2012 Winners

Discover the artistry behind the 2012 International Science & Engineering Visualization Challenge winners as they explain the processes, techniques and thoughts behind their entries.

Credit: National Science Foundation

Captions from Emily Underwood, *Science* 339: 509-519 (2013). Full story in *Science* magazine.

CATEGORIES

- Photography
- Illustration
- Posters & Graphics

- Games & Apps
- Video

PHOTOGRAPHY

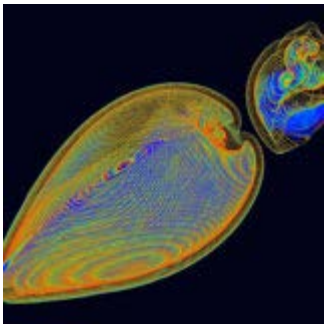
First Place and People's Choice

Biomineral Single Crystals
Credit: Pupa U. P. A. Gilbert and Christopher E. Killian; University of Wisconsin, Madison

These fantastical structures are the microscopic crystals that make up a sea urchin's tooth. Each shade of blue, aqua, green, and purple--superimposed with Photoshop on a scanning electron micrograph (SEM)--highlights an individual crystal of calcite, the abundant carbonate mineral found in limestone, marble, and shells.

The curved surfaces of the crystals look nothing like normal calcite crystal faces. Instead of flat sides and sharp edges, the sea urchin produces "incredibly complex, intertwined" curved plates and fibers that interlock and fill space in the tooth as they grow. Though made of a substance normally as soft as chalk, the teeth are hard enough to grind rock, gnawing holes where the sea urchins take shelter from rough seas and predators.

Honorable Mention



Self Defense
Credit: Kai-hung Fung, Pamela Youde Nethersole Eastern Hospital in Hong Kong

This is no shell game, but a matter of life or death. The clam (left) can snap its bivalve shell shut at the first sign of a threat. The whelk (right) has evolved another strategy: The spiral shell provides a series of barricades to potential invaders. This dramatic example of two different evolutionary strategies for self-defense caught the eye of radiologist Kai-hung Fung.

To create this image Fung used a CT scanner to visualize thin slices of the whelk and clam, then rendered their contours in rainbow colors to highlight their complex structures. Creating such images involves balancing "two sides of a coin," he says. "One side is factual information, while the other side is artistic."

Honorale Mention

X-ray micro-radiography and microscopy of seeds
Credit: Viktor Sykora, Charles University; Jan Zemlicka, Frantisek Krejci, and Jan Jakubek, Czech Technical University

Furred, fringed, and barbed, these fruits with tiny seeds are each no bigger than 3 mm across. To image the seeds' fine detail, the team used high-resolution, high-contrast x-rays (left) along with traditional microscopy (right). Although high-resolution x-rays are commonly used to visualize the internal structures of small objects without destroying them, according to the authors it has never before been applied to the visualization of seeds.

ILLUSTRATION

First Place

Connectivity of a Cognitive Computer Based on the Macaque Brain
Credit: Emmett McQuinn, Theodore M. Wong, Pallab Datta, Myron D. Flickner, Raghavendra Singh, Steven K. Esser, Rathinakumar Appuswamy, William P. Risk, and Dharmendra S. Modha

Inspired by the neural architecture of a macaque brain, this ghostly neon swirl is the wiring diagram for a new kind of computer that, by some definitions, may soon be able to think. Over the past 2 years, IBM's cognitive computing group in San Jose, Calif., has made great strides toward designing a computer that can detect patterns, plan responses, and learn from its mistakes, says Emmett McQuinn, a hardware engineer at IBM who designed the image.

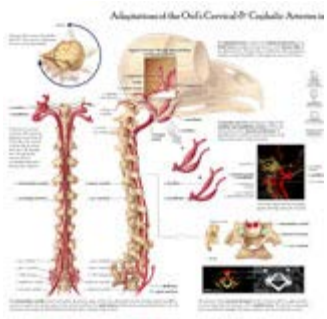
Honorable Mention and People's Choice

Cerebral Infiltration
Credit: Maxime Chamberland, David Fortin, and Maxime Descoteaux, Sherbrooke Connectivity Imaging Lab

A malignant brain tumor (red mass, left) of this person's brain, wreathed by fine tracts of white matter. The red fibers signal danger: If severed by the neurosurgeon's scalpel, their loss could affect the patient's vision, perception, and motor function. Blue fibers show functional connections far from the tumor that are unlikely to be affected during surgery. Together, the red and blue fibers provide a road map for neurosurgeons as they plan their operations. Computer science graduate student Maxime Chamberland of the Sherbrooke Connectivity Imaging Lab in Canada produces images like these on a weekly basis, he says. Using an MRI technique that detects the direction in which water molecules move along the white matter fibers, he generates a three-dimensional image of functional connections
in the brain.

