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TechTalk
SERVING THE MIT COMMUNITY

‘Snapshots’ provide clear picture of fusion reaction

Could help scientists harness implosions for energy

Anne Trafton
News Office

Physicists at MIT and the University of Rochester have devised a new way to take “snapshots” of the high-energy, high-temperature reactions seen as key to achieving the long-held dream of controlled nuclear fusion.

The work, which is reported in the Feb. 28 issue of Science, could one day help scientists harness nuclear fusion as an energy source. It could also shed light on basic questions about the physics of stars.

Nuclear fusion—the process by which atomic particles clump together to form a heavier nucleus—releases an enormous amount of energy (roughly one million times that of a chemical reaction). When nuclear fusion occurs in an uncontrolled chain reaction, it can result in a thermonuclear blast—such as the one generated by hydrogen bombs.

Achieving controlled nuclear fusion, which could be a safe and reliable source of nearly limitless energy, is one of the “holy grails” of high-energy-density physics, according to Richard Petrasso, senior research scientist at MIT’s Plasma Science and Fusion Center (PSFC) and an author of the Science paper.

For decades, scientists at MIT and elsewhere have been working toward that goal by setting off miniature implosions that recreate the high temperatures and densities found in stars.

One way physicists create the implosions is by bombarding tiny pellets of hydrogen fuel with lasers. Inside the pellet, the compressed gas reaches about 100 million degrees (about seven times hotter than the center of the sun). Under certain conditions, the gas’s density can reach 1,000 grams per cubic centimeter (50 times the density of gold).

“It really creates conditions you can only find in the interior of stars,” Petrasso said.

Until now, physicists have largely been able to study the implosions only by measuring the particles released by the imploding gas, such as protons, X-rays, neutrons and photons. Alternatively, they have also studied implosions with X-rays, creating images of the compressed pellets.

The new detection method allows scientists, for the first time, to take a snapshot of the electric and magnetic fields generated by the implosion.

The process requires two implosions: one to be studied, and a second that serves to illuminate the first implosion. The first implosion lasts about three nanoseconds (billionths of a second) and the second one can be timed to go off anytime within those three nanoseconds.

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It’s a ‘whisker’ wonderland

MIT researchers catch rats’ twitchy whiskers in action

Cathryn M. Delude
McGovern Institute

Rats use their whiskers in a way that is closely related to the human sense of touch: Just as humans move their fingertips across a surface to perceive shapes and textures, rats twitch their whiskers to achieve the same goal. Now, in a finding that could help further understanding of perception across species, MIT neuroscientists have used high-speed video to reveal rat whiskers in action and show the tiny movements that underlie the rat’s perception of its tactile environment.

Rats rely on whiskers to find their way in the dark, and they devote large areas of their brains to decoding the incoming signals, explains Christopher Moore, a member of the McGovern Institute for Brain Research at MIT and senior author of a study in the Feb. 28 issue of Neuron. Neuroscientists interested in perception have studied the whisker system intensively, but the information conveyed to the brain by whisker motions has remained a mystery—until now.

“Now that we can see what the rat’s whiskers are telling the brain, we can start to understand better how this amazing perceptual system works,” says Moore, who is also an assistant professor in MIT’s Department of Brain and Cognitive Sciences. “This understanding is relevant not only to the human sense of touch but to all forms of perception, because every sensory organ is an interface between the mind and the external world.”

What might a whisker-based sensation feel like? Imagine sweeping a stick across a picket fence. The frequency of vibrations depends on the spacing between the pickets, but the sensation in the hand is also affected by the length and flexibility of the stick and the speed of its movement.

Likewise, Moore reasoned, the whiskers’ movements and mechanical properties must influence the information that they relay to the brain. The whiskers are arranged in a pattern on the snout, with the shortest ones at the front. Experiments with isolated whiskers had demonstrated that, like harp strings, shorter whiskers are “tuned” to resonate at higher frequencies, creating a map of frequency information within the brain. But until now, no one had managed to see the detailed pattern of whisker movements in freely behaving animals.

Like the famous images MIT’s Harold “Doc” Edgerton made of bullets going through apples, the slow-motion version of these new movies provides the first glimpse of the micromotions that the whiskers transmit to the rat brain.

“We knew from watching rats’ behavior that there must be whisker micromotions that were too rapid to measure using available recording techniques,” explains Jason Ritt, a postdoctoral scientist in Moore’s lab and first author of the study. Ritt therefore spent several years developing a video system that captures whisker movements at a rate of 3,200 frames per second—100

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PHOTO / **WIKIMEDIA**

MIT physicists bask in the media limelight

Featured on late-night TV, ‘60 Minutes’

Anne Trafton
News Office

They say everyone gets his or her 15 minutes of fame—and that even includes MIT physicists.

From late-night TV shows and iTunes downloads to front-page stories in The New York Times, MIT physicists are getting more screen time and newsprint than some minor movie stars.

Professor Peter Fisher brought down the house during a Feb. 8 appearance on “Late Night with Conan O’Brien,” while physicists Max Tegmark and Edward Farhi have been featured in numerous news stories talking about the physics of teleportation. Physics lectures by Professor Walter Lewin are among the most popular downloads on iTunes, and he has been courted by late-night TV shows.

That media spotlight on physics can only help generate more enthusiasm for science among the general

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PHOTO COURTESY / **NBC**

MIT Professor Peter Fisher celebrates with NBC’s Conan O’Brien during an episode that aired in early February. Fisher, who helped the comedian spin his wedding ring on his desk for 51 seconds, is one of many MIT professors hitting the airwaves recently.

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OBITUARIES

MIT community mourns loss of senior Robert M. Wells, 22

Members of the MIT community are mourning the tragic death of Robert M. Wells, a senior in the Department of Brain and Cognitive Sciences. Wells, 22, was originally from Ballston Spa, N.Y.

Wells was found early Saturday morning outside the Delta Upsilon (DU) fraternity house, which is on Beacon Street in Boston. Boston police are leading the investigation, and MIT authorities are cooperating fully.

"This is a tragedy for the entire MIT community," said MIT Chancellor Phillip L. Clay. "Our thoughts are with Rob's family and friends during this very difficult time, and we are doing everything possible to reach out to those affected by this terrible loss."

Representatives of MIT's Division of Student Life and Mental Health Service met with members of the DU fraternity. MIT is also making counseling services available. Those who feel affected by the tragedy are encouraged to contact Mental Health Service for assistance at 617-253-2916.

Wells' family said a service will be held at 9:30 a.m. Saturday, March 8, at St. Mary's Church in Ballston Spa, N.Y. Friends and family are welcome to attend. In addition, a memorial service for Wells is being planned on campus for next week; more details will be released as they become available.

J. Mark Schuster, DUSP professor, 57

J. Mark Schuster PhD '79, a professor of urban studies and planning, an expert on arts funding policies and respected leader of First Night and other Boston cultural events, died Feb. 25 of complications from melanoma. He was 57.

"Schuster helped develop the field of urban cultural policy and showed how it could be a vital part of the practice of city planning. He showed how to integrate the world of urban design and the world of government policy-making, to the great benefit of both," said Lawrence Vale, professor and head of the Department of Urban Studies and Planning.

J. Mark Schuster

A native of Meriden, Conn., Schuster joined the MIT faculty in 1978, becoming an assistant professor in 1984 and a full professor in 1999. He held the Cecil and Ida Green Career Development Professorship from 1988 to 1990.

He quickly gained international prominence in the field of cultural policy, winning a Fulbright Scholarship in 1990 and serving as a consultant to national and international cultural institutions, including the National Endowment for the Arts and National Public Radio.

Schuster also gained early and steady recognition for his teaching, winning the Graduate Student Council Award for Outstanding Teaching in 1983 and his department's Award for Excellence in Teaching in 2006.

"He held his students—and his colleagues—to the highest possible standards and attention to detail. It was a special pleasure to co-teach with Mark because he knew the perfect balance between total preparedness and willingness to respond to unexpected opportunities," Vale said.

Last spring, when Schuster missed part of the semester due to illness, his students folded 1,000 colorful paper cranes into a floor-to-ceiling mobile for him, in an expression of support and hope.

Known for his delight in city festivals, Schuster participated as a trustee or board member in numerous arts, cultural and civic organizations. In 2006, he participated in the Northeast Mayors' Institute on City Design, held at MIT. In February 2008, he received Special Recognition for Contributions to First Night Boston from First Night International, in which he had been involved for many years.

A longtime resident of Cambridge, Schuster received his BA from Harvard University in 1972.

Schuster is survived by his wife, Charlotte Harrison; a son, Luc; a daughter, Leigh; a stepdaughter, Alison Watkins; a brother, Neil; and former wife, Devon Davidson.

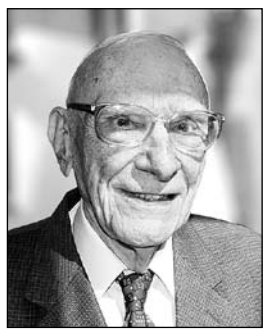
A memorial service at MIT is being planned. In lieu of flowers, donations can be made to First Night Boston, www.firstnight.org.

