRST PLACE (TIE)

Flight Patterns

Aaron Koblin, University of California, Los Angeles

Thousands of airplanes zoom through our skies every day. Ever wondered what this air traffic looks like? In this animation made by digital media artist Aaron Koblin of the University of California, Los Angeles, it looks much like fireworks shattering the darkness of a night sky.

Using air-traffic data from the Federal Aviation Administration, Koblin shows the changing dynamics of air traffic over the United States and Canada over a 24-hour period. After categorizing the data based on criteria such as "types of aircraft," "location," and "altitude," Koblin experimented with ways to visualize the information. He plotted the data using a programming language called Processing and animated it using Adobe After Effects and Maya.

The movie begins with a splash of dotted white and thin green lines that move slowly across the screen in different directions. As the numbers and destinations of flights increase after dawn breaks across the continent, the crisscrossing lines outline the underlying landmasses of the two countries. Then the scenes repeat with more vibrant colors, eventually zooming in on New York, Los Angeles, and Hawaii.

"Not only was it incredibly informational, [it was also] unbelievably engaging," says panel of judges member Felice Frankel, who described the depiction of air traffic as "brush strokes" in a "Japanese painting." "It's one thing to convey data and another to make somebody want to look," she added.

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Noninteractive Multimedia

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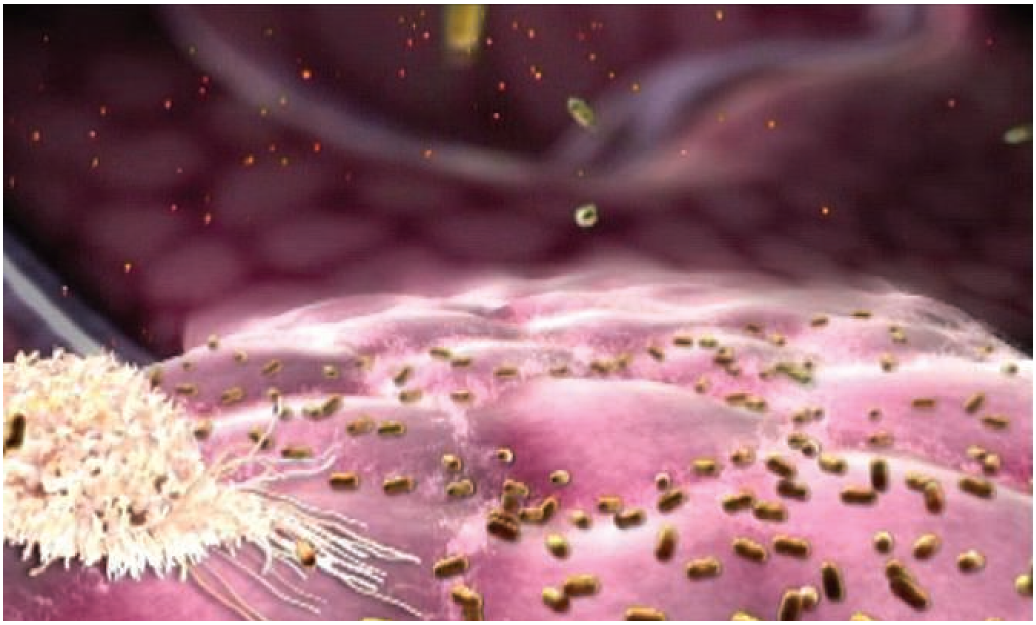


FIRST PLACE (TIE)

Body Code

Drew Berry, The Walter and Eliza Hall Institute, Melbourne, Australia; Jeremy Pickett-Heaps, University of Melbourne; and François Tétaz

Originally created for an art gallery, this animation could easily pass for a science-fiction movie. But in reality, it is a glimpse inside our own bodies, humming with activity at every level—from molecules to cells to tissues and organs.