POSTERS & GRAPHICS

First Place



Adaptations of the Owl's Cervical & Cephalic Arteries in Relation to Extreme Neck Rotation
Credit: Fabian de Kok-Mercado, Michael Habib, Tim Phelps, Lydia Gregg, and Philippe Gailloud, Johns Hopkins University School of Medicine, Department of Art as Applied to Medicine

Instead of moving their large, tubular eyes in their sockets, owls swivel their heads 270°. This poster explains the likely mechanism for the eerie ability. The team obtained 12 dead birds from educational centers in Michigan and Missouri. Then they created three-dimensional images of the owls' blood vessels and bones with a CT scanner, and injected the birds with radio-opaque dye and liquefied red plastic to preserve their arteries before dissecting them. On close examination, the owls revealed surprising secrets. The researchers found swellings in the birds' arteries that likely act as reservoirs for pooling blood when the head is turned, says Fabian de Kok-Mercado at Johns Hopkins University, as well as "backup" arteries that could help supply the brain when other arteries are pinched.

Honorable Mention

Earth Evolution: The Intersection of Geology and Biology
Credit: Mark Nielsen, Satoshi Amagai, HHMI; Bill Pietsch, Davey Thomas, Astronaut 3 Media Group; and Andy Knoll, Harvard University

All 4.6 billion years of Earth's history are squeezed onto this poster. The whole history of land vertebrates from dinosaurs to humans is barely visible in the top right corner. Because of its relatively young age and minor role in planetary evolution, Pangaea didn't even make the cut. Far more prominent is the evolution of photosynthetic bacteria, which enabled the evolution of many new types of metabolism, including our own by generating oxygen. The poster draws connections between biological and geological processes in Earth's history, such as mass extinctions, plate tectonics, and the greenhouse effect, says Mark Nielsen, a scientific education fellow at the Howard Hughes Medical Institute in Chevy Chase, Maryland, who helped design the graphic. Whereas many classic visualizations of life on Earth begin just 540 million years ago, when large animals became abundant, "Earth Evolution" tells a much longer story, stretching back 3.8 billion years to the earliest evidence of life.

People's Choice

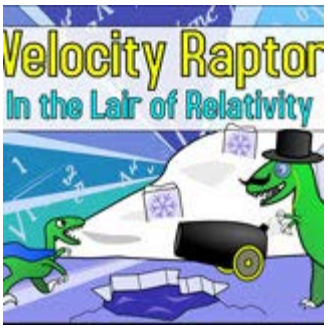
The Pharma Transport Town: Understanding the Routes to Sustainable Pharmaceutical Use
Credit: Will Stahl-Timmins, Mathew White, Michael Depledge, and Lora Fleming, European Centre for Environment and Human Health, University of Exeter Medical School; Clare Redshaw, University of Plymouth

This information graphic shows the complex transport routes of pharmaceuticals in the environment, and considers psychological influences upon drug usage and disposal. It illustrates the cyclical nature of pharmaceutical transport, highlighting an extensive range of points at which interventions could minimize environmental contamination. It also recognizes knowledge gaps--such as to what extent pharmaceuticals are active upon unintended consumption in food or water.

GAMES & APPS

Honorable Mention

Velocity Raptor

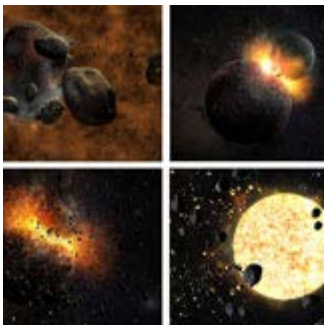


Credit: Andy Hall, TestTubeGames

This dapper green dinosaur wearing a bright blue cape is in a hurry to save the world—in fact, she moves at nearly the speed of light. At such breakneck speeds, the world behaves according to Albert Einstein's theory of special relativity. This poses practical problems for players who must guide the creature through a world that morphs according to her velocity, incorporating concepts such as Doppler shift and length contraction. Velocity Raptor is an attempt to "give people some intuition" about the physics of special relativity by letting them play with it themselves, game designer Andy Hall says.

Play Velocity Raptor

Honorable Mention



CyGaMEs Selene II: A Lunar Construction GaME
Credit: Debbie Denise Reese, Robert E. Kosko, Charles A. Wood, and Cassie Lightfritz, Wheeling Jesuit University; Barbara G. Tabachnick, California State University, Northridge

In this online game geared to grade 5–12 students, players create their own moon with raw space materials, then pummel it with asteroids and flood it with lava. As they adjust the rates of accretion--new materials glomming onto the moon--and differentiation--materials of varying densities settling into a core, mantle, and crust--students create different kinds of moons and gain an intuitive grasp of the physics of collisions, says game theorist and principal investigator Debbie Denise Reese at Wheeling Jesuit University in Wheeling, West Virginia.

