Volume 51 – Number 25
Wednesday – May 2, 2007

TechTalk
SERVING THE MIT COMMUNITY

Laser yields powerful 3-D images of retina

New visualization methods could improve early diagnosis of disease

PHOTO / **DONNA COVENEY**

James Fujimoto

Elizabeth Thomson
News Office

In work that could improve diagnoses of many eye diseases, MIT researchers have developed a new type of laser for taking high-resolution, 3-D images of the retina, the part of the eye that converts light to electrical signals that travel to the brain.

The research will be presented at the Conference on Lasers and Electro-Optics and the Quantum Electronics and Laser Science Conference in Baltimore on May 10.

The new imaging system is based on Optical Coherence Tomography (OCT), which uses light to obtain high-resolution, cross-sectional images of the eye to visualize subtle changes that occur in retinal disease. OCT was developed in the early 1990s by MIT Professor James Fujimoto, Eric Swanson at MIT Lincoln Laboratory and collaborators; Fujimoto is an author of the report to be presented in May.

"Within the last few years optical coherence tomography has become a standard diagnostic for ophthalmology. New techniques are now enabling dramatic increases in image acquisition speeds. These advances promise to enable new and powerful three-dimensional visualization methods which could improve early diagnosis of disease and treatment monitoring," said Fujimoto, who holds appointments in MIT's Department of Electrical Engineering and Computer Science and the Research Laboratory of Electronics.

Conventional OCT imaging typically yields a series of two-dimensional, cross-sectional images of the retina, which can be combined to form a 3-D image of its volume.

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Picower team reverses Alzheimer's-like symptoms in mice

'Lost' memories may prove accessible

Deborah Halber
News Office Correspondent

Mice whose brains had atrophied like those of Alzheimer's disease patients regained long-term memories and the ability to learn after living in an enriched environment, researchers at MIT's Picower Institute for Learning and Memory report in the April 29 online edition of Nature. The same results also were achieved with a new experimental class of drugs.

Li-Huei Tsai, Picower Professor of Neuroscience in the Department of Brain and Cognitive Sciences, and colleagues found that environmental enrichment—for laboratory mice, being exposed to stimuli that enhance their physical and psychological well-being—induced the animals' brain cells to start to sprout new connections.

"This is exciting because our results show that learning ability can be improved and 'lost' long-term memories can be recovered even after a significant number of neurons have already been lost in the brain," said Tsai, who is also

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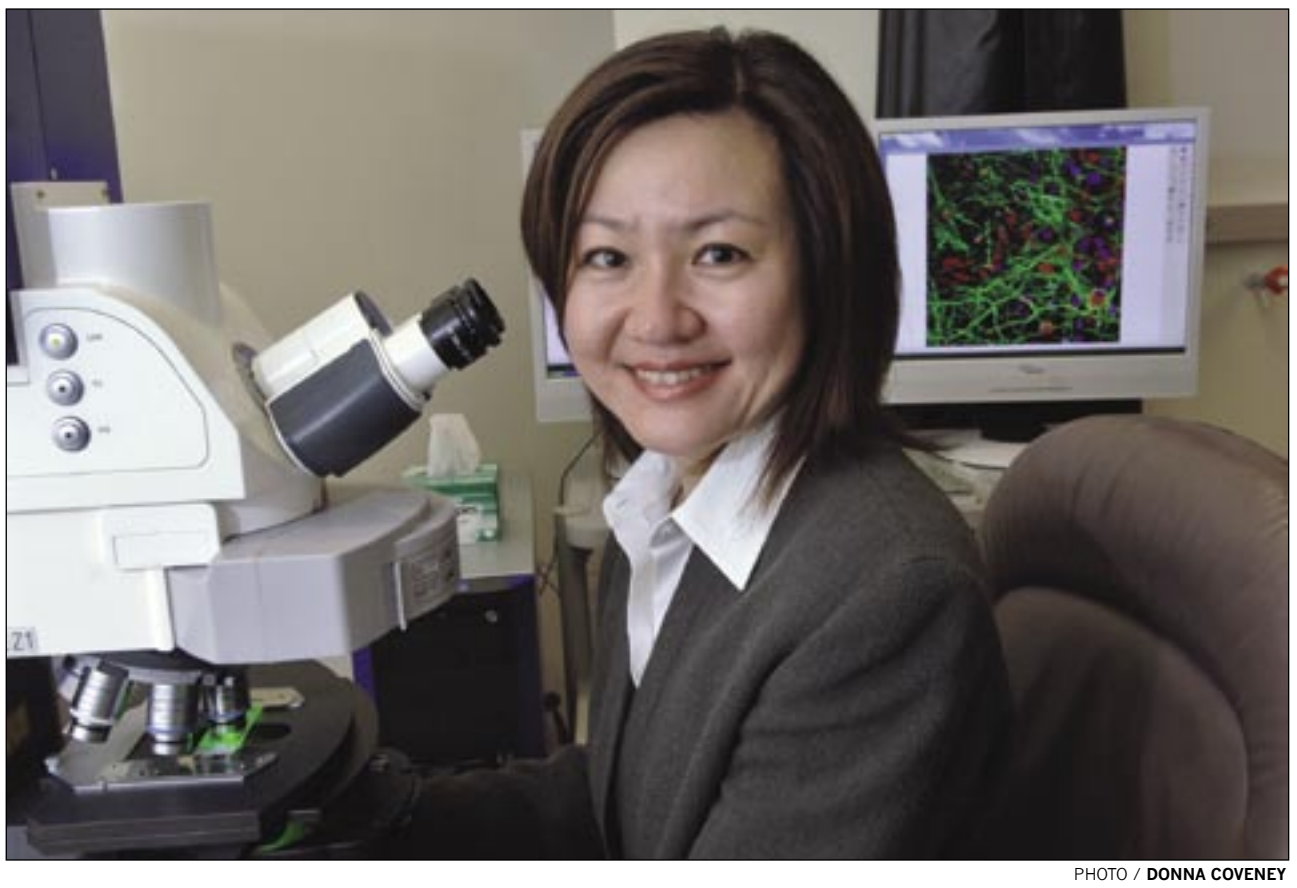

PHOTO / **DONNA COVENEY**

Li-Huei Tsai, Picower Professor of Neuroscience in the Department of Brain and Cognitive Sciences, and colleagues have found that exposing lab mice to certain environmental stimuli induced the animals' brain cells to make new connections.

Horvitz urges support for basic science

Deborah Halber
News Office Correspondent

When H. Robert Horvitz started studying fundamental molecular processes in the roundworm, he had no idea whether his work would ever be relevant to anything besides the obscure little organism on his lab bench.

Decades later, with a Nobel prize under his belt, Horvitz now knows his pioneering work on programmed cell death has provided new targets for possible new interventions for AIDS, cancer, autoimmune diseases and many others.

Horvitz, the David H. Koch Professor of Cancer Biology and Howard Hughes

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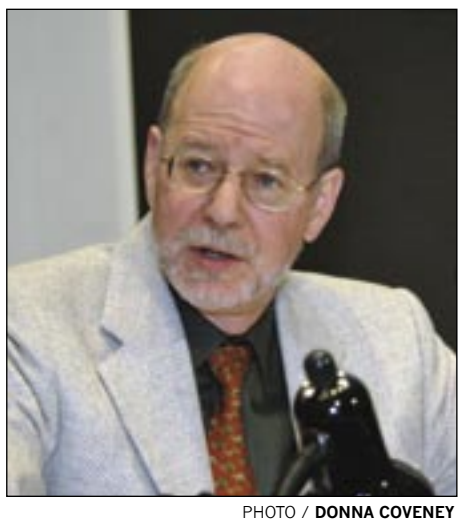

PHOTO / **DONNA COVENEY**

H. Robert Horvitz

Systems biology, in search of a metaphor, tries out language of machines, intestines

Robin H. Ray
News Office Correspondent

Sociology professor Joan Fujimura, visiting MIT from the University of Wisconsin at Madison, discussed her recent work at a Program in Science, Technology and Society (STS) colloquium on April 23. Formerly a specialist in anthropology at Stanford, Fujimura has since focused her attention on the sociology of science, particularly notions of nature/culture and science/society in the fields of genetics, bioinformatics and systems biology in the United States, Europe and Japan.

"One of the emphases in my frame," said Fujimura, "is to use ecological understanding from symbolic interactionism in my research," and she feels that "systems biology mirrors a lot of the kind of theoretical and methodological problems that we have in STS." As she noted, "Our problem"—in STS as much as in systems biology—"is how to represent complexity and still say something interesting and coherent."

