Volume 52, Number 15
Wednesday, February 6, 2008

TechTalk
SERVING THE MIT COMMUNITY

On the front lines of the genomic revolution

David Chandler
News Office

Manolis Kellis, a young and fast-rising MIT researcher, uses sophisticated computational tools to investigate the genomes of a variety of organisms, including humans, mice, fruit flies and yeast, and the insights emerging from that work could lead to important findings about human development and disease.

The work marks the early stages of a whole new field of comparative genomics, in which insights about individual species can be derived by studying the similarities and differences in the genomes of many different species. The method can probe the evolutionary process to reveal previously unknown mechanisms, suggesting specific hypotheses that can advance biological knowledge.

"This represents a new phase in genomics—making biological discoveries sitting not at the lab bench, but at the computer terminal," Kellis says.

It was partly a typical MIT kind of ser-

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PHOTO / **DONNA COVENEY**

Only 30 years old, researcher Manolis Kellis has published several landmark papers in Nature magazine and has received many accolades, including a National Science Foundation Career Award.

Hammond to address MLK breakfast

Sarah H. Wright
News Office

Reverend Ray Hammond, a physician and founding pastor of Bethel African Methodist Episcopal Church in Boston, will be the keynote speaker at MIT's 34th annual celebration of the life and legacy of Martin Luther King Jr.

The theme for the 2008 celebration is "Ensuring Educational Access: Our Challenge, Our Opportunity." Hammond will deliver his remarks at the breakfast event honoring King, to be held in Morss Hall on Thursday, Feb. 21, at 7:30 a.m.

MIT President Susan Hockfield

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PHOTO / **NASA/BILL INGALLS**

Mercury rising

Professor Maria Zuber, head of the Department of Earth, Atmospheric and Planetary Sciences, addresses a Jan. 30 NASA press conference in Washington in which results from the first mission to visit the planet Mercury in 30 years were unveiled. The MESSENGER spacecraft, which will later go into orbit around the planet, made a flyby in mid-January and returned a wealth of new data, revealing a surprisingly active planet with ridges that extend for hundreds of miles and an enigmatic spider-like pattern of cracks in the floor of one large crater. Zuber heads the science team's Mercury Laser Altimeter analysis and also chairs the geophysics group.

Team develops energy-efficient microchip

Could lead to longer-lasting cell phones, devices

David Chandler
News Office

Researchers at MIT and Texas Instruments have unveiled a new chip design for portable electronics that can be up to 10 times more energy-efficient than present technology. The design could lead to cell phones, implantable medical devices and sensors that last far longer when running from a battery.

The innovative design was presented Feb. 5 at the International Solid-State Circuits Conference in San Francisco by Joyce Kwong, a graduate student in MIT's Department of Electrical Engineering and Computer Science (EECS).

Kwong carried out the project with MIT colleagues Anantha Chandrakasan, the Joseph F. and Nancy P. Keithley Professor of Electrical Engineering, and EECS graduate students Yogesh Ramadass and Naveen Verma. Their Texas Instruments (TI) collaborators are Markus Koesler, Korbinian Huber and Hans Moormann. The team demonstrated the ultra-low-power design techniques on TI's MSP430, a widely used microcontroller. The work was conducted at the MIT Microsystems Technology Laboratories, which Chandrakasan directs.

The key to the improvement in energy efficiency was to find ways of making the circuits on the chip work at a voltage level much lower than usual, Chandrakasan explains. While most current chips operate at around one volt, the new design works at just 0.3 volts.

Reducing the operating voltage, however, is not as simple as it might sound, because existing microchips have been optimized for many years to operate at the higher standard-voltage level. "Memory and logic circuits have to be redesigned to operate at very low power-supply voltages," Chandrakasan says.

One key to the new design, he says, was to build a high-efficiency DC-to-DC converter—which reduces the voltage to the lower level—right on the same chip, reducing the number of separate components. The redesigned memory and logic, along with the DC-to-DC converter, are integrated to realize a complete system-on-a-chip solution.

One of the biggest problems the team had to overcome was the variability that occurs in typical chip manufacturing. At lower voltage levels, variations and imperfections in the silicon chip become more problematic. "Designing the chip to minimize its vulnerability to such variations is a big part of our strategy," Chandrakasan says.

So far the new chip is a proof of concept. Commercial applications could become available "in five years, maybe even sooner, in a number of exciting areas," Chandrakasan says. For example, portable and implantable medical devices, portable communications devices and networking devices could be based on such

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IAP 2008

GIDDY-IAP

Student experiences during IAP range from the filthy to the fiery to the funky.

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New invention could help eradicate TB in Asia and Africa.

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Richard Larson reveals his inspiration for studying queue psychology.

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INTERVIEW WITH THE DEAN

Dean Marc Kastner discusses his goals and challenges.

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Weinberg named first recipient of Swedish science prize

Professor Robert A. Weinberg of MIT's Department of Biology this week became the first recipient of a new Swedish science prize, in recognition of his cancer research.

The 20,000-euro prize, sponsored by a foundation set up by Swedish scientists Georg and Eva Klein, was presented by Sweden's Crown Princess Victoria at a Jan. 29 ceremony in Stockholm.

Weinberg, a member of the Whitehead Institute for Biomedical Research and the Daniel K. Ludwig Professor for Cancer Research, was awarded the prize for his pioneering discoveries in basal tumor biology. His research demonstrates how genes and the proteins they control combine to convert a healthy cell into a cancer cell. He has also made important discoveries on how tumor suppressant genes can prevent the development of tumors. Understanding these processes will make it easier for scientists to find effective treatments for different kinds of cancer.

Weinberg has been invited to spend two weeks at Stockholm's Karolinska Institutet, which awards the Nobel Prize in Medicine or Physiology, to give lectures and forge links with researchers.

PHOTO / © **STEFAN ZIMMERMAN**

Professor Robert Weinberg receives the Georg and Eva Klein Award from Crown Princess Victoria of Sweden at a ceremony in Stockholm.

2008 Burchard scholars selected

Twenty-six sophomores and juniors have been selected as Burchard scholars in the School of Humanities, Arts, and Social Sciences for 2008.

The awards, named after the school's first dean, John Ely Burchard, are given to students who demonstrate unusual abilities and academic excellence in the areas embraced by the school. According to Dean Deborah Fitzgerald, overseer of the Burchard Program, the students selected in the 22nd year of competition for the awards "are from exciting and diverse backgrounds and are a remarkable group of gifted young scholars."

The Burchard scholars and a rotating group of faculty will be invited to a series of dinners, beginning in February, at which an MIT faculty member or visiting scholar will present work in progress, followed by a discussion. This will allow students and faculty members to mix and will give students, especially, an opportunity to engage in the kind of intellectual exchange that characterizes scholarship in the humanities, arts and social sciences. The emphasis throughout the program will be interdisciplinary.

The selection committee consisted of Margery Resnick, associate professor of foreign languages and literatures; Rebecca Faery, director of first-year writing, writing and humanistic studies; Wyn Kelley, senior lecturer of literature; Thomas Levenson, professor of writing and humanistic studies; Jane Dunphy, director of ELS, foreign languages and literatures; Michael Ouellette, senior lecturer of music and theater arts; Janet Sonenberg, professor of music and theater arts; and Dean Fitzgerald as chair.

This year's Burchard scholars are as follows: junior Alona Birjiniuk (chemical-biological engineering); sophomore Tewfik Cassis (management science); junior Stephanie Chan (brain and cognitive sciences and physics); sophomore Matthew Cohen (brain and cognitive sciences); junior Jean Cui (humanities and engineering); sophomore Mihai Duduta (materials science and engineering); junior Bronwyn Edwards (nuclear science and engineering); junior Erin Fitzgerald (biology); junior Matthew Gethers (biological engineering); sophomore William Gibson (biological engineering and philosophy); junior Emily Ho (biology); junior Samuel Hollander (civil engineering and history); junior Yi Huang (biology); sophomore Seo Hyung Kim (mathematics); sophomore Akira Kobayashi (electrical engineering and computer science); junior Courtney Lane (biological engineering); junior Carmel Mercado (biology); sophomore Benjamin Park (physics); junior Adam Paxson (mechanical engineering); sophomore Niyatee Samudra (brain and cognitive sciences and physics); junior Matthew Serna (brain and cognitive sciences); junior Allison St. Vincent (environmental engineering); junior Gabriel Torres (electrical science and engineering); junior Veena Venkatachalam (chemistry and physics); junior Xiaowen Zhang (management science and mathematics).

