APS physics

Capitol Hill Quarterly

www.aps.org /publications/capitolhillquarterly/index.cfm April 2010 VOLUME 5, NO. 1

APS Commends President's Fiscal Year 2011 Proposed Scientific Budget

By Tawanda W. Johnson

The American Physical Society (APS) is delighted that President Obama's Fiscal Year 2011 budget proposal increases federal investments in transformational research that will keep the nation on a path of scientific advancement, technological innovation and economic growth.

Specifically, APS lauds the support of research programs at the Department of Energy's Office of Science (DOE), the National Science Foundation (NSF) and the National Institute of Standards and Technology (NIST). The President has proposed hiking the DOE budget by $226 million to $5.1 billion. NSF is slated to have its budget increase by $550 million to $7.4 billion. NIST would receive a boost of $67 million to $587 million.

Scientists, who receive funding from these agencies, are engaged in research that will generate solutions to the country's most pressing challenges, including developing technologies that create clean, affordable energy for all Americans. APS is also pleased that the President's budget is consistent with a promise to double the scientific agencies' budgets over a 10-year period.

President Obama's FY 2011 budget includes investments in:

• Nuclear energy research to generate technologies for the creation of safe, clean, nuclear power plants – a goal the President outlined in his State of the Union Address.

• Nuclear security to achieve the President's goal of reversing the spread of nuclear weapons and keeping the current stockpile safe and secure.

• Energy efficiency to develop more efficient batteries for electric cars, helping to reduce the nation's carbon footprint.

• The Graduate Research Fellowship program and the Faculty Career Development program to foster the nation's next generation of scientists and engineers.

"At a time when the nation is striving for an economic recovery, federal investments in science and technology are more critical to America's future than ever," said Michael S. Lubell, APS Director of Public Affairs. "APS encourages Congress to support the President's budget in its upcoming appropriations process." In spite of uncertainties in the NASA budget, APS is pleased that it includes strong support for scientific programs.

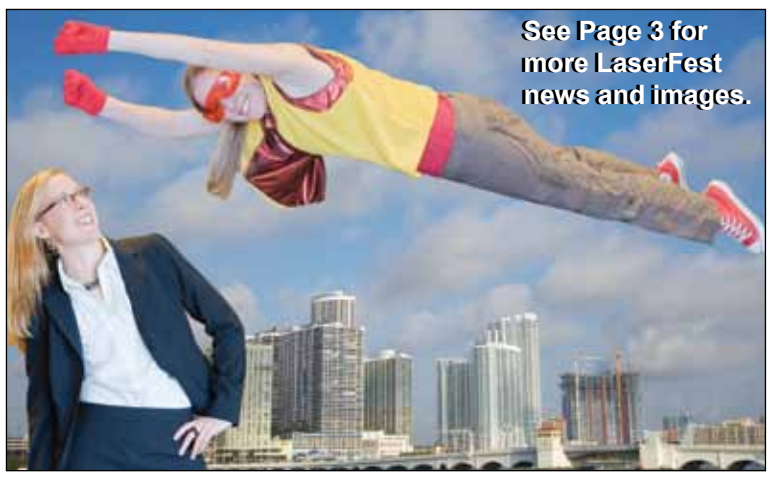


Photo by Ken Cole and Nancy B. Karasik/APS

Becky Thompson-Flagg as Spectra

Physicist Takes on Superhero Role for LaserFest

By Michael Lucibella

Watch out Superman, there's a new superhero in town! And she doesn't just shoot lasers, she actually is a laser. To coincide with this year's LaserFest, various events commemorating the 50th anniversary of the invention of the laser, APS debuted a series of comic books as part of its public outreach efforts.

Aimed primarily at pre-teens, the comic books (*Spectra: The Original Laser Superhero and Spectra's Power*) are based on the characters Lucinda Hene, a middle schooler, and her laser superhero alter ego Spectra, who fight against the evil Miss Alignment.