Systems biology is a rapidly changing field, one that even its practitioners cannot define to mutual satisfaction. "They are explicit about their ontological problems," Fujimura said. Some scientists use the term "systems biology" loosely to apply to projects exploring individual biological networks. Others see it as an outgrowth of

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PHOTO / **DONNA COVENEY**

Mary Haller, director of arts communication in the Office of the Arts, joins in the African drumming outside of Stata as part of MIT's Earth Day activities.

PHOTO / **DONNA COVENEY**

Earth day

This bale of aluminum soda cans and other containers was outside Stata to remind people to recycle.

Charles Ferguson

Broad Institute will screen 'No End in Sight'

"No End in Sight: The American Occupation of Iraq," a film directed by Charles Ferguson, visiting scholar at MIT's Center for International Studies, will be screened for the public in the auditorium of the Broad Institute of MIT and Harvard on Wednesday, May 2, at 6 p.m.

"No End in Sight" won a special jury prize at the 2007 Sundance Film Festival, held in Park City, Utah. The screening, to be followed by a discussion with the director, is sponsored by the MIT Center for International Studies' Starr Forum.

"No End in Sight" analyzes Iraq's descent into guerilla war, warlord rule, criminality and anarchy.

Based on more than 200 hours of footage, the film retells the events following the fall of Baghdad in 2003 through interviews of such high-ranking officials as former Deputy Secretary of State Richard Armitage, Ambassador Barbara Bodine (who was in charge of Baghdad during the spring of 2003), Lawrence Wilkerson, former chief of staff to Colin Powell, and General Jay Garner (who was in charge of the occupation of Iraq through May 2003), as well as Iraqi civilians, American soldiers and prominent analysts.

Ferguson received his B.A. in mathematics from Berkeley and his Ph.D. in political science from MIT. The author of three books, he has been a senior fellow at the Brookings Institution and a visiting scholar at MIT and Berkeley, and he is a life member of the Council on Foreign Relations.

The Broad Institute is at 7 Cambridge Center (corner of Main and Ames streets). Please R.S.V.P. to nhuch@mit.edu.

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a Howard Hughes Medical Institute investigator. "This hints at the possibility that cognitive function can be improved even in advanced stages of dementia."

What's more, the researchers' results help explain why even severely afflicted patients are occasionally lucid.

Master regulators

Tsai's team was also able to mimic the effect of living in an enriched environment by treating the Alzheimer's-like mice with histone deacetylase (HDAC) inhibitors. HDACs are a family of 11 enzymes that seem to act as master regulators of gene expression. Drugs that inhibit HDACs are in experimental stages and are not available by prescription for use for Alzheimer's.

Proteins called histones act as spools around which DNA winds, forming a structure in the cell nucleus known as chromatin. Histones are modified in various ways, including through a process called acetylation, which in turn modifies chromatin shape and structure. (Inhibiting deacetylation with HDAC inhibitors leads to increased acetylation.)

Certain HDAC inhibitors open up chromatin. This allows transcription and expression of genes in chromatin structures that had been too tightly packed to allow certain genes to be transcribed.

There has been exponential growth in HDAC research over the past decade. HDAC inhibitors are currently being tested in preclinical studies to treat Huntington's disease patients. Some HDAC inhibitors are on the market to treat certain forms of cancer. They may help chemotherapy drugs better reach their targets by opening up chromatin and exposing DNA. "To our knowledge, HDACs have not been used to treat Alzheimer's disease or dementia," Tsai said. "Future research should address whether HDAC inhibitors will be effective for treating neurodegenerative diseases."

A better model

Brain atrophy occurs during normal aging and is an early feature of neurodegenerative diseases that affect learning and memory. Until recently, there were no effective animal models for these diseases, limiting researchers' ability to explore strategies for recovering learning and memory after substantial brain damage had already taken place.

Tsai's laboratory developed a transgenic mouse in which expression of p25, a protein implicated in various neurodegenerative diseases, can be switched on or off with a change in diet. Mice that expressed the p25 protein had significant loss of brain cells and acted as though they did not remember tasks they had previously learned.

"It's not clear if memories were simply lost or became inaccessible due to synaptic and neuronal loss," wrote Tsai. "In the latter case, it might be possible to reestablish the access to such memories if sufficient refinement of the neuronal network can be achieved by the remaining neurons."

In 2003, a man who was barely conscious for nearly 20 years regained speech and movement at a Mountain View, Ark., rehabilitation center. Last year, doctors

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AWARDS AND HONORS

Professor Ian Waitz has been named the first Hunsaker Professor of Aeronautics in the Department of Aeronautics and Astronautics. The appointment enables the professor to "make, or continue to make, contributions at the forefront of important fields of aerospace sciences."

The chair is named for Jerome Hunsaker, the pioneering aviation engineer who founded the department as the first aerodynamics and aircraft engineering program in the United States. Waitz continues Hunsaker's pioneering aviation spirit with his work in propulsion, fluid mechanics, thermodynamics, reacting flows, aeroacoustics and, in particular, aspects of these disciplines that relate to environmental issues associated with aircraft design and operation.

Waitz is the director of the Partnership for AiR Transportation Noise and Emissions Reduction, an MIT-based leading aviation cooperative research organization sponsored by the Federal Aviation Administration, NASA and Transport Canada.

Submit awards for commencement issue

Tech Talk will publish the 2007 awards issue in print and online on June 6. The annual special section lists the names of winners of annual awards, by department, along with photographs where available.

Names of award winners must be submitted to Tech Talk by 5 p.m. on Thursday, May 10, in order to be included in the awards issue. Please note: Do not submit Infinite Mile Awards or awards from outside organizations.

All submissions to the awards issue should be made online at web.mit.edu/newsoffice/awards.html.

All photographs must be e-mailed to shwright@mit.edu. Please clearly identify the subjects and include the name of the photographer.

To see the 2006 Awards issue, please go to: web.mit.edu/newsoffice/2006/awards-index.html.

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Office of the Arts
http://web.mit.edu/arts

Printed on recycled paper

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Tech Talk is published by the News Office on Wednesdays during term time except for most Monday holiday weeks. See Production Schedule at http://web.mit.edu/newsoffice/techtalk-info.html. The News Office is in Room 11-400, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139-4307.

Postmaster: Send address changes to Mail Services, Building WW15, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139-4307.

Subscribers may call 617-252-1550 or send e-mail to mailsvc@mit.edu.

Tech Talk is distributed free to faculty and staff offices and residence halls. It is also available free in the News Office and the Information Center.

Domestic mail subscriptions are $25 per year, nonrefundable. Checks should be made payable to MIT and mailed to Business Manager, Room 11-400, MIT, 77 Massachusetts Ave., Cambridge, MA 02139-4307.

Periodical postage paid at Boston, MA.

MIT, IBM team up on first PlayStation®3 course

MIT's Department of Electrical Engineering and Computer Science and IBM have announced the recent completion of the first course in the United States structured around the capabilities of the Cell Broadband Engine (Cell/B.E.), the microprocessor that powers the new PlayStation®3 computer entertainment system.

During the four-week Independent Activities Period course in January, students not only learned about the new microprocessor, they designed and implemented projects to run directly on PlayStation®3 consoles. The student team with the best project—a 3-D version of the classic pong game—later presented its work and discussed the experience at the Game Developer Conference in March.

The course, which focused around introducing parallel programming to students, was taught by Saman Amarasinghe, a professor in MIT's Department of Electrical Engineering and Computer Science, and Rodric Rabbah of IBM.

"The fact that students—with no background in parallel programming or the Cell Broadband Engine—were able to get their projects done from scratch in just about one month largely goes to show the capability and determination of our students, coupled with the availability of a robust toolchain for Cell development," said Amarasinghe.

Throughout the course, students became familiar with the Cell/B.E. and how its design choices compare to other emerging architectures. Students also formed small project teams and participated in a course-long project to develop applications to run on the Cell Broadband Engine using the IBM Cell SDK available from IBM developerWorks.

"The Cell Broadband Engine is going to be an underlying architecture that has the potential to be included in a wide range of industry applications and solutions in the future," said Rabbah. "This course was able to break down the details of a highly complex microprocessor and challenge students to see where the performance, power and versatility could be applied outside of gaming. Based on the feedback we received from the students, it was a tremendous success."

A web site hosted by the Computer Architecture Group at MIT posts information on the course, including lectures and recitation plans. It has been visited more than 100,000 times since the completion of the course.

IBM and the Department of Electrical Engineering and Computer Science, with sponsorship from Sony, plan to jointly offer the course again in 2008. More information can be found at cag.csail.mit.edu/ps3/.

IBM is also currently hosting a first-of-its-kind programming contest—the Cell University Challenge—for college and university students in 25 different countries, offering cash prizes and awards for the most innovative applications of the Cell Broadband Engine. All information on eligibility, rules and requirements, and entry applications can be found at www-304.ibm.com/jct09002c/university/students/contests/cell/index.html.