Professor Emeritus J. Francis Reintjes, 96

MIT Professor Emeritus J. Francis Reintjes, celebrated for his keen wit and unassuming but steadfast leadership in electrical engineering and computer science, passed away Feb. 21 after a brief illness. He was 96.

He was born in Troy, N.Y., on Feb. 19, 1912, the son of George and Katherine (Lynch) Reintjes. Reintjes was a graduate of LaSalle Institute in Troy, N.Y., and received bachelor's and master's degrees in electrical engineering from Rensselaer Polytechnic Institute in Troy, N.Y.

During his career as an electrical engineer, educator and researcher, his work touched many of the technological advances of the 20th century. He began his career as an engineer with General Motors in Lockport, N.Y., and subsequently taught electrical engineering at Manhattan College in New York City.



J. Francis Reintjes

Reintjes playfully described himself in a 2006 interview for the MIT Laboratory for Information and Decision Systems as "the man who came to dinnerand never left." The dinner was a gathering in Boston of the Institute for Radio Engineers at which he met and was later invited by W.L. Barrow to become involved in the new radar school at MIT—ultimately joining the Institute in 1943. He would remain in academia, earning a faculty appointment at MIT in 1947.

Over his 65-year association with MIT, Reintjes' research interests expanded from the areas of radar and electronics, and early information storage and retrieval, to applications of computer-communications technologies. After five years working as a research staff member in the Research Lab of Electronics, Reintjes was appointed as the director of the Servo Lab, where he remained for 21 years.

As the Servo Lab grew under Reintjes' leadership, the emphasis focused increasingly on computerization of numerical control. Using the Whirlwind I computer, Reintjes and colleague Douglas T. Ross MS '54 developed an automatic programming system for numerical control in two dimensions, collectively known as Automatically Programmed Tools (APT).

Although he referred to the early Servo Lab as a kind of "military job shop," Reintjes was well aware of the need to build its theoretical and academic side. With added faculty through the 1950s, the lab, renamed the Electronic Systems Laboratory (ESL) in 1959, became a haven for not only master's but also for doctoral studies. Annual reports in the 1960s gave testament. Thesis research averaged 47 per year—not only in electrical engineering, but spilling into chemical and mechanical engineering, physics, mathematics, biology, nutrition and food science and aeronautical and astronautical engineering. ESL continued to prosper, ultimately taking on its current, independent lab status and from 1978 on became the Laboratory for Information and Decision Systems (LIDS).

Reintjes, in a sense, also launched the first "search engine" system, using general-purpose computers to locate research in professional literature through Project INTREX.

Reintjes' interest in pairing academia with industry throughout his career eventually paved the way for him to take on the directorship in 1960 of the MIT VI-A Cooperative (Internship) Program in Electrical Engineering. He opened up the program by putting admission to the VI-A MS degree on the same academic requirements scale as admission throughout the EE Department and spread the scope of administrative involvement across the department by assigning faculty members to take charge of the cooperative relationships with each of the companies, a practice still followed by VI-A today.

Retirement in 1978 did not hold Frank Reintjes back from remaining an involved presence in the EECS Department and LIDS. He returned weekly, attending events and meetings and often serving as the best source for historical information. As described in the May 2006 edition of LIDS|ALL, Reintjes is "friendly, funny and inspiring ... and his legacy won't be forgotten."

Frank Reintjes is survived by two sons, William F. Reintjes and his wife, Ann Marie, of Annandale, Va., and John F. Reintjes and his wife, Maura, of Alexandria, Va.; a daughter, Ellen E. Reintjes and her husband, Don Tatzin, of Lafayette, Calif.; a grandson; a sister, Marion R. Baker of Troy, N.Y.; and several nieces and nephews. His wife of 64 years, Elizabeth A. Walsh, passed away on May 19, 2007.

Funeral services will be held privately. For those who wish, in lieu of flowers, contributions in Mr. Reintjes' memory may be made to MIT for the J. Francis Reintjes Excellence in VI-A Industrial Practice Award, Account 3914000, Office of Memorial Gifts, MIT Room E19-370, 77 Mass. Ave., Cambridge, MA 02139, or to the American Cancer Society, 30 Speen St., Framingham, MA 01701.

John C. Szczepanski, Lincoln Laboratory senior staff member, 58

Physicist John C. Szczepanski SM '80, PhD '93, a retired lieutenant colonel in the U.S. Army and technical staff member at MIT Lincoln Laboratory for the past 15 years, died Feb. 11 in Huntsville, Ala., after a brief illness. He was 58.

Szczepanski was born in 1949 and grew up in Bethlehem, Pa. He received his BS in engineering from the U.S. Military Academy at West Point, his MS in computer science from New York Polytechnic Institute, and his SM and PhD in physics from MIT.

Szczepanski retired from active duty in the Army in 1993, having served for 22 years. He joined MIT Lincoln Laboratory in June 1993 as a staff member in the Ballistic Missile Defense Systems Engineering and Analysis Group. He worked in the early risk-reduction phase of the Terminal High Altitude Area Defense and Ground-Based Radar programs until his assignment to the Reagan Test Site at U.S. Army Kwajalein Atoll in 1999. Upon his return, he served as group leader of the Missile Defense Elements Group.

Szczepanski is survived by his wife, Christina; two sons, John and Mike; a daughter, Kristina Marie MacPherson; and five grandchildren.

NEWS YOU CAN USE

MacVicar Day being held on March 7

MacVicar Day 2008 will be held Friday, March 7, and to celebrate undergraduate teaching excellence, Nobel laureate Carl Wieman '73 will address the MIT community in a presentation titled, "Science Education in the 21st Century: Using the Tools of Science to Teach Science."

The talk will be held in Kirsch Auditorium (32-123) from 3:30 p.m. to 5 p.m.

The 2008 MacVicar Faculty Fellows will be announced at a faculty reception hosted by President Susan Hockfield at Gray House following the afternoon program.

Institute Awards Convocation nominations now being accepted

Nominations are now being accepted for the 2008 Institute Awards Convocation in May.

The IAC awards will honor students, faculty and staff who have made special contributions to the life of the MIT community. Descriptions of the awards can be found at http://web.mit.edu/awards.

Nomination letters are due on Friday, March 14. For more information, e-mail awards@mit.edu or call Fran Miles at 617-253-7546.

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MIT in the world

A leg to stand on

David Chandler
News Office

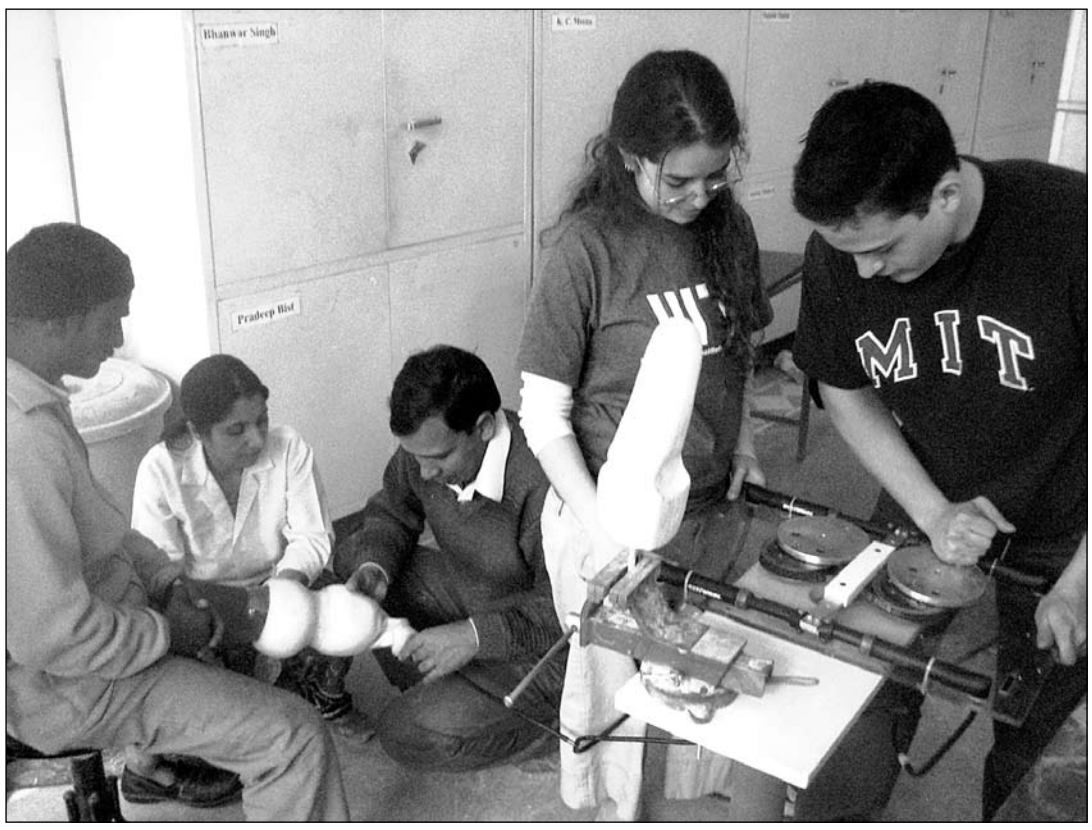


PHOTO / **GOUTAM REDDY**

MIT students Maria Luckyanova and Philip Garcia (at right) operate their prosthetic-fitting device at the Jaipur Foot Organization headquarters in India in January, as JFO specialists work on fitting a prosthetic leg on a patient.

