



National Science Foundation  
WHERE DISCOVERIES BEGIN



March 2010

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## NSF AT WORK

### Robots Climb the Walls

NSF-funded researchers have developed a robot capable of scaling vertical walls. The new robot, whose foot pads are covered with the same type of adhesive found on the feet of geckos, was named "stickybot" by its inventors, Mark Cutkosky of Stanford University and Kellar Autumn of Lewis and Clark College.

"The challenge was simply to get robots to go where robots have never been able to go before, like up walls of buildings," Cutkosky explains. "If robots can climb vertical surfaces, then they can do inspection of buildings and bridges and other hard-to-reach places."

The inspiration for stickybot was the Tokay gecko, one of the world's largest and heaviest geckos. Tiny structures on the pads of the gecko's feet allow it to climb walls by nestling these tiny structures close to small irregularities on the wall surface. The gecko's foot pad is only sticky in one direction, and the researchers discovered a way to mimic this by layering polymers in a way that the resulting hierarchical structures show directional adhesion.



A gecko's foot possesses a unique adhesion system  
Credit: [KellarAutumn.com](http://KellarAutumn.com)

The nanoscale structures on the gecko's foot pad interact with molecules in the wall through a type of intermolecular force called the van der Waals force. The force is powerful enough that the gecko can support its entire body weight with one toe. Cutkosky and Autumn are working to improve their initial design by, first, developing a way for the stickybot to rotate its "foot" at the "ankle," and, second, designing methods to increase the level of sensing and control available to the robot. Read more about this project [here](#).

### Controlling Machines With Our Minds



New research, **partially funded by NSF**, is turning the science-fiction scenario of controlling machines with our minds into a reality. Recent results from a **joint project between the Mayo Clinic and the University of North Florida** show that it is possible to "type" letters on a computer screen with nothing more than a thought and a brain-computer interface (BCI).

The research subjects are epilepsy patients who are monitored for seizures through BCI electrodes placed directly on the surface of their brains. The patients are asked to focus on a screen containing

Electrode cap used in mind-control research. Credit: Bin He

a 6-by-6 matrix of alphanumeric characters. When the subject looks at the letter "q," signals from the patient's brain direct a computer to type that letter on another screen.

The development of mind-control devices has largely evolved from studies aimed at improving epilepsy treatments. In an **NSF-funded project** at the University of Minnesota, electrical signals from electrodes placed on the outside of the patient's head are combined with information from non-invasive functional magnetic resonance imaging (fMRI) scans of the brain to more accurately pinpoint the source of seizures. Bin He, lead investigator of the Minnesota project, has shown that this combination of brain signals can, like the Mayo Clinic/Florida project, be used to control computers, but without the need for surgery to place electrodes on the brain surface. Watch a video and read more about He's work **here**.

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## Hacking the Cellular Codes of Health and Disease

You may not realize it, but the cells in your body act like billions of tiny computers, each using a complex system of genes, proteins, enzymes and other tools working together like a piece of software to receive, process and send information. When something goes haywire in those cells' processing systems, serious illnesses can result, including cancer.



Credit: Nicolle Rager, NSF

For John Tyson, a professor of biology at Virginia Tech, thinking about cells as information-processing systems makes a lot of sense.

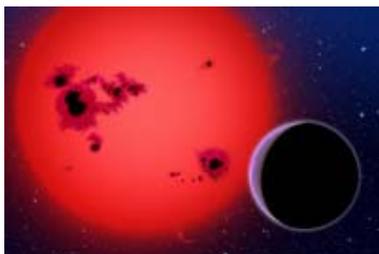
"Cells receive information in the form of chemical signals, physical attachments to other cells, or radiation damage, for instance," Tyson says. "On the basis of this information, the cells must make the correct response, such as to grow and divide, or to stop growing and repair damage, or to commit suicide."

Tyson has worked, with **NSF support**, to develop mathematical models of the myriad ways cells process information. Once these models are successfully created, computers are able to use them to simulate cell behavior and provide important insights into how cells work and what is happening when they don't work properly.

"If the math model behaves in the computer the way cells behave in the lab, we gain confidence that we understand the molecular interactions correctly. If not, we can be sure that our models are missing something important," Tyson says. This approach may someday make fixing our bodies as straightforward as reprogramming a computer. Read more about this work **here**.

