

The Science of Innovation



Barrett Technology's WAM-based robot, Marvin, using Intel's Electric Field Pretouch robotic grasping technology, with California Governor Arnold Schwarzenegger on stage with Intel CEO Craig Barrett and German Chancellor Angela Merkel at CeBIT'09 (Centrum für Büro und Informationstechnik). Credit: Brad Hood, eyetrix.com

The Small Business Innovation Research ([SBIR](#)) program is administered by the U.S. Small Business Administration and involves eleven federal agencies. The program ensures that the nation's small, high-tech, innovative businesses are a significant part of the federal government's research and development efforts.

With funding from the National Science Foundation (NSF) through its [SBIR](#) program via awards [0646448](#) and [0823008](#), Barrett Technology, Inc., of Cambridge, Mass., has developed one of the world's most advanced robotic arms, the Whole-Arm Manipulation, or WAM, tool. The new type of robotic arm has the unique ability to respond to human touch and provide sensitive feedback to its operator.

Now a workhorse for several multinational companies, and even surgeons, WAM recently appeared on stage with German Chancellor Angela Merkel, California Governor Arnold Schwarzenegger and leaders from industry at an international technology show in Germany. A video showing the arm in action can be seen [here](#).

Barret was also recently awarded a [patent](#) for its Puck, an ultra-compact, high-performance motor controller developed with the support of two other NSF SBIR awards, [0712348](#) and [0823008](#).

Other NSF SBIR projects that have had successful industrial outcomes include the following:

- Bioprocessors Corp. received NSF SBIR funding through award [0321506](#) in 2003 to develop a "cell bioreactor-on-a-chip" device to monitor fermentation conditions in drug production and to screen for new drug entities. Its product reached the market in 2006, and since that time, a number of major pharmaceutical companies have adopted the system for fermentation monitoring and drug screening. The analytical technology for this product was licensed from the University of Maryland. Bioprocessors Corp. was acquired by a Massachusetts-based biosciences company in the first quarter of 2009.
- 4th Wave Imaging received NSF SBIR awards [0216413](#) and [0321747](#) to develop software for analyzing underground seismic shock waves and predicting likely oil and gas deposits. In 2007, 4th Wave was acquired by a Dutch company that used the same type of resource discovery. 4th Wave's technology has recently been applied in an important new environmental role: locating and monitoring underground caverns that store greenhouse gas effluents, such as carbon dioxide.
- Mercury emissions from coal-fired power plants pose a major national health issue. Experts say removal must be cheap, efficient and capable of handling the huge gas volumes involved. With the support of NSF SBIR awards [0349752](#) and [0620518](#), Sorbent Technologies Corp. developed a special brominated carbon absorbent and method for its manufacture. Within a year of its commercial introduction, public utilities had purchased millions of pounds of the new material. Shortly thereafter, Sorbent was acquired by a multi-billion-dollar specialty chemicals producer.

Untangling the Mysteries of Spider Silk

NSF-sponsored [research](#) at the University of the Pacific is unraveling some of spider silk's mysteries and revealing how to make stronger, yet lighter, fibers. Spider silks are composed of several different compounds that determine the silk's strength, elasticity, and toughness. Craig Vierra's research group is using a wide range of techniques to study the proteins that make up the silk of one particular spider--*Latrodectus hesperus*, also known as the black widow spider. Vierra's research is helping scientists understand the production of spider silk at a molecular level. These insights could lead to the development of synthetic high performance fibers, modeled on those made by spiders.



Craig Vierra and Coby La Mattina microdissect a black widow spider. Credit: Craig Vierra.

In addition to the potential for producing incredibly strong, elastic, and biodegradable fibers, Vierra's work has provided a tremendous opportunity for community involvement. Members of the local community have partnered with the research team to help collect spiders from wood piles and garages, offering a natural platform to educate the public and allow them a hands-on opportunity to participate in research. Read more about Vierra's work [here](#).



Ronald Mallett. Credit: Robert Parkey III

A Son's Quest for Time Travel

Growing up in New York City in the 1950s, Ronald Mallett idolized his father, a television repair man and amateur inventor who sparked young Ron's curiosity about the world. "He was the most important thing in my life, my entire universe," Mallett recalled in a [National Public Radio interview](#) in 2007.

Tragically, Mallett's father died suddenly at the age of 33 from a heart attack, devastating 10-year-old Ron. Shortly after that loss, however, a comic book adaptation of HG Wells' classic "The Time Machine" inspired Ron and set him on a life-long quest--if time travel was possible, he would build a time machine, go back in time and warn his father about his heart condition.