Physicist Rebecca Thompson-Flagg, who heads APS's Public Outreach Department, is the creative force behind Spectra. She developed the characters, wrote the script and has been instrumental in bringing Spectra to life. She even designed a Spectra costume for public appearances.

In 2008, the APS Outreach De-

SUPERHERO continued on page 3

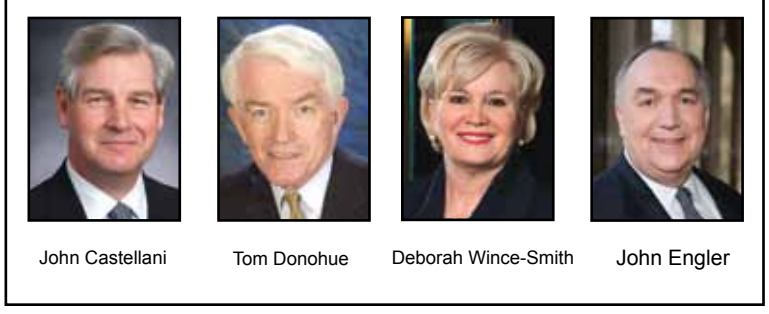
On the Back Page

U.S. Rep. Frank Wolf discusses keeping the U.S. strong through basic scientific research.

Business Leaders Call for Re-Authorization of America COMPETES Legislation

By Tawanda W. Johnson

Four business leaders testified recently before the U.S. House Science & Technology Committee, urging Congress to re-authorize the America COMPETES bill to keep the nation on a track of scientific advancement, technological innovation and job creation.



John Castellani | Tom Donohue | Deborah Wince-Smith | John Engler

The legislation, set to expire at the end of the current fiscal year, calls for the doubling of research funding for the Department of Energy's Office of Science, the National Science Foundation and the National Institute of Standards and Technology, among other programs.

John Castellani, president of the Business Roundtable; Tom Donohue, president of the U.S. Chamber of Commerce; former Michigan Gov. John Engler, president of the National Association of Manufacturers; and Deborah Wince-Smith, president and CEO of the Council of Competitiveness all stated that the legislation is critical to ensuring that the U.S. can successfully compete in the global economy of the 21st century.

Passed with bipartisan support in 2007, the COMPETES bill was developed after the highly acclaimed *Rising Above the Gathering Storm* report recommended the following:

Increase America's talent pool by vastly improving K-12 science and mathematics education.

Sustain and strengthen the nation's traditional commitment to long-term basic research.

Make the U.S. the most attractive setting in which to study and perform research, so that the country can recruit and retain the best and brightest students, scientists and engineers throughout the world.

Ensure that the U.S. is the premier place in the world to innovate. See http://physicsfrontline.aps.org.

Secretary Chu Names 2009 Enrico Fermi Award Winners

University of Texas and Stanford University Professors Share Presidential Award

U.S. Energy Secretary Steven Chu has named John Bannister Goodenough, Ph.D. and Siegfried S. Hecker, Ph.D., as the winners of the Enrico Fermi Award – one of the most prestigious science and technology awards awarded by the U.S. government. The Presidential Award carries an honorarium of $375,000, which will be shared equally, and a gold medal. The award is administered on behalf of the White House by the U.S. Department of Energy. It honors the memory of Nobel Laureate Enrico Fermi.

"The 2009 Enrico Fermi Award will go to two scientists who have selflessly devoted themselves to our nation's energy and national security challenges," said Secretary Chu before the official announcement of the award. "These two individuals are pioneers in innovative research, and I want to thank them for their work and congratulate them on this award."

About the 2009 Enrico Fermi Award Winners

John Bannister Goodenough, Ph.D.

Goodenough, 87, is currently a professor at the Cockrell School of Engineering at the University of Texas at Austin, where he holds the Virginia H. Cockrell Centennial Chair in Engineering. He received the Fermi Award in recognition for his lasting contributions to materials science and technology, especially the science underlying lithium-ion batteries.

