Volume 53, Number 21
Wednesday, April 8, 2009

TechTalk

SERVING THE MIT COMMUNITY

GARDENERS ON THE ROOF

Vegetables, flowers to grow atop West Garage this summer

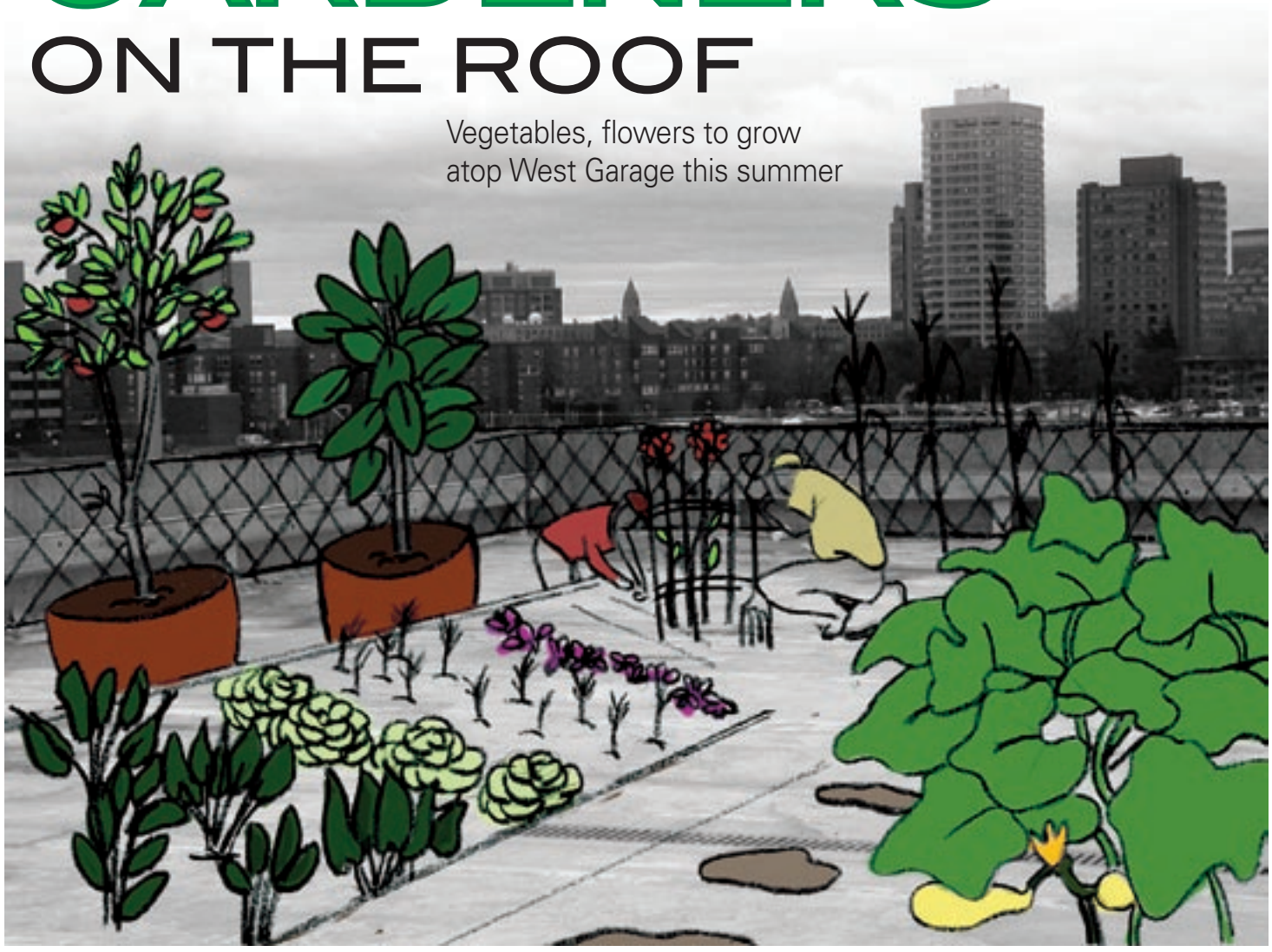

ILLUSTRATION / **REBECCA MACRI**

Patrick Gillooly
News Office

This summer, vegetables, flowers and herbs will take the place of some of the cars and trucks atop MIT's West Garage as part of MIT's first-ever community garden.

