Volume 53, Number 18
Wednesday, March 11, 2009

TechTalk
SERVING THE MIT COMMUNITY

Liskov wins Turing award

ACM cites 'foundational innovations' in programming language design

Institute Professor Barbara Liskov has won the Association for Computing Machinery's A.M. Turing Award, one of the highest honors in science and engineering, for her pioneering work in the design of computer programming languages. Liskov's achievements underpin virtually every modern computing-related convenience in people's daily lives.

See a Q&A with Barbara Liskov
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Liskov, the first U.S. woman to earn a PhD in computer science, was recognized for helping make software more reliable, consistent and resistant to errors and hacking. She is only the second woman to receive the honor, which carries a $250,000 purse and is often described as the "Nobel Prize in computing."

"Computer science stands squarely at the center of MIT's identity, and Institute Professor Barbara Liskov's unparalleled contributions to the field represent an MIT ideal: groundbreaking research with profound benefits for humankind. We take enormous pride that she has received the Turing Award," said MIT President

▶Please see LISKOV, **PAGE 6**

PHOTO / **DONNA COVENEY**
Institute Professor Barbara Liskov

CINDERELLA SEASON ENDS

Engineers win first-ever NCAA tournament game; are ousted by Farmingdale State in second match

PHOTO / **DAWN ANDERSON**
Senior guard Bradley Gampel drives to the basket during the MIT men's basketball team's NCAA Div. III tournament game against Rhode Island College on March 6.

After an upset win over Rhode Island College Friday night, the MIT men's basketball team again looked to do something it never had: advance to the sectional round of the NCAA Division III tournament.

But standing in MIT's way Saturday night was a team — Farmingdale State — that had never made it that far either. Unfortunately for the Engineers, it wass Farmingdale State that got to play on after beating MIT, 67-61.

The weekend started off strong for MIT, which fought hard in the waning minutes of Friday night's contest against Rhode Island and took the tight match into overtime. MIT freshman Billy Bender provided the late spark, knocking down four free throws in the final minute of regulation to send it to overtime, then came up with a steal, a key offensive rebound and two more free throws to help MIT stun the nationally ranked Anchormen, 73-68.

Trailing 30-22 at the start of the second period, the Engineers received a huge boost from an unexpected source: their fans. Two busloads of MIT fans packed the Murray Center during halftime and greeted the Engineers with a thunderous applause that lasted for the duration of the contest. With MIT's faithful drowning out hometown crowd, the Engineers reeled off the first eight points of the half to tie the game.

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Energy opportunities seen amid world crisis

Conference speakers cite chances for progress

David Chandler
News Office

Speakers at MIT's fourth annual student-led Energy Conference on Saturday emphasized the historic opportunity now open to proponents of clean energy: a global economic crisis that can be directly addressed by sweeping changes to the way we produce and use energy. And research universities, they said, could play a major role in helping to bring about such a transformation.

"We need to focus on alternative energy because reviving the economies of the world requires a return to fundamental economic growth," MIT President Susan Hockfield said. "I'm convinced that the next wave of economic growth will rise from the same source that powered the information and biotechnology

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PEOPLE

MacVicar fellows named

Four professors were named MacVicar fellows last week in recognition of their innovative teaching practices.

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RESEARCH & INNOVATION

New greenhouse gas identified

The early detection of a potentially potent gas could help to reduce its effects before it is too late.

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NEWS

The future of transportation

Regional meeting of NAE members, held at MIT, discusses what's next for transportation.

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Let the nominating begin: Awards Convocation deadline is March 20

Nominations for MIT's annual Awards Convocation are being accepted now through Friday, March 20.

Encompassing more than 30 awards across many areas and departments, the Awards Convocation honors those — including students, faculty and staff — who have made special contributions to the life of the MIT community. The winners will be announced during the convocation, which will be held at 4 p.m. on Tuesday, May 5, in 10-250.

For more information, and to browse the awards descriptions and previous recipients, see http://web.mit.edu/awards/.

Events at MIT

Today

• **MIT Transportation Fair.** 11 a.m.-2 p.m. the Stata Center's Student Street. The fair encourages the MIT community to re-examine transportation choices and commit to trying less impactful options for commuting to work, and for other trips. MIT Parking and Transportation team members and our partners will be available to discuss commuting options such as walking, bicycling, carpooling, vanpooling, public transportation by bus, subway and train, car sharing, teleworking, hybrid taxi service, and more.

• **"Six months on the International Space Station."** 3-4 p.m. in 37-212. Dr. Greg Chamitoff, Aero-Astro alum '92 and NASA JSC astronaut will discuss his time aboard the ISS.

• **City Design and Development Forum: Landscape + Urbanism.** 5:30-7 p.m. in 10-485. Speaker: Lisa Tziona Switkin on adaptations; reusing, reclaiming and reconstructing new landscapes.

• **"The energy storage industry and its opportunities."** 6-7 p.m. in E51-335. Richard Baxter, senior vice president at Ardour Capital Investments, will give an overview presentation on the energy storage industry and current trends. He covers this sector at Ardour, and he has previously written an excellent book on the applications, technologies, and regulations effecting the energy storage sector for grid scale energy storage.

Thursday, March 12

• **"Building a supply chain in Iraq: challenges and solutions."** Noon-1 p.m. in E51-145. Gerald Brown, director for industry revitalization, Task Force on Improving Business and Stability Operations in Iraq, will speak on the topic of building a secure supply chain in Iraq.

Four professors honored with MacVicar fellowships

Two professors from the School of Engineering and two from the School of Humanities, Arts, and Social Sciences were named MacVicar Faculty Fellows this year in recognition of their innovative teaching practices and accomplishments.

Vladimir Bulovic and Daniel Jackson, of electrical engineering and computer science; Diana Henderson of literature; and David Jones of science, technology and society are the newest MacVicar fellows.

The honor was formally announced by Provost L. Rafael Reif at a faculty reception on Thursday, March 5, at Gray House. The fellows were chosen by a special committee headed by Dean for Undergraduate Education Daniel Hastings.

The program, now in its 18th year, is designed to create an elite group of MIT scholars committed to excellence in teaching and innovation in education — causes championed by the late Dean for Undergraduate Education and Professor of Physics Margaret L.A. MacVicar, whom the program honors. Dean MacVicar died in 1991.

"We are a faculty dedicated to research and scholarship and also dedicated to providing an excellent education for our students," said Hastings. "The MacVicar program is a tangible statement of that caring."

The fellowships provide an annual scholar's allowance to assist each fellow in developing ways to enrich the undergraduate learning experience. MacVicar Faculty Fellows serve 10-year terms.

Two of the fellows, Bulovic and Jackson, were named Van Buren Hansford (1937) – Margaret MacVicar Faculty Fellows.

Vladimir Bulovic

Bulovic, the KDD Associate Professor of Communications and Technology, earned BS (1991), MA (1995) and PhD (1998) degrees from Princeton University. He joined the MIT faculty in 2000.

Bulovic's research interests include studies of physical properties of nanodot composite thin films and structures, and development of novel optoelectronic organic and hybrid nanoscale devices. In 2004, he was named as one of the TR100, Technology Review magazine's annual list of top young innovators in technology.

