National Science Foundation
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The Colors of Fall: Long-term as Well as Seasonal Changes

The leaves of the American chestnut turn yellow in the fall. Sugar maples display striking reds and oranges. But in the northeastern and mid-Atlantic states, where the rich displays are an important tourist attraction, the colors have been evolving—not just for the season, but over decades.

Harvard Pond lies within NSF's Harvard Forest LTER site. *Credit: John Burk*

Autumn colors were different in those regions 50 years ago, says David Foster, an ecologist at NSF's Harvard Forest Long-Term Ecological Research (LTER) site in Massachusetts. The mix of tree species has changed due to land-use patterns, introduced pests and diseases, warming temperatures and drought. According to Foster, **the changes** are likely to continue.

"Over time," Foster says, "the autumn colors of our forests may fade as conditions become less favorable for northern trees such as sugar maples."

At the start of the 20th century, much of the New England landscape south of Maine was covered by white pine forests. As the pines were harvested, they were succeeded by broadleaf, or deciduous, trees: chestnuts, maples, oaks, birches and other species that boast autumn colors.

Mature chestnuts, however, have largely been wiped out by a fungal disease. Sugar maples, planted extensively along roadsides in the 18th and 19th centuries, are expected to move north as temperatures rise, Foster says. Trees left behind, such as ashes, dogwoods and others, face diseases that are already spreading through the forests and may be exacerbated by warmer temperatures—decreasing the odds for vibrant fall colors.

For more news from the Harvard Forest LTER site, visit the **website**.

Arctic Heat Unmatched in 1,800 Years, Study Shows

The **high temperatures** recorded during the past 50 summers on a northern Norwegian archipelago were unmatched in the past 1,800 years, an NSF-funded research team has found.

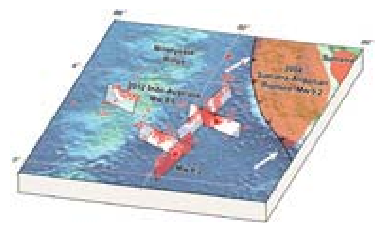
Climate scientist William D'Andrea of the Lamont-Doherty Earth Observatory at Columbia University, New York, led the analysis of evidence captured in sediment beneath a deep-water lake in the Svalbard Archipelago.

Since 1987, summer temperatures on Svalbard have been 2-2.5 degrees Centrigade (3.6-4.5 degrees Fahrenheit) hotter than even during the Medieval Warm period, from about 950 to 1250--years often cited as a period of warming attributed to a natural increase of solar radiation.

William D’Andrea collects sediment from a lake bottom. *Credit: William D'Andrea, LDEO, Columbia University*

Researchers produced the 1,800-year Arctic climate record by analyzing characteristics of the algae buried in the sediments of Kongressvatnet Lake. Whereas most Arctic climate records come from ice cores that preserve only cold-season temperatures, lake sediments can also provide a record of summer temperatures.

Tectonic Plate Faulted Internally in 2012, Study Shows



Large strike-slip faults activated during the April earthquake. *Credit: Han Yue/Thorne Lay, UCSC*

An unusual pattern of seismic faults played a major role in the earthquake that struck under the Indian Ocean off the coast of Sumatra in April 2012, an NSF-funded team of scientists recently reported.

During the magnitude 8.7 earthquake, the Indo-Australian plate--a major tectonic plate that includes Australia and the surrounding ocean--ruptured over a complex network of at least four mid-plate faults, some of them lying at right angles to one another.

Most great earthquakes occur at the edge of plates in subduction zones, where one plate slides under an adjoining plate. Motion along the fault causes vertical displacement at the surface. According to the team of earth and planetary scientists at the University of California-Santa Cruz, the Indian Ocean earthquake involved horizontal ("strike-slip") motion along faults in the middle of the plate. The Indo-Australian plate appears to be gradually fragmenting into two separate plates, the team reported.