Eureka! Lemelson-MIT and Museum of Science host celebration of inventors and inventions

The Lemelson-MIT Program, in partnership with the Museum of Science, Boston, kicks off EurekaFest, a multiday celebration of activities to fuel the inventive spirit, today.

EurekaFest events will be held May 2-5 at MIT and the Museum of Science. Most events are open to the public.

The partnership's goal for EurekaFest is to "ignite a creative spark that inspires young people and others interested in invention to believe they, too, can contribute to society," said Merton Flemings, director of the Lemelson-MIT Program.

Timothy Swager

Ioannis (Yannis) Miaoulis, president and director of the Museum of Science, echoed Flemings' enthusiasm for this first-ever event.

"We are very pleased to collaborate with the Lemelson-MIT Program. The hands-on engineering activities, combined with special guest presentations, are a perfect complement to the museum's programs," Miaoulis said.

One highlight event of EurekaFest is "The Windy 500," an engineering design challenge created to "drive" interest and enthusiasm among more than 100 Massachusetts high school students and their teachers.

Student teams will collaborate on a surprise project with science and engineering mentors in a race against time and each other. Tom and Ray Magliozzi, aka Click and Clack, the hosts of "Car Talk" from National Public Radio, will be on hand to declare one team the victor of "The Windy 500." They will also present several other awards, including "The Most Inventive Use of Duct Tape" award and the "Oh No, I Can't Believe It!" award.

"The Windy 500" runs from 9 a.m. to 3:30 p.m. at the Museum of Science on Friday, May 4. Museum visitors can watch student teams race their designs from 2 to 3:30 p.m.

The 2007 winners of the $30,000 Lemelson-sponsored student prizes—Nathan Ball from MIT, Brian Schulkin from Rensselaer Polytechnic Institute and Michael Callahan from the University of Illinois at Urbana-Champaign—will join a panel discussion, "Inventors Who Shape Our World," at the Museum of Science on Thursday, May 3 at 3 p.m.

Also speaking in "Inventors Who Shape Our World," beginning at 4 p.m., are MacArthur Professor of Chemistry Timothy Swager, the 2007 winner of the $500,000 Lemelson-MIT Prize, and Dartmouth College engineering professor Lee Lynd, the 2007 winner of the $100,000 Lemelson-MIT Award for Sustainability. Among Swager's inventions is an amplified chemical sensor that can detect vapors of common explosives, such as TNT. Lynd's work focuses on the cost-effective conversion of cellulosic biomass into ethanol for fuel.

Both sessions are open to the public and included with the Museum of Science exhibit halls admission.

Two other accomplished inventors, Iqbal Quadir and H. Harish Hande, will lead a day-long workshop at MIT titled "Invention to Venture: Affordable Technology" on Saturday, May 5, from 9:30 a.m. to 3:30 p.m. Quadir founded Grameenphone, the largest and fastest-growing mobile phone company in Bangladesh, and Hande co-founded Solar Energy Light Company, which provides infrastructure solutions to underserved households and businesses in the developing world. The National Collegiate Inventors and Innovators Alliance is collaborating with the Lemelson-MIT Program on the workshop. Advance registration is required; visit the "Invention to Venture" web site for more information: www.invention2venture.org/events/LMIT/index.html.

For a full list of events, times and locations, visit web.mit.edu/invent/eurekafest.html.

Admission to the events at the Museum of Science is free for MIT students with a valid ID.

PHOTO COURTESY / **LEMELSON-MIT PROGRAM**

MIT graduate student Nathan Ball, who invented a device for rapidly scaling large heights, is this year's winner of the $30,000 Lemelson-MIT Student Prize.

PHOTO / **DONNA COVENEY**

Puppet principles

Joe Zane, who taught Introduction to the Visual Arts this semester, poses with puppets made during his course. The one at left is a self-portrait made of upholstery foam with ping pong balls, fake fur and felt. These and other puppets were featured in the foyer of N52-390 to entice potential puppeteers to the CAVS artist's presentation "Let's Put on a Puppet Show!" offered to members of the MIT community and the public on Friday, April 6.

Quarter Century Club induction will be held May 8

The MIT Quarter Century Club induction ceremony and luncheon for new members will be held this year on Tuesday, May 8. New membership in the club is offered to the faculty, administrative, research, support and service staff who will celebrate their 25th anniversary with the Institute on or before June 30, 2007. If you believe you are eligible for membership but have not received an invitation to attend the induction luncheon, please contact the Quarter Century Club in the Community Services Office at x3-7914 or tswartz@mit.edu.

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said the man's brain spontaneously rewired itself by growing tiny new nerve connections to replace the ones damaged in a car crash. Tsai said the case provides evidence that reestablishment of a neural network may allow recovery of long-term memories in humans as well as rodents.

Using the transgenic mice, Tsai and Picower research affiliates Andre Fischer, Farahnaz Sananbenesi and Xinyu Wang and technical assistant Matthew Dobbin set out to see if they could boost the plasticity—the ability to change—and the function of the animals' remaining neurons.

Environmentally enriched (EE) mice have shelves, perches, nesting material, tunnels and other objects in their habitats and are allowed to touch, see, hear or smell other mice. The mice may get opportunities to exercise or learn tasks. Neuroscientists use EE to increase synaptic function in rodents, but no one is sure how or why it works.

In the Nature study, groups of genetically engineered mice were trained for four weeks before neuronal deficits were induced by turning on p25.

Despite the substantial loss of brain cells in the mice, the researchers found that environmental enrichment or elevated histone acetylation resulting from treatment with HDAC inhibitors helped the mice recall maze tasks and other behaviors they had learned weeks before.

The fact that long-term memories can be recovered by environmental enrichment or elevated histone acetylation supports the idea that apparent memory "loss" is really a reflection of inaccessible memories, Tsai said. "These findings are in line with a phenomenon known as 'fluctuating memories,' in which demented patients experience temporary periods of apparent clarity."

Tsai said, "We really hope that our results will lead to a suitable therapeutic approach to treat dementia. However, the immediate next steps are to determine which HDACs regulate distinct forms of synaptic plasticity, learning and memory."

This work is supported by the National Institutes of Health.