In the United States, a typical prosthetics specialist who fits artificial legs for amputees might handle 15 or 20 such patients a year, fitting them with custom-built legs that can cost upward of $6,000 apiece. Each patient then gets a series of follow-up visits to make sure the new limb was properly fitted.

But in India, the Jaipur Foot Organization handles that many patients every day in each of its local centers. The charity is the world's largest provider of prosthetics and has worked with about a million patients since being founded in 1975.

The JFO, also known as Bhagwan Mahavir Viklang Sahyata Samiti, is based in Jaipur, a city of more than three million people that is the capital of Rajhastan in northern India. The artificial legs they provide, based on a locally developed design, cost about $40, and the company has little time or funding for follow-up consultations, or for developing new methods.

A team of MIT students has been working on a new device that could greatly simplify the process of fitting these legs, producing a better fit while eliminating some steps in the process and reducing waste materials. The hand-powered system, which requires no external power, would also greatly simplify the fitting of legs in rural areas, where the present electrically powered fitting system requires bringing along a bulky generator.

The first step in fitting a leg is to make a mold of the person's stump to provide a precise fit. This is done by placing the stump into a container filled with tiny glass beads and covered with soft silicone rubber, and then creating a vacuum so that the beads seal tightly around the limb. This "negative" mold is filled with more glass beads (referred to as "sand") to form a positive mold—an exact replica of the stump—and the socket of the prosthetic leg is made to fit that replica. Alternatively, the two steps can be done with plaster of paris instead of the sand—a process that doesn't require electricity but does use heavy, non-reusable plaster.

The MIT system was designed under the auspices of the D-Lab in the Department of Mechanical Engineering. Mechanical engineering students Philip Garcia, Maria Luckyanova and Tess Veuthey, physics student Jessica Schirmer, and D-Lab instructor Goutam Reddy have been working on the project—some of them for more than a year.

The new fitting system they devised uses a handcrank to produce the vacuum, eliminating the need for electric power. And the same device can be used to produce both the initial negative mold and the positive mold that replicates the shape of the stump.

Garcia, Luckyanova, Reddy and Schirmer spent two weeks at the Jaipur facility this January, thanks in part to a grant from MIT's Public Service Center and a $7,500 award from last year's IDEAS competition. They did one test run of a fitting, and the JFO personnel were very impressed.

"They were really pleased with the results," Luckyanova says. They liked the fact that the new system produced less waste, required no electricity and seemed to produce a better fit that might lead to a longer-lasting prosthetic. That's because the plaster of paris in the traditional method shrinks slightly as it hardens, making the fit less exact.

The Jaipur technicians also had some useful suggestions for simplifying and streamlining the device. "Basically, they wanted a black box," Garcia says, a system in which the working parts are hidden from view and would be simple to set up and use in the field. The students are now hard at work refining the design in a seminar class they are conducting this semester that includes about 20 students from a variety of different disciplines.

After that, "this summer we'll do some field testing" back in Jaipur, Luckyanova says. The Jaipur company is so busy serving patients that they don't have much time to work on researching better systems, Luckyanova says, so they were delighted to have MIT's help on that part of the process.

The trip to India was a big eye-opener for the students. Garcia says, "I learned a lot about the world." He's not sure what he intends to do after he graduates this spring but says that it will "probably be something involving the developing world."

Luckyanova says this project "changed my perspective a lot." While she enjoys working on high-tech engineering projects, she says, with this project, "you feel such a sense of accomplishment when you see that something you made can affect people's lives right away. It is very gratifying."

In the World *is a column that explores the ways people from MIT are using technology—from the appropriately simple to the cutting edge—to help meet the needs of local people in places around the planet. If you know of a good example and would like the News Office to write about it, please e-mail dlc1@mit.edu.*

Lawrence project puts MIT on U.S. service honor roll

Sarah H. Wright
News Office

The Corporation for National and Community Service has named MIT to the President's Higher Education Community Service Honor Roll for exemplary service efforts and service to disadvantaged youth. The Honor Roll recognizes colleges and universities that support innovative and effective community service programs.

The Honor Roll award was granted in recognition of the success of MIT@Lawrence, a partnership between the Institute and a growing network of community-based organizations in Lawrence, Mass.

Initiated and administered by the Department of Urban Studies and Planning, MIT@Lawrence focuses on affordable housing development, community asset-building and youth pathways to career and education. Participants from MIT work with Lawrence community leaders and residents.

PHOTO / **LORLENE HOYT**

MIT was recently named to the President's Higher Education Community Service Honor Roll for exemplary service efforts and service to disadvantaged youth for the success of its MIT@Lawrence project. This photo, taken in 2004, shows MIT student Claudia Canipa and Lawrence resident Rebecca Camargo mapping properties in Lawrence.

"We are honored to receive this recognition and will continue to work as a team with the Lawrence community to make a true difference. Grounded in the Institute's motto, mens et manus (mind and hand), MIT@Lawrence is an ongoing experiment in linking rooted institutions in Lawrence to MIT with the aim of relating academic knowledge to the needs of the larger society," said Lorlene Hoyt, program director of MIT@Lawrence and assistant professor of urban studies and planning.

Students and faculty from departments, schools and groups across the Institute have provided more than 20,000 combined service hours to Lawrence residents and organizations through the MIT@Lawrence partnership, according to Honor Roll materials.

In addition to the Department of Urban Studies and Planning, MIT@Lawrence collaborators include the Public Service Center, the Center for Real Estate, the MIT Media Lab, the MIT Sloan School and the Community Innovators Lab. Recently, the Center for Advanced Visual Studies, the Teacher Education Lab, the Special Program for Urban and Regional Studies and the MIT Museum have joined the partnership.

Partners in Lawrence include Lawrence CommunityWorks Inc., Groundwork Lawrence, Merrimack Valley Habitat for Humanity, Higher Education Resource Center, Arlington Community Trabajando and Lawrence Family Development Charter School.

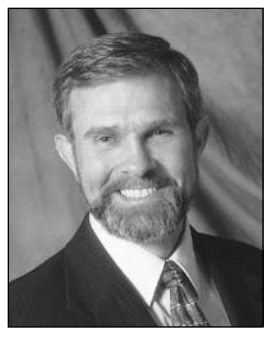
Honorees for the award were chosen based on factors including scope and innovativeness of service projects, percentage of student participation in service activities, incentives for service and the extent to which the school offers academic service-learning courses.

Expert says big energy picture must balance security, sustainability and supply

Deborah Halber
News Office Correspondent

The world has no choice but to build more energy-producing plants—and find new sources of energy—but the build out process will not happen overnight, a government expert recently told an MIT audience.

A worldwide boost in demand for energy, coupled with environmental concerns, will force a huge U.S. increase in the number of nuclear power plants—but it will take more than two decades to come to fruition, according to Carl O. Bauer, director of the U.S. Department of Energy's National Energy Technology Laboratory (NETL).



Carl Bauer

Bauer's Feb. 26 colloquium, "Energy Supply and Demand, Economics and Greenhouse Gas Management: Are They Related?" was sponsored by the MIT Energy Initiative. The discussion focused on the intertwined aspects of security, sustainability, supply and the environment in relation to the world's energy production.

Bauer said blackouts in California, Texas and New England by 2016 are just some of the challenges facing decision makers as they tackle America's energy future.

"I happen to believe we're right on the cusp of a huge energy build-out because we have no choice," Bauer said. But, he added, the lack of U.S. nuclear plant construction in recent decades has led engineers to turn to other fields, and construction companies to commit resources to building plants overseas.

In facing the U.S. energy challenge, decision makers, he said, must juggle three "codependent" entities: the economic sustainability of energy sources; energy supply and security; and the effect of solutions on the environment and climate change. But "too often we divorce the circles and make a decision in policy that we can't live with," he said.

Coal, natural gas and oil use will remain largely unchanged in the United States over the next two decades, projections show, while the use of renewables is likely to increase from 6 percent to 9 percent of the total. Nuclear is slated to remain constant at 8 percent because old plants will shut down and new plants can't come on line fast enough to make a big dent in usage patterns by 2030.

And while U.S. energy use is expected to increase by 25 percent in that time frame, worldwide energy demand is expected to leap 50 percent, further straining resources.

"Do we think the oil supply can grow by 50 percent? The challenge for increasing the oil supply is increasingly

See **MITEI**
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PANTHER sensor from Lincoln Laboratory quickly detects pathogens

Anne Trafton
News Office

Researchers at MIT Lincoln Laboratory have developed a powerful sensor that can detect airborne pathogens such as anthrax and smallpox in less than three minutes.