The pilot program in urban sustainable agriculture is the result of a months-long effort spearheaded by MIT Police Sgt. Cheryl Vossmer and Libraries Administrative Assistant and Public Service Support Associate Ryan Gray. Working with administrators and staff across the Institute, the two were able to secure seven little-used parking spaces and a strip of grass at West Garage to house the garden, which will comprise several dozen plots. The remainder of the spots on the garage's roof will still be open for parking this summer.

"It's a wonderful opportunity to reduce our carbon footprint and do great outreach," Vossmer says, noting that the garden fits in with a number of different Institute objectives regarding sustainability and green living.

The project also aims to foster community and give back to

▶Please see GARDEN, **PAGE 6**

PHOTO / **DONNA COVENEY**

BELOW: Cheryl Vossmer and Ryan Gray measure out space on the roof of the West Garage to determine the number of plots in MIT's new community garden.

New virus-built battery could power cars, electronic devices

Anne Trafton
News Office

For the first time, MIT researchers have shown they can genetically engineer viruses to build both the positively and negatively charged ends of a lithium-ion battery.

The new virus-produced batteries have the same energy capacity and power performance as state-of-the-art rechargeable batteries being considered to power plug-in hybrid cars, and they could also be used to power a range of personal electronic devices, said Angela Belcher, the MIT materials scientist who led the research team.

The new batteries, described in the April 2 online edition of Science, could be manufactured with a cheap and environmentally benign process: The synthesis takes place at and below room temperature and requires no harmful organic solvents, and the materials that go into the battery are non-toxic.

In a traditional lithium-ion battery, lithium ions flow between a negatively charged anode, usually graphite, and the positively charged cathode, usually cobalt oxide or lithium iron phosphate. Three years ago, an MIT team led by Belcher reported that it had engineered viruses that could build an anode by coating themselves with cobalt oxide and gold and self-assembling to form a nanowire.

In the latest work, the team focused on building a highly powerful cathode to pair up with the anode, said Belcher, the Germeshausen Professor of Materials Science and Engineering and Biological Engineering. Cathodes are more difficult to build than anodes because they must be highly conducting to be a fast electrode, however, most candi-

▶Please see VIRUS, **PAGE 5**

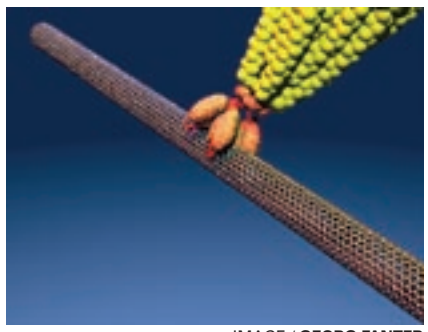

IMAGE / **GEORG FANTER**

Researchers at MIT have found a way to use benign viruses and nanotubes to create high-powered batteries. Above, a virus grabs a carbon nanotube.

THE GAMES MICROBES PLAY

Game theory study in yeast shows how cooperative behavior meshes with evolutionary theory

Anne Trafton
News Office

One of the perplexing questions raised by evolutionary theory is how cooperative behavior, which benefits other members of a species at a cost to the individual, came to exist.

Cooperative behavior has puzzled biologists because if only the fittest survive, genes for a behavior that benefits everybody in a population should not last and cooperative behavior should die out, says Jeff Gore, a Pappalardo postdoctoral fellow in MIT's Department of Physics.

Gore is part of a team of MIT researchers that has used game theory to understand one solution yeast use to get around this problem. The team's findings, published in the April 6 online edition of Nature, indicate that if an individual can benefit even slightly by cooperating, it can survive even when surrounded by individuals that don't cooperate.

In short, the study offers a concrete example of how cooperative behaviors can be compatible with evolutionary theory.