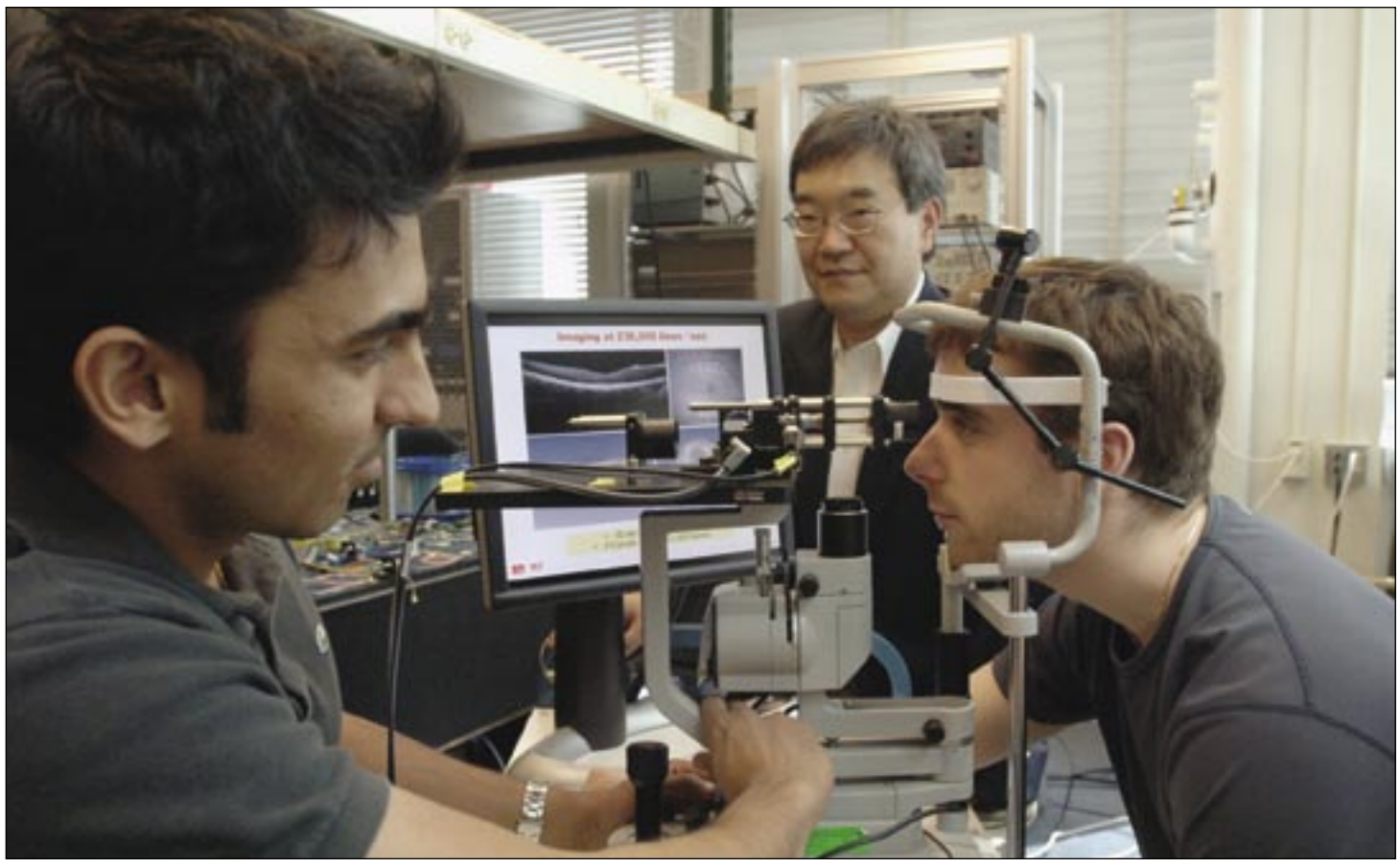

PHOTO / **DONNA COVENEY**

Professor James Fujimoto, center, with students using the eye-imaging technique he began developing in the early 1990s. With his head in the apparatus is Desmond C. Adler, graduate student in materials science. At left, taking measurements, is Vivek Srinivasan, graduate student in electrical engineering and computer science.

EYE IMAGING

Continued from Page 1

The system works by scanning light back and forth across the eye, measuring the echo time delay of reflected light along micrometer-scale lines that, row by row, build up high-resolution images.

Commercial OCT systems scan the eye at rates ranging from several hundred to several thousand lines per second. But a typical patient can only keep the eye still for about one second, limiting the amount of three-dimensional data that can be acquired.

Now, using the new laser, researchers in Fujimoto's group report retinal scans at record speeds of up to 236,000 lines per second, a factor of 10 improvement over current OCT technology.

Future clinical studies, as well as further development, may someday enable ophthalmologists to routinely obtain three-dimensional "OCT snapshots" of the eye, containing comprehensive volumetric information about the microstructure of the retina. Such snapshots could potentially improve diagnoses of retinal diseases such as diabetic retinopathy, glaucoma and age-related macular degeneration.

Fujimoto's colleagues on the work are Robert Huber, a visiting scientist at MIT now at the Ludwig-Maximilians University in Germany, Desmond C. Adler and Vivek Srinivasan. Adler and Srinivasan are both graduate students in EECS.

The current research was sponsored by the National Science Foundation, the National Institutes of Health and the Air Force Office of Scientific Research.

Mitchell portrays MIT campus design process

Deborah Halber
News Office Correspondent

Early explorations of what would eventually become the Ray and Maria Stata Center included crumpled pieces of paper, piles of toy-like wood and plexiglass blocks and something resembling a mass of discarded tin foil.

These were not designs, exactly, but provocative attempts by architect Frank Gehry to get his diverse group of MIT clients and the future inhabitants of the building to start to think about what they really wanted—to react, directly and emotionally, to the propositions on the table before them.

The stories behind the conceptualization, design and construction of the Stata Center and four other major buildings—Kevin Roche's Zesiger Sports and Fitness Center, Steven Holl's Simmons Hall, Charles Correa's Brain and Cognitive Sciences Complex and Fumihiko Maki's new project for the Media Laboratory—are contained in William J. Mitchell's new book "Imagining MIT: Designing a Campus for the Twenty-First Century."

Mitchell, former dean of the MIT School of Architecture, is the Alexander W. Dreyfoos Professor of Architecture and Media Arts and Sciences and director of the Smart Cities research group at MIT's Media Lab. Mitchell, who was heavily involved in all the building projects, said he wanted to show "how ideas evolved and changed" by providing a rare insider's glimpse of the process of creating iconic new campus spaces.

Published by MIT Press, the 142-page volume is a "new kind of architecture book," Mitchell said, which relates the good without shying away from the bad and the ugly. The book, which Mitchell first drafted in one long weekend at a Dublin hotel, is filled with images and anecdotes that reflect the complex and often surprising process through which the new buildings came to be. "The behind-the-scenes story about how architecture gets done—a rarely told story, a hard-to-tell story—needed to be written," Mitchell said.

Architecture is not "sitting down in a room and dreaming things up," he said. "There's money involved, and politics, and incredibly complex social forces and endless negotiation, and you have to try to make great buildings out of all that."

Mitchell, by including pictures of designs at different stages of the projects, wanted to show "how ideas evolved and how they changed. Large organizations such as universities are fundamentally conservative and want to minimize risk, so adventurous, innovative design for them takes both imagination and flexibility. Promising ideas had to be abandoned for practical reasons." The result is a book that appeals to an audience that includes the general public as well as urban designers and architects.

PHOTO / **DONNA COVENEY**

MIT Professor Bill Mitchell of architecture.

Stata was a particularly challenging project because Frank Gehry's extraordinary Guggenheim Museum in Bilbao, Spain, had projected him into "rock star fame," Mitchell wrote. Everyone had an opinion about him. Mitchell, meanwhile, was very aware of Gehry's professionalism: his attention to detail, his responsiveness to his client's day-to-day needs, his ability to keep costs in check. "Some people thought because he did radical things that he must be a crazy man," Mitchell said. "But he's a highly experienced, extremely skilled architect. And I knew the match to MIT would be fantastic." It was Mitchell who managed to keep Gehry's name in play for the project and helped mediate the ongoing, sometimes contentious discussions.

The process did generate more than a few infuriated e-mails when Gehry at one point suggested that the interior space mimic an "orangutan village." But in the end, the ensuing discussion led to a pivotal organization scheme for research groups within the building. And the Stata Center did not, Mitchell attested, come in absurdly over budget. "On a dollars-per-square-foot basis, it came out to no more than the median for comparable buildings constructed in the United States at roughly the same time," he wrote.

"Over the last few decades, MIT had been playing it very safe with its buildings," Mitchell said. "This was setting the bar of ambition much higher." Mitchell credited former MIT President Charles M. Vest with the "courage" to commit to the project. Vest did have his doubts, but, he wrote in an afterward to "Imagining MIT," after Gehry spent most of their first phone call telling stories about physicist Richard Feynman, "I hung up feeling great confidence that we would get what we wanted and needed."

Vest is elected NAE president

He will deliver MIT's Commencement address

President Emeritus Charles M. Vest has been elected to a six-year term as president of the National Academy of Engineering, effective July 1.

"Engineering is at the core of addressing fundamental challenges to the U.S. economy, environment, health, security, and way of life in the 21st century," Vest said in an April 26 statement on the future of the National Academy of Engineering (NAE).

"As an independent organization of nearly 2,000 of the nation's most accomplished engineers charged to provide the federal government with objective, informed advice on technological matters, the NAE can and will play an important role in securing our nation's future," Vest wrote.

Vest will deliver the 2007 Commencement address at MIT before assuming his new NAE leadership role.

The NAE is part of the National Academies, which also include the National Academy of Sciences, Institute of Medicine and National Research Council. These independent, nonprofit institutions serve as advisers to government and the public on issues related to science, engineering and medicine. NAE's membership consists of the nation's premier engineers, who are elected by their peers for their distinguished achievements.

The NAE president is a full-time employee of the organization at its headquarters in Washington, D.C., and also serves as the vice chair of the National Research Council, the principal research arm of the National Academies.

Vest served as MIT's president from 1990 through 2004. During that time, "he worked to strengthen federal-university-industry relations and undertook a number of initiatives to bring education and research issues to broader public attention," according to the NAE.

Selected as a member of the bipartisan Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, which completed its report in 2005, Vest brought a strong science and engineering background to the analysis. He led a U.S. Department of Energy task force on the future of science programs in 2002-2003 and chaired a presidential advisory commission on the redesign of the International Space Station in 1992-1994. Vest was vice chair of the Council on Competitiveness for eight years, is a former chair of the Association of American Universities, and serves on the U.S. Secretary of Education's Commission on the Future of Higher Education.

Vest was elected to the NAE in 1993 "for technical and educational contributions to holographic interferometry and leadership as an educator," and he currently serves on the NAE Council.

Vest earned a B.S. degree in mechanical engineering from West Virginia University in 1963. He received his M.S. and Ph.D. degrees in 1964 and 1967, respectively, from the University of Michigan, where he later held the positions of dean of engineering, provost and vice president for academic affairs. He is the recipient of 10 honorary doctoral degrees.