Goodenough, a physicist, identified and developed the cathode materials for the lithium-ion rechargeable battery that is ubiquitous in today's portable electronic devices. This material has proven to be inexpensive, environmentally friendly, safe, sustainable, and capable of thousands of charge cycles with a constant output voltage without a loss of capacity.

Photo courtesy of the U.S. Department of Energy

Left to right are: Steven Koonin, Under Secretary for Science; Steven Chu, Secretary of Energy; John Holdren, Director, OSTP; Siegfried S. Hecker, John Bannister Goodenough, William Brinkman, Director, DOE Office of Science.

Batteries incorporating this cathode material are used worldwide for cell phones and other portable wireless devices, power tools, hybrid automobiles, small all-electric vehicles, as well as increasingly for electrical energy storage for alternative energy, such as wind and solar power. As this technology continues to develop, it can be expected to have an enormous impact on the U.S. economy and the environment by helping to reduce carbon dioxide greenhouse gas emissions.

Goodenough received his Ph.D. in physics in 1952 at the University of Chicago. He was a research engineer at Westinghouse before moving to the MIT Lincoln Laboratory as a research scientist and group leader from 1952 through 1976. He continued his career as Professor and Head of Inorganic Chemistry at Oxford University. After retiring from Oxford, he returned to the United States in 1986 to join the University of Texas at Austin.

WINNERS continued on page 3

Capitol Hill Quarterly is a publication of the American Physical Society, www.aps.org. APS is a non-partisan, professional society of physicists with more than 47,000 members.

APS Members in the Media

United Press International

"Although Iran might claim that this work is for civil purposes, there is no civil application… This is a very strong indicator of weapons work."

***David Albright**, Institute for Science and International Security,* **(District of Columbia)** *after scrutinizing secret documents about Iran's nuclear program,* United Press International, *December 14, 2009.*

The Washington Post

"My job is neat…The improvements in time and frequency measurements have made possible a revolution in telecommunications services and other important technological advancements for our country."

***Judah Levine,** NIST* **(CO-2nd)**, The Washington Post, *January 4, 2010.*

The Los Angeles Times

"Europeans only used half as much energy per dollar of GDP, and it was clear that their lifestyle was as good as ours."

***Arthur H. Rosenfeld,** California Energy Commission,* **(CA-9th)** The Los Angeles Times, *January 11, 2010.*

The New York Times

"It is a tool that will allow us to see what was previously unseen."

Persis Drell, SLAC, **(CA-14th)** *on the Linac Coherent Light Source,* The New York Times, *October 17, 2009.*

United Press International

"The petascale supercomputer gives us the capacity to look for similarities across whole populations of acute patients."

Tanmoy Bhattacharya, **(NM-3rd)** *on using the world's fastest supercomputer to create a comprehensive model of HIV's evolutionary history,* UPI, *October 29, 2009.*

CBS5.com

"Nationally, this is the first effort to have physical scientists work together in close proximity with oncologists. This has never been done before."

Jan Liphardt, UC Berkeley, **(CA-9th)** *describing how University of California at Berkeley is part of a new national effort to combat cancer by scientists from a variety of backgrounds,* CBS5.com, *October 28, 2009.*

The New York Times

"Without the stimulus money, we would have sat on the sidelines."

***Wim Pieter Leemans**, Berkeley National Lab,* **(CA-9th)** *on the infusion of funds for the Berkeley Lab Laser Accelerator,* The New York Times, *October 17, 2009.*

ABC News.com

"We have codes to protect buildings in earthquake-prone cities like Toyko…We don't have anything like that in the financial world."