PHOTO / **STEPHEN MARCUS**

Tech trekkies

From left, MBA students Alex Rouse, Taariq Lewis and Ayodele Alaran speak during a networking event at the Plug and Play Tech Center in Sunnyvale, Calif. The event in Silicon Valley was part of a "Tech Trek"—an annual trip organized by MIT Sloan students to test the economic waters and meet with prospective employers in the technology sector.

Since they began more than a decade ago, the treks have grown in terms of student popularity and company interest. This year, nearly 200 MIT Sloan students fanned out across the country on three such trips. Separate teams visited with well-known companies such as Google, Amazon and Microsoft, but also targeted smaller firms and startups.

–Patricia Favreau, MIT Sloan School of Management

BRIEFLY

MIT-CTL, Colombia's LOGyCA ink $19 million deal to create logistics center

MIT's Center for Transportation and Logistics (MIT-CTL) and LOGyCA, a Colombia-based logistics company, have signed an agreement worth $19 million creating the Center for Latin-American Logistics Innovation (CLLI), the leading research and education center for supply chain and logistics in Latin America.

CLLI will join MIT-CTL and the Zaragoza Logistics Center (ZLC) in Spain as the third member of MIT's growing international network of centers dedicated to supply chain education and research that now spans the United States, Europe and Latin America.

CLLI will help Latin American businesses and individuals compete in local, regional and global markets by delivering leading-edge research, technology and educational programs in logistics, transportation and supply-chain management. The Center will also become a major force in academia within Latin America and across the globe.

MIT Professor of Engineering Systems and Director of MIT-CTL Yossi Sheffi said that launching CLLI extends the reach of both MIT-CTL and the ZLC, and enhances their ability to meet the ever-growing demand for truly global supply-chain education and research programs.

McGovern researchers awarded $8.5 million to study brain basis of autism and dyslexia

Two researchers at MIT's McGovern Institute for Brain Research will head an ambitious new project to study the origins of autism and dyslexia, supported by an $8.5M grant from the Ellison Medical Foundation. The project leaders, Nancy Kanwisher and John Gabrieli, are prominent experts in neuroimaging and human brain development.

Human neuroimaging methods have advanced greatly over the last five years, and a major emphasis of the new project will be to translate these advances to pediatric neuroimaging. Brain imaging with young children presents many challenges, not least of which is their inability to lie still for long periods in the scanner. The McGovern investigators will collaborate with neuroimaging experts Larry Wald, Bruce Fischl and Ellen Grant at Massachusetts General Hospital, who will develop scanning coils designed specifically for children's heads, along with new procedures to shorten scan times and methods to analyze data from brains that are not yet fully developed.

"We expect these technological advances to radically improve pediatric neuroimaging and help us make major strides in understanding typical and atypical human brain development," said Kanwisher, the Ellen Swallow Richards Professor of Cognitive Neuroscience. Kanwisher, a member of the National Academy of Sciences, will lead the work on autism. Gabrieli, who is the Grover Hermann Professor in Health Sciences and Technology and Cognitive Neuroscience, will lead the dyslexia component.

New MIT program aims to monitor air, water quality continually, pervasively around the globe

Researchers from MIT and two Singaporean universities met last month for an inaugural workshop to launch a bold new international research program called CENSAM, the Center for Environmental Sensing and Modeling. The program will develop pervasive environmental sensor networks to collect data on parameters such as air and water quality from many sources and use this data to provide accurate, real-time monitoring, modeling and control of the environment.

One of the first goals of the research group is to provide proof of the feasibility of the concept in a carefully managed urban area like Singapore. The greater hope is that these concepts might one day be widely applied on different scales to provide up-to-the-minute data about the environment in areas as small as a building or as large as the Earth's biosphere.

CENSAM is a research component of the Singapore-MIT Alliance for Research and Technology Centre, a joint project of MIT and the National Research Foundation of Singapore that was announced Jan. 23.

Professor Andrew Whittle of the Department of Civil and Environmental Engineering is head of the CENSAM research group. Whittle and an initial group of about 15 MIT faculty members from civil and environmental engineering, mechanical engineering, architecture, and earth, atmospheric and planetary sciences will work with researchers from the National University of Singapore, the Nanyang Technological Institute, the Singaporean Public Utilities Board, and other governmental agencies and companies.

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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 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 In The World

Every year, 10 million new cases are diagnosed and two million people die of the disease.

Smart pillbox could be a lifesaver

David Chandler
News Office

It's not that new treatments are needed—medical science long ago figured out how to cure tuberculosis using a cocktail of antibiotics. The problem is getting the medicine to the people who need it and, most difficult, making sure they follow the six-month regimen of daily doses.

Failure to follow the regimen not only leads to likely death of that patient, but fosters the development of antibiotic-resistant strains of the disease. "The problem is, how do you get people to take this complex regimen," says Manish Bhardwaj, a doctoral student in the Department of Electrical Engineering and Computer Science who works in the Microsystems Technology Laboratories.

After a year of hard work and about eight revisions, Bhardwaj and a team of collaborators think they may have found the answer. It's a high-tech solution in a simple, inexpensive and easy-to-use package.

The first part of the two-component system is a kind of "smart" pillbox, called the uBox. It has 14 chambers that can each be loaded with several pills, which it dispenses from one chamber per day. To alert the patient that it's time to take the medicine, the box flashes its lights and sounds a buzzer. When the compartment is opened, the uBox records the exact time and prevents double-dosing by refusing to open again until the next treatment is due.

After two weeks, a health care worker reloads the box and digitally records and transmits the information stored in it. Doctors and public health services can then get complete data on compliance, patient by patient, in almost real time, instead of having to wait until the end of the six-month treatment.

"How do you know if pills are getting to the patients or if patients are taking them? Today, there's no good way of doing this," Bhardwaj says. If people fail to take all their pills, "it is possible to do harm by treatment that doesn't have good adherence." Even missing a few pills can lead to the development of resistant strains, which can then be spread by that noncompliant patient. "The people they infect have no chance." Typical treatment trials have compliance rates as low as 50 percent, according to World Health Organization statistics.

"We want to make sure the worker is motivated," Bhardwaj says, and at present there's no way to tell which workers are diligent about making the calls and which ones may skip some of their appointed visits. Accordingly, the uBox has an additional feature: a receptacle for a tiny key, like a headphone plug, which is carried by the visiting health care worker. At each visit the worker inserts the key, thus recording the fact that the patient really has been visited—another important gauge of compliance.

The second part of the group's new system is a cell phone, called the uPhone. By using special software, health care workers can record a patient's temperature, weight, and answers to a list of questions related to symptoms, which adds to the set of detailed patient data analyzed by doctors monitoring the study.

By looking at patterns of effects, the doctors can tell which field workers are achieving the best adherence rates with their patients and find out just what it is that those people are doing right. They can then be recruited to train additional workers.

Bhardwaj has been working with MIT alumni Goutam Reddy and Sara Cinnamon on the engineering and electronics of the pillbox, doctoral student Bill Thies and alumnus Pallavi Kaushik on the uPhone software, and MIT seniors Oliver Venn and Jessica Leon on fundraising and logistics.

PHOTO COURTESY / **TENZIN PRIYADARSHI, THE PRAJNOPAYA FOUNDATION**

Priyanka Kumari and Shashi Pallavi try out the uBox, a "smart" pillbox that metes out medication at a prescribed rate, at a recent training session in India.

Bhardwaj and Thiess went to Bihar province this January to begin their first field test of the product, conducting a training session for 22 workers who will, in turn, train the field workers to distribute the pillboxes in the field. In March, they will return to India to begin the first actual field test with 100 of the boxes and 10 cell phones.

If all goes well, a second round of testing, using 1,000 uBoxes, is set to begin. After that, it all depends on the results—and on the ability to raise funds for future deployment. Health officials in India are already keenly interested in this test, and Bhardwaj recently met with a representative of the Bill & Melinda Gates Foundation to discuss possible support.

The Ven. Tenzin Priyadarshi, MIT's Buddhist chaplain, helped to get the project started and says, "I am hopeful that the uBox-uPhone project will revolutionize the way we understand and provide health care in rural areas of the world."