PHOTO / **DONNA COVENEY**

Charles M. Vest

New MIT technique weighs single living cells

One promising application is creation of a cheap and robust device to monitor CD4 cell numbers in AIDS patients

Anne Trafton
News Office

For the first time, MIT researchers have found a way to measure the mass of single cells with high accuracy.

The new technique, which is based on a micromechanical detector, could allow researchers to develop inexpensive, portable diagnostic devices and might also offer a unique glimpse into how cells change as they undergo cell division.

Unlike conventional methods, the MIT technique allows cells to remain in fluid while they are being measured, opening up a new realm of possible applications, says Scott Manalis, senior author of a paper on the work that appeared in the April 26 issue of Nature.

In addition to weighing cells, the technology can be used to "weigh nanoparticles or submonolayers of biomolecules with a resolution in solution that is six orders of magnitude more sensitive than commercial mass sensor methods. One direction we're pursuing is mass-based flow cytometry, a way to weigh and count specific cells," said Manalis, an associate professor in MIT's Departments of Biological Engineering and Mechanical Engineering.

Current mass-measurement methods achieve a resolution down to a zeptogram (10^{-21} grams) but only work with nonliving things because the procedure must be performed inside a vacuum. So, the MIT researchers decided to turn the conventional system inside out.

In the traditional method, the molecules to be weighed are placed on top of a tiny slab, or cantilever, made of silicon. The slab vibrates at its resonant frequency (the frequency at which the material naturally tends to vibrate) inside a vacuum. When a molecule sits on the slab, the frequency changes slightly, and the mass of the molecule can be calculated by measuring that change.

This measurement must be performed in a vacuum to prevent air (or fluid) from interfering with the frequency of oscillation. However, cells cannot survive in a vacuum, so they must be measured in fluid, which diminishes the accuracy of the measurement.

The researchers solved this dilemma by placing the fluid containing the sample inside the silicon slab, which still oscillates within a vacuum surrounding it. The biological sample is pumped through a microchannel that runs across the slab, without impairing its ability to vibrate.

"The resonator is sealed in a tiny vacuum cavity inside the chip, so there is virtually no resistance to the vibration," said co-lead author Thomas Burg, a research associate in biological engineering. "This lets us measure a mass change, say 10 parts in a billion, of the already very light microcantilever."

So far, the researchers have weighed particles with a resolution down to slightly below a femtogram (10^{-15} grams), but Manalis believes that with refinements, the sensitivity could potentially be lowered by several orders of magnitude within a few years. "Every step along the way will open up new possibilities," he said.

The researchers can also measure the mass density of particles or cells "by varying the density of the surrounding solution," said Michel Godin, co-lead author and postdoctoral associate in biological engineering.

The research team is already looking into several applications for the new technique.

One area of great promise is creating a device that would mimic the cell-counting capabilities of flow cytometers, which are often used to monitor CD4 cell numbers in AIDS patients. By counting CD4 cells, a type of immune cell, doctors can tell how far a patient's AIDS has progressed. However, flow cytometry devices, which work by bouncing light off a flowing stream of cells, are too large and expensive to be useful in developing countries where many AIDS patients live.

A tiny chip that could count cells using the new MIT weighing method would be a "cheap and robust" alternative to commercially available flow cytometers, which typically cost more than $20,000, Manalis said.

"Since the device is batch-fabricated by conventional semiconductor processing techniques, it could potentially be used in a disposable format," he said.

William Rodriguez, an AIDS researcher at Massachusetts General Hospital who is familiar with Manalis' research, said the new technology could have a tremendous impact on AIDS testing in rural areas of

See **CELLS**
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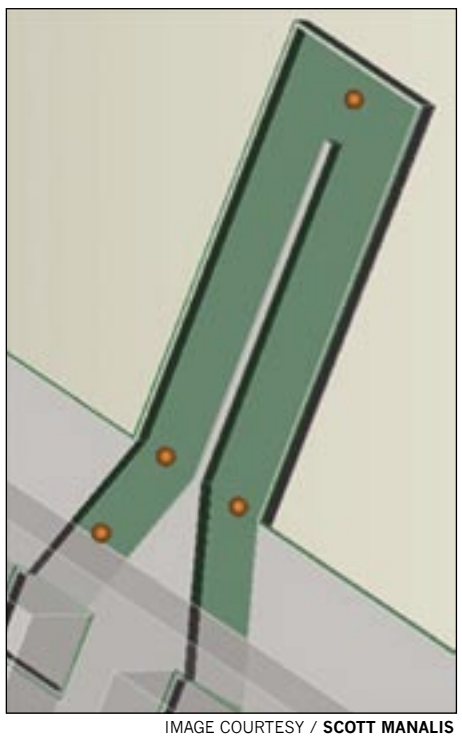

IMAGE COURTESY / **SCOTT MANALIS**

MIT researchers have developed a tiny chip that can be used to weigh single cells or particles. As particles flow through the device, the frequency of vibration of the cantilever (green) is slightly altered, allowing the mass of the particles to be calculated.

IMAGE COURTESY / **THOMAS BURG**

This illustration shows an artistic depiction of the concept that enables measuring the mass of a single bacterium and single nanoparticles in fluid with a very high resolution. A hollow resonator, represented by a hollow, fluid-filled guitar string, vibrates while small particles, represented here by a red bacterium, flow through it. As the particles flow through the resonator, they change the frequency (tone) of the vibration.

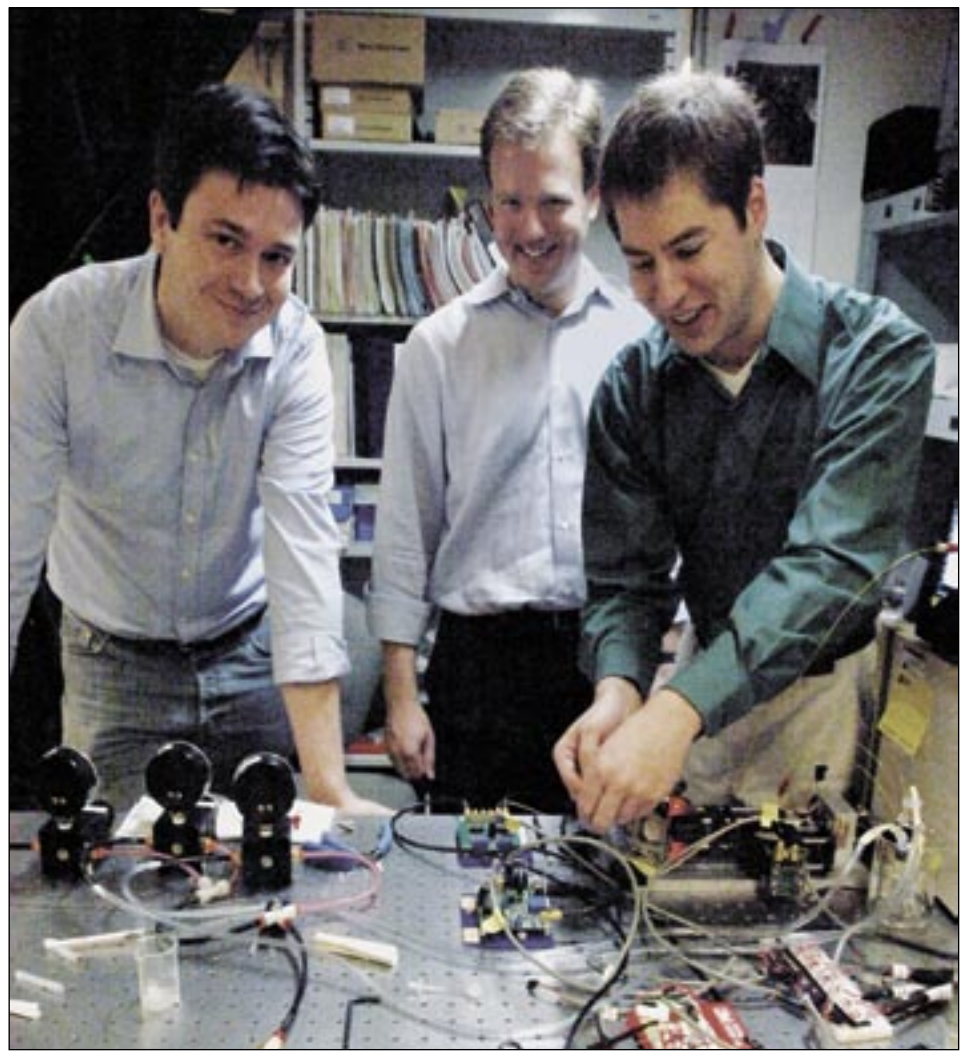

PHOTO / **DONNA COVENEY**

Postdoctoral associate Michel Godin, left, Associate Professor Scott Manalis of biological engineering and postdoctoral associate Thomas Burg are part of an MIT team that has developed a technique to measure the mass of single cells.