The new device, called PANTHER (for PAthogen Notification for THreatening Environmental Releases), represents a "significant advance" over any other sensor, said James Harper of Lincoln Lab's Biosensor and Molecular Technologies Group. Current sensors take at least 20 minutes to detect harmful bacteria or viruses in the air, but the PANTHER sensors can do detection and identification in less than three minutes.

The technology has been licensed to Innovative Biosensors Inc. (IBI) of Rockville, Md. In January, IBI began selling a product, BioFlash, that uses the PANTHER technology.

"There is a real need to detect a pathogen in less than three minutes, so you have time to take action before it is too late," said Harper, the lead scientist developing the sensor.

The PANTHER sensor uses a cell-based sensor technology known as CANARY (after the birds sent into mines to detect dangerous gases) and can pick up a positive reading with only a few dozen particles per liter of air.

The device could be used in buildings, subways and other public areas, and can currently detect 24 pathogens, including anthrax, plague, smallpox, tularemia and E. coli.

"There's really nothing out there that compares with this," said Todd Rider of Lincoln Lab's Biosensor and Molecular Technologies Group, who invented the CANARY sensor technology.

Rider started developing CANARY in 1997 when he realized that there were no sensors available that could rapidly detect pathogens. His idea was to take advantage of nature's own defense system—specifically the B cells that target pathogens in the human body. "B cells in the body are very fast and very sensitive," Rider said.

The CANARY concept uses an array of B cells, each specific to a particular bacterium or virus. The cells are engineered to emit photons of light when they detect their target pathogen. The device then displays a list of any pathogens found.

CANARY is the only sensor that makes use of immune cells. Other available sensors are based on immunoassays or PCR (polymerase chain reaction), which take much longer and/or are not as sensitive as the technology used by CANARY.

Rider and colleagues first reported the success of CANARY (which stands for Cellular Analysis and Notification of Antigen Risks and Yields) in the journal Science in 2003. Since then, they have been working to incorporate the technology into a portable device that could be used in a variety of settings where environmental threats might exist.

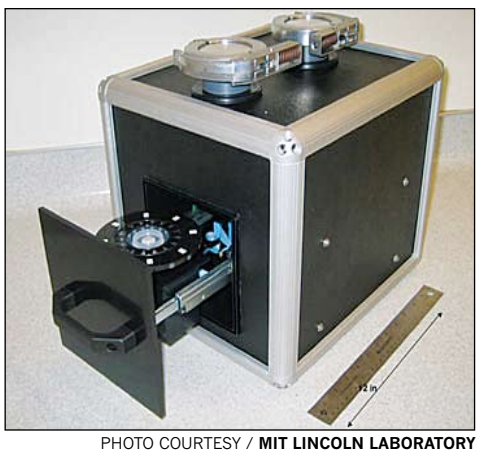


PHOTO COURTESY / **MIT LINCOLN LABORATORY**

This prototype of the PANTHER device is about one cubic foot and weighs 37 pounds.

The new device, PANTHER, takes the CANARY technology and combines it with an air sampler that brings pathogens into contact with the detector cells. The prototype sensor is approximately a cubic foot in size, weighs 37 pounds and is well suited to building-protection applications. With minor modifications it could also enhance biological detection capabilities for emergency responders.

CANARY has been tested in rural and coastal environments as well as urban ones. It could eventually be used on farms or in food-processing plants to test for contamination by E. coli, salmonella or other food-borne pathogens.

Another potential application is in medical diagnostics, where the technology could be used to test patient samples, giving rapid results without having to send samples to a laboratory.

"Instead of going to the doctor's office and waiting a few days for your test results, with CANARY you could get the results in just a minute or so," said Rider.

The research on PANTHER was funded by the Defense Threat Reduction Agency.

Team probes mysteries of oceanic bacteria

Wee creatures are key to Earth's environment

Anne Trafton
News Office

Microbes living in the oceans play a critical role in regulating Earth's environment, but very little is known about their activities and how they work together to help control natural cycles of water, carbon and energy.

A team of MIT researchers led by professors Edward DeLong and Penny Chisholm is trying to change that.

Borrowing gene sequencing tools developed for sequencing the human genome, the researchers have devised a new method to analyze gene expression in complex microbial populations. The work could help scientists better understand how oceans respond to climate change.

"This project can help us get a better handle on the specific details of how microbes affect the flux of energy and matter on Earth, and how microbes respond to environmental change," said DeLong, a professor of biological engineering and civil and environmental engineering.

"The new approach also has other potential applications, for example, one can now realistically consider using indigenous microbes as in situ biosensors, as well as monitor the activities of human-associated microbial communities much more comprehensively," DeLong said.

Their technique, which has already yielded a few surprising discoveries, is reported in the March 3 issue of the Proceedings of the National Academy of Sciences.

The work was facilitated by the Center for Microbial Oceanography: Research and Education (C-MORE), a National Science Foundation Science and Technology Center established in 2006 to explore microbial ocean life, most of which is not well understood.

The traditional way to study bacteria is to grow them in Petri dishes in a laboratory, but that yields limited information, and not all strains are suited to life in the lab. "The cast of characters we can grow in the lab is a really small percentage of what's out there," said DeLong, who is research coordinator for C-MORE.

The MIT team gathers microbe samples from the waters off Hawaii, in a part of the ocean known as the North Pacific Gyre.

Each liter of ocean water they collect contains up to a billion bacterial cells. For several years, researchers have been sequencing the DNA found in those bacteria, creating large databases of prevalent marine microbial genes found in the environment.

However, those DNA sequences alone cannot reveal which genes the bacteria are actually using in their day-to-day activities, or when they are expressing them.

"It's a lot of information, and it's hard to know where to start," said DeLong. "How do you know which genes are actually important in any given environmental context?"

To figure out which genes are expressed, DeLong and colleagues sequenced the messenger RNA (mRNA) produced by the cells living in complex microbial communities. mRNA carries instructions to the protein-building machinery of the cell, so if there is a lot of mRNA corresponding to a particular gene, it means that gene is highly expressed.

The new technique requires the researchers to convert bacterial mRNA to eukaryotic (non-bacterial) DNA, which can be more easily amplified and sequenced. They then use sequencing technology that is fast enough to analyze hundreds of millions of DNA base pairs in a day.

Once the sequences of highly expressed mRNA are known, the researchers can compare them with DNA sequences in the database of bacterial genes and try to figure out which genes are key players and what their functions are.

The team found some surprising patterns of gene expression, DeLong said. For example, about half of the mRNA sequences found are not similar to any previously known bacterial genes.

Lead authors of the paper are Jorge Frias-Lopez, research scientist in MIT's Department of Civil and Environmental Engineering (CEE), and CEE graduate student Yanmei Shi. Maureen Coleman, graduate student in CEE, Gene Tyson, postdoctoral associate in CEE, and Stephan Schuster of Pennsylvania State University also authored the paper with Chisholm and DeLong.

FUSION

Continued from Page 1

The second implosion generates a stream of protons that all have the same energy level, 15 million electron volts. Because protons are charged, their paths are influenced by the fields surrounding the first implosion. These protons can be recorded, just like photons, to create an image of the fields' effects. Photons, however, are unaffected by such fields and thus cannot detect their presence.

"It's a way of capturing images with protons instead of photons," Petrasso said.

Such images can help scientists figure out whether the implosions are close to symmetrical.

To achieve nuclear fusion, the implosion must occur with near-perfect symmetry. Such an event, also known as ignition, has never been demonstrated experimentally.

If ignition occurs, between 10 and 150 million joules of fusion energy would be released. (150 million joules is approximately the amount of energy in a gallon of gasoline, released from something the size of a pin head.)

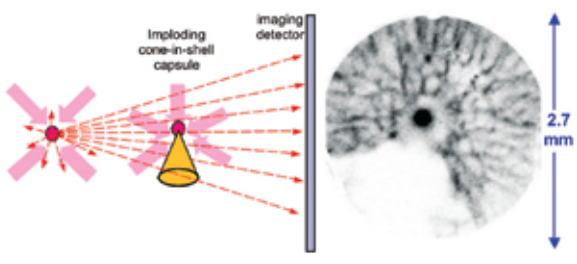
Most of this work was conducted using a laser system at the Laboratory for Laser Energetics at the University of Rochester. The laser system, called Omega, is about the size of a football field.

The National Ignition Facility, where scientists hope to achieve ignition for the first time, is scheduled to open at the Lawrence Livermore National Laboratory in California in 2010. Assuming ignition is achieved in 2010-2012, scientists will begin directly addressing how one might utilize this prodigious energy for electricity generation.

Lead author of the Science paper is Ryan Rygg, formerly a Physics Department graduate student and a recent PhD recipient at the PSFC, now at Lawrence Livermore. Other MIT authors are Fredrick Seguin and Johan Frenje, research scientists at the PSFC; Chikang Li, principal research scientist at the PSFC; and Mario Manuel, graduate student in aeronautics and astronautics.