While Bhardwaj is proud of the product his team developed, he is not proprietary about it. "We hope to make the uBox and the uPhone the standard of treatment in Bihar. We worked very hard to make something very simple and elegant," he says. "But we'd be delighted if someone beats us to it and builds a uBox cheaper. We hope other people will copy us."

In The World *is a new 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.*

EUREKA!
Breakthrough tales at MIT

A silver line-ing

Sarah H. Wright
News Office

Waiting in line isn't what it used to be. A robo-voice tells Red Line riders when a train is entering the station. Waist-high stanchions and nylon ropes force serpentine lines in fast-food places. E-Z Pass and cash toll-payers don't mix lanes. Soothing, eh?

You can thank Professor Richard Larson for that.

Larson, director of the Center for Engineering Systems Fundamentals and Mitsui Professor of Engineering Systems and Civil and Environmental Engineering at MIT, is a key figure in the field of queue psychology—the study of how to make waiting bearable and even enjoyable.

Back in 1976, Larson sat in a line he just couldn't forget.

At the time, he was pure operations research; his focus was on urban service systems. The line that got etched in his mind—a line that launched a whole new field—started out with a simple errand: to buy his young son his first bike.

"It looked so easy: My wife and kids would wait in the car while I went into Sears and got the bike. We'd be home by dinner," recalls Larson SB '65, SM '67, PhD '69.

All went well for a time. He picked out the bike, paid, took his receipt to a window at the back of the store and confidently assumed his place, second in line.

"The woman sitting in first place was weeping. She'd waited over an hour for a waffle iron, while others had gotten their items. I sympathized, sure it was a fluke. Then a half hour went by. Others got their things *before I did*. By the time I got back to the car, my kids were crying and I was furious," Larson says.

He returned the bike box, unopened, two days later, with a lifetime pledge to never, ever, darken the doors of that Sears again.

"I was prepared to be patient. I was happy to comfort the weeping woman. *I believed I would get my bike when my turn came.* But this was a HUGE violation of 'first-come, first-served,'" Larson says.

PHOTO / **DONNA COVENEY**

Richard Larson

Larson couldn't get the experience out of his head.

"So I did what MIT teaches all engineers to do: Generalize! Look for a bigger picture. Look for patterns," Larson recalls.

The pattern he spotted went beyond aggravation into the area of social justice. After all, people who skipped ahead of him in line caused his place—his just and rightful place—to slip further from the bike pickup window. Skipping ahead and slipping had to be studied, too.

Larson sought and received funding from the National Science Foundation to research the psychology of queuing, including the slips and skips of queues gone bad. With that, his career took a surprising and fruitful new turn.

His seminal paper, "The Psychology of Queuing and Social Justice," was published in Operations Research in 1977, with journal articles, interviews and articles on his work following in The New York Times, and on radio and network television. To this day, he is asked to speak on queuing psychology.

Larson's research led to new computational techniques, such as the Queue Inference Engine and the Hypercube Queuing Model, and to whole new approaches to easing congestion in urban traffic, fast-food lines and banks.

Larson doesn't credit himself with the birth of queuing psychology, despite his success in defining the field. Applied queuing psychology itself was born in 1955, when Disneyland opened in Anaheim, Calif., he says.

"Who but Disney could get people to wait 45 minutes for a two-minute ride? Their visitors are so distracted, they voluntarily prolong their waits," Larson says.

Larson describes this as an A+ application of queuing psychology. But most of life happens outside of theme parks, and most people in queues grow cranky. Skipping can even provoke what he calls "queue rage."

For a queue to work well, people must believe their patience will pay off. They must believe in their queue's efficiency and fairness. They must have signs of hope—the train *is* coming; your call *will* be answered in 12 minutes.

Since Larson's first paper, the field has broadened in scholarly and social venues. Larson has supervised a half-dozen theses in this area, most recently in the psychology and physics of urban drivers' search for affordable on-street parking.

New queuing research has found parking hunts to be a major cause of urban traffic congestion, according to Larson.

Larson himself even got a new identity thanks to that fateful errand 30 years ago. For a time, he was known as "Dr. Q," dispenser of 10 annual tips on avoiding lines during holiday shopping.

Eureka *is a new column that aims to show how real-life experiences outside the lab can inspire breakthroughs in research or new directions in academic thought. If you've had or know of an MIT "Eureka" example, please e-mail shwright@mit.edu.*

Teams battle to on-screen victory

David Chandler
News Office

Tanks, soldiers, snipers, mortars and bombers fanned out rapidly over unfamiliar undulating terrain, searching for their enemy counterparts and trying to seize control of battle towers. Some armies swarmed frenetically over the land, searching and fighting as they went, while others moved cautiously while staying huddled in a tight group, building their strength slowly and methodically.

Hundreds of spectators watched and cheered Feb. 1 as the rival armies battled it out on giant screens in Kresge Auditorium. Out of 150 teams that signed up to write the programs controlling those battle swarms during IAP, the best eight, chosen after a full day of one-to-one matches earlier in the week, slogged it out for the final victory in a double-elimination tournament.

The BattleCode software competition has become an annual tradition at MIT, and this year's battle was the fastest, most complex and most detailed yet. As second-year computer sciences student Joel Stein, one of the event's organizers, explained before the final tournament, the 300 students who participated ended up writing a total of 350,000 lines of computer code.

The BattleCode contest has become an even bigger event than MIT's fabled 6.270 annual autonomous robot competition, Stein said.

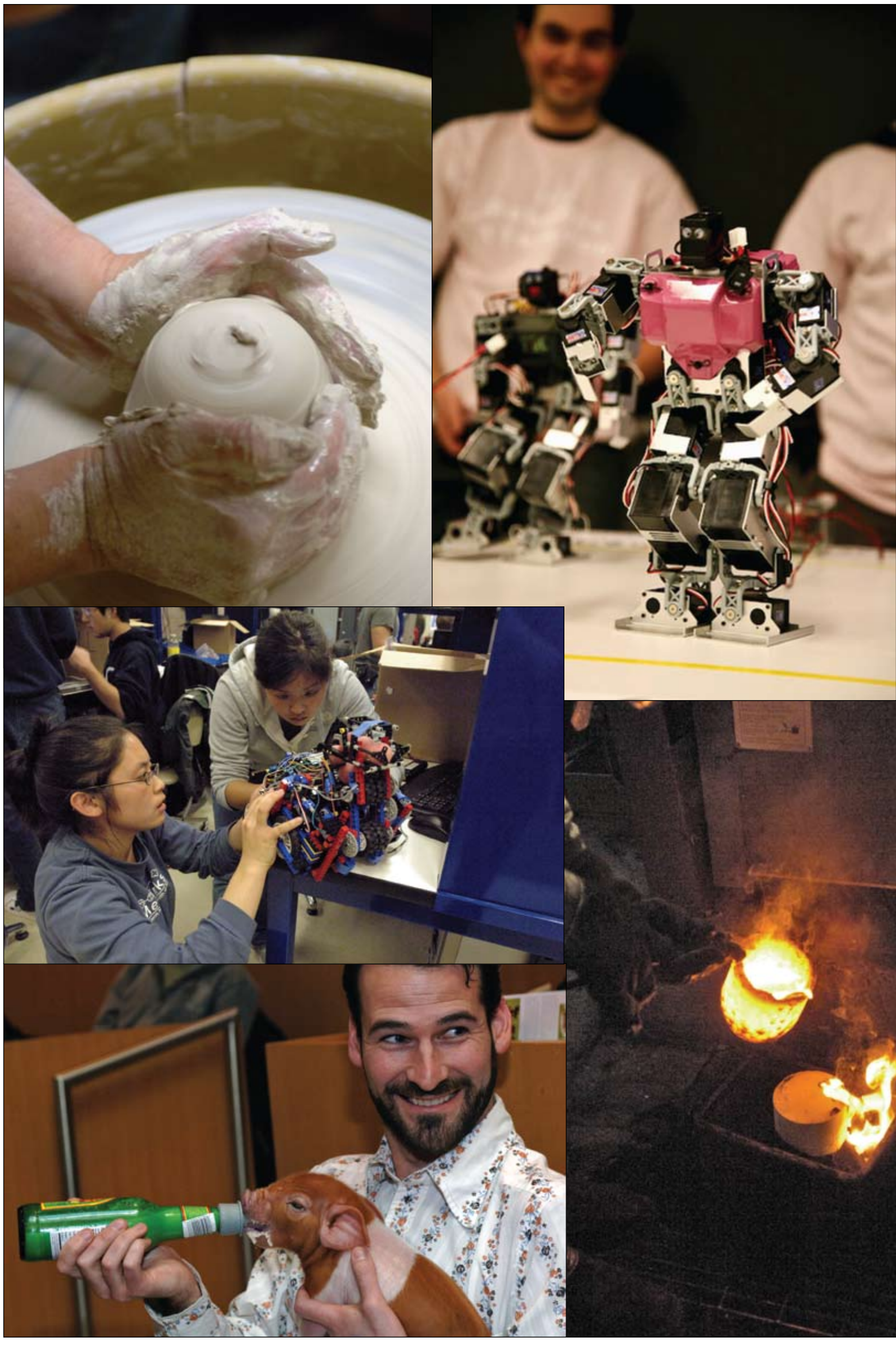
Although the teams who wrote the code stood on the stage and narrated the action while the battles unfolded, they had no control over the action at that point—everything was determined by the strategies built into the software ahead of time, and by the vagaries of the undulating terrain, filled with obstacles, whose contours were different in each round of the contest.