Read **more** about the largest strike-slip earthquake and the largest intraplate earthquake ever recorded. Despite its magnitude, the 2012 quake did not have as large an impact as the December 2004 earthquake in the same region because of the primarily horizontal, as opposed to vertical, movement.

Scientist Discovers Plate Tectonics on the Red Planet

Credit: NASA

An NSF-supported planetary geologist has discovered evidence of plate tectonics on Mars. An Yin, of the University of California-Los Angeles, normally conducts geologic research in the Himalayas and Tibet, where two of the earth's seven major plates divide.

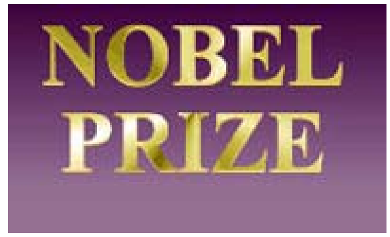
Yin analyzed about 100 satellite images of the Mars surface taken by the NASA spacecraft THEMIS and Mars Reconnaissance Orbiter.

He found features that indicate the presence of processes similar to those on Earth--such as rifting, strike-slip faulting, and subsurface mass removal. He believes Mars has two plates, compared with Earth’s seven.

Learn more about Yin's research in this university **news release**.

NSF Consistently Supports Nobel Prize Winners

Of the 10 Nobel laureates announced in October 2012, five have received NSF grants. Economics winners Alvin Roth of Harvard University and Lloyd Shapley of the University of California-Los Angeles were cited for addressing a central economic problem of how to best match resources to individuals. One of Roth's NSF-funded projects resulted in an efficient system for matching kidney donors with recipients. The donor system is described in this **video**.

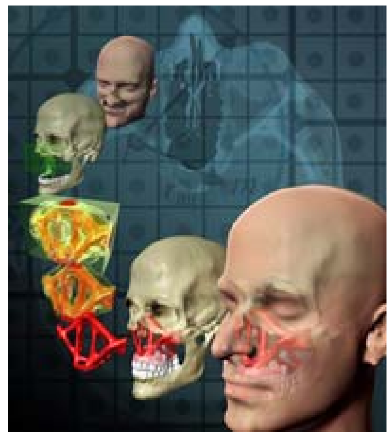


More than 200 Nobel Prize winners have received NSF support for their research at some point in their careers. NSF has supported Nobel laureates in the following categories: 62 in physics, 51 in chemistry, 44 in medicine and 47 in economics.

Learn more about Nobel laureates supported by NSF in this **fact sheet**.

Engineering a New Face After Injury

Surgeons face many limitations in helping a patient with severe craniofacial injuries--damage to the skull and face. They want the patient to recover not only his or her appearance, but also the ability to perform essential tasks: speak, eat and even breathe.



Evolution of a patient's recovery from facial injury through the use of topological optimization. *Credit: Hanlon, Beckman ITG, University of Illinois*

To reconstruct the facial bone structure, the surgeon builds a frame with bone from other parts of the body (called autologous tissue). Experience and skill are crucial.

"The middle of the face is the most complicated part of the human skeleton," said Glaucio Paulino, engineering professor at the University of Illinois at Urbana-Champaign. "What makes the reconstruction more complicated is the fact that the bones are small, delicate, highly specialized and located in a region highly susceptible to contamination by bacteria." Paulino pointed out that the patient may improve but still suffer from significant deformity.

An NSF-supported research team, including Paulino and colleagues at the Ohio State University Medical Center and University of Illinois, is studying how to bring **topological optimization** to the operating room to help more patients fully recover. Topological optimization is a mathematical method that uses given loads, the applied force on an area and spatial limits to optimize a specific structure's layout. The result is an optimized structure that fits the existing constraints.

This method is also successfully used to engineer spaceships and airplanes. The Airbus 380 wing, for example, was designed with topological optimization.

This **video** shows the process of creating a structure for a patient with severe gunshot injury using topological optimization. Although the results do not resemble the natural bone structure, they preserve the vital functions of facial organs and provide a safe platform for prosthetics and plastic surgery.