***Eugene Stanley,** Boston University,* **(MA-8th)** ABCNews.com, *September 15, 2009*

Snapshots from Physics History

The Birth of Jean-Baptiste Joseph Fourier

The human ear splits incoming sound waves into their component frequencies through mechanical means by exploiting natural resonances: namely, different nerve endings in our ears are sensitive to different frequencies. But it is also possible to analyze a sound mathematically to determine its component frequencies. This can be done thanks to a method, devised by an 18th-century French mathematician named Jean-Baptiste Joseph Fourier, known as a Fourier transform.

Born on March 21, 1768, Fourier was the son of a tailor in the village of Auxerre, France. Orphaned by age 10, the young Joseph received an early rudimentary education at a local convent, thanks to a recommendation by the local bishop. He proved such an apt pupil and went on to study at the École Royale Militaire of Auxerre. There he fell in love with mathematics. By 1790, Fourier was teaching at his alma mater.

Revolution was brewing in France. Fourier was sympathetic at first to the cause, drawn by "the natural ideas of equality," and a hope "of establishing among us a free government exempt from kings and priests." He joined his local Revolutionary Committee, but soon regretted it, as the ultra-violent Reign of Terror gripped France and thousands of nobles and intellectuals fell victim to the guillotine.

Fourier made the mistake of defending the stance of his own Auxerre faction before a rival sect while on a trip to Orléans. In July 1794, he was arrested and imprisoned for the views he'd expressed on that trip and found himself facing the guillotine. But with the death of Maximilien Robespierre, the Revolution lost steam and Fourier and his fellow prisoners were freed. Fourier was selected for a new teacher-training school to help rebuild France, where he studied under three of the most prominent French mathematicians: Joseph-Louis Lagrange, Pierre-Simon Laplace and Gaspard Monge. By September 1795, Fourier was teaching at the prestigious École Polytechnique.

Joining Napoleon's Army

A few years after his academic appointment, he joined Napoleon's army as a scientific adviser when Napoleon invaded Egypt, engaging in archaeological expeditions and helping found the Cairo Institute as Napoleon's military fortunes waxed and waned. By 1801, Fourier was back in France, teaching until Napoleon appointed him prefect in Grenoble. He promptly stirred up a mathematical controversy with his conclusions about his experiments on the propagation of heat.

The culprit was an equation describing how heat traveled through certain materials as a wave. He based his reasoning in part on Newton's law of cooling: The flow of heat between two adjacent molecules is proportional to the difference of their temperatures. Fourier concluded that every wave-like "signal," no matter how complex, can be represented by adding together many different waves. In other words, complicated periodic functions – whether continuous or discontinuous – can be expanded and written out as simple waves mathematically represented by sines and cosines.

The Memoir Controversy

Fourier completed his memoir, *On the Propagation of Heat in Solid Bodies*, in 1807 and read it to the Paris Institute on December 21 of that year. The reception was mixed. Both Lagrange and Laplace objected to the notion of what we now call Fourier series: the expansions of functions as trigonometrical series. Along with another scientist, Jean-Baptiste Biot, they also objected to Fourier's derivation of the equations of transfer of heat. (Biot had written an earlier paper on the topic in 1804, although that paper proved incorrect.)

Nonetheless, when the Paris Institute held a competition on the topic of how heat propagates in solid bodies in 1811, Fourier submitted his memoir for consideration. He won the prize, in part, because only one other entry was received. The selection committee (which included Lagrange and Laplace) recorded their reservations in their report: "The manner in which the author arrives at these equations is not exempt of difficulties and… his analysis to integrate them still leaves something to be desired on the score of generality and even rigor."

Because of the controversy, Fourier's memoir was not published until 1822, after his election to the Académie des Sciences in 1817 – the same year he became the Académie's secretary. His work did contain flaws, but it also provided the basis for later work on trigonometric series and the theory of functions of a real variable, most notably the Fourier transform, an operation that turns one function of a real variable into another. It is widely used in digital signal processing, as well as in the physical study of wave motion and optics.