As a teacher, Bulovic seamlessly blends his artistic skills with extraordinary technical acumen, according to his colleagues. He has an incredible ability to engage and motivate students, and to inspire them to new heights. Moreover, he is able to take complex ideas and present them in a manner that makes them especially clear and intuitive.

"As he presents materials, Professor Bulovic is constantly gauging the students' absorption of the material," one of his students told the MacVicar Nominating Committee. "If there are any confused looks or bewildered faces from students, he re-explains the material in another way and waits for questions or a sense of student understanding. He seems to enjoy answering questions, which makes students comfortable asking them."

Diana Henderson

Henderson, professor of literature and dean for curriculum and faculty support, jointed the MIT faculty in 1996 after spending several years on the faculty at Middlebury College. She earned a BS in philosophy and English from the College of William & Mary in 1979, and an MA (1980), MPhil (1983) and PhD (1989) in English from Columbia University.

Henderson's areas of research include gender studies, Shakespeare, early modern culture, modernism and world drama. She has written several books on Shakespeare and won the 2005 Everett Moore Baker Memorial Award for Excellence in Undergraduate Teaching.

According to colleagues, Henderson has been a force behind the revitalization of the literature major at MIT, and works hard to show that learning is enjoyable and that reading and understanding difficult texts can become a pleasure.

"Professor Henderson is one of those rare people who is able to spread her enthusiasm and academic vigor for any literary topic to make even the most terrified or uninterested student want to learn more," one of her students told the nominating committee. "She doesn't lecture, she engages."

Daniel Jackson

Jackson, professor of electrical engineering and computer science, graduated from Oxford University in 1984 and earned MS and PhD degrees from MIT in 1988 and 1992, respectively. He joined the MIT faculty in 1997 after spending six years as an assistant professor at Carnegie Mellon University.

His research interests include finding ways to make software more dependable and easy to use, and to reduce the cost of development.

Jackson's colleagues say that he is a gifted teacher who cares deeply about his teaching and about the learning experience of MIT undergraduates. His lecturing style is clear, articulate and precise, and — through his artful use of the blackboard — he bucks the lecture trend of PowerPoint information delivery at firehose speeds.

"I greatly admire the evident passion that Professor Jackson has for his students and his teaching," one of his students told the panel. "The excitement in his voice about the subject and the humor he injected into his lectures made every lesson, dare I say, enjoyable!"

David Jones

Jones, Associate Professor of the History and Culture of Science and Technology, holds BA (1993), MA (1997), MD (2001) and PhD (2001) degrees from Harvard University. After completing his degrees, he was a teaching fellow in pediatrics at Boston University's School of Medicine and a clinical fellow in pediatrics and psychiatry at Harvard Medical School. He has been at MIT since 2004.

Jones has written a book on epidemics among American Indians, and has also studied Cold War medicine, HIV and other sexually transmitted infections, and the history of cardiac surgery.

Jones has a knack for understanding how to package important ideas so that students quickly appreciate the connection between big social and scientific issues and their own, humble experiences, according to his colleagues. As a practicing physician, as well as a historian of science and medicine, Jones has great credibility when he talks about controversial issues, and can cover very complicated angles with ease and gravitas.

"Three hours of David Jones per week simply isn't enough!" one of his students said. "Often after recitation, there were large clusters of students staying beyond class time, even missing portions of other classes, clamoring to glean more from David."

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Printed on recycled paper

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Tech Talk is published by the News Office on Wednesdays during the academic year except for holiday weeks; no July and August issues. 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.

PHOTO / **GEORGE DALEY**

Lifting the ban

H. Robert Horvitz (far left), the David H. Koch Professor of Biology, was among a group of 10 Nobel laureates who stood alongside President Barack Obama on Monday, March 9, as he signed an executive order on stem cell research. Horvitz, who won the 2002 Nobel Prize in physiology and is also a Howard Hughes Medical Institute (HHMI) investigator and a member of the McGovern Institute, applauded as the president opened up embryonic stem cell research to federal funding.

Horvitz noted he was not the lone member of the MIT community at the event: Eric Lander, professor of biology and founding director of the Broad Institute, and President Emeritus Charles M. Vest were among those gathered in the audience. Lander is also a co-chair of the President's Council of Advisors on Science and Technology.

As Obama signed the order reversing the ban on federal funding of embryonic stem cell research, he also issued a presidential memorandum aimed at ensuring that policy decisions are based on what he called "the soundest science."

"That's exactly the way it should be," Richard Hynes, the Daniel K. Ludwig Professor for Cancer Research in the Department of Biology, told the Boston Herald in reaction to Obama's memorandum. Hynes, a cell biologist and HHMI investigator, was co-chair of a 2005 committee established by the National Academies that developed guidelines for research involving human embryonic stem cells.

MIT hosts diversity roundtable for N.E. schools, hospitals

Stephanie Schorow
News Office

Diversity means more than recruiting unrepresented minorities; that's only the start. Diversity means paying attention to "micro-messaging" that implies someone got special hiring treatment. It means encouraging cultural competency among faculty and senior administrators to help them interact effectively with people from different backgrounds. Above all, it requires leadership at all levels of an institution.

Those were some of the messages explored by participants in the March 9 New England Higher Education Recruitment Consortium (HERC) 2009 Diversity Roundtable, hosted by MIT. HERC supports efforts to recruit and retain outstanding faculty, administrators and staff through sharing information and resources.

"Diversity recruitment in challenging economic times calls for leadership that makes sense of the perils and exploits the opportunities," said Robbin Chapman SM '99, PhD '06, manager of diversity recruitment in MIT's School of Architecture and Planning and the organizer of the event.

The need for diversity must be fully threaded into an institution's mission, MIT Human Resources Vice President Alison Alden told the gathering. "Diversity is not something you do on Sunday but is baked into everything we do," she said.

Chapman said she was determined to create a format in which participants did more than listen to speeches. Accordingly, the nearly 80 representatives from the region's schools and teaching hospitals split into 10 groups and worked through an exercise aimed at thinking creatively about promoting diversity and inclusiveness. The exercise, known as a "Diversity Inclusion Score Card," was created by Matt Thompson, director of staff diversity at MIT's Department of Human Resources.

PHOTO / **DONNA COVENEY**

Robbin Chapman SM '99, PhD '06, manager of diversity recruitment in the School of Architecture and Planning, welcomes participants to a diversity roundtable discussion held Monday, March 9.

"This is the first time leadership activities have been embedded in the roundtable program," Chapman said. "According to the debriefing that took place during closing activities, knowing how to lead the diversity and inclusion work within your institution could influence and galvanize real change."

WIN AN IPHONE!

Don't forget, the first-ever Sustainability at MIT Photo Contest is going on through March 31, so there's still time to submit your photos. Show us what you see and what your aspirations are as MIT launches its greeningMIT campaign to help the Institute walk the talk on energy and the environment.

The grand-prize winner will receive an iPhone and have his or her winning entry published on the MIT home page and in MIT's official newspaper, Tech Talk. Prizes will also be awarded to the first- and second-place finishers.