MLK professor teaches 'excitement' of solving math–and life–problems

Deborah Halber
News Office Correspondent

In the small southern Ethiopian town where Akalu Tefera grew up, mathematics and physics textbooks were scarce. High school students who were as inspired by their teachers as he was borrowed their teachers' books.

Tefera, who has been named a Martin Luther King Jr. Visiting Professor for 2006-2007, now passes along his love for mathematics to others. He enjoys teaching mathematics at many levels—just as he used to help his classmates in Ethiopia—and has mentored undergraduate students in cutting-edge research.

Despite the fact that Tefera did not attend one of the elite private schools in the capital, he did manage to "pass through the needle's eye" as one of only a few thousand out of more than 100,000 students to pass the rigorous exam for admittance to Addis Ababa University, where he earned undergraduate and graduate degrees. He earned his Ph.D. degree from Temple University.

Tefera, associate professor of mathematics at Grand Valley State University in Allendale, Mich., specialized in the branch of mathematics called combinatorics, which studies collections of objects that meet certain criteria. An example of a combinatorial problem is: What is the number of possible ways to order a deck of 52 playing cards? The answer involves multiplying 51 digits and arriving at a number 68 digits long.

Besides solving problems, combinatorics is about theory building.

Tefera works on software that facilitates mathematical expressions in symbolic form. His work in computer algebra has resulted in software packages that have useful applications in mathematics, in particular, to computer-generated proofs of combinatorial and integral identities.

"Research and exploration of algorithmic techniques used in computer-aided discovery and proof of mathematical theorems has been gaining a lot of momentum over the past decade," he said. "Some mathematical problems involve determining the number of different ways certain things can be done and finding a simple formula for doing so.

PHOTO / **DONNA COVENEY**

Akalu Tefera

"One of the exciting discoveries in the early '90s was the introduction of a method by which the computer can prove large classes of identities using an elegant algorithmic checking procedure. For example, in the summer of 2005, I helped a student study a special class of sums and summation algorithms. Using these algorithms cleverly, the student was able to solve challenging and new problems that involve combinatorial identities," he said.

Tefera is energized by working with undergraduates. "I believe an exciting undergraduate research project is a key factor for cultivating and retaining student interest in pursuing advanced studies in mathematics," he said.

"I also like to work on research problems that stem from my classroom teaching experience and that enhance my classroom teaching," he said. "For example, I ask questions based on students' mathematical mistakes and misconceptions, such as, 'We know that this does not work in general, so for what class of objects does it work? Can we characterize those objects for which this generally wrong statement will be true?'"

While it may seem counterintuitive to dwell on mistakes, Tefera has found that mistakes have led to interesting problems. "The research problems and results are very interesting and exciting," he said.

Bonvillian wins IEEE public service award

A stalwart supporter of federal R&D programs

William B. Bonvillian, director of the MIT Washington, D.C., office and a former legislative director and chief counsel for Sen. Joseph Lieberman (D-Conn.), has been presented with a 2006 Distinguished Public Service Award by the Institute of Electrical and Electronics Engineers (IEEE-USA) "for outstanding support of science and technology-related legislation and policy in the U.S. Congress."

Bonvillian and David J. Goldston, currently a scholar-in-residence with the Woodrow Wilson School of Public and International Affairs at Princeton, will share the Distinguished Public Service Award.

"Their support for investment in high-tech research and development (R&D) has helped to boost U.S. competitiveness and contributed greatly to our nation's innovation enterprise," IEEE-USA President John Meredith said.

"This helps U.S. engineers thrive in an increasingly competitive global environment," he said.

Bonvillian will join 17 award recipients to be honored during the IEEE-USA annual meeting in Scottsdale, Ariz., in September.

According to award materials, Bonvillian has been a "stalwart supporter" of federal R&D programs since his tenure in the Department of Transportation (1977-1980). He is credited for developing a wide array of initiatives for Lieberman, including the Clean Air Act (1990); the Technology Talent Act (2001); the Homeland Security Department Authorization (2002); the National Nanotechnology R&D Act (2003); and the National Innovation Act (2005), among others.

IEEE-USA award recipients are recognized for their professionalism and technical achievements, as well as literary contributions to public awareness and understanding of the engineering profession in the United States.

PHOTO / **DONNA COVENEY**

William B. Bonvillian

CELLS

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Africa and elsewhere.

"Simply put, a cheap, simple CD4 counting device that can be used by a community health worker…would be a breakthrough advance in global health," according to Rodriguez.

Manalis is also planning a collaboration with MIT associate professor of biology Angelika Amon, who is interested in studying how the mass density of a single cell changes as it goes through cell division. Using the new method, scientists can ultimately trap a single cell and observe it over a long period of time. Changes in mass could correlate to production of proteins, offering a new way to study what the cell does during division, Manalis said.

Another application of the new technology is to measure small particles, or beads. It's important to know the size of particles used in paint, drug-delivery devices, coatings and nanocomposite materials, said Manalis, who added that the new technology could become the "gold standard" way to measure these particles one by one.

Other authors on the Nature paper are Scott Knudsen, MIT postdoctoral associate in biological engineering; Wenjiang Shen, Greg Carlson and John S. Foster of Innovative Micro Technology in Santa Barbara, Calif.; and Ken Babcock of Innovative Micro Technology and Affinity Biosensors in Santa Barbara.

The research was funded by the National Institutes of Health Cell Decision Process Center, the Institute for Collaborative Biotechnologies from the U.S. Army Research Office, the Air Force Office of Sponsored Research, the National Science Foundation and the Natural Sciences and Engineering Research Council of Canada.

HORVITZ

Continued from Page 1

Medical Institute investigator, delivered the 35th annual Killian Award lecture April 24. Winner of the 2006-2007 James R. Killian Jr. Faculty Achievement Award, Horvitz spoke on "Worms, Life and Death: Cell Suicide in Development and Disease."

Horvitz is concerned that because of declining government support, today's young researchers will not have the same freedom he did to pursue basic research. "Basic research may lead not only to intellectually stimulating findings, but also to major insights of a practical nature," he said. "Basic research must be supported outside the private sector by governments and foundations because only such organizations can act on a basis that will benefit humanity but cannot possibly constitute a business plan."

The current downward trajectory of government funding "is positively frightening," Horvitz said. It underestimates the rate of inflation in the cost of doing biomedical research. Six to 8 percent annual increases are needed simply to maintain the current level, he said, while 10 to 12 percent increases are needed to "propel biomedical research to take advantage of current knowledge." The average 1 percent increases over the past few years have led to "an unprecedented low success rate for new projects," Horvitz said.

"Without the NIH (National Institutes of Health—the major government supporter of biomedical research), I have deep concern for the future of government-funded basic science," he said.

Horvitz has identified many genes involved in pathways of key processes that correlate directly to human development and disease. In the roundworm, there are 131 cells generated during development that are not found in the adult because they die through normal programmed cell death. Biologists used to think that only old or damaged cells died off, but researchers now know that cell death is "an active process, governed by specific genes," he said.

Cells die in many scenarios—tadpoles lose their tails as they turn into frogs, and webbing between the fingers of humans in utero is sculpted out by programmed cell death, while ducks retain their webbed feet because those cells are not killed off.

Because the process can go right, it can also go wrong. Many disorders stem from a disruption in the perfect equilibrium between cell division and programmed cell death. Some, like cancer, involve too little cell death. Some, like neurodegenerative diseases, involve too much.

The Horvitz laboratory has identified genes and proteins involved in the four-step genetic pathway of cell division and death. The human counterparts of the roundworm genes are potential therapeutic targets in a broad range of diseases. "If we could inhibit a killer gene, we could prevent the pathological process of programmed cell death and cause dying cells to survive," he said. "For diseases involving too little cell death, such as cancer, if we could activate the cell death pathway, we should be able to cause cells to die that have otherwise escaped death."

Potential therapeutics developed by a biotechnology company Horvitz founded are now in clinical trials.

Established in 1971 as a tribute to MIT's 10th president, the Killian Award recognizes extraordinary professional accomplishment by an MIT faculty member. The winner delivers a lecture in the spring term.

FUJIMURA

Continued from Page 1

theoretical models derived from systems theory, mathematics, statistics, artificial intelligence, robotics, engineering and similar fields.

As Fujimura explained, molecular genetics started off a couple of decades ago with great optimism and the idea that, once the sequencing of the human genome was complete, diseases like cancer and type 2 diabetes would soon be cured. Something of a malaise fell over the field at the end of the 1990s, when it became clear that the Human Genome Project was not going to solve all of our medical problems, and that biological systems were massively more complicated than the older "one gene–one trait" model had foreseen. One result has been the proliferation of "omics"—e.g. proteomics, metabolomics, glycomics—as the study of the genome splinters into dozens of subspecialties.