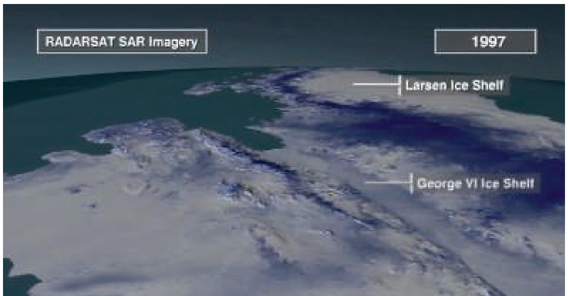
Made by scientific animator Drew Berry of The Walter and Eliza Hall Institute in Melbourne, Australia, time-lapse imaging expert Jeremy Pickett-Heaps of the University of Melbourne, and independent sound artist François Tétaz, this 9-minute animation takes the viewer on a wordless journey through a universe of alien structures and "factorylike" activities that keep us alive.

In one scene, a protein receptor sticks out of a cell's surface waiting for a messenger protein to attach itself. When that happens, the receptor transmits a message into the cell, triggering the cell to divide. Another scene takes the viewer on a roller-coaster ride through a strand of DNA with machinelike transcription enzymes, as they zip through the DNA churning out messenger RNAs along the way.

According to Berry, "time-lapse footage" had a "pivotal influence" on his reconstructions of the "living interior" of cells. He also used data from x-ray crystallography and electromagnetic tomography.

"For those of us who think cells are these static structures that divide in a passive way and pass chemicals between them passively, this was a stunning revelation," says panel of judges member Thomas Lucas, who describes the animation as a "real masterpiece."

2006 Visualization Challenge

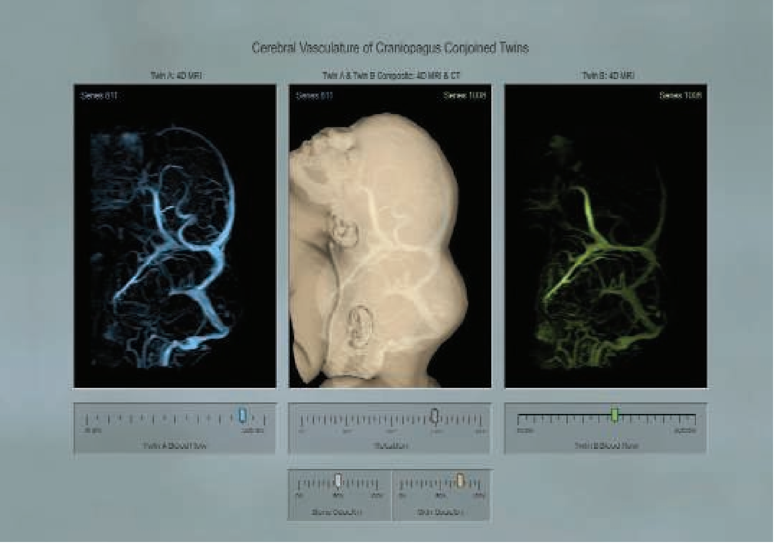


HONORABLE MENTION

A Short Tour of the Cryosphere

Jennifer Brennan, ADNET Systems Inc./NASA Goddard Space Flight Center; Waleed Abdalati and Horace Mitchell, NASA Goddard Space Flight Center; and Walter Meier, National Snow and Ice Data Center

The chain of interactions between Earth's cryosphere and its climate is endless, and this 5-minute animation gives a bird's-eye view of it all—from the crumbling Larsen B Ice Shelf in Antarctica to the shrinking sea ice in the Arctic to the seasonal ebb and flow of the snow cover in the Rockies. The movie shows the changing snow and ice cover of our planet and how these shifts could affect the global environment. Made by a group of animators and researchers at NASA's Goddard Space Flight Center and the National Snow and Ice Data Center, the animation is based on data from multiple NASA satellites.



FIRST PLACE

Cerebral Vasculature of Craniopagus Conjoined Twins

Travis Vermilye, Stephen Humphries, and Andrew Christensen, Medical Modeling, Golden, Colorado; and Kenneth Slayer, International Craniofacial Institute, Dallas, Texas

Surgeons trying to separate conjoined twins joined at their heads face a complex problem: The twins' brains are distinct, but they share major blood vessels. The challenge is to divide the blood vessels between the twins so that each has an adequate blood supply. To evaluate the chances of successfully separating one set of so-called craniopagus conjoined twins, a group of surgeons at the International Craniofacial Institute in Dallas, Texas, used an interactive tool developed by medical illustrator Travis Vermilye, medical physicist Stephen Humphries, and their team members at Medical Modeling LLC in Golden, Colorado.