For complete rules, including how to enter, please visit web.mit.edu/newsoffice/2009/photo-contest-rules.html.

Awards &Honors

MIT's Training Delivery Guide garners honor

MIT's Training Delivery Guide, a tool produced by the MIT Training Alignment Team to assist in training design and delivery decisions, was recently cited as the Best Product of 2009 by the Training Media Review. The guide, available at http://web.mit.edu/training/trainers/tool/index.html, is charged with supporting "Institute-wide training initiatives for world-class work."

Events at MIT

Thursday, March 12

• **iAmbassador.** Noon-1 p.m. in E40-380. Learn about the society, politics, culture and technology of the Republic of Ireland from one of Ireland's very own.

• **getfit@mit mid-point event.** Noon-1:30 p.m. in 10-250 Come celebrate your achievements so far! Drop in any time from noon to 1:30 p.m. to pick up your T-shirt, enjoy healthy snacks, and win fabulous door prizes.

• **MIT & Harvard Housing Cities Symposium 2009.** 6:30-8:30 p.m. Stata Center 4th floor R&D Commons. On Thursday, March 12, we will open the symposium with "A Conversation with Sandra Henriquez," administrator and CEO of the Boston Housing Authority.

• **MIT Writers Series: Nick Montfort.** 7-8 p.m. in 32-141. Montfort, assistant professor of digital media at MIT, has collaborated on the blog 'Grand Text Auto,' the sticker novel 'Implementation,' and '2002: A Palindrome Story.'

Friday, March 13

• **The Ronald F. Probstein Lecture in Engineering Science.** 3:30-4:30 p.m. in 34-101. Speaker: Robert H. Socolow, Princeton University on "Technology, Policy, and Values for Living in a Greenhouse."

• **Digital Apollo: How MIT's computers landed on the moon.** 6-8 p.m. in W79- Simmons Hall Multi-Purpose Room. Speaker: Prof. David Mindell. The presentation will describe the last 10 minutes of the Apollo 11 moon landing, when Neil Armstrong and Buzz Aldrin landed on the moon using computers and software developed at MIT. It's a story of engineers, human operators, software, "bugs" and triumphs, and has much to teach us about engineering and life critical systems today.

• **GAM3RS.** 8-10 p.m. at the MIT museum. GAM3RS is a one-man show written by Walter G. Meyer and Brian Bielawski that humorously explores the conflicts that arise when one man puts his online gaming life ahead of his work and relationship priorities.

• **MIT Symphony Orchestra: John Harbison Tribute.** 8-10 p.m. in W16, Kresge Auditorium.

Tuesday, March 17

• **Women In Math Lecture Series.** 5:30-6:30 p.m. in 4-145. Speaker: Rina Anno (University of Chicago), on "The geometry of flag varieties and Springer fibers."

• **"The Intersections of the Artistic and Scientific Process."** 6:30-8 p.m. in N52-390. CAVS graduate Affiliate Laurel Braitman and artist Dario Robleto explore the intersection of the artistic and scientific processes in the contexts of climate change, landscape transformation and biological extinctions.

Submit your events!

Log on to events.mit.edu to add your events to MIT's online calendar. Certain events will be selected from the online calendar to be published in Tech Talk each Wednesday.

New gel permits controlled drug delivery

Self-assembling hydrogel could help treat cancer and diabetes, among others

Anne Trafton
News Office

MIT researchers have demonstrated that a gel composed of small, woven protein fragments can successfully carry and release proteins of different sizes, potentially enabling delivery of drugs such as insulin and trastuzumab (Herceptin).

Furthermore, the researchers can control the rate of release by changing the density of the gel, allowing for continuous drug delivery over a specific period of time. The team, led by Shuguang Zhang, associate director of MIT's Center for Biomedical Engineering, reported its findings in the March 9 online edition of the Proceedings of the National Academy of Sciences.

The gel, known as a "nanofiber hydrogel scaffold," enables, over hours, days or even months, a gradual release of the proteins from the gel, and the gel itself is eventually broken down into harmless amino acids — the building blocks of proteins.

Traditional drug-delivery systems are based on either synthetic polymer materials, which may contain residual chemicals and other cross-linking agents that are toxic for humans, or animal-derived collagen, which may contain residual growth and/or viruses from animal tissues. Peptide hydrogels are ideally suited for drug delivery as they are pure, easy to design and use, non-toxic, non-immunogenic, bioabsorbable, and can be locally applied to a particular tissue.

Zhang first discovered the material in the early 1990s, and since then it has shown promise in regenerative medicine and stopping bleeding. Composed of self-assembling amino acid chains (peptides), the gel is about 99 percent water by volume.

Depending on the size and density of the mesh, it can carry protein molecules between 14,000 and 150,000 daltons (a unit of molecular weight). Trastuzumab, an antibody protein often used to treat breast and ovarian cancer under the brand name Herceptin, is about 50,000 daltons.

Earlier work showed that the hydrogels could also carry smaller molecules, between 300 and 900 daltons. "It can deliver both small molecules and big molecules," said Zhang.

In the PNAS paper, the researchers also showed that proteins carried by the gel emerge unscathed after delivery, with no adverse affect on their function.

Potential applications include delivery of insulin, monoclonal antibodies such as Herceptin, hormones, growth factors and cancer drugs, as well as eye medications, said Zhang. He hopes to license the technology to a biotech company that will carry out preclinical testing of the hydrogel.

Lead author of the paper is Sotirios Koutsopoulos, a postdoctoral fellow in MIT's Center for Biomedical Engineering. Other authors are Larry Unsworth, a former MIT postdoctoral associate, and Yusuke Nagal, a former visiting scientist from Menicon Co. Ltd. in Japan.

The research was funded in part by the National Institutes of Health and the HighQ Foundation.