In the end, adaptability and responsiveness won the day. A team called "in memory of James Albrecht," whose program was especially adept at discerning its opponents' strategies and modifying its own accordingly, swept to victory in a record about as strong as that of the New England Patriots. The team, named in honor of an MIT senior who died last summer and had been a former teammate, lost only a single game out of the 16 played through to the finals.

The four-member winning team walked away with the $5,000 first prize, as well as several additional prizes, but overall more than 20 teams ended up with cash prizes, certificates and trophies by the evening's end, and even the hundreds of spectators got a free T-shirt just for watching the action. In addition to cash awards totaling $40,000 for the top 16 teams (donated by a long list of corporate sponsors), prizes were awarded for everything from cleverest strategy and most-unusual formation (one team had its soldiers dash out onto the field to form the letters "LOL" before actually beginning to fight) to the best team name.

BattleCode is also known as course 6.370, and contestants whose code was good enough to overcome a basic reference program and who wrote up descriptions of the strategy they used earned six credits for participating.

Following last week's final tournament, there is also an open version of the contest that can be entered by anyone outside the MIT community. That final competition will be held in March.



MICROCHIP

Continued from Page 1

chips, and thus have greatly increased operating times. There may also be a variety of military applications in the production of tiny, self-contained sensor networks that could be dispersed in a battlefield.

In some applications, such as implantable medical devices, the goal is to make the power requirements so low that they could be powered by "ambient energy," Chandrakasan says—using the body's own heat or movement to provide all the needed power. In addition, the technology could be suitable for body area networks or wirelessly enabled body sensor networks.

"Together, TI and MIT have pioneered many advances that lower power in electronic devices, and we are proud to be part of this revolutionary, world-class university research," said Dennis Buss, chief scientist at Texas Instruments. "These design techniques show great potential for TI's future low-power integrated circuit products and applications including wireless terminals, battery-operated instrumentation, sensor networks and medical electronics."

The research was funded in part by a grant from the U.S. Defense Advanced Research Projects Agency.

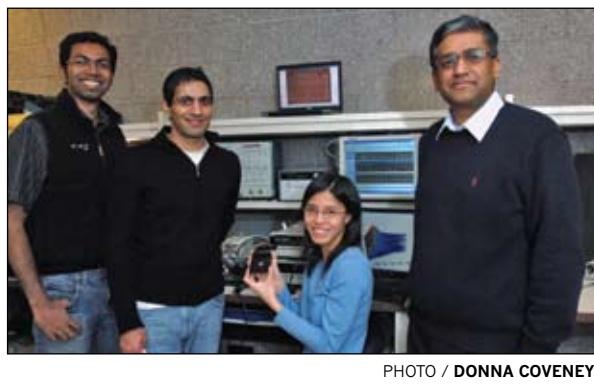
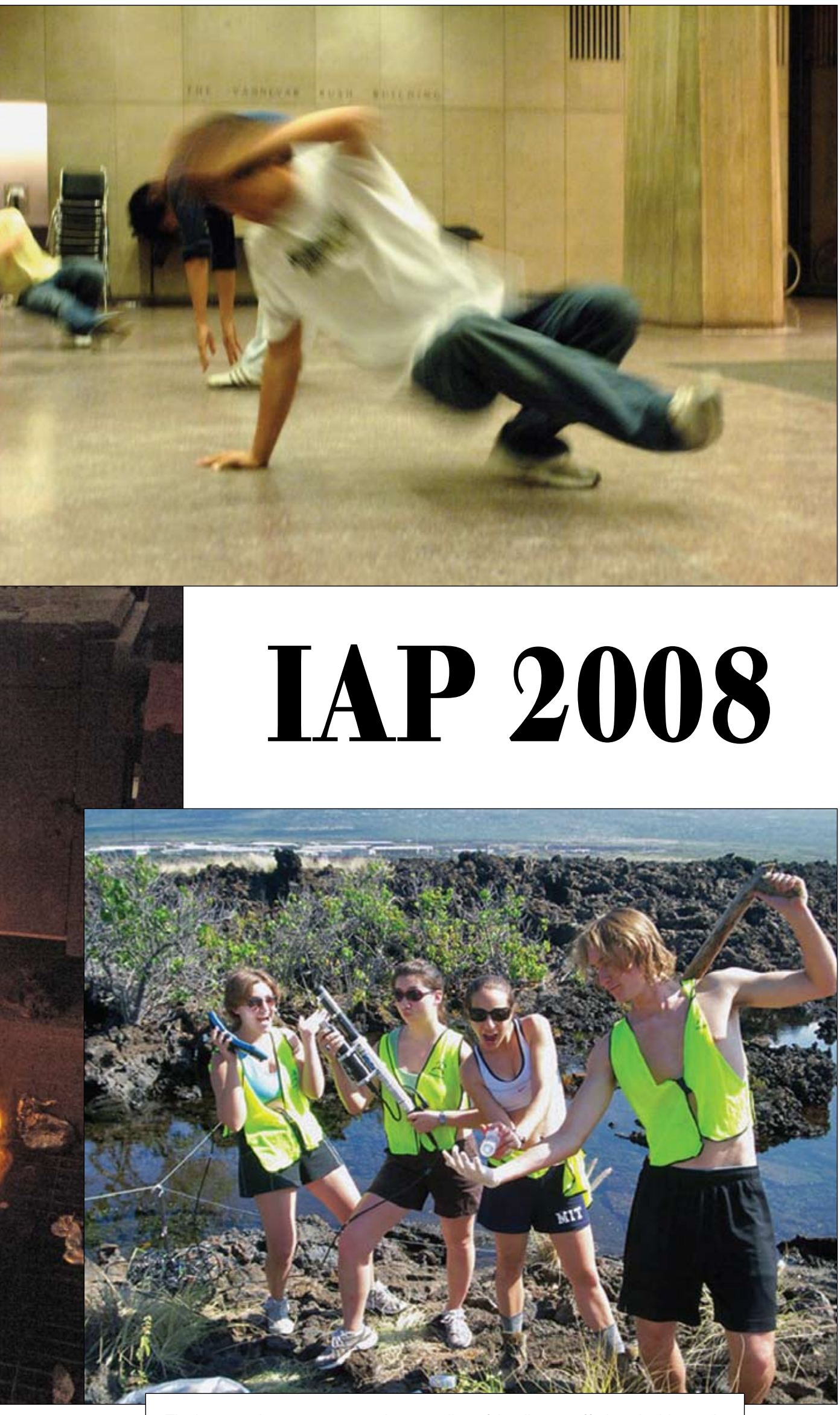


PHOTO / **DONNA COVENEY**

From left, electrical engineering graduate students Yogesh Ramadass, Naveen Verma and Joyce Kwong, along with Professor Anantha Chandrakasan. This team has developed a microchip that can be up to 10 times more energy-efficient than present technology.