The tool uses three sets of images. The ones on left and right each show the blood flow through a single twin's head. Those in the center show the twins' joint blood vessels within the framework of the twins' skeletal and facial features. The slider bars below each panel rotate the individual frames through 360 degrees—to view the images from all possible angles—and also control the opacity of the facial and skeletal tissues. Vermilye used volumetric magnetic resonance imaging scans of each twin to construct a three-dimensional view of the cranial circulation, and he relied on computed tomography scans for the skeletal and soft facial tissue animations. This tool helped the surgeons postpone the separation of the twins.

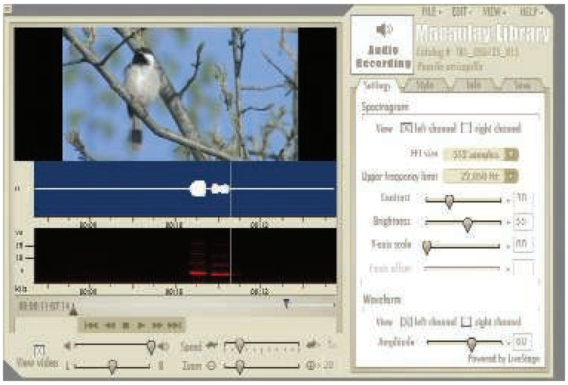
Panel of judges member Thomas Lucas says he was impressed by the "simplicity of the tool in contrast to the complexity of interactions." He adds: "It offers the layperson an incredibly fascinating glimpse into nature gone awry."

SECOND PLACE

A Real-Time Audio and Video Sound Visualization Tool

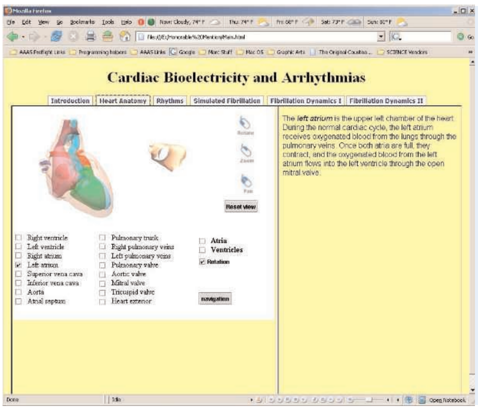
Jack Bradbury, Guillaume Iacino, Erica Olsen, and Robert Grotke, Cornell Lab of Ornithology, Cornell University

For scientists and laypeople alike, this tool, made by Jack Bradbury and his team members at Cornell University, offers a unique opportunity to hear and see sounds in real time. The user can listen to sounds of all sorts of animals—including crickets, seals, whales, fish, and birds—while watching the animal on the top panel (in most cases, videos are available) and view dynamically generated waveforms and spectrograms of the sound in the middle and bottom panels, respectively. Control bars allow the viewer to change various parameters, such as the color of the spectrogram and its brightness. Intended as an educational tool, it is available free at www.animalbehaviorarchive.org and can be used by anyone with a computer, an Internet connection, and a QuickTime player.



Interactive Multimedia

HONORABLE MENTION



Cardiac Bioelectricity and Arrhythmias

Flavio Fenton and Elizabeth Cherry, Cornell University

Deep inside a human heart, its pacemaker sends out bursts of electrical signals that keep the heart pumping rhythmically, supplying life-giving oxygen to the body. When these electrical waves become disorganized, the heart starts beating irregularly or arrhythmically. Flavio Fenton and Elizabeth Cherry of Cornell University made this interactive program to educate people about arrhythmias. It presents detailed information on cardiac anatomy, normal cardiac electrophysiology, and different kinds of arrhythmias using a combination of words, pictures, and computer simulations and animations.

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