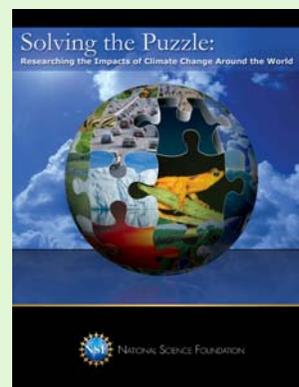
Despite the barriers African-American students faced at the time, Mallett earned a doctorate in physics from Pennsylvania State University and became a tenured faculty member at the University of Connecticut. Over the years, while Mallett engaged in research on black holes, general relativity and other facets of theoretical physics, he continued quietly working on the concept of time travel, receiving [NSF support](#) for his work. Eventually he published a paper that built on the work of Einstein and others, and raised the possibility of using light to bend time--a process which could, theoretically at least, allow for time travel.

Recently, director Spike Lee acquired the rights to produce a feature film version of Mallett's published memoir, "Time Traveler: A Scientist's Personal Mission to Make Time Travel a Reality" (Basic Books, 2007), co-authored with Bruce Henderson and published around the world. While Mallett continues making contributions to physics, thanks to his father's inspiration, his own life inspires others.

DID YOU KNOW?

In mid-May, NSF released a major report on global climate change, entitled "Solving the Puzzle: Researching the Impacts of Climate Change Around the World," that describes how, over nearly 60 years, NSF-funded researchers have found signs of a changing climate in nearly every corner of the globe, from the icy expanses of Earth's polar regions to its equatorial ecosystems.

Climate change research and education have been identified as presidential priority areas for NSF, and the report's release coincides with the recent announcement of the President's fiscal year 2010 budget for NSF. The FY10 budget request includes an increase of approximately million for climate research, which would double NSF's investment in this area. The online version of the report can be found [here](#), or in pdf form [here](#).



FACES OF NSF RESEARCH

Powering the Planet With Science

Dan Nocera, MIT. Credit: Donna Coveney/MIT

Dan Nocera, chemistry professor at the Massachusetts Institute of Technology (MIT), talks a lot these days about “personalized energy.” Nocera envisions a future without gas stations or power transmission lines, one in which all of your personal energy needs will be supplied by the sun—a future that should be, he says, a major goal of national and global energy policies.

Recently named as one of *Time Magazine’s* “[One Hundred Most Influential People](#),” Nocera has been a tireless advocate for the basic research needed to develop new energy technologies. Several years ago, working with the program “NOVA,” he developed the pilot for what became “scienceNOW,” a PBS production supported, in part, by NSF. The pilot show on fuel cells was later nominated for an Emmy Award.

The key to turning Nocera’s futuristic scenario of personalized energy into reality is inexpensive energy storage. We need a way to capture and hold the energy in sunlight, he says, so it can be used at night or on rainy days. Rather than working on better batteries, as most researchers have done,

Nocera has taken a cue from the world of plants and discovered a better solar conversion method.

All green plants convert sunlight into a form of fuel that can be stored until the plant needs it, using photosynthesis, a chemical process that splits water into hydrogen and oxygen. Nocera and his coworkers at the *Powering the Planet* [Center for Chemical Innovation](#) have discovered an inexpensive cobalt catalyst that works in a similar way. The center, headed by Harry Gray, chemistry professor at the California Institute of Technology, is a five year, \$20-million dollar multi-institution effort funded by NSF, which has, as one of its goals, to enhance U.S. competitiveness in the renewable energy area.

The new type of solar catalyst developed by Nocera and his colleagues mimics the process in plants in which the water-splitting catalyst is allowed to periodically fall apart. A small amount of solar energy is then used to reconstruct the catalyst and start the conversion cycle again. “This is the nirvana of what we’ve been talking about for years: an inexpensive catalyst that is self healing, easy to manufacture and works under the conditions of natural photosynthesis,” says Nocera. “Solar power has always been a limited, far-off solution. Now we can seriously think about solar power as unlimited and soon.” Read more about the research [here](#).

NSF IN THE NEWS

[Improved Technology Allowing Researchers to Scan Ancient Texts](#) (*The Wall Street Journal*) In a 21st-century version of the age of discovery, teams of computer scientists, conservationists and scholars are fanning out across the globe in a race to digitize crumbling literary treasures. Scholars are now studying ancient texts with X-ray fluorescence, multispectral imaging used by NASA to photograph Mars and CAT scans used by medical technicians. This project is funded, in part, by NSF.