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## Scientists Discover Nearby Water World



Artist's conception of newly discovered planet. Credit: David Aguilar, Harvard-Smithsonian

NSF-funded researchers recently reported the discovery of a water-covered planet approximately twice the radius of the Earth and six-and-a-half times its mass, orbiting a nearby red dwarf star, about 40 light years from Earth. The discovery was made during the first year of operation of the NSF-funded **MEarth Observatory**, an array of eight 16-inch-diameter telescopes atop Mt. Hopkins in Arizona.

"The discovery is exciting for several reasons," explains **David Charbonneau**, head of the MEarth project and Harvard professor of astronomy. "First, the planet mass and radius are consistent with a water-dominated composition with only a thin atmosphere, whereas previously discovered worlds have been hydrogen-dominated giants much more akin to the gas and ice giants of the solar system.

Second, because the star is so small and nearby, we should be able to study the planetary atmosphere with current observatories."

The MEarth discovery is one of dozens of recent exoplanet discoveries, but it's the first to show clear evidence of the presence of water. The next step, direct confirmation that water is present, will require the use of a space-based instrument, such as NASA's Hubble Space Telescope.

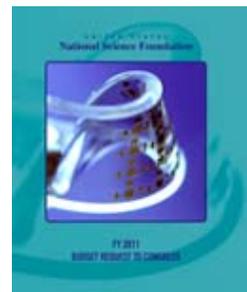
"Since this planet is so close to Earth," Charbonneau says, "Hubble should be able to detect the atmosphere and determine what it's made of." Read more about this exciting discovery **here**.

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## DID YOU KNOW?

On February 1, 2010, NSF submitted its fiscal year **2011 budget request** to Congress. The proposed \$7.4 billion budget represents an 8 percent increase over 2010 and aligns with the administration's National Innovation Strategy.

NSF Director Arden L. Bement, Jr., highlighted three NSF programs in the request that address the administration's goals of educating the next generation of Americans: (1) the Advanced Technological Education program, aimed at community colleges; (2) Graduate Research Fellowships and the Faculty Career Development program, both aimed at new investigators; and (3) a program on climate change education, aimed at all levels of learners.



## FACES OF NSF RESEARCH

### NSF Director to Lead New Global Policy Institute



NSF Director Arden L. Bement, Jr., recently announced his acceptance of a position as director of Purdue University's new Global Policy Research Institute (GPRI) in West Lafayette, Ind. Bement will leave his current position as director of NSF and take on his new duties at GPRI on June 1, 2010.

Bement was named director of NSF by President George W. Bush in November 2004, arriving at NSF from his previous position as director of the National Institute of Standards and Technology (NIST), a position he had held since 2001.

During his tenure as NSF director, Bement oversaw the foundation's more than \$7 billion budget and led the agency onto a path that is expected to double its budget over 10 years. His achievements at NSF include: the establishment of the Office of Cyberinfrastructure; increased investments in high-end computational facilities and a more robust grid network; improvements in the management of major facilities; and the development of grant mechanisms and management practices for funding transformative research. He was also key in increasing NSF's role in international science policy.

Prior to joining NIST, Bement was the David A. Ross Distinguished Professor of Nuclear Engineering and head of the School of Nuclear Engineering at Purdue University. He also held faculty appointments in materials engineering, electrical and computer engineering and the Krannert School of Management. In addition to his positions at Purdue, Bement was the director of the Midwest Superconductivity Consortium and the Consortium for Intelligent Management of the Electrical Power Grid.

Before joining the faculty at Purdue, Bement held a variety of posts in industry, government and academia, including positions at TRW, Inc., DARPA, Batelle Northwest Laboratories, and General Electric Co., among many others. He is the recipient of many awards and served in numerous government advisory roles. He is also a retired Lieutenant Colonel of the U.S. Army Corps of Engineers and a recipient of the Distinguished Service Medal of the Department of Defense. In 2009, the Emperor of Japan awarded him the Order of the Rising Sun, Gold and Silver Star, for his contributions to international understanding through science and technology.

"With the submission of his 2011 budget, President Obama has underscored again the critical role that the National Science Foundation plays in ensuring our nation's continuing preeminence in science and technology," said John P. Holdren, assistant to the president for science and technology and director, Office of Science and Technology Policy. "I want to thank Dr. Bement for his nearly seven years of distinguished service at NSF's helm and his unwavering commitment to America's research and education enterprise."