Discovering the 'Greenhouse Effect'

Fourier's other claim to fame is the discovery in 1824 of the "greenhouse effect": namely, that certain gases in the Earth's atmosphere could trap heat from the sun instead of having it radiate back into space, thereby increasing the surface temperature of Earth. He was inspired by an earlier experiment with so-called "hot boxes" by Horace-Bénédict de Saussure, in which a wooden box lined with black cork was exposed to sunlight. De Saussure then inserted three small panes of glass into the cork, and noted that the temperature rose in those compartments closer to the center of the box.

However, de Saussure did not have a solid theory for this observed effect. Fourier rightly surmised that the Earth gains energy from numerous sources, most notably solar radiation causing an increase in temperature. He also stated that the Earth also radiates energy via infrared radiation (which he called chaleur obscure, or "dark heat"), and that a balance must be maintained between heat gain and heat loss. He incorrectly assumed that a significant amount of radiation from interplanetary space contributed to the greenhouse effect, but grasped that the rate of infrared radiation increased with the Earth's temperature. This latter insight was mathematically defined 50 years later with the Stefan-Boltzmann law, further refined by Planck's law 20 years after that.

Fourier continued to publish papers on mathematics until his death in 1830, when he tripped and fell down the stairs at him home. His tomb is in the Père Lachaise Cemetery in Paris, decorated with an Egyptian motif in honor of his position as secretary of the Cairo Institute.

APS Capitol Hill Quarterly

APS Physics Capitol Hill Quarterly is published four times yearly by the Washington Office of the American Physical Society (APS). It contains news of the Society and of physics relevant to Capitol Hill as well as opinions.
The APS Headquarters is located at One Physics Ellipse, College Park, MD 20740-3844. Phone: (301) 209-3200.

April 2010 • Series 2, Vol. 5, No. 1 • © 2010 The American Physical Society

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Gala Laser Celebration Sparkles in the Snow

By Michael Lucibella

Lasers play important roles in our lives, said U.S. Energy Secretary and Nobel Laureate Steven Chu, who served as the keynote speaker during a recent gala event at the Smithsonian Museum of American History.

Sponsored by APS and the Optical Society of America (OSA), the event was held to kick off LaserFest, a series of events celebrating 50 years of laser innovations and applications, including fiber optic communications, bar code scanners and CD players.

APS partnered with OSA, the Society of Photographic Instrumentation Engineers (S.P.I.E.) and the Institute of Electrical Electronic Engineers Photonics Society (IEEE) to organize events throughout the year to educate the public about the importance of lasers in modern society and honor physicists and engineers who made it all possible.

"Lasers are everywhere in society," said Chu, who won the Nobel Prize in 1997 for optically trapping and cooling atoms using lasers.

"Many times, society doesn't know how deeply embedded they are. The first 50 years have been great; hopefully, the next 50 years will be even better."

More than 300 guests braved a cold February night to attend the event.

Including Chu, five Nobel Laureates attended the gala. The others were: Nicolaas Bloembergen, Roy J. Glauber, John Hall and William Phillips–all of whom either helped to develop lasers or used them in their research. During his talk to the gala's attendees, Chu pointed out that 12 Nobel Prizes in the last 50 years featured a laser in an important way.