Student's invention holds promise for engineering tissues and organs

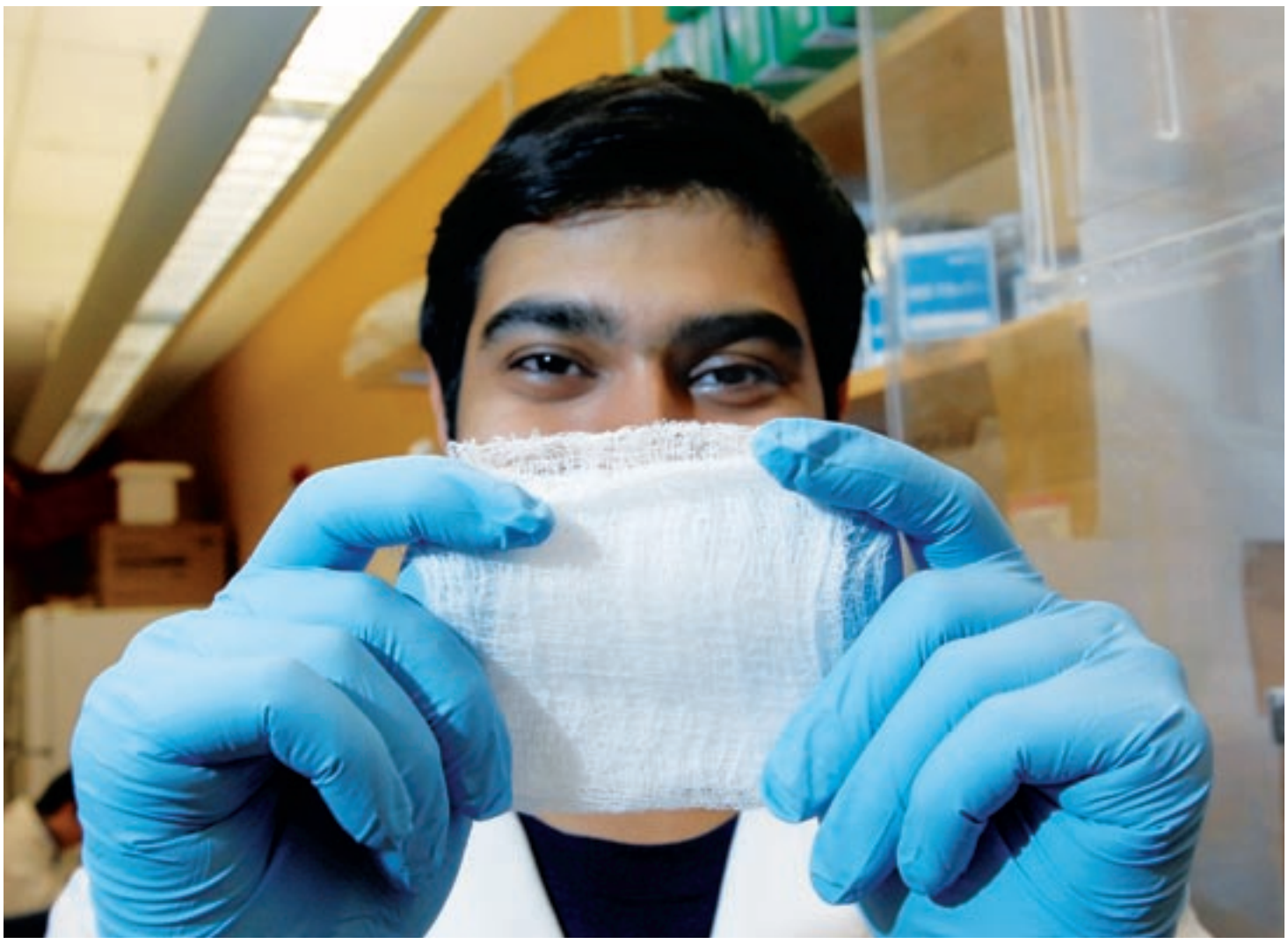

PHOTO / **DONNA COVENEY**

Sophomore Asad Moten holds up a fibrous scaffold he developed that can help regenerate cartilage and other tissues.

Anne Trafton
News Office

As a high school sophomore, Asad Moten read a news story about engineering new organs for patients waiting for a transplant, and decided to start his own tissue-engineering project.

His efforts led to the invention of a scaffold that can help regenerate tissue and that may one day be able to help patients with spinal cord injuries, serious burns, nerve defects and other chronic wounds. The invention, known as a protein printboard, may also lead to methods to engineer transplantable organs, which could help some of the 80,000 people in the United States waiting for donated organs.

"Twenty of these patients die every day due to a lack of replacement organs and tissues for them," says Moten, who is forming a startup, ECMatrix Inc., to develop tissue replacement scaffolds.

Moten's invention has won him numerous awards and accolades, the most recent being an induction into the Young Inventor's International Hall of Fame. He was also a regional finalist in the 2006-2007 Siemens Westinghouse Competition.

Now a sophomore at MIT majoring in brain and cognitive sciences and biological engineering, Moten, who is originally from Pakistan, says he became passionate about science and medicine in elementary school. As a high school student in Houston, he completed several projects in nanotechnology, computational neuroscience, gene therapy and biomedical engineering.

He is now working with other students to launch ECMatrix: Salvatore Mascia, an MIT postdoctoral associate in chemical engineering; Benjamin Geisler, an MD and a student at Harvard School of Public Health; Nate Huebsch, a PhD student in the Harvard-MIT Division of Health Sciences and Technology; and Francesco Renzo, an MBA student at MIT Sloan.

The team is filing for a patent on the tissue scaffold, writing grant applications and entering venture capital and business plan competitions.

One possible application of the scaffold is the regeneration of spinal discs. Moten envisions that the scaffold could be implanted to replace a deteriorated disc, and the patient's own cells would then migrate to the scaffold and start forming new cartilage. "The body does most of the regeneration after implantation," he says.

Currently there are no implantable devices that can regenerate tissue the way this scaffold would, he says.

"This is a highly important area, and Asad's approach is novel and a significant step forward," says Ali Khademhosseini, a faculty member at the Harvard-MIT Division of Health Sciences and Technology and Harvard Medical School who has advised Moten on his research.

Moten developed the protein scaffold at Rice University, University of Texas Medical Branch and NASA Johnson Space Center, later at Stony Brook University in New York, and now at Harvard-MIT Division of Health Science and Technology.

Moten is driven by his desire to develop innovative technology that can improve patient care — a goal he pursues on top of his regular workload as a double major.

"It doesn't seem like work when you are truly passionate and dedicated," he says.

To find new worlds...

This past Friday night, NASA launched Kepler, a satellite designed to discover Earth-sized planets — potential homes for alien life forms — that may orbit nearby stars.

But that's only part of what the new orbiting telescope can do, says MIT planetary scientist Sara Seager (inset), one of the members of the Kepler team. For instance, it can learn a lot more about the many 'hot Jupiters' — giant planets that have been discovered orbiting very close to their parent stars — including how reflective they are, which could be a clue to their composition. New discoveries could be announced within a year, Seager says, and 'there's no reason why Kepler shouldn't find hundreds of new planets.'

IMAGE / **NASA**; PHOTO / **DONNA COVENEY**

New greenhouse gas identified

Early detection may permit 'nipping it in the bud' before its production increases

David Chandler
News Office

A gas used for fumigation has the potential to contribute significantly to future greenhouse warming, but because its production has not yet reached high levels there is still time to nip this potential contributor in the bud, according to an international team of researchers.

Scientists at MIT, the Scripps Institution of Oceanography in San Diego and other institutions are reporting the results of their study of the gas, sulfuryl fluoride, this month in the Journal of Geophysical Research. The researchers have measured the levels of the gas in the atmosphere, and determined its emissions and lifetime to help gauge its potential future effects on climate.

Sulfuryl fluoride was introduced as a replacement for methyl bromide, a widely used fumigant that is being phased out under the Montreal Protocol because of its ozone-destroying chemistry. Methyl bromide has been widely used for insect control in grain-storage facilities, and in intensive agriculture in arid lands where drip irrigation is combined with covering of the land with plastic sheets to control evaporation.

"Such fumigants are very important for controlling pests in the agricultural and building sectors," says Ron Prinn, director of MIT's Center for Global Change Science and a co-author on the new paper. But with methyl bromide being phased out, "industry had to find alternatives, so sulfuryl fluoride has evolved to fill the role," he says.