[Wildfires Found to Fuel Climate Change](#) (*Scientific American*) New research, funded in part by NSF, shows that wildfires are not just a result of a changing climate; they also contribute to an overall warming trend. As vegetation burns, it releases stored-up carbon into the atmosphere, speeding global warming and thereby exacerbating conditions that may generate a greater incidence of wildfires in the coming years, according to a major report published in *Science* in late April.

[Energy Storage Poised for a Breakthrough](#) (*MSNBC*) A new material holds promise for producing batteries that can charge in minutes instead of hours. The material, lithium ion phosphate, is being investigated for potential use as an energy-storage medium in electric vehicles and for wind energy storage. The work is funded, in part, by NSF.

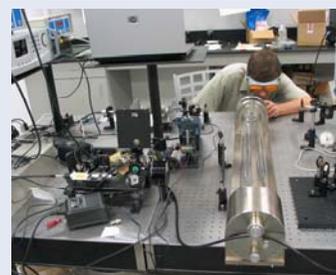
THE RIPPLE EFFECT

Stimulus Funding Expected to Strengthen Nation's Research Infrastructure

In mid-May, NSF announced two special funding opportunities for projects expected to strengthen the research infrastructure for the country. Funding of \$200 million was provided for repairs and renovations of the nation's research infrastructure through the Academic Research Infrastructure (ARI) program as part of the American Recovery and Reinvestment Act (ARRA), signed into law by President Barack Obama in February 2009. An additional \$300 million in ARRA funding is available through the Major Research Instrumentation (MRI) program to provide researchers and students with access to state-of-the-art equipment for science and engineering.

A letter of intent, due in July, is required for the ARI program; full proposals for both the MRI and ARI programs are due in August, 2009 and will undergo NSF's normal merit review process. All NSF-supported fields of science, mathematics and engineering are eligible for consideration. Further details can be found [here](#).

Additional information related to NSF's plans and activities for ARRA funding can be found [here](#).



A mid-infrared laser being developed with support from NSF's Major Research Instrumentation program. Credit: Sergey Mirov, University of Alabama-Birmingham

The Science Behind "Angels & Demons"



Cast members for the movie "Angels & Demons" meet at CERN in Geneva, Switzerland. Credit: Columbia Pictures

On May 15, the movie "[Angels & Demons](#)," was released, bringing the world's largest particle physics laboratory to the silver screen. Based on Dan Brown's best-selling novel, this major motion picture, starring Tom Hanks and directed by Ron Howard, focuses on a plot to destroy the Vatican using a small amount of antimatter. That antimatter is made using the Large Hadron Collider (LHC) and is stolen from the European particle physics laboratory CERN. Parts of the movie were filmed at [CERN](#).

Embracing this opportunity to discuss the real science behind CERN--the science of antimatter, the LHC and particle physics research--NSF hosted a [live media briefing](#) on May 19, 2009, which brought together three world-renowned physicists: Rolf-Dieter Heuer, director-general, CERN; Leon Lederman, author, "The God Particle," and Boris Kayser, distinguished scientist, Fermilab and former program director, NSF Theoretical Physics. These experts fielded questions from journalists, college and high school students and interested individuals from around the world. This webcast is part of "[Angels & Demons: The Science Revealed](#)," a worldwide series of lectures and "Angels & Demons"-related events hosted by scientists working on experiments at the LHC.

U.S. participation in the LHC project is supported by the Department of Energy's Office of Science and the NSF.

This [NSF webcast](#) compliments NSF efforts to inform and support Hollywood's incorporation of science into entertainment and popular culture. Dramatic license with scientific ideas is often taken in popular films, but scientists and moviemakers agree that getting at least some of the science right makes for more plausible stories in films. Read more about the science behind "Angels & Demons" [here](#).



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 2009, its budget is \$9.5 billion, which includes \$3.0 billion provided through the American Recovery and Reinvestment Act. NSF funds reach all 50 states through grants to over 1,900 universities and institutions. Each year, NSF receives about 44,400 competitive requests for funding, and makes over 11,500 new funding awards. NSF also awards over \$400 million in professional and service contracts yearly. NSF expects to make an additional 3,000 awards with the Recovery Act funds. Contact [NSF's Office of Legislative and Public Affairs](#) for more information, to unsubscribe or for permission to reuse newsletter images.