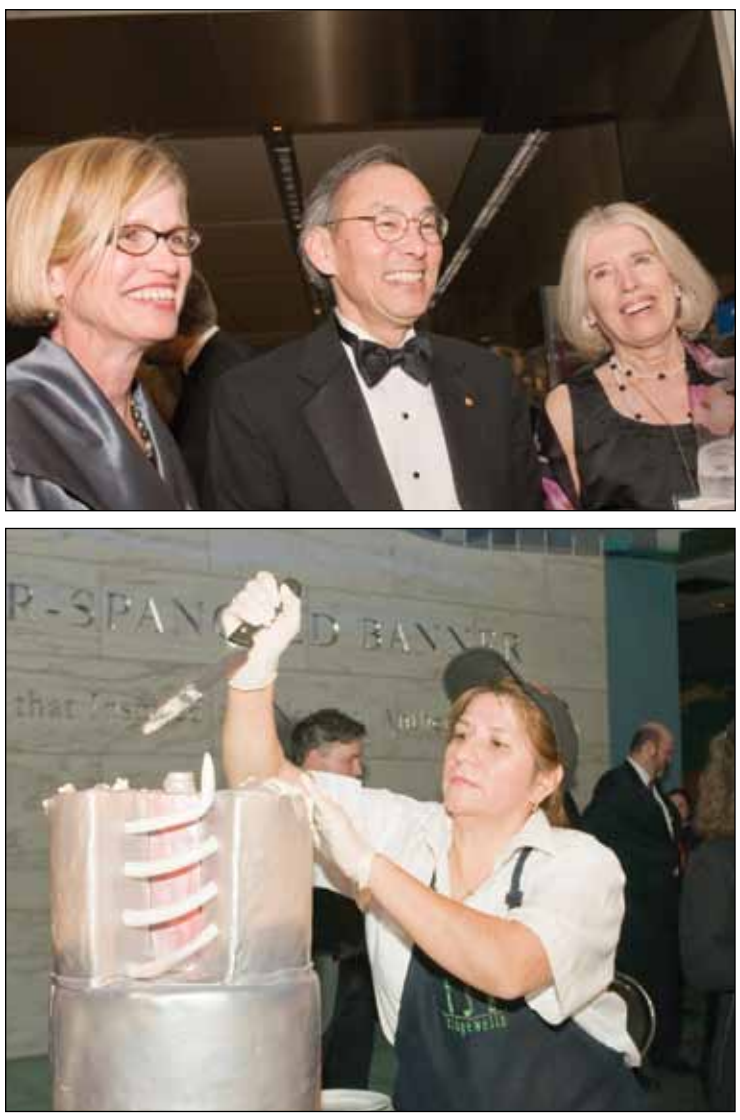
For the kickoff event, the museum's Flag Hall was transformed into a blue-and-white LaserFest extravaganza.

A giant LaserFest logo was projected onto the wall above the hall's newly installed sculpture of Old Glory. Also featured in the center of the floor, was a 3-foot-tall silver and red cake sculpture in the shape of Theodore Maiman's original ruby laser.

To keep the laser celebration going, the museum will feature a display case on its first floor containing artifacts that trace the history of laser innovations and applications.

Brent Glass, the museum's director, said there are more than 300 items in the museum's laser collection. By all accounts, everyone had a good time at the gala.

"It was terrific. Everyone came out in the elements and celebrated the 50th anniversary and had a fun time," said Barbara Hutchison, LaserFest project manager at OSA. Added James Roche, LaserFest coordinator at APS, "Everyone enjoyed the reception. Steven Chu is a fantastic speaker."



Photos by Ken Cole/APS

Top: Enjoying the celebration are (left to right) Optical Society Chief Executive Officer Elizabeth Rogan, Secretary of Energy Steven Chu, and APS Executive Officer Kate Kirby. **Bottom:** The LaserFest celebration featured a large birthday cake in the shape of Theodore Maiman's original ruby laser. At some point, however, hunger overtook the crowd, and the cake was sacrificed.

SUPERHERO continued from page 1

partment's first comic book, *Nicola Tesla and the Electric Fair*, was created as a companion piece to APS's PhysicsQuest kit–scientific experiments and activities for middle-school students focused on the lives of famous physicists. APS annually sends more than 13,000 free kits to classrooms throughout the country.

Thompson-Flagg said the Outreach Department decided to develop an original character to educate students about laser science for the 2009-10 school year.