IAP 2008

The images above represent a tiny sampling of the diverse offerings in this year's Independent Activities Period, which ran from Jan. 7 to Feb. 1. Clockwise from top left: A participant throws pottery in Ceramica Botanica (photo by Donna Coveney); a robot competes in a basic walking competition during the Robo-One Workshop (photo by Jason Dorfman); a student practices moves during Breakdance 202 (photo by Donna Coveney); sophomore Katie Puckett, juniors Allison Dee and Ilana Rotmensch, and sophomore Adam Talsma take a break during an experiment in Koloko-Honokohoa National Historic Park in Hawaii as part of TREX (Traveling Research Environmental eXperiences), a six-credit field research course that teaches students how to manage earth systems in a sustainable way (photo courtesy TREX); Michael Tarkanian, technical instructor in the Department of Materials Science and Engineering, pours molten metal as part of Intro to Metal Casting (photo by Donna Coveney); Barker Engineering Library's Ryan Gray feeds a three-day-old pig during the Makin' Bacon workshop on sustainable livestock farming (photo by Donna Coveney); seniors Daphne Wang, left, and Cindy Chen put finishing touches on a robot they built for the Autonomous Robot Design Contest (photo by Donna Coveney).

PHOTO COURTESY / **COMMITTEE OF INQUIRY (COI, 2005)**

The Nicoll Highway in Singapore experienced a devastating collapse in April 2004. During IAP, Professor Andrew Whittle tackled the reasons behind the debacle.

IAP class probes Singapore highway collapse

Deborah Levey
Civil and Environmental Engineering

An extensive subway system with lines fanning out in many directions speeds transportation in small, crowded Singapore. On April 20, 2004, during construction for the new Circle line of the subway, a deep excavation suddenly collapsed. The catastrophe killed four people, twisted steel beams, swallowed two construction cranes and knocked out a substantial chunk of the main highway running over the tunnel.

"This was one of the largest failures of a civil engineering project under construction in about 50 years," said Professor Andrew Whittle of the Department of Civil and Environmental Engineering in a Jan. 9 IAP class, "What Caused the Collapse of the Nicoll Highway in Singapore?"

Singapore authorities promptly began an intensive inquiry into the disaster, and Whittle was chosen by the Singaporean Land Transit Authority to be one of four international experts to investigate the accident and determine the causes. During what Whittle called "some of the most intense meetings I've ever attended," the experts studied the evidence and wrote a report on the collapse. Twenty ongoing excavation projects were temporarily shut down for design-practice reassessment, resulting in very large costs associated with delays and changes.

"Failure is always a combination of factors," said Whittle, who listed a series of cascading errors.

The original design misinterpreted the local geology and overestimated the soil shear strength in its analysis. The structure was therefore underdesigned to resist lateral earth pressures. Excavations for the subway extended more than 100 feet below the ground surface where the strongest marine clay was "weaker than the weakest clay in Boston," Whittle said.

There were also errors in detailing the structural connections for the structural bracing system; the collapse occurred when one level of bracing was overloaded and there was inadequate capacity to redistribute the loads among the remaining supports. Although large wall deflections occurred during the excavation, the measured strut loads were smaller than expected. As a result, the project engineers were apparently unaware of the potential for a catastrophic failure.

The complete findings from the official committee of inquiry were published in a 460-page report with detailed graphs and photos: http://cee.mit.edu/index.pl?id=23286&isa=Item&field_name=item_attachment_file&op=download_file.

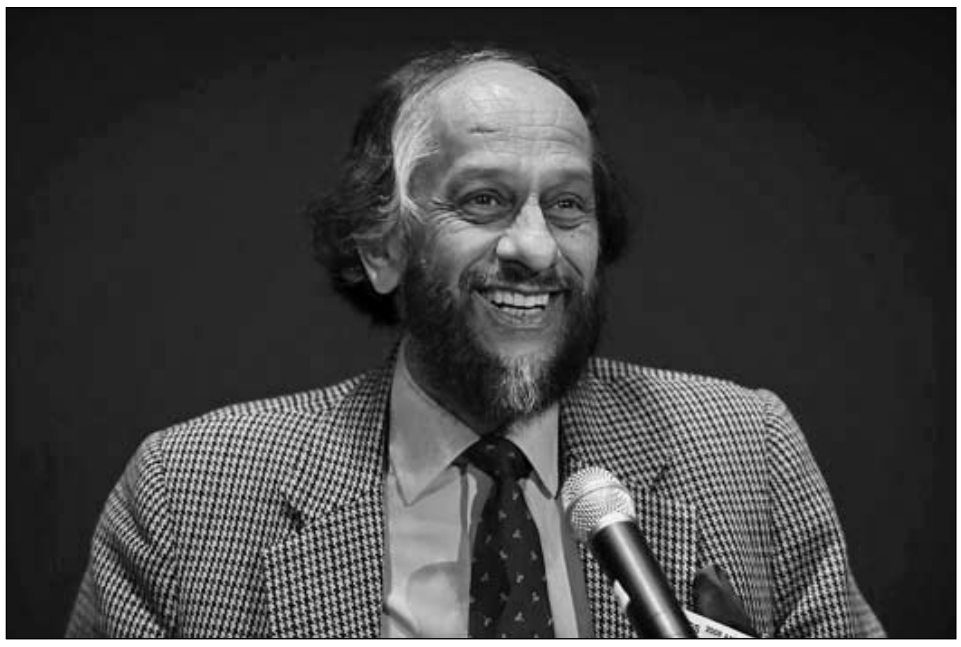


PHOTO COURTESY / **JUSTIN KNIGHT PHOTOGRAPHY**

IPCC head Rajendra Pachauri delivers the keynote address at the 12th annual meeting of the Alliance for Global Sustainability. He stressed the need to immediately reduce harmful greenhouse gas emissions.

Time to act on global sustainability, AGS meeting speakers say

David Chandler
News Office

It's time for work toward sustainable development and sustainable energy systems to turn a corner, shifting emphasis from looking for possible solutions to taking action and finding ways to get those solutions implemented.

That was the message that emerged as more than 300 researchers and students from 16 countries around the world converged on MIT last week for the 12th annual meeting of the Alliance for Global Sustainability, a partnership that began in 1997 between MIT and three other major research universities with a technology focus.

In her opening talk to the three-day meeting, MIT President Susan Hockfield said the creation of the alliance "legitimized a whole new field," despite some initial resistance from people who felt that the whole concept of sustainability was "too elusive, too hard to define" and that universities were not the right place for such studies.

"It's impossible to ignore how much the landscape has changed" in the decade since then, she said.

Public attitudes on climate change have shifted dramatically, as reflected in the U.S. Congress finally taking action on new mileage standards for cars. Quoting New York Times columnist Thomas Friedman, Hockfield said "green has become the new red, white and blue."

But along with the new awareness has come a wave of despair that must be overcome. As Hockfield said, "the public is starving for some sense of focus, clarity and direction. And I believe that the people in this room are well equipped to provide that leadership."

Among the many top researchers who addressed the group were leaders of the Intergovernmental Panel on Climate Change (IPCC), co-winners of last year's Nobel Peace Prize, including three MIT faculty members. IPCC head Rajendra Pachauri, who gave the meeting's keynote speech, began by stating the scientific case clearly: "Climate change is unequivocal," he said, "and in the last 50 years the rate has been accelerating."

Climate change will continue for decades even if dramatic measures are taken now to reduce emissions, he said, and it will "impede present and future generations' ability to meet basic needs." Such changes will not be evenly distributed: "The poorest of the poor are left behind," he said, "but even the richest countries in the world are not immune from these effects."

Despite claims by some leaders that efforts to curb emissions will be too costly, Pachauri said, the most stringent measures—far beyond those proposed so far—needed to stabilize carbon dioxide levels at below 535 parts per million (compared to today's 380 parts per million) would have quite modest costs, "reducing the growth rate of nations' gross domestic product by less than 0.12 percent." Because of the many new business opportunities that would be created by such measures, he said, "it might even turn out to be a negative cost—that is, a gain."

And there could be additional gains at the same time, he said: "Increased energy security, health benefits from reduced air pollution, more rural development, increased agricultural production and reduced pressure on natural ecosystems."

MIT commercial property index shows further real-estate weakness

The value of U.S. commercial real estate owned by big pension funds fell another 5 percent in the fourth quarter of 2007, according to an index produced by the MIT Center for Real Estate.