Are biosystems engines?

Biologists looking for ways of thinking about the complexity of living systems have reached, in Fujimura's view, into two very different repositories of thought. One is largely mechanistic, and its language is drawn from control theory and machines—using terms like "circuitry," "modularity," "redundancy" and "robustness," which are also used to describe cars, electronics, traffic, robots and airplanes. For example, one prominent systems biologist, Hiraoki Kitano, used a schematic of a Boeing 747's hydraulic control systems to model biological systems. This reductionist model has begun to look less useful as we become increasingly aware of the complexity of living organisms.

Or are they intestines?

The other line of thinking, exemplified by British scientist Jeremy Nicholson, looks to natural ecosystems as models. His work, said Fujimura, could be summarized as "diverse, dynamic and intestinal," exploring the multitude of microorganisms that inhabit and indeed largely comprise the human body. Again, speaking of systems biology as a mirror of STS studies, Fujimura noted, "I would argue that we are now witnessing the reintroduction of time, place, interaction, multiple actors, history, environment, dynamics and diversity into what previously had been this timeless, unsituated and unidirectional picture of reductionist molecular genetics."

Fujimura has had a busy semester at MIT, interacting with colleagues in the area while teaching two courses, one on the development of systems biology and another that examines how the notion of population is conceptualized and operationalized in human genetics research. In a recent e-mail, she remarked, "At first, I was concerned about the effort of moving here for just one semester, but I am so glad that I did!"

CLASSIFIED ADS

Tech Talk runs classified ads in the first issue of each month. Members of the MIT community may submit one classified ad per month. Ads should be 30 words maximum; they will be edited. Submit by e-mail to ttads@mit.edu or mail to Classifieds, Rm 11-400. Deadline is noon Wednesday the week before publication.

VEHICLES

2000 Honda Accord EX V6 – $8,200. Green, tan leather interior, 98K, great condition; all maintenance records kept, timing belt & water pump have been replaced. E-mail npadgals@mit.edu or call 580-917-5011.

1997 Chrysler Concorde LXI, good cond., leather seats, 102K, new timing belt, brakes, plugs, pcv, filters & good tires. Well maintained. $2400. Call Pete at x4572 Linc, Tues, Wed, Thurs.

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3-4BR, 1BA, fenced yard. Walk to new Weymouth Landing T or bus. New bath ('05), roof ('02), deck ('03), swing set ('04), fenced yard, deleaded, hdwd floors, workshop. $359.9K. bjsmiles@mit.edu.

Cambridge–walk to MIT. Three apartments, clean, quiet, safe. 1BR, fully furnished & fully equipped, great view, avail. June 1, $1250. 2BR, partially furnished, avail. May 1, $1525. 3BR, 2BA, unfurnished, avail. May 1, $2250. Contact johnnatale@verizon.net or 781-729-7725.

FOR SALE

Himalayan rock salt crystal lamp w/ wooden base, stands about 9 inches high. Purifies air by emitting natural ions, enhance well-being, beautify surroundings, helps w/ asthma & allergies. $40. Call 617-251-8813.

Solid oak desk w/ legal or letter size hanging folder drawer. 29" H, 55" W, 27" D. Asking $300. Please contact Charles Wright, x3-6025, 9am-2pm.

Electric single bed (hospital bed), like new, for donation to MS Society, whatever you want to donate. E-mail jundzilo@mit.edu.

Matching beige sofa & love seat, v. good cond., $650/best. Call 617-253-7451, 617-697-1603 or 781-662-1206.

Queen size black platform bedroom set includes ultra-firm mattress, large and small chests of drawers, vanity table, $150. PotteryBarn brand new round wood side tables with drawer, $35 each. 617-484-0308.

New in box Coleman RoadTrip Grill, 20,000 BTU propane gas grill. $150/best. Call Sue at x3-6522 or 617-969-4260.

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VACATION

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Ptown waterview condo. Private beach, 1BR, 1.5BA. Private deck w/bay view. Parking. Basement washer/dryer. Furnished. June 1–Sept 30, $10,500. Monthly rental option. No pets/smoking. 781-910-8362 or Sharejo1@yahoo.com. http://www.geocities.com/cmirochelle/ptownCondoWeichman.html.

Cottage, Lake Maranacook, ME. Crystal clear 7 mi. lake, fishing, canoe, rowboat. 2BR, bath, kitchen, 260 ft. sandy pvt. beach. $825/wk. Photos & ref. at MIT. 6/30-7/7 or 7/14-7/21. Call Tom at 508-376-4336.

Enjoy a whitewater rafting trip on the Kennebec River in Maine during summer 2007, excludes Saturdays. For 2 people, cost $125. Website: www.threeriverswhitewater.com. Contact Cheryl x8-5673 or cheryl@mit.edu.

Ocean front summer cabin, Mount Desert Island, ME: 2BR/1BA w/living/kitchen area; picture windows, deck overlooking water; stairway to beach. Mins from Acadia National Park, Bar Harbor. $1,000/week June-Sept. Steve at 253-5757 or chorover@mit.edu.

MISCELLANEOUS

Writing your thesis? Submitting a paper to a journal? MIT-based editor w/ extensive experience can correct grammar, improve style & enhance the clarity of your document. Flexible rates. Fast turn-around time. E-mail wordplayer06@yahoo.com.

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Kenyan center supports literacy, development

Aisha Walcott, a graduate student in electrical engineering and computer science, recently traveled to Laare, Kenya, as a representative of the Imara outreach program, which was funded by a grant from the MIT Public Service Center.

Her mission was to teach educators and other residents of the small rural village how to use computers, to help put in place strategies for sustaining the technology center and to ensure that it had the greatest impact possible.

Walcott admits that as a member of the Computer Science and Artificial Intelligence Lab (CSAIL), she has grown accustomed to her $283.5 million surroundings at the Stata Center. She can always count on working electricity, clean running water and being surrounded by the latest technology. Until her recent trip to Laare, Kenya, these were all things she depended on.

The Laare Community Technology Center (Lacotec) is located at the Laare Catholic Community Church compound and lacks many of the amenities Walcott has grown accustomed to. The small classroom is dimly lit; when the electricity is working, the light reveals a thin layer of dust covering the plastic chairs and handcrafted wooden tables that serve as office furniture. One training manual is used to instruct classes of 10 to 15 students.

Walcott admits the differences posed "interesting" challenges, but she was more struck by the promise of the small community center than by any of its shortcomings. "It's amazing how much gets done in that small room," Walcott marvels. "There is so much room for potential growth and so much that can still be done."

The center was founded in 2005 through the efforts of Eric Mibuari, an MIT alumnus originally from Laare, and the MIT Public Service Center. It was one of the first projects taken on by the CSAIL Imara outreach program. It was founded to increase general computer awareness and literacy of Laare residents by providing accessible and inexpensive training on the use of computers.

Since the center began to operate in 2005, more than 120 students have been trained on its 10 computers, helping a significant number of them find better employment as teachers, clerks and technicians in local institutions and businesses. It has also made it easier for some of the students to get into more advanced computer courses in other technical colleges in the country.

Currently, the project is still in what Walcott refers to as its initial stages. Walcott knew that she was going to an area where people had very little exposure to computers, but she was not prepared for how little experience the teachers sent by the local primary schools had with computers.

Initially Walcott and her colleague, Shawntel Hines, also an MIT graduate student, asked the schools to send teachers who had some experience working with computers. With this in mind, Walcott prepared a curriculum geared toward introducing the teachers to the Edubuntu Linux-based educational software and showing them ways to incorporate it into their lesson plans.

At Walcott's first lesson with the teachers, it became apparent that none of the teachers had any prior experience with computers and the class would not be following the curriculum that she had designed. Instead, she adapted her curriculum "on the fly" to include topics ranging from proper care of the computers to basic operation of the hardware.

Rather than feeling frustrated by this experience, Walcott embraced the challenge. She praises the teachers for their willingness and ability to thrive with minimal direction, and particularly their desire to learn.

In parallel with the growth of the people in Laare, Walcott has undergone a personal growth of her own.

"You only live once. I want to make as big of a contribution to humanity as possible. The most natural way for me to contribute is through my passion for teaching," she said. By working with the Laare community, Walcott and other participants in the CSAIL Imara program have empowered residents to affect change in their community through computer technology.

A program that gives Saudi women a SWIFT start in technology

Amy MacMillan
MIT Sloan Educational Services

Nada Hashmi was shocked when she returned to her native Saudi Arabia three years ago and realized how far behind the country lagged in technology.