Until the new work, nobody knew accurately how long the gas would last in the atmosphere after it leaked out of buildings or grain silos. "Our analysis has shown that the lifetime is about 36 years, or eight times greater than previously thought, with the ocean being its dominant sink," Prinn says. So it would become "a greenhouse gas of some importance if the quantity of its use grows as people expect." For now, the gas is only present in the atmosphere in very small quantities of about 1.5 parts per trillion, though it is increasing by about 5 percent per year. Its newly reported 36-year lifetime, along with studies of its infrared-absorbing properties by researchers at the University of California at Irvine, "indicate that, ton for ton, it is about four thousand times more potent a heat-trapping gas than carbon dioxide" says Prinn.

Ron Prinn

Fortunately, though, "we've caught it very early in the game," says Prinn, the TEPCO Professor of Atmospheric Science in MIT's Department of Earth, Atmospheric and Planetary Sciences. The detection was made through a NASA-sponsored global research program called the Advanced Global Atmospheric Gases Experiment (AGAGE). "In AGAGE, we don't just monitor the big greenhouse gases that everybody's heard of," he says. "This program is also designed to sniff out potential greenhouse and ozone-depleting gases before the industry gets very big."

The lead author of the research paper is Jens Muhle of Scripps, and besides Prinn, the co-authors include Jin Huang, a research scientist at MIT's Center for Global Change Science, Ray Weiss of Scripps, who co-directs AGAGE with Prinn, and eight others from Scripps, the University of Bristol in the United Kingdom, the Centre for Australian Weather and Climate Research, and the National Oceanic and Atmospheric Administration in Boulder, Colo.

Prinn adds that "fumigation is a big industry, and it's absolutely needed to preserve our buildings and food supply." But identifying the greenhouse risks from this particular compound, before many factories have been built to produce it in very large amounts, would give the industry a chance to find other substitutes at a time when that's still a relatively easy change to implement. "Given human inventiveness, there are surely other alternatives out there," says Prinn. He describes this approach as "a new frontier for environmental science — to try to head off potential dangers as early as possible, rather than wait until it's a mature industry with lots of capital and jobs at stake."

ENERGY: Speakers at student-led Energy Conference cite changes for progress amid crisis

Continued from **Page 1**

revolutions: from innovation. And today, by far the most powerful potential for immediate, catalytic innovation is alternative energy."

The sold-out conference, organized by the MIT Energy Club and the MIT Sloan Energy and Environment Club, attracted hundreds of energy professionals, investors, entrepreneurs, policy makers, academics and students. Saturday's gathering was preceded by an Energy Showcase on Friday night that featured more than 60 students' posters about academic research projects on energy as well as displays from dozens of energy companies, many of them spinoffs from MIT research, and a variety of interactive exhibits.

Conference keynote speaker Lars Josefsson, CEO of Swedish energy company Vattenfall, recently announced plans for his company — which operates in several other European nations — to achieve complete carbon neutrality in all its power production by 2050, making it the world's first major energy supplier to make such a sweeping commitment.

"If we can do it, anyone can do it," said Josefsson, adding that the global nature of climate problems requires coordinated worldwide action. He emphasized that although the sweeping changes needed will take decades to implement, it is essential to begin the process immediately.

If bold action is taken now, the problems "will be solvable," he said. But "if we carry out business as usual for 10 years, the equation will have no solution, it won't be possible, which means the time to act is now. If we delay, we'll reach the point of no return."

If Josefsson is right, however, not all action will be painful. About a third of mankind's carbon emissions, he asserted, could be eliminated by measures that have "negative costs." Such measures, typically in the form of improvements in efficiency, save more money than they cost to implement, but often fail to be implemented solely because of the way their costs are allocated (as when it is the owner of a building who pays for efficiency improvements, but the tenants who enjoy the resulting savings). For the most part, Josefsson contended, these can be addressed simply with changes in regulations and standards.

Josefsson also spoke of the importance, as the world works to curb emissions, of carbon capture and sequestration, which holds the promise of reducing greenhouse gases from the production of energy from fossil fuels. Already, a pilot coal-fired plant Vattenfall operates in Germany has demonstrated the feasibility of capture and sequestration, he said. "Technically, it's possible to do 100 percent" capture of the carbon emissions, he said, although it remains to be seen whether that can be achieved economically.

Vattenfall is investing aggressively in wind power, including a new project under way to provide 6,000 megawatts from a string of wind turbines off the coast of England. It is also investing in new nuclear plants, as well as wave power and biomass plants.

PHOTO / **YING SHI**

Lars G. Josefsson, CEO of the European energy company Vattenfall, speaks at the 2009 MIT Energy Conference.

'A liberating event'

U.S. Rep. Jay Inslee (D-Wash.), a member of the House Select Committee on Energy Independence and Global Warming, said in his keynote talk, "I believe the clean energy revolution can succeed," and that it's scientists and engineers rather than politicians who will lead the way. What's needed now, he said, is a national commitment to energy research and development similar to that of the Apollo program.

Inslee said that, contrary to some people's feeling that in the present economic crisis we should scale back plans to fund energy research and address global warming, he sees this as "a liberating event" and a chance to "break with old investment practices and start anew." New approaches to energy are now "an economic necessity," he said, and "it would be a crime not to recognize and seize" this opportunity. "An economic crisis sets the psychological conditions for change."

Inslee detailed seven steps that he said need to be implemented to deal with our energy and economic problems. First and foremost, he said, is to "level the playing field" by requiring that energy costs reflect the true costs to society. Currently, he said, "the deck is stacked … Fossil fuels get a free ride." A crucial step, he said, is for the government to set emissions limits and then auction off permits for emissions — a cap-and-trade system — raising essential capital for research and development in the process.

In addition, he called for national renewable energy standards for utilities, incentives for energy efficiency and an overhaul of the nation's electric transmission grid. Overall, he said, "I believe all these things have a good chance of happening this year." We also need creative new ways of financing energy improvements, he said: Right now, the utility industry spends less money on R&D than the dog food industry.

While global climate change continues to be politically controversial, Inslee said, energy issues overall cut across partisan divides, because the issue of energy security "unites everyone in the country." And the present financial situation behooves us to "turn this crisis into green," he said, "not just ecologically, but economically."

Hockfield opened the conference by paying tribute to the student leaders who plan and manage every aspect of the annual gathering, which she said has become "one of the premier energy conferences in the nation." The event gives the world "an inkling of what MIT students are capable of," she said.

LISKOV: Institute Professor wins prestigious Turing Award from the ACM

Continued from **Page 1**

Susan Hockfield.

"Barbara Liskov pioneered some of the most important advances in fundamental computer science," said Provost L. Rafael Reif. "Her exceptional achievements have leapt from the halls of academia to transform daily life around the world. Every time you exchange e-mail with a friend, check your bank statement online or run a Google search, you are riding the momentum of her research."

Liskov heads the Programming Methodology Group in the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT, where she has conducted research since 1972. Last year, she was named an Institute Professor, the highest honor awarded to an MIT faculty member.

"For nearly four decades, Barbara has been a seminal leader in programming languages and systems research at MIT, combining great intellectual insights with practicality," said CSAIL Director Victor Zue, the Delta Electronics Professor in the Department of Electrical Engineering and Computer Science. "All of us at CSAIL are extremely pleased and proud of this latest accolade — the highest honor in computer science."