The drop in the quarterly transaction-based index (TBI), which tracks the price at which big pension funds buy and sell properties like shopping malls, apartment complexes and office towers, was the second straight quarterly decline. It was deeper than the 2.5 percent drop in the third quarter, and it means the cumulative fall since last year's midsummer peak is now more than 7 percent.

"This is evidence that the commercial property market continued to fall, and at an accelerated rate, through the last quarter of 2007, no doubt due to the effects of the credit crunch," said MIT Center for Real Estate Director David Geltner.

The TBI, based on properties sold from the National Council of Real Estate Investment Fiduciaries (NCREIF) database, grew 64 percent from 2004 through 2006, then had another 8 percent spurt in the first half of 2007. The decline in the second half of 2007 still leaves commercial property prices at their level of a year ago, a level that was considered historically high at the time.

"If this is as far as it goes, the price decline we see so far in commercial property as reflected in the TBI may simply represent a correction of the froth that occurred in early 2007 as a result of very aggressive commercial mortgage underwriting practices," said Geltner.

Despite the upsurge in the first half of the year, this was the poorest calendar year annual performance for the index since 1992, when commercial property experienced its worst crash since the Great Depression. Index co-director Henry Pollakowski was quick to point out, however, that fundamentals in the commercial property market are much stronger now than they were in 1992.

KELLIS

Continued from Page 1

endipity that first got him interested in the field. While still a graduate student in computer science at MIT, he ran into a friend who was reading a biology book and the two started talking about genetics and evolution. Kellis soon was shown one of the first assemblies of the human genome on a computer screen, which he said was like looking in a mirror, and he "could never look back." Soon the friend introduced him to Eric Lander, who eventually became his thesis advisor.

Lander, director of the Broad Institute of MIT and Harvard, describes his former student as an "awesome" person.

"He's a perfect example of how the world of biology has undergone just a dramatic transformation," Lander says. The genomic revolution is providing "a whole new biology that can only be done by analyzing massive data sets. What is required is both biological knowledge and algorithmic and mathematical skills."

"It's still very rare in the world," Lander says, to find people with strong skills in both fields. "He's a whirlwind of energy, positive and energetic. He works around the clock, always with a smile, always enthusiastic."

Even as a graduate student, Lander recalls, Kellis was doing amazing work. Lander suggested he work on a thesis project to compare the entire genomes of four species of yeast. "I neglected to mention that nobody had ever done anything as ambitious as that, much less a graduate student," Lander admits. "He proceeded to do amazing things with it, and ended up publishing several landmark papers in Nature—which is unheard of for a computer science graduate student."

Kellis grew up in Athens, Greece, before moving to France when he was 12, and to New York in his teens. He and his brother and sister were all admitted to MIT in the same year. He earned his BS, MEng and PhD here, and was appointed to the faculty in 2004. He is now the Karl Van Tassel Career Development Assistant Professor in the Department of Electrical Engineering and Computer Science, and a member of the Computer Science and Artificial Intelligence Lab and of the Broad Institute. At 30, he has already earned numerous awards and accolades, including a National Science Foundation Career Award last year and a place in Technology Review magazine's 35 innovators under 35 for 2006.

Among Kellis' research subjects is recognizing functional elements in DNA, based on their patterns of change across different species that contain them—often separated by millions of years of evolution—revealing the specific functions of those regions. His lab has used such methods to discover protein-coding genes, as well as RNA genes, microRNAs and DNA patterns involved in gene regulation, which govern when genes are turned on or off.

"When we find a region of high sequence conservation in the genomes of distantly related species, we know it is under selective constraints and probably gives the organism a selective advantage," Kellis says. Conservation shows that these sequences are important, even without knowing what they actually do. By studying more closely the patterns of change within these elements, researchers can go a step further and recognize their precise function.

A recent project that Kellis co-led, along with a large team of researchers here and at several other institutions, mapped and analyzed the genomes of 12 different species of fruit flies—the largest project yet comparing different genomes. It produced more than 40 papers published over the last three months in Nature and several other journals.

"Comparative genomics had never been done at this scale before," Kellis says.

The techniques Kellis and his colleagues developed "can now be used to discover functional regions in any genome, including the human," Kellis says. He and his colleagues have moved on to a similar, even-more-massive project to map the genomes of 24 species of mammals.

The work aims to find out not just what is contained in strands of DNA—the sequence of genes and other information encoded on the long chains—but how it all functions as a system. "We want to make sense of the cell's circuitry at a systems level," Kellis says. "How is the genome controlling all of the cell's differentiation processes, the minutely choreographed dance of genes and regulators during development?"

The software tools that Kellis and his team developed also provide a new way of finding the stretches of DNA that represent genes or regulatory elements, buried within the much longer stretches that have no known function.

Despite his energetic pace of work, Kellis still finds time to enjoy the pleasures of life. He remains active in sailing, traveling, photography, and in Greek dancing and cuisine.

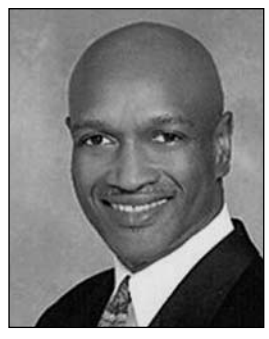
"He makes a great Greek halvah," Lander says. "He's just delightful. He's one of my kids' favorite people."

HAMMOND

Continued from Page 1

will host the program, which will include musical selections by the MIT Gospel Choir, student speakers and recognition of MIT's 2008 MLK Leadership Award winners.

Hammond, a native of Philadelphia, is well known in the Boston area for his leadership and involvement in community and youth activities. He is chair and co-founder of the Ten Point Coalition, an ecumenical group of clergy and lay leaders working to prevent violence and mobilize the Greater Boston community on behalf of at-risk youth.



Ray Hammond

Hammond also serves as executive director of Bethel's Generation Excel program; as chair of the Boston Foundation; and as vice president for membership of the Boy Scouts Minuteman Council in Boston. He is an executive committee member of the Black Ministerial Alliance and serves as a trustee of Catholic Charities of Boston, of the United Way of Massachusetts Bay and of the Yawkey Foundation, among other organizations.

Hammond received his BA from Harvard College. He was a graduate of the first cohort of the Joint Harvard-MIT Division of Health Sciences and Technology, receiving his MD degree from Harvard Medical School. After completing his surgical residency at New England Deaconess Hospital in Boston, he joined the emergency medicine staff at Cape Cod Hospital.

He has written widely on topics including academic achievement, diversity and the ethics of reproductive technology, and has received numerous honors including honorary doctorates from Boston University, Lesley College and Northeastern University.

He devoted himself to the ministry in 1976 and received his MA in religion, concentrating on Christian and medical ethics, from Harvard University in 1982.

Hammond is married to Reverend Gloria White-Hammond, MD, a pediatrician, co-pastor of Bethel AME in Boston, and co-chair of the Massachusetts Coalition to Save Darfur. They have two daughters and live in Boston.

The MIT breakfast program honoring King is open to students and other members of the MIT community. Space is limited and reservations are necessary. To register, please visit www.regonline.com/Checkin.asp?EventId=175069.

Claerbout exhibit opens Friday at List Center

Sarah H. Wright
News Office

The MIT List Visual Arts Center is presenting the first U.S. museum survey of works by Belgian artist David Claerbout, on exhibit Feb. 8 through April 6.

Claerbout, 39, mixes snapshots and video to form images that explore our ever-changing sense of time and our subtle, often-overlooked gestures of intimacy, disconnection or bafflement.

Filmed mostly in modern urban settings, Claerbout's works reward the patient observer with subtle, poignant narratives that an accelerated media culture doesn't allow: In "Sections of a Happy Moment," a family slowly plays catch beneath the dehumanizing gaze of surveillance cameras; in "The Stack," sunlight illuminates a sleeping homeless person and a highway overpass during 36 minutes of approaching twilight.

Other Claerbout works at the List exhibit include "Vietnam, 1967, near Duc Pho (reconstruction after Hiromishi Mine)." Here, Claerbout reconstructs a war reporter's iconic black-and-white photo of a plane shot down by friendly fire during the Vietnam War. Using digital technology to freeze the historic still in a film of the lush, jungly present, Claerbout erases and accentuates the 33-year gap between the two.