The research was funded by the Fusion Science Center for Extreme States of Matter and Fast Ignition at the University of Rochester and the U.S. Department of Energy, Office of Inertial Confinement.

PHOTO / **SEAN MCDUFFEE**



GRAPHIC / **RICHARD PETRASSO**

ABOVE: Graduate students Dan Casey and Mario Manuel and Professor Richard Petrasso of the Plasma Science and Fusion Center work on the detector used to study implosions that recreate the high temperatures and densities found inside stars.

LEFT: This schematic drawing shows the system MIT physicists are using to study tiny implosions of hydrogen fuel. On the left, protons streaming away from the far-left implosion travel through magnetic and electric fields generated by the other implosion. On the right is the resulting image of the fields, with the compressed hydrogen pellet in the center.

Grad student wins Lemelson-MIT Student Prize

Timothy Lu targets drug-resistant bacteria

MIT graduate student and synthetic biologist Timothy Lu is passionate about tackling problems that pose threats to human health. His current mission: to destroy antibiotic-resistant bacteria.

A discovery made by Lu, a 27-year-old MD candidate and PhD in the Harvard-MIT Division of Health Sciences and Technology, netted him the $30,000 Lemelson-MIT Student Prize on Feb. 27 and promises to combat bacterial infections by enhancing the effectiveness of antibiotics at killing bacteria. The discovery could also help in eradicating biofilm—bacterial layers that resist antimicrobial treatment and breed on surfaces such as those of medical, industrial and food processing equipment.

The $30,000 Lemelson-MIT Student Prize, annually given to an MIT senior or graduate student, awards someone who has created or improved a product or process, applied a technology in a new way, redesigned a system or demonstrated remarkable inventiveness in other ways.

Lu's work focused on a subject matter that could have widespread impact. The Centers for Disease Control and Prevention estimates that the antibiotic-resistant bacterium MRSA, or methicillin-resistant Staphylococcus aureus, causes approximately 94,000 infections and contributes to 19,000 deaths annually in the United States, through contact that occurs in a variety of locations, including schools, hospitals and homes. Bacteria can also infect food, including spinach and beef, and damage industrial equipment.

Fewer pharmaceutical companies are inventing new antibiotics, Lu explained, because they are expensive, prone to failure and require a long time to develop. According to the Tufts Center for the Study of Drug Development, the cost to develop a new drug is $930 million (based on the value of the dollar in 2006). These factors, coupled with a decline in the number of prescriptions authorized for antibiotics, constrain profits.

"Antibiotic-resistant bacteria are also becoming more prevalent," Lu noted. "My inventions enable the rapid design and production of inexpensive antibacterial agents that can break through the defenses of antibiotic-resistant bacteria and bacterial biofilms."

Delivering a 1-2 punch

Working with his adviser, J.J. Collins, a professor of biomedical engineering at Boston University, Lu developed two bacteriophage platforms to overcome antibiotic resistance. Bacteriophage, which are viruses that only infect bacteria, not human cells, have been used since the early 20th century to treat bacterial infections. They fell out of favor in the United States, however, due to the advent of antibiotics. Lu's work represents an exciting application of synthetic biology, an emerging field focused on the rational engineering of organisms to achieve novel functions.

Lu has engineered bacteriophage to boost antibiotic effectiveness. The bacteriophage carry DNA that codes for factors that target bacterial gene networks, which former treatments failed to reach, and destroys bacterial antibiotic resistance mechanisms. The weakened bacterial defenses enable antibiotics to perform better. Administered together, Lu's bacteriophage and antibiotics have the potential to eliminate nearly 30,000 times more bacteria than antibiotics alone, including cells that survive antibiotic-only treatment. This combination treatment also thwarts development of stronger antibiotic resistance, which can extend the lifetime of existing and future antibiotic drugs.

"While working at a hospital as part of a graduate course, I saw many patients who contracted new infections due to already-compromised immune systems or equipment that is extremely difficult to keep sterile," Lu recalled. "Being infected by difficult-to-eradicate bacteria is a traumatic experience for patients and a serious public health issue that needs attention. I thought that there had to be a solution for these infections."

Penetrating biofilms

Lu also applied his work with bacteriophage to create a new technique for reducing harmful biofilms, which are slimy layers of bacteria that develop on the surfaces of medical, industrial and food processing equipment and are difficult to penetrate and remove. Current treatment methods to penetrate biofilms can involve peptides or enzymes, which must be administered systemically and are costly. Medical devices infected by biofilms, such as replacement hip joints or pacemakers, often have to be removed surgically.

Lu invented enzymatically active bacteriophage that directly target the infection site, where they can simultaneously penetrate the biofilm's protective slime layer and kill the bacteria underneath.

"Think of it as a Trojan Horse," he explained. "First you sneak into the bacteria and use it to overproduce enzymes precisely where they are needed most in order to overwhelm and break up the biofilm slime. Once the slime is disrupted, the bacteriophage then move in and kill the bacteria."

"As a physician who has treated patients with resistant bacterial infections, I am well aware of the devastating effect they have on morbidity and mortality," added Collin M. Stultz, associate professor of biomedical engineering in the Harvard-MIT Division of Health Sciences and Technology, and one of Lu's recommenders for the award. "Tim has developed a series of methods that can be used to treat such problematic infections."

PHOTO COURTESY / **LEMELSON-MIT PROGRAM**

MIT graduate student and synthetic biologist Timothy Lu recently won the Institute's $30,000 Lemelson-MIT Student Prize for his work on the use of bacteriophage to fight antibiotic-resistant bacteria.

In tests, Lu's platform proved greater than 99.997 percent effective at destroying biofilms—a significant improvement over current treatment options.

"The ultimate goal is to develop a sustainable source of antibacterial therapies that are effective and easy to produce at low cost, and will last us through the 21st century," Lu said.

According to Lu, his engineered enzymatically active bacteriophage could be initially applied in food processing settings to kill food-borne bacteria, such as Escherichia coli (E. coli) that contaminate spinach and cause severe illness when ingested. In line with these hopes, there is evidence that U.S. regulatory authorities are warming up to the therapeutic use of bacteriophage. For example, in 2006, the U.S. Food and Drug Administration approved the first U.S. treatment for Listeria contamination of processed meats using natural bacteriophage.

Lu added that enzymatically active bacteriophage could also benefit industry by being used to treat infected pipes and reduce corrosion.

The Lemelson-MIT Student Prize also named two other finalists for the prize, who each won $1,000. They were:

- **Erez Lieberman**, a graduate student in applied mathematics and genomics at Harvard University and a student at the Harvard-MIT Division of Health Sciences and Technology
- **Manu Prakash**, a PhD candidate at MIT's Media Lab and Center for Bits and Atoms

Inherited inventiveness

Born in Stanford, Calif., and raised in Yorktown Heights, N.Y., and in Taiwan, Lu credits his inventiveness to his father, Nicky, an engineer and entrepreneur who helped develop modern semiconductor memories with IBM and the integrated circuits industry in Taiwan. Lu recalls spending time at his father's office during his formative years, where he reviewed plans and designs for new integrated circuits.

"I inherited my interest in invention and entrepreneurship from my father," Lu said. "It was very inspiring to see the amount of effort my father and his team put into their work and their joy and elation when they achieved success."

And others see Lu's future potential beyond his groundbreaking discovery.

"Tim is one of the young stars in the emerging field of synthetic biology," said Collins, his adviser. "I am confident he will develop into a leading clinical investigator and innovator."

Josh Schuler, executive director of the Lemelson-MIT Program, said Lu's work, and personality, fit the bill for a $30,000 Lemelson-MIT Student Prize recipient.

"Tim demonstrates the type of ambitious and inventive thinking the $30,000 Lemelson-MIT Student Prize was established to recognize," Schuler said. "What is truly impressive about Tim's approaches is the breadth of his applications. Not only does his work have potential in health care, but also in protecting the general public through safer food processing and prevention of industrial biofouling. Harmful bacteria everywhere should be afraid."

MIT to lead development of new telescopes on moon

David Chandler
News Office

NASA has selected a proposal by an MIT-led team to develop plans for an array of radio telescopes on the far side of the moon that would probe the earliest formation of the basic structures of the universe. The agency announced the selection and 18 others related to future observatories on Friday, Feb. 15.

The new MIT telescopes would explore one of the greatest unknown realms of astronomy, the so-called "Dark Ages" near the beginning of the universe when stars, star clusters and galaxies first came into existence. This period of roughly a billion years, beginning shortly after the Big Bang, closely followed the time when cosmic background radiation, which has been mapped using satellites, filled all of space. Learning about this unobserved era is considered essential to filling in our understanding of how the earliest structures in the universe came into being.

The Lunar Array for Radio Cosmology (LARC) project is headed by Jacqueline Hewitt, a professor of physics and director of MIT's Kavli Institute for Astrophysics and Space Science. LARC includes nine other MIT scientists as well as several from other institutions. It is planned as a huge array of hundreds of telescope modules designed to pick up very-low-frequency radio emissions. The array will cover an area of up to two square kilometers; the modules would be moved into place on the lunar surface by automated vehicles.