Advances in software design

PHOTO / **DONNA COVENEY**
Institute Professor Barbara Liskov

Liskov's early innovations in software design have been the basis of every important programming language since 1975, including Ada, C++, Java and C#.

Liskov's most significant impact stems from her influential contributions to the use of data abstraction, a valuable method for organizing complex programs. She was a leader in demonstrating how data abstraction could be used to make software easier to construct, modify and maintain. Many of these ideas were derived from her experience at MIT in building the VENUS operating system, a small timesharing system that dramatically lowers the cost of providing computing and makes it more interactive.

In another contribution, Liskov designed CLU, an object-oriented programming language incorporating clusters to provide coherent, systematic handling of abstract data types. She and her colleagues at MIT subsequently developed efficient CLU compiler implementations on several different machines, an important step in demonstrating the practicality of her ideas. Data abstraction is now a generally accepted fundamental method of software engineering that focuses on data rather than processes.

Building on CLU concepts, Liskov followed with Argus, a distributed programming language. Its novel features led to further developments in distributed system design that could scale to systems connected by a network. This achievement laid the groundwork for modern search engines, which are used by thousands of programmers and hundreds of millions of users every day and which face the challenges of concurrent operation, failure and continually growing scale.

Her most recent research focuses on techniques that enable a system to continue operating properly in the event of the failure of some of its components. Her work on practical Byzantine fault tolerance demonstrated that there were more efficient ways of dealing with arbitrary (Byzantine) failures than had been previously known. Her insights have helped build robust, fault-tolerant distributed systems that are resistant to errors and hacking. This research is likely to change the way distributed system designers think about providing reliable service on today's modern, vulnerable Internet.

The Turing Award is given annually by the Association for Computing Machinery and is named for British mathematician Alan M. Turing, who helped the Allies crack the Nazi Enigma cipher during World War II. Liskov will formally receive the award at an ACM gathering on June 27 in San Diego.

Q&A with Barbara Liskov

On the occasion of her winning the Turing Award, Institute Professor Barbara Liskov participated in an interview with the MIT News Office in which she discussed her role in shaping the past, present and future of computer science.

Q. When you began your career in computer science, it was still a relatively young field. How have you seen this discipline evolve over time — at MIT and elsewhere?
A. The change has been tremendous. When I started, most of the field was unexplored and there were obvious problems everywhere — lots of low-hanging fruit, but also very fundamental issues that were poorly understood and very confusing. Today the field is on a very sound foundation. There are still many problems to work on, but now this work happens in the context of all that has gone before. When I started, this context was missing, so you just struck out on your own.

Q. Looking back at your career, what is the single accomplishment of which you are most proud?
A. Probably the development of the concept of data abstraction and the CLU programming language. This work was done at MIT in the 1970s.

Q. Where do you plan to focus your research going forward?
A. Today I am working primarily on distributed systems — systems that run on many computers connected by a network like the Internet. My focus recently has been on the security of online storage. I believe that more and more users will store their information online, but the storage they use needs to be implemented so that they don't lose their information, their information is available when they need it, and they can be confident that their confidential information will not be leaked.

Q. As the first U.S. woman to earn a PhD in computer science, what advice would you give to other women who are considering going into this field?
A. I have found computer science to be a wonderful field to work in. I think the main reason is that the kind of thinking and problem-solving it requires matches my abilities. I believe that finding work to do that you like, and are good at, is the most important way to find a satisfying career. Young women (and young men) who find that computer science is a match for them should pursue it. There is lots of interesting work remaining to be done.

Q. When you began studying computer science at Stanford, computers were big mainframes and the Internet was still in the distant future. Today, computers fit in the palm of our hands — many are much smaller — and the Internet is ubiquitous. Given that you have watched these transformations over the last five decades from a front-row seat, what do you think the next half-century will hold?
A. I don't have a crystal ball! It seems obvious that computers and the Internet will continue to be very important to individuals, companies and society. But I don't know the exact form this will take.

Hologram seminar probes past and future of 3-D imaging

Stephanie Schorow
News Office

The grayish holograms of ocean plankton, produced by engineers in MIT's 3D Optical Systems Group and showcased during a March 6-7 holography seminar at the MIT Museum, didn't look much like the dazzling holograms that fired the popular imagination back in the 1970s. Yet these images represent some of the new developments in the field of holography, which may have implications for numerous fields of research.

"Holography has an amazingly high potential, with minimum applications so far," said MIT Museum Manager Seth Riskin, organizer of "Photons, Neurons and Bits: Holography for the 21st Century," which brought together scientists, artists and historians. "Therefore, it has been seen as isolated, stagnant and not living up to its early billing."

Sean Johnston, associate professor in the history of science and technology at the University of Glasgow, recounted holography's checkered 60-year history and emphasized how the technology was originally oversold as the "new photography." Hologram pioneers like electrical engineering professor Emmett Leith of the University of Michigan attempted to interest investors in holography as a new photography and/or engineering process. Despite initial interest by the military in secretly developing holographic imaging, the impetus for holographic development died in the 1970s. Even Dennis Gabor, who won the Nobel Prize in Physics for his holography innovations, finally dismissed holography as a "white elephant" after no compelling applications were developed, Johnston said.

Commercial applications — in creative packaging and security, such as the holograms on lottery tickets and paper currency — were more successful. But the once-touted holographic movie never emerged. V. Michael Bove Jr., director of MIT's Consumer Electronics Laboratory, regaled the audience with stories of garish 3-D movies (such as the trashy but highly successful 1969 film, "The Stewardesses") that gave all 3-D entertainment an aura of tawdriness and hype.

> *Few if any other scientific concepts or technologies ... are so readily accessible in their basic form to those with little formal scientific or engineering training [as holograms].*
>
> **Charles M. Vest, president emeritus**

Art rushed in where science stumbled, Johnston said. Artists, intrigued with the possibilities of holograms, "took over and reshaped the subject." Artists perceived holograms in fundamentally different ways than engineers and created bodies of work in holographic art, he said. Today the MIT Museum has the world's largest collection of historical holograms, and much of the seminar was devoted to discussing how best to preserve and display its holdings.

Some members of the MIT community, including President Emeritus Charles M. Vest, never lost their fascination with holography.

"Holography's importance is attested to by its continuing ability to inspire and excite those who encounter it for the first time," Vest said in the seminar's keynote address. "Few if any other scientific concepts or technologies of the second half of the 20th century are so readily accessible in their basic form to those with little formal scientific or engineering training."

Holography's potential is now being realized in labs such as the 3D Optical Systems Group. Using videos and remote cameras, George Barbastathis, associate professor of mechanical engineering, and graduate students Jose Dominguez-Caballero and Nick Loomis demonstrated the use of computer-generated holography as a form of data acquisition. The lab is designing a holography system that can simultaneously produce images of multiple layers within an object under scrutiny. Dominguez-Caballero compared it to tearing apart a building to view the floors side by side. "It's like having a camera that is always in focus across a very large volume," Loomis said. Such "volume holographic imagery" has implications for medical imaging of human tissue, they said.