In "Shadow Piece," a number of passersby attempt to open a set of glass doors into the entrance hall of a building. Their shadows remain fixed, suggesting either that time or humanity is pretty much at a standstill.

Claerbout's priceless video, "Cat and Bird in Peace," shows a long-haired tabby and a little canary sharing a box for 10 minutes. Cat stares at monitor; bird peeks at cat now and then. Is it a pause before violence or the peaceable kingdom?

Educated in Antwerp and Amsterdam, Claerbout lives and works in Antwerp and Berlin. His work has been exhibited in Belgium, the Netherlands, Spain and New York.

The exhibition was designed and organized by the Centre Pompidou in Paris, France. After MIT, it will travel to Switzerland, the Netherlands and Japan.

The MIT List Visual Arts Center is located in the Wiesner Building, 20 Ames St., at the eastern edge of the MIT campus. All exhibitions at the center are free, open to the public and wheelchair accessible.

These images, from Belgian artist David Claerbout's "Sections of a Happy Moment," display a family playing catch beneath the dehumanizing gaze of surveillance cameras.

PHOTOS COURTESY / **GALERIE MICHELINE SZWAJCER, YVON LAMBERT, HAUSER & WIRTH, AND JOHNEN & SCHÖTTLE**

Exhibit to kick off DUSP 75th-anniversary celebrations

A series of events to celebrate the 75th anniversary of MIT's landmark Department of Urban Studies and Planning will kick off with an exhibit in the Wolk Gallery, opening Tuesday, Feb. 12.

The show, "Changing Cities: 75 Years of Planning Better Futures at MIT," uses archival, graphic and multimedia materials to portray the evolution and influence of the department in academic and practical spheres. It will continue through April 11.

Over the past seven decades, the department has gained renown for pioneering new ways to analyze and enhance the physical form of cities; for embracing the social sciences in planning; and for expanding research to include studies of comparative planning and development practice around the world.

"Changing Cities" chronicles changes within DUSP as it has engaged with the scale and pace of urbanization in the larger world.

A daylong "Changing Cities" symposium, celebrating the 75th anniversary of DUSP and the 40th anniversary of the Special Program for Urban and Regional Studies (SPURS), will be held Friday, April 4.

A second exhibit, "Urban Design and Civil Protest: A Contemporary Meditation," opens Thursday, Feb. 28, in the Compton Gallery.

NEWS YOU CAN USE

Sports business conference at MIT

On Feb. 9, the second annual MIT Sloan Sports Business Conference will explore the role of analytics in managing successful professional teams and leagues.

Panelists from across the sports world will be represented. Speakers include Bill Polian, president of the Indianapolis Colts; R.C. Buford, general manager of the San Antonio Spurs; Jed Hoyer, assistant general manager of the Boston Red Sox; and the keynote speaker, Wycliffe "Wyc" Grousbeck, managing partner, governor and CEO of the Boston Celtics.

Registration starts the day of the event at 7:45 a.m., and the conference, which will be held in the Stata Center (Building 32), will run from 9 a.m. to 5:30 p.m., followed by a networking reception.

For more information and to register for the MIT Sloan Sports Business Conference, please visit www.sloansportsconference.com or contact Chris Johnson at 617-529-0316.

Application for IDDS 2008 now available

The International Development Design Summit (IDDS) 2008 will take place from July 14 through Aug. 8.

The inaugural IDDS occurred last summer, bringing students, mechanics, social workers, doctors, carpenters, farmers and professors from 18 countries together to collaborate and build technologies to improve the quality of life in the developing world. The summit is headed by MIT Senior Lecturer and MacArthur Fellow Amy Smith, and is organized by MIT, Caltech and Olin.

For more information and to apply online, please visit www.iddsummit.org.

Service fair

Make a commitment to serve this year and come to the annual MIT Service Fair. Meet and talk with more than 30 local nonprofit agency representatives and find out what you can do to serve the Cambridge-area community. Learn about tutoring children at a nearby after-school program, serving healthy meals to those living with critical illness, helping recent immigrants adjust to American society, assisting victims of domestic violence and many other opportunities. The MIT Service Fair will take place Friday, Feb. 8, from 11 a.m. to 2 p.m., in W20-306 and will feature refreshments and giveaways. For more information, e-mail Heather in the MIT Public Service Center at trickett@mit.edu.

CLASSIFIED ADS

Members of the MIT community may submit one ad each issue. 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.

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Men's jacket: Size large, brown-leather look, below hip length, warm fleece lining throughout. Made in Italy. New, $35. Call Rosalie at 781-391-1307.

Sony AM/FM Stereo radio. mdl:STR-DE197 with Remote. New in box, never opened, 250 watts, 4hz to 20khz, Dolby Pro Logic. 2 audio inputs, 1 audio output, AB switching. Fantastic receiver. $100. Contact: 781-893-3377 or k1cei@arrl.net.

FOR RENT

Ocean front summer cabin, Mount Desert Island, ME: 2BD/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. Contact Steve at 253-5757 or chorover@mit.edu.

HELP WANTED

ME/EE/robotics student wanted to help on a classic car project, restoring swivel function to headlamps on a 1972 Citroën Maserati. Fun project, some $$, Watertown location. E-mail shwright@mit.edu.

Interview with the dean: Marc Kastner, School of Science

Over the course of the spring semester, Tech Talk will be bringing you a series of interviews with each of MIT's five school deans—four of whom have been in their positions for less than 18 months. The first in the series features Dean Marc Kastner, a physicist who took charge of the School of Science last summer. In the following interview with Greg Frost and Anne Trafton of the MIT News Office, Kastner discusses the goals he has set, the challenges he faces and the surprises he has witnessed in his new position.

Q. *Coming in as dean, what are some of your long- and short-term goals for the School of Science?*

A. Let me take the long term first. I think that the School is spectacular in its depth and breadth, and both the faculty and the students are wonderful. But we could do better at providing the resources that they need to do their jobs. My long-term goal is to focus more on providing resources for our current faculty. We do quite well in providing resources when we bring new faculty members into MIT, but I think we need to do better for the people who are here. And that means better space, better infrastructure and making it easier for them to do their research. This will make MIT a more attractive place to be, which will help to attract the best faculty, including more women and minorities.

That's very broad and very long term. On the shorter term I think that President Hockfield's initiatives are really the right ones for the Institute as a whole, and for the School of Science, in particular. The new Koch Cancer Institute, which joins superstars from the School of Science and the School of Engineering to work on cancer, is a great model for bridging biology and engineering. I think we have lots of opportunities to connect biology with other departments in science, as well as with engineering. For example, faculty in math, physics, chemistry and EAPS [Earth, Atmospheric and Planetary Sciences] bring new points of view to biology. More broadly, President Hockfield has urged all the deans to foster interschool collaborations, and there are particularly exciting opportunities for me to work with the new dean of engineering [Subra Suresh]. There are many universities with great schools of science, but we're almost unique in being a great science school in a great engineering institute. We should be able to take more advantage of that. Everything I've done in my own research was made possible by capabilities that were here because we're an engineering institute. I'd like to see more of that happen in other areas. Certainly energy and the environment are examples of fields where there are really exciting things happening at the interface of engineering and science, and we should be getting more out of the collaboration between them.

Q. *Do you have any thoughts on how to get people in different departments to work together?*

A. You know, it's not very hard at MIT. I think that we have very few obstacles to collaboration across departmental or school boundaries. People do it quite naturally. I think there are some examples where faculty need just a little help and a little encouragement. And there are long lists of possible projects that Dean Suresh and I have been discussing. We want to work together to encourage people and help them do things they already want to do. I think that's really the way to do it.

Q. *What's the most surprising thing you've run into thus far in your new role?*

A. Well, you know, it shouldn't be surprising, but I am still often startled when I meet a new faculty member that I haven't talked to before, and learn about the research he or she is doing. One of the biggest surprises I had was talking to Kerry Emanuel and finding out that he actually climbs into airplanes and flies into hurricanes at the interface between the ocean and the air to measure the energy in the hurricanes. That is amazing!

Another example is Rebecca Saxe telling me how she's discovered a part of the brain that becomes active when you're thinking about what somebody else is thinking; it's absolutely spooky. So every time I talk to one of the science faculty members I get a surprise.