## NSF IN THE NEWS

**Getting the Science Right** (*CNN, The Los Angeles Times*) Academy-Award winning director and producer Ron Howard says the science in movies and TV shows should ring true. A new initiative, the Creative Science Studio, a partnership between NSF and the University of Southern California School of Cinematic Arts, will help with this.

**Scientists Scour Haiti for Earthquake Clues** (*The Washington Post*) The Jan. 12 earthquake in Haiti reordered the local geology, according to a team of NSF-funded scientists probing the causes of the 7.0-magnitude quake. The team is aiming to improve prediction of future quakes through its study.

**Scientists Move Toward At-home Cancer Detection Kit** (*FOXNews*) A highly sensitive acoustic-resonance sensor, smaller than a human hair, is under development by NSF-funded scientists, raising hopes that a home-based kit to test body fluids for cancer might someday become a reality.

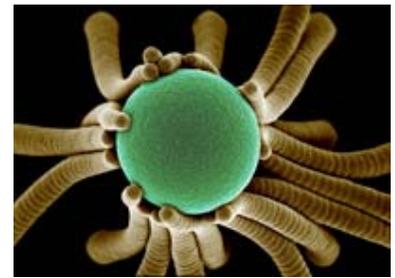
**Developing a New Type of Hybrid Car** (*Irish Times*) Research funded by NSF has led to the development of a new type of hybrid electric vehicle that generates part of its power from wind or solar sources and can be plugged into the grid to sell excess power back to the utility company.

## THE RIPPLE EFFECT

### Visualization Challenge Winners Announced

On Feb. 18, 2010, NSF and the journal *Science*, published by the American Association for the Advancement of Science (AAAS), announced the winners of the seventh annual International Science and Engineering Visualization Challenge. The winners, published in the Feb. 19 issue of *Science*, were chosen from among entries in a variety of categories including photography, illustration, and even interactive games. The award-winning images can be viewed on NSF's Web site [here](#).

At right is the winning entry in the photography category of the 2009 Challenge. Tiny plastic fingers, each with a diameter of 1/500th of a human hair, grasp a plastic sphere. The image, which brings to mind global efforts to promote sustainability, was created with a scanning electron microscope and digitally enhanced for color.



First Place, Photography: "Save Our Earth. Let's Go Green." Credit: Sung Hoon Kang, Joanna Aizenberg and Boaz Pokroy, Harvard University

### EU, US and China Join Forces



Credit: Roger Bales, Univ. of California, Merced

Scientists from the United States, Europe and China have established a network of field research stations to study how soils benefit humanity. The research will focus on processes in the critical zone, the region between the top of a forest canopy and the rock beneath soil. This new **international collaboration** will determine how to protect soil from threats due to climate change and the heightened food and energy demands of an increasing human population.

Funding from the European Commission includes support for European and Chinese teams to link with researchers funded by **NSF's Critical Zone Observatory (CZO) program**. Three new CZOs have recently been established with funds from NSF through the American Recovery and Reinvestment Act, bringing the number of NSF-funded CZO sites to six. The new sites are in the **Christina**

**River Basin** in Delaware and Pennsylvania, the **Luquillo National Forest** in Puerto Rico and the **Jemez River Basin** in New Mexico and Arizona.

This new international partnership promises to shed new light on how these important critical zone processes are affected by climate, the water cycle and land use changes.

## Partnership

On Feb. 4, 2010, Microsoft Corp. and NSF announced a **new agreement** to provide cloud computing resources through Microsoft's Windows Azure to researchers chosen through the NSF merit-review process. By extending the capabilities of easy-to-use applications via Microsoft cloud services such as Azure, the partnership aims to broaden the nation's research capabilities, foster collaborative research communities and accelerate scientific discovery.

"SciGirls," a new weekly PBS series partially funded by NSF and aimed at kids ages eight to 12, premiered in February and features real middle-school girls engaging in scientific investigations. Read more about this project **here**.



Credit: SciGirls, PBS



*The National Science Foundation (NSF) is an independent federal agency that supports fundamental research and education across all fields of science and engineering. In fiscal year 2010, its budget is \$6.9 billion. NSF funds reach all 50 states through grants to over 1,900 universities and institutions. Each year, NSF receives about 48,000 competitive requests for funding, and makes over 11,300 new funding awards. NSF also awards over \$400 million in professional and service contracts yearly. Contact **NSF's Office of Legislative and Public Affairs** for more information or for permission to reuse newsletter images.*



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