The lab has built an underwater ocean holography camera that has captured specialized images of plankton, recording their position and density, which can provide data on species distribution in the ocean. "From a single hologram, we get a lot of information," Dominguez-Caballero said. The lab is working on holographic applications that measure particles in the flow of liquid in fuel injection systems or in the airflow around cars, which could help improve transportation designs.

3-D television has recently garnered a huge amount of attention, particularly as movies such as "The Stewardesses" have faded from memory, said the Consumer Electronics Laboratory's Bove. He predicted that commercial holographic television would be a reality within five years.

Holography "opens up a world of research and a world of expression," Riskin said.

NAE meeting at MIT eyes future of transportation

Chad Galts
School of Engineering

Predicting global transportation needs and their potential effect on the environment is a tricky business, but making predictions people want to work toward is even more complicated. "As we think about the future," Dan Sperling told a regional meeting of National Academy of Engineering members held at MIT on March 5, "most projections are pretty scary. Many of the challenges leave us with a simple question: 'How important is it to us to solve these problems?'"

The director of the Institute for Transportation Studies at the University of California-Davis, Sperling is California Gov. Arnold Schwarzenegger's point person for climate policy as it relates to transportation. A frequent spokesman on transportation-related issues around the country (he put in an appearance on The Daily Show with Jon Stewart last month), Sperling described the potential for a sustainable transportation future. It can happen — provided there are major transformations in the vehicles we use, the fuels those vehicles consume, and the mobility or accessibility systems such as railways and public transportation systems.

Sperling was careful to distinguish between transforming these things and simply transferring technology advances in each area. For example, a shift to alternative fuels that relies on corn ethanol and coal-based gasoline will actually produce more carbon dioxide because of how these fuels are processed and produced. And, Sperling added, "Even though the automotive industry has made tremendous advances in efficiency over the last two decades, most of [these advances] have been directed to making cars more powerful. In the mid-1980s, the average car could go zero to 60 in 14.5 seconds. Today, the average car does it in 9.5 seconds."

Transforming mobility and accessibility may be the most daunting challenge. "In the U.S., we have essentially vanquished mass transit," Sperling said. "Only 2.5 percent of the miles traveled by Americans today are through public transportation." But mobility, he said, is also the area that presents some of the greatest opportunities — not only for innovation, but for improvement as well. The average automobile costs about $8,000 per year to operate and maintain. If the resources we are expending individually could be collectively harnessed and deployed in novel programs that make better use of technology — ride- and vehicle-sharing systems, neighborhood electric vehicles, "smart" paratransit, etc. — consumers could actually end up with more, and more appropriate transportation options.

Sperling pointed to Transportation@MIT, the new three-school initiative launched at MIT, as a model for incubating the needed transformations in transportation. Three key faculty in the new initiative — Ian Waitz of aeronautics and astronautics, John Heywood of mechanical engineering and Henry Jacoby of the MIT Sloan School of Management — made presentations on aviation, automotive research, and transportation policy, respectively, and described the intersections and interconnections of the work.

Heywood, who is director of the Sloan Automotive Laboratory at MIT, pointed to one of the most vexing elements of changing transportation: "As engineers, we must quantify the impacts of different solutions and find the best leverage points in the systems," he said. Getting those solutions into the market, he adds, is the next step. "Why haven't we done them already? It's not easy to find something people will like — that is the great challenge."

CELEBRATING EXCELLENCE

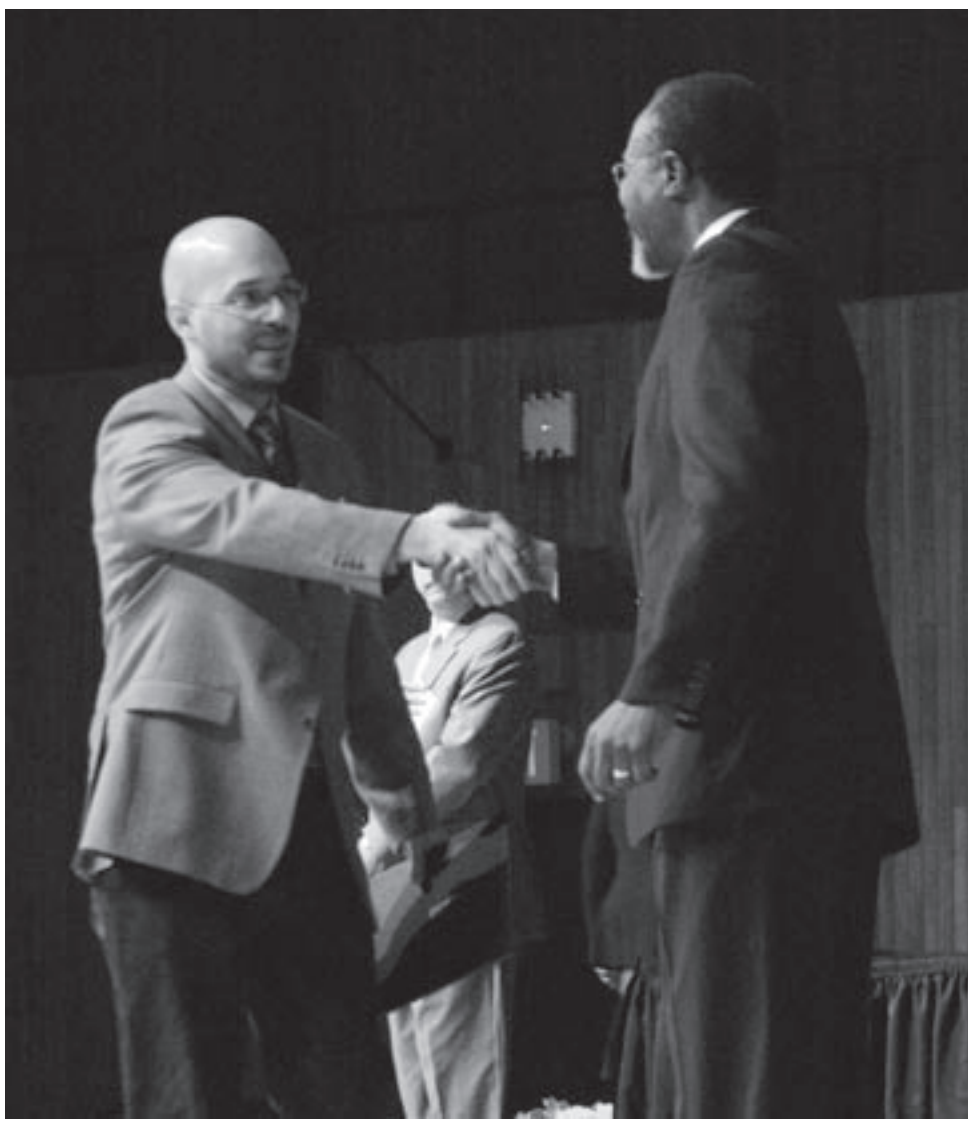

PHOTO / **PATRICK GILLOOLY**

Michael Tarkanian, a technical instructor in the Department of Materials Science and Engineering, receives his Serving the Client award from Chancellor Phillip Clay during the MIT Excellence Awards ceremony on March 4.