Observations of the cosmic Dark Ages are impossible to make from Earth, Hewitt explains, because of two major sources of interference that obscure these faint low-frequency radio emissions. One is the Earth's ionosphere, a high-altitude layer of electrically charged gas. The other is the Earth's radio and television transmissions, which produce background interference everywhere on the Earth's surface.

The only place that is totally shielded from both kinds of interference is the far side of the moon, which always faces away from the Earth and therefore is never exposed to terrestrial radio transmissions.

Besides being the top priority scientifically for a telescope on the moon, this low-frequency radio telescope array will be one of the easiest to build, Hewitt says. That's because the long wavelengths of the radio waves it will detect don't require particularly accurate placement and alignment of the individual components. In addition, it doesn't matter if a few of the hundreds of antennas fail, and their performance would not be affected by the ever-present lunar dust.

The new lunar telescopes would add greatly to the capabilities of a low-frequency radio telescope array now under construction in Western Australia, one of the most radio-quiet areas on Earth. This array, which also involves MIT researchers, will be limited to the upper reaches of the low-frequency radio spectrum, and thus will only be able to penetrate into a portion of the cosmic Dark Ages.

The new observations could test current theories about how the universe formed and evolved into its present state.

According to prevailing theory, this unobserved span of time in the universe's infancy includes a period when dark matter—an unknown component of the universe that accounts for a majority of all matter—collapsed from a uniform soup of particles into clumps that formed the scaffolding for all the structures that emerged later, from stars and black holes to entire galaxies. All astronomical observations made so far only reveal the results of that whole formation process—except the cosmic background radiation, which only shows the raw material before the process began. The whole gestation and birth of all the kinds of objects seen in space today, which all took place in the Dark Ages, has so far been hidden from view.

The new observations could test current theories about how the universe formed and evolved into its present state, including the theory of cosmic inflation first proposed by MIT Professor Alan Guth.

In addition to their primary mission, the new telescopes would also be useful for studying huge eruptions from the sun, called coronal mass ejections, which can sometimes disrupt communications and electrical grids on Earth. They could also study space weather, the radio emissions from other planets and emissions from collisions between galaxies.

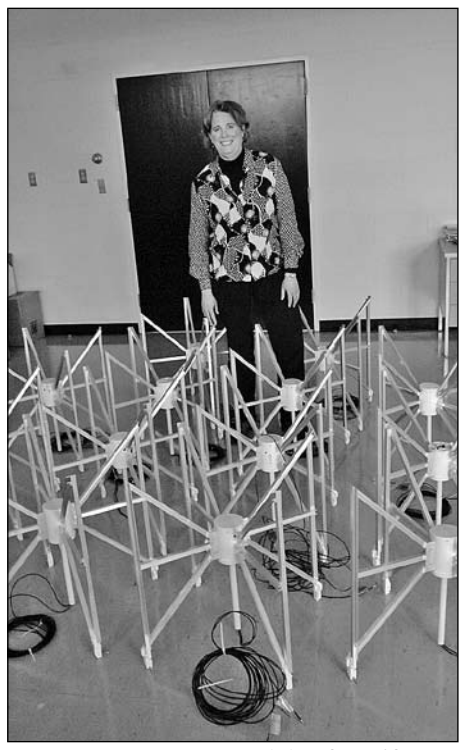


PHOTO / **DONNA COVENEY**

Professor Jacqueline Hewitt, director of the Kavli Institute, stands behind a prototype of the radio telescope array to be built on the far side of the moon.

The present plan is for a one-year study to develop a detailed plan for the telescope array, whose construction would probably not begin until sometime after the year 2025 and is expected to cost more than $1 billion. The project to develop the plan is led by MIT's Hewitt, with a team that includes MIT professors Jeffrey Hoffman, of the Department of Aeronautics and Astronautics, and Maria Zuber, chair of the Department of Earth, Atmospheric and Planetary Sciences, as well as others from MIT and scientists from Harvard, the National Radio Astronomy Observatory, the University of California at Berkeley, University of Washington and NASA's Jet Propulsion Laboratory.

To develop this detailed plan, NASA is awarding a grant of $500,000, to be divided between the MIT-led team and a second team that is independently developing a similar proposal, headed by scientists at the Naval Research Laboratory.

PHOTO / **JUSTIN KNIGHT**

MIT and Eni forge partnership

Paolo Scaroni, chief executive officer of Italian energy company Eni, discusses his company's multimillion-dollar partnership with MIT during a Feb. 26 press conference. The company has pledged $50 million over the next five years, half of which will go toward establishing the Eni-MITEI Solar Frontiers Research Program. The remainder of the donation will support the company's founding membership in MITEI.

MIT students design graduate student development program

Sarah H. Wright
News Office

An MIT PhD candidate in electrical engineering and computer science described a novel professional development program for graduate students and its impact at MIT in a presentation last month at the annual meeting of the American Association for the Advancement of Science in Boston.

Aisha Walcott, the PhD candidate, helped found the innovative program, called the Academy of Courageous Minority Engineers (ACME), with other MIT doctoral students in 2003.

Walcott's presentation was based on a paper titled "The Academy of Courageous Engineers: A Model for Supporting Minority Students in the Completion of Science and Engineering Degrees." It included a demonstration with fellow MIT graduate students and ACME alumni.

The ACME framework includes web technology, weekly face-to-face meetings and a research seminar series. It also features a forum for addressing inherent aspects of the graduate student experience, such as building advisor-advisee relationships, leveraging collegial networks and selecting good lab environments.

Aisha Walcott

According to Walcott, who studies robotics, the ACME program has broad applications for any graduate student body since support and goal setting are universal challenges. Students participating in ACME have specialized in disciplines including aeronautics and astronautics, architecture, biology, chemistry, computer science, mechanical engineering and operations research.

Academic institutions have tried support groups and other efforts to facilitate graduate student success. ACME designers went further.

"Examining basic peer-to-peer support mechanisms, we found that smaller groups were more efficient and effective. Then we went on to develop computational supports for fostering accountability, providing constructive feedback and setting realistic goals," Walcott said.

The ACME web-based system was designed by Eric Brittain, a PhD candidate in EECS who studies educational technology. The system is used for managing and tracking goals specific to achieving graduate degree milestones. Users can also share comments and personal and peer progress.

To date, more than 45 graduate students have participated in the ACME program, and approximately half of these students have earned their graduate degrees.

ACME alumna Ishara Mills PhD '07 said, "ACME provided me with multiple opportunities to explain my research to my peers from a variety of research backgrounds. As a result of the feedback, I was able to determine the crucial hypotheses and experimental directions that I wanted to address."

Robbin Chapman, manager of diversity recruitment in the School of Architecture and Planning, credits her 2006 PhD, in part, to ACME's combination of professional support, scholarship and strategic goal setting.

"ACME was a valuable tool I used to identify my graduate program needs, engage in critical reflection on effective strategies and move toward my goals. It made it possible for me to see both the forest and the trees," said Chapman.

ACME receives support from the MIT Graduate Students Office.

LIMELIGHT

Continued from Page 1

public, those professors say.

"I think it's always a good thing when news stories talk about real physics. There are so few compared to the number that talk about Paris Hilton and Britney Spears and so on," said Tegmark, an associate professor of physics.

At a Jan. 17 MIT event arranged by producers of the film "Jumper," Tegmark and Farhi received more applause than the film's director and star, Doug Liman and Hayden Christensen.

While many students in the crowd came to see Christensen, leading man in two "Star Wars" films, students enthusiastically cheered Tegmark and Farhi as they debunked the notion that human beings can teleport, as Christensen's character does in "Jumper."

Since then, Tegmark, a cosmologist, and Farhi, who works on quantum computing, have been quoted in articles in The New York Times, New York Post, Boston Herald, USA Today and many others.

Late Night

Professor Fisher was also recruited to lend expertise to a scientific cause. Fisher appeared on the last episode of "Late Night with Conan O'Brien" before the recent writers' strike ended. During the strike, O'Brien had been filling air time by spinning his wedding ring on his desk.

His record for longest spin was 41 seconds, and about a week before the strike ended, "Late Night" producer Frank Smiley decided to go all out to try to break the record.

He picked Fisher from a list he had compiled of about 30 physicists and mechanical engineers from several schools, including Columbia, Cornell and New York University. Smiley said he was immediately impressed with Fisher when they spoke on the phone.

"He was just so enthusiastic about it," Smiley said. "I'm glad we ended up with an MIT physicist, because it sounds good."

> *I was going to dance but I was afraid of getting hit or kicked (by Conan O'Brien).*
>
> **Professor Peter Fisher, on his 'Late Night with Conan O'Brien' appearance**

During Fisher's 14-minute segment, he squeezed in shout-outs to his 8.02 students, one of his postdocs, Jocelyn Monroe, and his daughter, Olympia, all of whom helped him figure out how to get the ring to spin longer.