"Spectra is a laser superhero," Thompson-Flagg said. "Anything a laser can do, she can do. Anything light can do, she can do." Throughout the course of the story, Spectra uses her powers to save her kidnapped friends from the clutches of the evil Miss Alignment. She can travel at the speed of light, change color, cut through solid metal, pass through windows, reflect off of mirrors and diffract into multiple copies of herself.

"I wanted to really create a full character that could carry the story and to make her more than just a plot device," said Thompson-Flagg who consulted Girl-Wonder.org, a network of web sites that promote positive depictions of female characters in comics.

Thompson-Flagg said she wants to attract more females to science because they have been historically underrepresented in the field.

Thompson-Flagg and APS's Art Director Kerry G. Johnson worked together to create diverse characters for the book.

"It was very important to draw a strong, progressive superhero," said Johnson, who created the artwork. He added that he hoped that children, including his own middle-school daughter, would read the book and see science as accessible to everybody.

Johnson decided to base Spectra's look on Thompson-Flagg, in part, to inspire her to create as realistic a character as possible.

KGJ APS © 2009

Spectra

"It's not Becky, but it does resemble Becky," he said about the Spectra character. Despite their likeness, Thompson-Flagg said she didn't base Spectra on herself at a young age. "I just came up with a middle-school girl," she said.

"I think I created her to be way cooler."

Spectra has quickly become the emblem for much of LaserFest's public outreach efforts.

Feedback from teachers and students who have read the original comic book has been overwhelmingly positive, and it is already in its fourth printing.

"Part of the plan is to use Spectra to bring the excitement of physics to new audiences," said Thompson-Flagg. The outreach team has secured space at San Diego's annual Comic-Con this summer. The massive convention, which each year attracts more than 140,000 comic book fans, will be the largest conference of any kind the outreach team has attended.

"We're excited about getting the opportunity to reach a different community," Thompson-Flagg said.

Photo by Michael Lucibella/APS

Flag Hall of the Museum of American History was redecorated for the LaserFest celebration.

WINNERS continued from page 1

Siegfried S. Hecker, Ph.D.

Hecker, 65, was director of DOE's Los Alamos National Laboratory from 1986-1997 and remained at Los Alamos as senior fellow until 2005. He currently is a research professor in the Department of Management Science and Engineering, a senior fellow at the Freeman Spogli Institute for International Studies, and the co-director of Center for International Security and Cooperation, all at Stanford University.

He received the Fermi Award in recognition of his contributions to plutonium metallurgy, his broad scientific leadership and for his energetic and continuing efforts to reduce the danger of nuclear weapons around the globe. Hecker is credited with resolving a long-standing controversy involving the stability of certain structures (or phases) in plutonium alloys near equilibrium that arose from significant discrepancies between U.S. and former USSR research on plutonium metallurgy. Hecker also contributed to the understanding of plutonium aging, which is of pivotal importance in assessing the reliability and performance of the U.S. nuclear weapons stockpile. In addition, he was one of the principal architects of the science-based stockpile stewardship approach, still in use today to certify the safety and reliability of America's nuclear deterrent. During the latter part of his tenure at Los Alamos National Laboratory, Hecker was a pioneer in global nuclear non-proliferation and threat reduction, establishing collaborative research and mutual cooperation with the nuclear weapons laboratories in Russia and other former Soviet Republics. Hecker received a B.S. in metallurgy in 1965, an M.S. in metallurgy in 1967, and a Ph.D. in metallurgy in 1968–all from Case Western Reserve University.

The Back PAGE

Keep America Strong by Investing in Basic Scientific Research

By Congressman Frank Wolf

Most Americans think the United States will have a smaller role in the world economy in the coming years, and many believe that while the 20th century may have been the "American Century," the 21st century will belong to China, according to recent national polling data.

This is not good news, and we must act now to ensure that our country isn't left behind as our nation grapples with a struggling economy, unprecedented debt and increased global competition.