Q. *You mentioned before that you're hoping to provide all the resources that people here need. Is it hard to deal with the loss of federal research funding?*

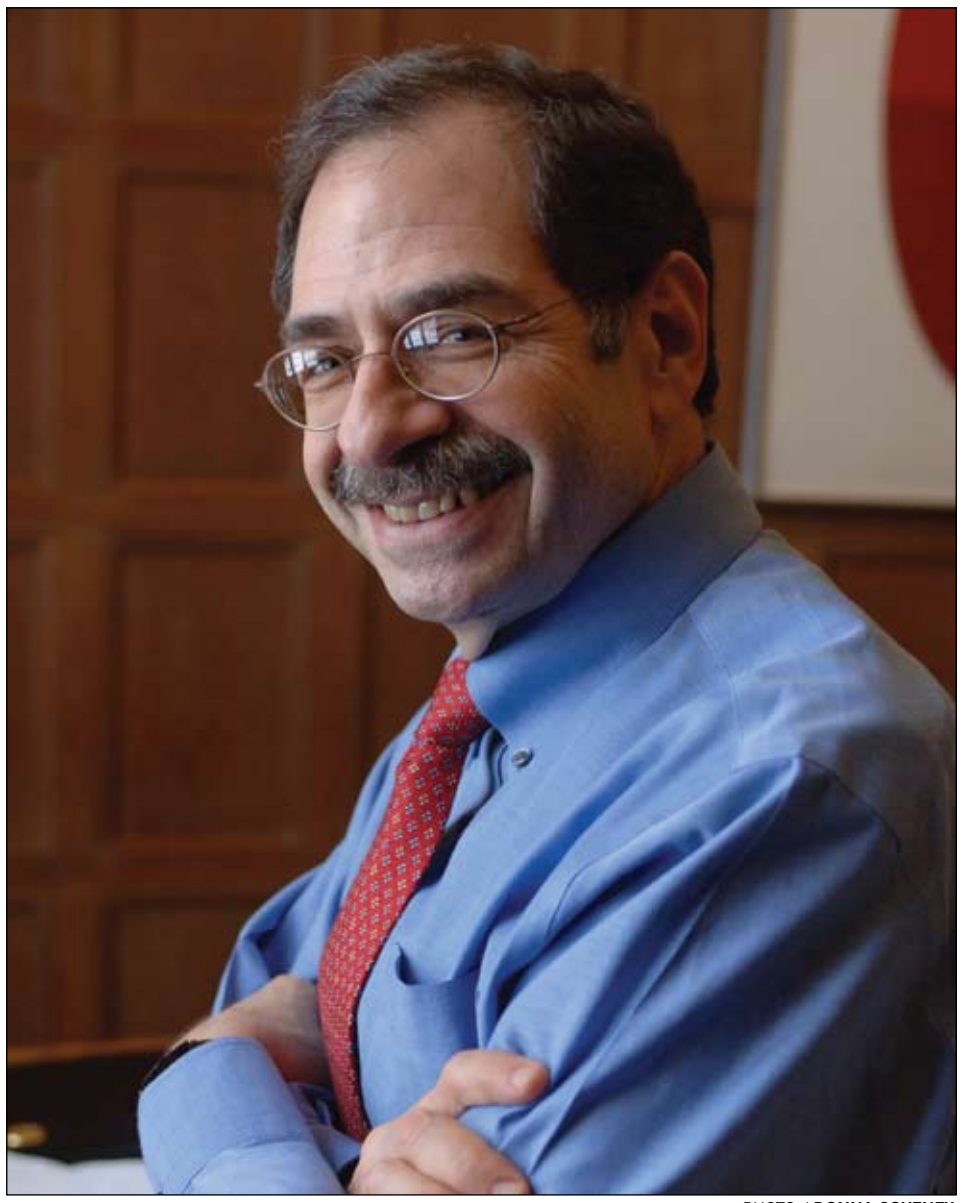

PHOTO / **DONNA COVENEY**

Marc Kastner

A. Yes, it's very difficult. In the physical sciences there's been great difficulty in getting enough resources since the mid-1980s, which reflected the end of the Cold War. In the life sciences during the 1990s there was a doubling in the NIH budgets, and things were pretty good. But in the last couple of years the NIH budgets have been flat and people are having a very hard time. This is a common challenge for all the universities in the country, but I think it's tougher at MIT because such a large fraction of our faculty members do research that is very expensive. As a result, we are much more sensitive to these variations in government funding. I think we have to find other sources of support to augment the government funding, and that's why the support of our donors has become more important than ever before.

Q. *Are you hoping to focus on fundraising for the School of Science as a whole, and get resources directly into the departments?*

A. I think that the way fundraising works best is to connect the donors with faculty and students who are doing things they're interested in. This does not mean that we compete with the other MIT schools. It means that we go out and meet donors and show them what we're doing, and try to get them interested in what we're doing. If they're more interested in engineering than science, for example, that's fine, and we'll let the engineering school know about them. Resource development works best when everybody is on the same team, because the most important thing is to have the donors feel that they're supporting something that is really satisfying to them. Donors differ in the kind of research and education they are interested in, and they also differ in how they want to support it.

Some like named professorships, others graduate fellowships, or naming buildings or parts of buildings. If you go to the physics department's Green Center you'll see lots of names of people who supported the physics department. One of the things that's most rewarding to donors is supporting fellowships for graduate students, because then they get to know the students that they're supporting. Supporting undergraduate financial aid is also rewarding to donors. My experience with our donors is that each person is interested in something different. You have to show them what's going on at MIT and let them choose what they're excited about.

Q. *You mentioned the Green Center. Are there any plans in the works to renovate other buildings in the School of Science or are you going to take a rest?*

A. No, we can't rest. There are several groups of faculty that desperately need better space. One example is the Green Building, which houses the Department of Earth, Atmospheric and Planetary Sciences (EAPS). Their space no longer meets their needs, and the EAPS faculty collaborates with civil and environmental engineering faculty, so it would be great if they could be in one building. Another example is the chemistry and math space in Building 2; in reality the entire main group needs renovation. I think that the new PDSI project is a great model of how to renovate the whole main group. I would hope that we could move forward on that. The [Bosworth] buildings are going to be 100 years old in 2016, and they should be renovated by then.

Q. *What you think your biggest challenges will be as dean?*

A. One of the most important and difficult is to continue to increase the diversity of the faculty in the school. Our associate dean, Hazel Sive, and I have been discussing this issue with the new associate provosts for faculty equity, Barbara Liskov and Wes Harris, as well as with the department heads and faculty. For both women and minorities, the great challenge is to increase the pool of qualified applicants and then attract them to MIT. For women, the fraction in the applicant pool for postdoctoral and faculty positions is smaller than the fraction of our graduate students, and for minorities the fraction of our graduate students is painfully low. Our focus for both groups will be to make MIT more attractive so that qualified graduate students and postdocs will want to have academic careers at MIT. We, as a community, have to continue to work hard to increase our diversity and to value the unique contributions that we each make. This is a long-term challenge, but we can only have the best faculty if it is a diverse one.

Another challenge, which I discussed earlier, is finding a way to adequately support the faculty and the students. I don't think it's healthy to have a community that is stretched beyond its means. Some stretch is OK, but too much is not good. And I don't like the fact that faculty are spending so much of their time writing proposals instead of doing research and teaching, which is really what they're good at.

Q. *Can MIT apply its scientific know-how and innovation experience to making that easier for faculty across the Institute?*

A. So far what has happened is the opposite: The government seems to use technology to make it harder. The growing scarcity of available research funds requires that faculty members submit more proposals to maintain their research programs. At the same time, the reporting and monitoring of grants is becoming more complicated. The agencies require that all proposals have to be submitted electronically, and the programs used by some agencies are not very good, so it is very painful. I doubt that technology is the answer. I think that we need to provide better staff support for faculty and provide management training for faculty so they can use their time more effectively.

Q. *What do you do in your spare time, assuming you have any?*

A. I play tennis. I started when I was about 50 years old. I had played about once a year when I was younger, and I used to jog, but when I took my first administrative job at MIT I found that, whereas as a professor jogging was relaxing, and I would think about physics, once I took on administrative responsibilities, I would go out jogging, and all I would think about was the problems I couldn't solve. I would come back stressed. So I decided I needed a sport that was sufficiently life threatening that I couldn't think.