All of those efforts paid off: With Fisher's help, O'Brien shattered his record with a time of 51 seconds, achieved by spinning the ring on a Teflon surface. Earlier attempts involving a vacuum chamber and a Vaseline-greased desk were unsuccessful.

As the show's audience and crew went wild, O'Brien started dancing around his desk and doing push-ups, and confetti and balloons fell from the ceiling. Fisher, grinning, stayed put in his chair.

"(Conan)'s really kind of a spaz. I was going to dance but I was afraid of getting hit or kicked," Fisher said.

Fisher found the experience of being on stage to be "addictive," but said the most fun part of the day was hanging out with the technical staff getting the props ready for his segment.

Smiley, the producer, agreed: "It was so much fun hanging out with him that day, trying to see how long we could get the ring to spin. That was probably the most fun I've had in the entire time I've been here."

Fisher sees his appearance as a good way to get people who aren't scientists interested in physics.

"This was really good because there was a very specific objective," he said. "Everybody could understand the problem and see how you use science to solve a problem."

Physics for all

MIT Professor Walter Lewin's lectures have long been legendary around the Institute, but now his fame has spread worldwide. Last summer, his lectures on electricity and magnetism were the number one download on Apple's iTunes U, a source of online educational content, and five of his lectures have been in Google video's top 100 listing.

After The New York Times profiled Lewin on its front page Dec. 19, the story was at the top of the Times' most e-mailed list for days. Since then, he has been interviewed by dozens of newspapers and TV shows, hired an agent, started working on a book proposal with Sara Rimer, who wrote the Times article, and has been pursued by most of the major late-night talk shows.

Lewin, who has received thousands of e-mails from students around the world since the Times story appeared, has yet to appear on any of the late-night shows because he did not want to cross picket lines during the writers' strike. He is now in negotiations with a few of the shows, and did appear on the "CBS Evening News" and the international "Riz Khan" show on Al Jazeera.

In his lectures, Lewin aims to inspire students and connect physics with their everyday lives. He explores the physics of rainbows, musical instruments, sunsets, pacemakers and particle accelerators. He attributes the popularity of his lectures to his enthusiasm, love of physics, and humor.

"My style is different. It seems to catch on even with people who have never had physics," he said.

He has three lecture series posted on MIT's OpenCourseWare, and they are among the most popular in the online educational program.

"What is fantastic is that people all over the world can now become educated in almost any field they want to," Lewin said.

PHOTO / **WIKIMEDIA**

Penny wise

Another MIT physicist, Pappalardo Fellow Jeff Gore, has been sought after as a commentator on an area that has no relation to his research interests: the fate of the penny.

Gore, a biophysicist who studies the evolution of cooperative behavior in yeast, has become a de facto spokesperson for the movement to abolish the penny, ever since he calculated the amount of time and money wasted each year because of pennies.

On Feb. 10, Gore appeared on "60 Minutes" to offer, as correspondent Morley Safer put it, the "nerd's-eye view" of the problem.

A few years ago, Gore read a study that estimated that pennies add an extra 2 to 2.5 seconds to every cash transaction. "That doesn't sound like that much time, but if you multiply it out, it adds up," he says.

Assuming that each transaction involves an average of three people (cashier, customer, and a customer waiting in line), Gore figured out that pennies cost the U.S. economy about $10 billion per year.

ABC's World News Tonight interviewed him for a story on the penny in 2002, and since then, he has regularly fielded interview requests. "I sort of became the 'expert' on why we should get rid of the penny," he says.

— Anne Trafton, News Office

MITEI

Continued from Page 3

onerous, and many believe peaking will happen in this decade," Bauer said. We will become increasingly dependent on coal and natural gas, which have their own supply and production problems, he said.

Besides possible peak-usage brownouts and blackouts, the shortfall could bump up electricity prices in states neighboring high-demand regions by 30 to 40 percent.

While alternatives such as wind look promising, even the country's windiest states—such as North Dakota and South Dakota—don't have enough consistently windy days to meet high demand. Nights—when demand is down for air conditioning—tend to be windiest.

Managing public electricity consumption by limiting use during peak times or setting allowances could become a reality.

If so, Bauer predicted that Americans might be in for some unfamiliar discomfort.

"How much are we willing to sweat or shiver?" he said. "How much are we going to allow someone to manage our own use through a meter on our house to control the flow of electricity and shut us down if demand goes too high?"

CROSSWORD SOLUTION FROM LAST WEEK'S TECH TALK

1 D	2 I	3 S	4 C	5 S	■	6 F	7 A	8 Z	9 E	■	■	10 X	11 V	12 I
13 A	C	H	O	O	■	14 A	M	E	N	■	15 Q	U	I	Z
16 D	O	U	B	L	17 E	X	I	N	G	■	18 A	P	S	O
19 A	N	T	■	20 V	I	E	D	■	21 R	22 A	T	T	E	D
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25 M	26 A	27 X	I	N	E	■	28 R	E	V	E	R	E	29 N	30 T
31 O	N	S	E	T	■	32 M	A	G	E	S	■	33 B	A	R
34 P	I	P	S	■	35 C	O	L	O	R	■	36 J	A	V	A
37 E	S	E	■	38 I	H	O	P	S	■	39 C	A	N	E	D
40 D	E	E	41 P	D	I	S	H	■	42 P	A	D	D	L	E
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45 F	46 I	B	U	L	A	■	47 A	U	R	A	■	48 O	49 H	50 O
51 A	V	I	D	■	52 S	53 I	G	N	O	F	54 T	H	E	X
55 R	A	K	E	■	56 E	T	R	E	■	57 E	R	N	I	E
58 O	N	E	■	■	59 A	S	I	S	■	60 S	W	O	R	N

MIT Sloan to help boost management education in Portugal

Effort is part of wide-ranging MIT Portugal Program

The MIT Sloan School of Management, two universities in Portugal and a group of Portuguese private corporations have entered into an agreement involving the Portuguese Ministry of Science, Technology and Higher Education under which MIT Sloan will help the schools strengthen their capacity in business education and management science at an international level. The initiative will also provide the opportunity for MIT Sloan faculty to continue to broaden their exposure to new global business developments and challenges.

Under the five-year agreement, which is part of the wide-ranging MIT Portugal Program, MIT Sloan faculty will offer guest lectures to Global MBA Program students at the School of Economics and Business at the Portuguese Catholic University and the School of Economics and Management at the Universidade Nova de Lisboa. MIT Sloan will also offer a summer immersion program for the Portuguese students, and, under the agreement, professors from those schools will travel to Cambridge as International Faculty Fellows to be exposed to teaching practices which are designed to assist with their goal of enhancing their teaching effectiveness.

"This relationship fits into MIT Sloan's long history of international collaboration," which goes back to MIT Sloan's establishment of the Indian Institute of Management at Calcutta in the 1960s, said MIT Sloan Dean David C. Schmittlein. "We look forward to helping our colleagues in Portugal develop programs that will help them, their students and their economy."

The MIT Portugal Program was unveiled in 2006 as part of a major initiative by the Portuguese government to strengthen the country's knowledge base at an international level through a strategic investment in people, knowledge and ideas. The program initially involved faculty from MIT's School of Engineering and Engineering Systems Division working with professors and researchers from seven Portuguese universities.

MIT Sloan's role in the program provides opportunities that both Institutions hope will offer lasting benefits, said Professor Manuel V. Heitor, Secretary of State for Science, Technology and Higher Education in the Portuguese government. "MIT is already known and respected throughout this region and the world," he said. "And MIT Sloan has proven itself to be a global business school in a global business community. Our faculty will be greatly strengthened by what they learn at MIT Sloan, and MIT Sloan faculty and students will have the opportunity to deepen their ties with a worldwide academic community."

MIT Sloan faculty will help their counterparts in Portugal develop curriculum and content, said MIT Sloan Professor of Management Paul Osterman. "MIT Sloan has extensive experience with such international efforts," he said. "But it's a two-way process. For our part, we gain new knowledge for our faculty and students that will help them better understand global economic and business practices."

In related news, the MIT Portugal Program last month launched a newly designed web site (www.mitportugal.org) that will enable users inside and outside the program to learn about its latest initiatives, education and research, events and successes. Features include a new online application form for the Advanced Studies and PhD programs offered, a resource area where users can find related reports, papers and documents, and a prospective student area.

The site, which accentuates a new brand identity for the program, also includes information on the education and research focus areas, research projects, schools and faculty involved in the program, and tips for visiting MIT.

The site highlights four areas of the MIT Portugal Program: bioengineering, sustainable energy systems, engineering design and advanced manufacturing, and transportation systems and provides curriculum details about each. Information on the education and research programs in these areas and in engineering systems is also available.