Hashmi, a graduate student in system design and management (SDM), had spent five and a half years in the United States earning her undergraduate and master's degrees in computer science and math and finding a great job in her field. But on her return to Saudi Arabia, she found "technology is just catching up. And women always get left behind."

She also noted that since people who are educated often leave, the "area gets drained. The reason I went back is because I wanted to give back."

In 2005, Hashmi moved home to work for the College of Business Administration, a private college established seven years ago in the city of Jeddah, the second-largest city in Saudi Arabia. Due to gender segregation policies, the 500 women enrolled are separated from the 1,400 male students.

In 2006, Hashmi coordinated a partnership for the women's campus with Women in Technology (WIT), which is funded by the Middle East Partnership Initiative of the U.S. Department of State and managed by the Institute of International Education, to teach Saudi women basic computing skills. WIT's goal is to empower women by teaching them basic computing and IT skills at a low cost. WIT receives support from Microsoft Unlimited Potential curriculum and instructor training and also has partners in Iraq, Kuwait, Oman, United Arab Emirates and Yemen.

"I wanted to do a project that's good for society and the school," she said. So she helped the students organize their own nonprofit company within the school. This gave students real-world experience and local women affordable computer training. The students named the enterprise Student Women Initiative For Technology, or SWIFT.

PHOTO COURTESY / **MIT SLOAN**

Nada Hashmi

Hashmi assisted the students in determining a SWIFT hierarchy with a president, vice president and various departments such as marketing, human resources, finance and IT. The students then interviewed one another to decide who else would be selected for the program.

An outside trainer enabled the students to become Microsoft-certified. These women then taught the entire Microsoft Office suite, as well as the basics of the Internet and e-commerce, to other Saudi women.

Hashmi said one of the most exciting parts of the project was that the program provided the 50 student participants with a sense of working in a real company. "They had to go through finance to raise and manage funds, and they had to deal with a president and a vice president," she said.

The project won the first runner-up prize in the Jeddah Economic Forum Collegiate Business Venture Award 2007.

Hashmi was in the United States for the SDM program and was informally mentoring students. When asked what was most satisfying about the project, she said, "working with the students and watching them change and grow."

Hashmi has a B.A. in computer science and math from Washington College and an M.S. in computer science from the University of Maryland. Having now returned to Saudi Arabia, Hashmi envisions continuing to help her society through similar projects. "Education is a liberation factor. With education, you can empower yourself," Hashmi said.

'WACK!' weighs the impact of feminist art

Elizabeth Knox
News Office Correspondent

"WACK! Art and the Feminist Revolution," published by MIT Press to accompany an exhibition of the same name, inspires challenging questions. The exhibition, originating in Los Angeles, is a collection of art produced by women during the height of the feminist movement, primarily the late 1960s through the 1970s. One of the purposes of the exhibition and its catalogue is to rouse discussion about both the impact of the feminist art movement and the need to re-examine this art today. The book and the exhibition are ambitious, confrontational and far-ranging in scope.

The WACK! exhibition, based in Los Angeles' Museum of Contemporary Art, was proposed and curated by Cornelia Butler. It is the largest-ever exhibition of work entirely by women artists; its level of ambition, commitment and organization is suggested by a glance at the page listing lenders to the exhibition—184 strong, many the artists themselves.

The catalogue includes not only full-color, high-quality plates, but also short biographies of each artist or collective and essays by respected art history scholars. The attention to design is evident from the arresting wraparound cover image depicting Martha Rosler's "Body Beautiful, or Beauty Knows No Pain: Hot House, or Harem," a tangle of women's bodies, mostly nudes, and the positioning of the title in white, heavyweight print. This is perhaps not a book to display on the coffee table, unless you desire to make a bold statement.

"WACK!" is divided into three sections: the plates, the biographies and the essays, bookended by Butler's introduction and a chronology of all-women group exhibitions from 1943 to 1983. Here again, the attention to detail is evident from the texture and color of the paper: glossy for the plates, apricot-colored for the biographies (this and the narrow column setting makes them look like aged newsprint) and plain off-white for the essays.

The arrangement allows the reader to first examine the work on its own, then to learn more about the artists, and finally to read in depth about the movement. The format also encourages flipping backwards and forwards through the pages to reference plates or bios.

The scope of the works—from harrowing performances such as that of Marina Abramovic and Gina Pane to paintings by Joan Semmel and Judith F. Baca—and the amount of information included permit even the uninformed reader to form well-grounded opinions and make connections among artists and artworks. Readers not as familiar with feminist art will encounter artists not well known in the United States.

PHOTO COURTESY / **WIKIMEDIA**

MIT's 'Transparent Horizon' is by Louise Nevelson, an artist mentioned in 'WACK!'

The organizers were intent on including an international spectrum of artists and succeeded in bringing together the work of artists from 21 countries. These artists' contributions encompass a diversity of ideas and cultural influences that may be outside many Westerners' awareness.

Ironically, considering the international flavor of the show, the American artists included are overwhelmingly white: Six black American women are included individually, compared to about 60 white American women. The event-poster artwork from Spiderwoman Theater (a Native-American collective founded in 1975 and still active today) and Where We At (an African-American collective active between 1971 and 1997) does not seem like enough to represent the rich output from these groups. Valerie Smith's essay, "Abundant Evidence: Black Women Artists of the 1960s and 70s," provides more substance, if not more visual richness.

Why "WACK!" now? As Butler says in her introduction, "the impact of feminist art has yet to be fully theorized and accepted by academic and museum institutions." She could have added "the general public" to that list. Though many of these artists are already well respected by both the art world and the general public—Cindy Sherman and Alice Neel, for example—others continue to shock.

One could argue that with the popularity of television shows like "America's Next Top Model," and "Pussycat Dolls: The Search for the Next Doll," there is a clear need for women to speak out as people with complex ideas, not just as pretty faces and sexy bodies. One of the strongest arguments for this exhibition and book is probably that art movements, as representative of historical periods, are in need of ongoing examination. The feminist art movement is one of the most misunderstood in the history of art, in large part because it was so different from previous and contemporary movements. It seems likely that "WACK!" will stimulate further conversation.

PHOTO / **DONNA COVENEY**

Water power

Members of MIT Sea Grant designed an autonomous vehicle called the 'Katrina' boat, which can collect samples from waters that may be unsafe to drink or travel on. The boat was demonstrated on the Charles River on Monday, April 23, as part of the Cambridge Science Festival.

IMAGE COURTESY / **MIT MUSEUM**

Pulse beat

Pulse Car is a single-passenger, all-electric commuter concept vehicle powered by Professor Yet-Ming Chiang's new generation of lithium-ion rechargeable batteries. The Pulse Car, on display at the MIT Museum, was developed by an international group of students at the 2006 MIT Vehicle Design Summit.

Broad Institute presents World Music Weekend

Two of MIT's world music ensembles, Gamelan Galak Tika and Rambax, will present a World Music Weekend at the Broad Institute on Saturday and Sunday, May 5 and May 6.

Gamelan Galak Tika, MIT's resident Balinese music ensemble of 30 musicians playing a shimmering orchestra of metallophones, gongs and drums, will perform traditional and modern music from Bali on Saturday, May 5, at 8 p.m. General admission is $12; $8 for students, senior citizens and MIT and Harvard community members; and free for MIT and Harvard students and children under the age of 12.

Gamelan Galak Tika will perform the world premiere of "Wariga," the newest composition by Dewa Ketut Alit, one of Bali's most innovative young composers. "Wariga," loosely translated, means "calendrical convergence," and the piece is inspired by the auspicious and inauspicious days found in the cycles of the Balinese calendar. The ensemble, led by MIT Professor Evan Ziporyn, will also perform "Taruna Jaya," or "Dance of the Victorious Youth," an early 20th-century composition, featuring dancer Cynthia Laksawana; "Gringsing"; and "Pelog Slendro," a groundbreaking composition for the group, features two gamelans playing together. For more information, see www.galaktika.org.

Rambax MIT, an ensemble dedicated to learning the art of sabar, a vibrant drum and dance tradition of the Wolof people of Senegal, West Africa, will present a free concert on Sunday, May 6, at 3 p.m. Titled "Cosaan" ("tradition" in the Wolof language), the event combines Senegalese drumming, song and dance, and also features the traditional Senegalese lion dance known as simb. Special guest artists include Senegalese master drummers and dancers Paa Seck, Moha Seck, Talla Ngom, Cheikh Ngom and Demba Sène. Co-directed by artist-in-residence Lamine Touré and Associate Professor Patricia Tang, Rambax MIT consists of MIT students and other members of the MIT community. For more information, visit web.mit.edu/rambax.

PHOTO / **CHRISTINE SOUTHWORTH**

MIT Professor Evan Ziporyn.

PHOTO / **COLIN DILLARD**

Lamine Touré (center), artist-in-residence, with Rambax members.