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People's Choice

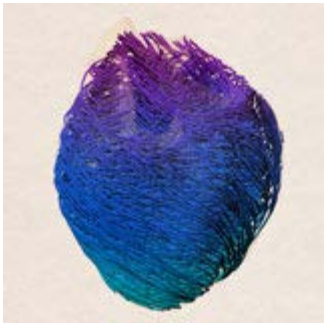
UNTANGLED
Credit: Gayatri Mehta, University of North Texas

When faced with the problem of how to wire a more efficient computer chip, engineer Gayatri Mehta of the University of North Texas in Denton turned to crowdsourcing. Inspired by a game that recruits online players to discover novel ways to fold proteins, Mehta designed UNTANGLED, a game in which users compete to make the most compact circuit layout on a grid. To entice math and sciencephobes, she used bold color blocks and left out the underlying algorithms. The game allows her to record millions of new moves and discover human strategies for circuit design that could be employed to develop smaller, more powerful, and longer-lasting electronic devices. "I've learned a lot," she says. "People have amazing skills."

Play UNTANGLED

VIDEO (SCREEN SHOTS)

First Place and People's Choice



Alya Red: A Computational Heart
Credit: Guillermo Marin, Fernando M. Cucchietti, Mariano Vázquez, Carlos Tripiana, Guillaume Houzeaux, Ruth Arís, Pierre Lafortune, and Jazmin Aguado-Sierra, Barcelona Supercomputing Center

This image is an artistic rendering of Alya Red, a new computer model of the heart that marries modern medical imaging techniques with high-powered computing. Based on MRI data, each colored strand represents linked cardiac muscle cells that transmit electrical current and trigger a model human heartbeat. Despite centuries of study, scientists are still largely baffled by the heart's complex electrical choreography, says physicist Fernando Cucchietti, who helped produce the video. The most challenging part was to get the heart fibers in the image to move in a realistic way, Cucchietti says.

Video

Honorable Mention

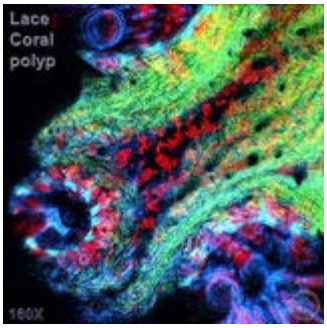
Fertilization
Credit: Thomas Brown, Stephen Boyd, Ron Collins, Mary Beth Clough, Kelvin Li, Erin Frederikson, Eric Small, Walid Aziz, and Nobles Green Nucleus Medical Media

The video "Fertilization" starts with 300 million sperm, following their perilous journey up the cervix and into the fallopian tube with unprecedented detail and continuity, say Thomas Brown, chief creative officer of Nucleus Medical Media. By the time the last few dozen surviving sperm

reach the egg, he says, "you're famished, troubled, and hopeful." In a new twist based on recent science, he says, the first sperm to reach the egg is rewarded with an embrace, as the egg's inner membrane encloses and absorbs it.

Video

Honorable Mention



Observing the Coral Symbiome Using Laser Scanning Confocal Microscopy
Credit: Christine E. Farrar, Zac H. Forsman, Ruth D. Gates , Jo-Ann C. Leong, and Robert J. Toonen, Hawaii Institute of Marine Biology, University of Hawaii, Manoa

No dyes or digital software produced the brilliant color of these corals--the glory is all their own. Fluorescent molecules, innate to the corals and to the red algae that live inside and nourish them, shine under different wavelengths of light emitted by a confocal microscope. In the video, which compiles the images into three-dimensional, time-lapse animations, corals extend and retract their glowing tentacles. Tiny creatures crawl over the corals, all part of a complex and threatened ecosystem. In the future, coral biologist Ruth Gates says, it might be possible to use confocal microscopy to classify different coral species or diagnose coral disease by their fluorescent patterns.

Video

Honorable Mention

Revealing Invisible Changes in The World
Credit: Michael Rubinstein, Neal Wadhwa, Frédo Durand, William T. Freeman, Hao-Yu Wu, John Guttag, MIT; and Eugene Shih, Quanta Research Cambridge

In this video, a team of computer scientists at the Massachusetts Institute of Technology in Cambridge demonstrates a new method of magnifying subtle changes normally invisible to the eye. Using video as input, the team analyzes each pixel for slight variations in color over time--for example, rhythmic reddening in a man's face as blood pulses through his veins. Then they apply an algorithm that magnifies the variation, and extract the information they need. By amplifying the man's slight blush, for example, they were able to obtain his heartbeat. Among other applications, they say, the technique could help doctors take their patients' vital signs remotely.

Video

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