RATS

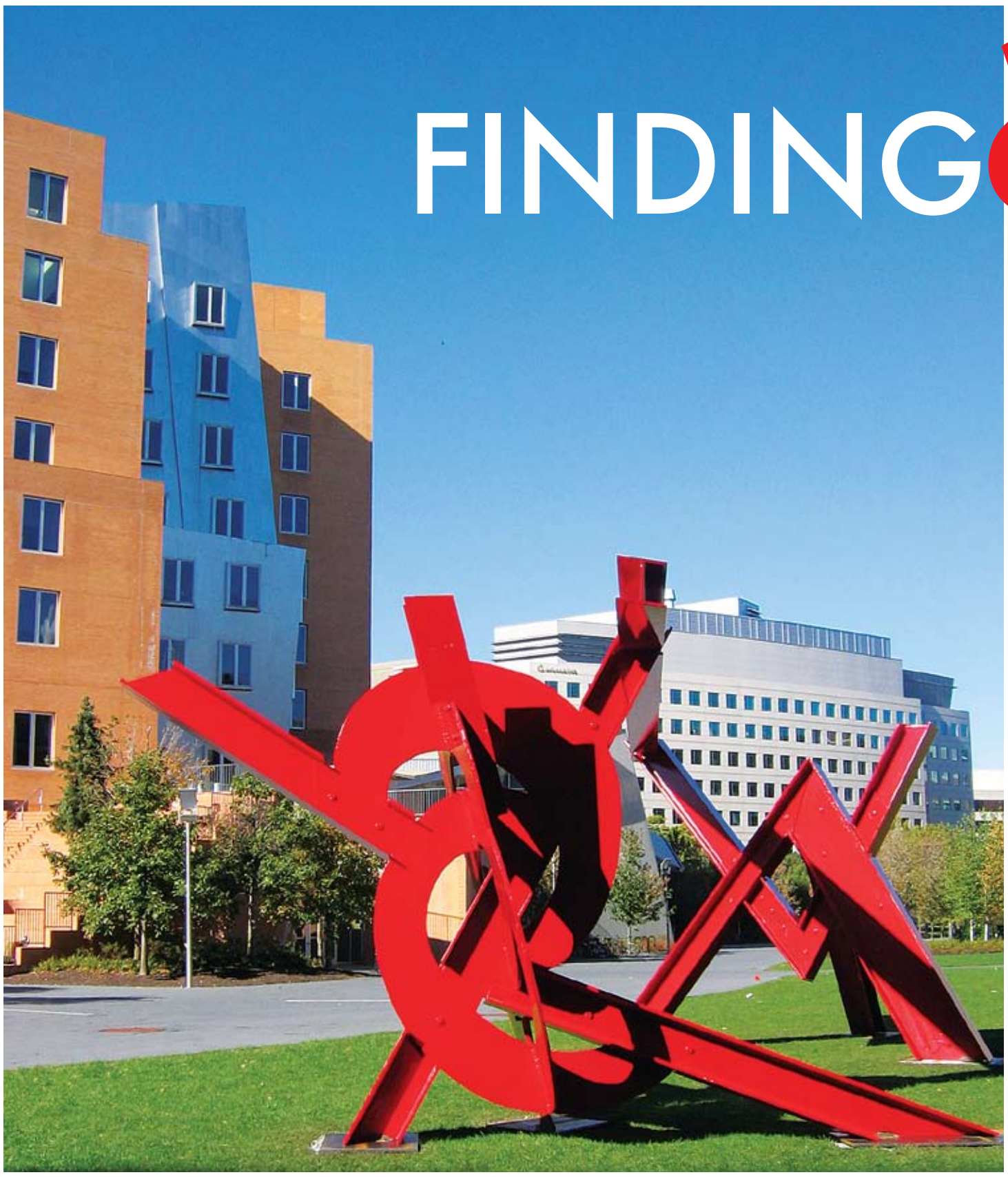
Continued from Page 1

times faster than typical home videos—and an automatic tracking system to analyze the resulting deluge of video data, about 1 gigabyte per second.

For the experiments, the researchers trained rats to choose either a smooth or a rough surface using their whiskers. Correct choices were rewarded with chocolate milk, and the whisker movements were captured on video. Analysis of the video revealed an unexpectedly complex pattern of movements, including periodic "waves" of motion when the rat touched a smooth surface, and irregular, large and high-velocity movements when contacting a rough surface.

"These patterns are larger and more complex than anything previously observed in anesthetized animals or plucked whiskers, but they are the key to a rat's perceptions and behavior," comments Moore.

This study was supported by grants from the NIH and NSF, a predoctoral fellowship from the Howard Hughes Medical Institute to second author Mark L. Andermann, and a Burroughs Wellcome Career Award at the Scientific Interface to Ritt.



FINDING art

New web site sheds light on works both seen and unseen

Sarah H. Wright
News Office

The List Visual Arts Center has just made MIT's public art collection more accessible to the public with a new web site, http://listart.mit.edu.

Inspired by MIT's OpenCourseWare program, the new List site, launched Feb. 19, is designed to offer people who may not be able to visit campus a chance to see its art collection and to use List Center materials, according to List Director Jane Farver.

"Education is a major part of the List Center mission, and the staff wants the collection and center brochures, press materials and lectures to be widely available. We are grateful to the Institute of Museum and Library Services for making the new web site's interactive map of MIT's public art collection possible. The site has just begun, and we'll continue to devote time and resources to improving it," Farver said.

Named in 2006 as one of America's 10 Best Campus Art Collections by the Public Art Review, the MIT collection includes works by the world's most prominent artists—Pablo Picasso, Auguste Rodin, Alexander Calder—placed amid buildings by such notable architects as Alvar Aalto, Frank Gehry and I.M. Pei.

But locating these works on MIT's campus presented a problem: Some are outside and some inside buildings; some works are large; some are small enough to escape notice.

List's solution is a web site that tracks arts events, displays images from current exhibitions and has, as its innovative centerpiece, an interactive, searchable campus map of MIT's public art collection.

The map looks like the usual MIT campus map, but it's rich with arts information. Click on "search for," and a list offers names of artists and architects whose work is in the Institute collection and on public view. Click on a name—say, painter Jennifer Bartlett—and a yellow dot pulses in NW30, where her work, "Overhill Road, Shawnee Mission," hangs.

Other search functions include clickable thumbnail photos of artwork and buildings and additional windows containing biographical information on artists and architects.

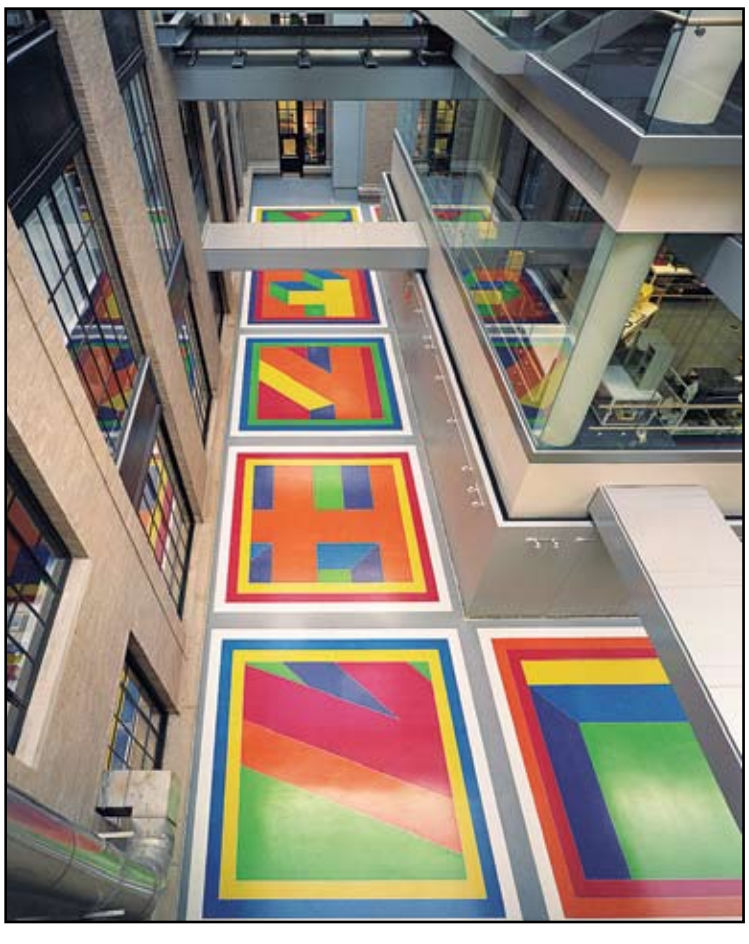
In the future, site users will be able to download streaming audio of the List Center's archive of lectures, artist talks and other educational programs, Farver noted.

ABOVE: Mark di Suvero's 'Aesop's Fables II,' located on the northeast center lawn, outside of the Stata Center (which is also listed on the web site).

RIGHT: The searchable, interactive map on the List Visual Arts Center's new web site.

BELOW: Sol LeWitt's 'Bars of Color within Squares,' located in the Green Center for Physics (Building 6C).

PHOTOS / **COURTESY OF THE LIST VISUAL ARTS CENTER**



LEFT: Frank Stella's 'Loohooloo,' located in a conference room on the third floor of Building 7, in the Department of Architecture and Planning.

PHOTO / **DONNA COVENEY**