PHOTO / **DAWN ANDERSON**

MIT President Susan Hockfield, center, celebrates with fans at the MIT men's basketball game in Rhode Island on Satruday. The Engineers won their first ever NCAA tournament game against the Anchormen on Friday night.

BASKETBALL: Men fall in second NCAA game

Continued from **Page 1**

Senior star Jimmy Bartolotta, who started quietly in the first half, rebounded to finish with a game-best 27 points. Senior Billy Johnson added 19 points on 7-of-11 shooting and a game-high 11 rebounds, while freshman Jamie Karraker chipped in 10. Bender closed with nine points as the Engineers shrugged off an eight-point halftime deficit to equal the program record for wins in a season (21).

Saturday's contest proved to be a battle of conference players of the year, with Bartolotta and Farmingdale State's Damien Santana combining for the game's first 18 points and keeping the game knotted up, 9-9, after just two minutes.

The Engineers took the lead, 10-9, on a free throw by Johnson at 15:07 and held the advantage for the next 12:51. MIT built a seven-point advantage, 22-15, following a Bartolotta three at 8:21.

Despite falling behind, the Rams closed out the half on an 18-4 run to take a seven-point advantage into halftime at 33-26. In the second, MIT whittled the deficit down to two points, 43-41, with 13:34 left behind its potent perimeter shooting. Karraker sandwiched a pair of three-pointers around a Bartolotta three during the run.

With slightly more than a minute remaining, MIT was able to cut the deficit down to two points, 63-61. That, however, would be as close as the Engineers would get as Farmingdale nailed two pairs of free throws down the stretch.

Bartolotta led all scorers with 27 points, to go along with seven rebounds and two assists. Karraker scored all 12 of his points over the final 20 minutes, while Johnson grabbed a game-high 11 rebounds. Senior guard Bradley Gampel contributed four points, six rebounds and a game-high seven assists.

Senior spotlight

MIT tri-captains Bartolotta, Gampel and Johnson close out their college careers as the best senior class in the history of the MIT men's basketball program. The trio paced MIT to a four-year best 68 wins, while securing the program's first NEWMAC championship and first NCAA tournament berth.

Bartolotta retires with a plethora of Institute records, including 2,279 career points and 184 career steals. He also ranks third in career blocks, fifth in career assists, and sixth in career rebounds, while leaving as the top three-point and free-throw shooter.

Gampel, who set single-season MIT records for assists (207) and steals (80), ranks third all-time in assists, and second to Bartolotta in steals with 183.

Johnson enjoyed a stellar senior campaign and finished the year with 836 career points despite seeing limited time as a rookie and missing nearly all of his sophomore season due to injury.

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MIDDLE AGE, MIDDLE INCOME SQUEEZE

Older workers taking lower-wage jobs due to broad-based market shifts, MIT study shows

PHOTO / **DONNA COVENEY**

MIT economist David Autor's work indicates that older workers — even those with college educations — are being pushed into lower-wage jobs.

Stephanie Schorow
News Office

If long-term job market trends continue, the person asking, "Do you want fries with that?" will be increasingly likely to have a college education, an MIT analysis finds.

Dramatic shifts in the U.S. labor market in the last 25 years are relegating older workers — even those with a college education — to lower-wage jobs, according to a research paper by MIT Economics Professor David Autor.

This trend appears likely to steepen in the current recession, as employers accelerate the rate at which they shed nonessential positions.

In a paper co-authored with graduate student David Dorn, "This Job is 'Getting Old': Measuring Change in Job Opportunities using Occupational Age Structure," which was presented last month at the American Economics Association conference, Autor analyzes a phenomenon that he refers to as the "hollowing out" of the U.S. job market from 1980 to 2005.

"One of the most remarkable developments in the U.S. labor market of the past two and a half decades has been the rapid, simultaneous growth of employment in both the highest- and lowest-skilled jobs," Autor says. European labor markets echo this shift.

Automation, computerization and offshoring are reducing the number of middle-wage, skilled occupations — stock clerks, inspectors, telemarketers, payroll workers, sales agents and software programmers — Autor finds. These jobs are particularly vulnerable to automation because their core tasks follow well-understood routines that can increasingly be codified in software and executed by machinery.

Ironically, many jobs that require less formal education — such as construction workers, janitors, truck drivers, auto mechanics, home health workers and wait staff — are more difficult to automate than these white-collar positions because they demand physical flexibility and rapid adaptation to unpredictable circumstances (e.g., oncoming traffic, unhappy customers). Humans excel at this form of flexibility while current technology falls short. Demand also remains high for high-wage, high-skill jobs, such as attorneys, physicians, engineers and top managers — all of which perform analytic, interpersonal and problem-solving tasks requiring both expertise and intellectual flexibility.

> *It's more difficult for a mid-career worker to say, 'Oh, there are not too many opportunities for middle management these days, I think I'll go to law school.'*
>
> **David Autor, economics professor**

'Hollowing out'

As the labor market "hollows out," workers who in a previous generation would have occupied middle-skill, white-collar positions must increasingly find their fortunes elsewhere — either in high-skill, high-education professional, technical and managerial positions, or in less-educated manual labor and in-person service jobs. Autor's data indicate that since 1980, older workers with at least some college education are increasingly doing what was once thought of as "non-college" work, i.e. non-routine, but not highly skilled jobs.

According to data compiled by Autor and Dorn, the share of college-educated workers found in low-wage, non-routine occupations rose from 19.9 percent to 23.6 percent from 1980 to 2005. Moreover, the average age of those with college education working in such jobs rose by 6.7 years during this time.

"While young college workers are gaining employment in high-skill, non-routine occupations, older college workers are increasingly found in low-skill, non-routine work," Autor says. And as computers and offshore sourcing continue to reduce jobs in areas such as accounting and sales, this trend has accelerated. While economists can only speculate about the effect of the ongoing sharp contraction of world economic activity on this trend, it seems likely that employers will attempt to reduce costs wherever possible, which may mean using increasingly cheap automation to substitute for relatively expensive white-collar workers.

When occupations contract, the average age of workers in those occupations tends to rise, Autor says. "Young people don't want to stake their futures in shrinking fields. Meanwhile, older workers have an incentive to stick around as they have skills and knowledge specific to these jobs."

Young workers also have the opportunity to tailor their educational paths to match the current state of the labor market. "Young college workers are basically educating themselves for a set of activities that are in rising demand," Autor says. "It's more difficult for a mid-career worker to say, 'Oh, there are not too many opportunities for middle management these days, I think I'll go to law school.'"

Autor also suspects employers facing rising health costs and falling profit margins are more likely to hire young people because of the higher health care costs associated with older workers.

Thus, Autor's findings underscore the importance of both career retraining and, potentially, public assistance with health coverage in softening the brunt of the economic downturn on older workers. But they also challenge assumptions about the long-term value of a college education.

Higher education, particularly an advanced degree, is still the best way of ensuring future income, Autor says. However, "the degree to which a college education insulates you from downturns and from loss of prestige and earning power of your occupation is unfortunately smaller than it used to be."