Among the fundamental steps that need to be taken to get our nation back on track is to invest in basic scientific research, a proven economic engine that has led to innovation and prosperity for the nation. The seeds of this research that are planted today will yield the profitable innovations of tomorrow.

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Since World War II, 50 percent of U.S. economic growth has been attributable to science and technology. Every dollar invested in basic research translates into $40 in domestic growth, according to a study by the Council for Chemical Research. The Internet, magnetic resonance imaging (MRI) and global positioning satellites are just a few examples of the inventions that were developed as a result of federal investment in basic research.

Over the last decade, I have become increasingly concerned about our country's lag in innovation and manufacturing. I authored language creating the "Rising Above the Gathering Storm" Commission, led by former Lockheed Martin CEO Norm Augustine, whose report coalesced business community support for science funding in 2006.

The report offered four recommendations:

• Increase America's talent pool by vastly improving K-12 science and mathematics education.

• Sustain and strengthen the nation's traditional commitment to long-term basic research that has the potential to be transformational to maintain the flow of new ideas that fuel the economy, provide security and enhance the quality of life.

• Make the United States the most attractive setting in which to study and perform research so that we can develop, recruit and retain the best and the brightest students, scientists and engineers from within the United States and throughout the world.

• Ensure that the United States is the premier place in the world to innovate; invest in downstream activities such as manufacturing and marketing; and create high-paying jobs based on innovation by such actions as modernizing the patent system, realigning tax policies to encourage innovation and ensuring affordable broadband access.

In August 2007, Congress responded to this landmark report by passing the America COMPETES Act with bipartisan support. The legislation authorized a doubling of funding for key federal agencies by investing in basic research in the physical sciences. It also strengthened science, math, technology and engineering programs. Scientists at those agencies–the U.S. Department of Energy's Office of Science, the National Science Foundation and the National Institute of Standards and Technology–are engaged in transformational research to develop solutions to some of the nation's most pressing challenges.

Americans must not forget the lesson of Sputnik more than 50 years ago. Following the former Soviet Union's launch of Sputnik, America faced a serious challenge as we confronted the reality that our nation might not be the world's scientific and technological leader. The American people responded to the challenge of President Kennedy with bold initiatives, pumping unprecedented amounts of money into science, leading to a boom in innovation that resulted in the development of semiconductor electronics, high-speed computers, and lasers.

There's no doubt that the nation is facing an unprecedented set of challenges, including national security concerns ranging from energy to health to economic and physical security. Quick fixes aren't enough. The American people need to know that their government leaders are employing a long-term view on how to address those challenges. And investing in basic scientific research is the best place to begin.

Since World War II, 50 percent of U.S. economic growth has been attributable to science and technology. Every dollar invested in basic research translates into $40 in domestic growth, according to a study by the Council for Chemical Research. The Internet, magnetic resonance imaging (MRI) and global positioning satellites are just a few examples of the inventions that were developed as a result of federal investment in basic research.

Nevertheless, countries like China and India have copied the U.S. innovation strategy, spurring economic growth in their nations and challenging our hard-won position as a global economic leader, a post that once made us the envy of the world, especially in the area of high technology.

We cannot afford to continue to lag behind our competitors. Case in point: The Organization for Economic Cooperation and Development's (OECD) most recent 2006 report measuring science and math literacy among 15-year-olds internationally shows that the U.S. has a long way to go in educating its students in these critical areas.

According to the results, U.S. students ranked 21st in science and 25th in math among the 30 OECD members, lower than they did in 2003. Furthermore, the students were outscored by students in Korea and Finland, which boasted the top scores on the 2006 test, respectively.

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Congressman Frank Wolf is a Republican from northern Virginia, which is home to hundreds of high-tech and defense companies that are on the cutting-edge of science and technology. He is the lead Republican on the House Appropriations Subcommittee that funds NASA, NSF, the White Office of Science and Technology, the Department of Commerce and the Office of the U.S. Trade Representative.