National Science Foundation in the News

Kids Play the Way Scientists Work (*Discover*) - The way preschoolers play is similar to the way scientists do experiments: come up with general principles, based on data from their daily lives.

Franklin Institute Awards Announced (*Philadelphia Inquirer*) NSF Director Subra Suresh was chosen for the Benjamin Franklin medal, for his research in mechanical engineering and materials science.

Revised AP Physics, U.S. History Coming Soon (*Education Week*) - Recommendations from NSF contributed to the revisions in the Advanced Placement physics course.

New Research Infrastructure

R/V *Sikuliaq* Will Support Arctic Marine Research

The R/V *Sikuliaq. Credit: Val Ihde Photography*

NSF recently launched the R/V *Sikuliaq*, one of the most advanced research vessels in the world. The ship was built in Wisconsin with funding provided by NSF through the American Recovery and Reinvestment Act, and will be operated by the University of Alaska-Fairbanks.

Sikuliaq is an Iñupiat word meaning "young sea ice." The 261-foot vessel is the first global-class, ice-capable ship owned by NSF. Its hull is specifically designed to operate in Arctic sea ice and the open waters surrounding Alaska.

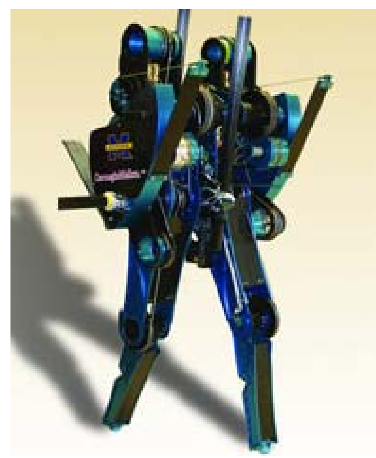
The ship is projected to spend up to 270 days at sea each year, supporting roughly 500 researchers and students, including persons with disabilities.

Supercomputer Will Support Atmospheric and Earth Sciences

NSF recently dedicated a supercomputing center and one of the world's most powerful supercomputers in Cheyenne, Wyo. The center will be managed by NSF's National Center for Atmospheric Research (NCAR).

The supercomputer, known as "Yellowstone," can work at 1.5 petaflops--equal to 1.5 quadrillion (a million billion) mathematical operations per second. Its speed is comparable to 7 billion people (the world's population) each simultaneously conducting 200,000 calculations a second. Yellowstone will be used to improve scientific understanding of climate change, severe weather, air quality and other atmospheric and geosciences research.

Popular Mechanics Recognizes Robot and Camera Breakthroughs



MABEL. *Credit: Rose Anderson/Catharine June, University of Michigan*

MABEL, one of the fastest moving and most sophisticated bipedal robots on Earth, has earned its developers a coveted Popular Mechanics Innovator award.

"Unlike other robots, MABEL has human-like gait and a reflex response that allows it to step over obstacles," says Radhakisan Baheti, an NSF program officer in the Directorate for Engineering who has funded the work for over a decade.

"Innovations in feedback control theory--through the study of highly nonlinear dynamics--have played a key role in MABEL's bipedal locomotion design."

Read about two more NSF-funded winners: a laser camera that sees around corners and an ultralight metal.

A full list of winners, including short features about their work, can be found at the Popular Mechanics **website**.

The National Science Foundation (NSF) is an independent federal agency that supports fundamental research and education across all fields of science and engineering. Its Fiscal Year 2012 budget is $7.0 billion. NSF funds reach all 50 states through grants to nearly 2,000 colleges, universities and other institutions. Each year, NSF receives more than 50,000 competitive requests for funding, and makes about 11,000 new funding awards. Contact NSF's ***Office of Legislative and Public Affairs*** *at 703-292-8070 for more information or for permission to reuse newsletter images. Editor: Amber Jones.*

The National Science Foundation, 4201 Wilson Boulevard, Arlington, Virginia 22230, USA Tel: (703) 292-5111, FIRS: (800) 877-8339 | TDD: (800) 281-8749