Yeast may seem unlikely subjects for a study of cooperative behavior, but in fact they are perfectly suited to such studies, says Gore. Unlike humans, yeast have

▶Please see YEAST, **PAGE 5**

News in brief

PHOTO / **DONNA COVENEY**

A new campaign around campus is urging people to use energy-saving revolving doors.

Resolve to revolve: MIT encouraging using of energy-saving doors

Interested in saving the Institute money while lessening our carbon footprint? Then Resolve to Revolve. This month, you will start noticing signs on or near revolving doors encouraging you to take a spin instead of using a traditional swing door.

Research from MIT students indicates that if everyone were to use the revolving doors in Building E25, for example, MIT would save almost $7,500 in natural gas a year. That's enough to heat five houses over the same timeframe, and it also adds up to nearly 15 tons of CO_2. More details about the students' work can be found at http://sustainability.mit.edu/projects/revolving-door.

Over the past few months, the Department of Facilities has repaired the revolving doors to prepare them for increased use. However, if you find that a revolving door is too difficult for you to push, call 617-253-4948 or enter a work order through SAPWeb http://mit.edu/sapweb/PS1/facilities_home.shtml.

If you have any questions about the Resolve to Revolve campaign, please contact Steve Lanou at slanou@mit.edu.

Joining the Quarter Century Club

The MIT Quarter Century Club Induction Ceremony and Luncheon for new members will be held this year on Thursday, April 16. New membership in the club is offered to the faculty, administrative, research, support and services staff who will celebrate their 25th anniversary with the Institute on or before June 30, 2009. If you believe you are eligible for membership but have not received an invitation to attend the Induction Luncheon, please contact the Quarter Century Club in the Community Services Office at 617-253-7914 or tswartz@mit.edu.

Two from MIT in top 5 at Putnam math contest

Anne Trafton
News Office

Two MIT students placed in the top five in the prestigious William Lowell Putnam intercollegiate mathematics competition for 2008.

Junior math majors Yufei Zhao and Bohua Zhan earned recognition as Putnam Fellows for their top five finishes, an award that carries a $2,500 prize.

More than 3,600 students from across the country took the six-hour mathematics exam on Dec. 6, 2008. The 12-question test is given annually on the first Saturday in December.

For the second year in a row, MIT's math team took third place in the team competition. Overall, 23 MIT students finished in the top 79.

The Putnam questions require students to be creative in applying their knowledge of basic calculus and algebra. The test is extremely difficult — out of a possible 120 points, the median score this year was 1. The highest score was 117.

Before the exam, each participating school chooses three students to form a team whose combined scores determine the overall school winner. MIT's team members this year were Zhao, junior math major Qingchun Ren and senior math major Xuancheng Shao.

The team's third-place finish earned $15,000 for the MIT math department, and each team member receives $600. Harvard's team took first place in the competition, with Princeton second.

Other MIT students in the top 16 were Ren, freshman Colin Sandon, and sophomore Jacob Steinhardt. Senior math major Thomas Belulovich and junior math major Gabriel Bujokas finished in the top 25.

The team was coached by Professor Emeritus Hartley Rogers; Richard Stanley, the Norman Levinson Professor of Applied Mathematics; and Associate Professor Kiran Kedlaya.

Mr. Magnet to end his traveling roadshows

PHOTO / **PAUL RIVENBERG**

Mr. Magnet, a.k.a. Paul Thomas, right, oversees a plasma demonstration with Melissa Hornstein and Ken Marr.

After 17 years, 150,000 miles, and more than 1,100 school visits, MIT's Mr. Magnet is taking his show off the road.

For almost two decades, Paul Thomas, a technical supervisor at MIT's Plasma Science and Fusion Center, has brought his truckload of magnetic demonstrations to area schools to excite students about science. Under Mr. Magnet's guidance, students have experienced the pull of scientific experimentation, whether using an electromagnet to create a wreath of colorful paperclips, heating and cooling a nugget of gadolinium to change its magnetic property, or deflecting glowing plasmas with a dipole magnet.

When Thomas began visiting schools in 1992, he simply borrowed the center's blue van. But as his demonstrations increased in number and size, he needed larger vehicles. At the height of the program, Mr. Magnet was transporting more than 6,000 pounds of equipment in a white cargo-styled truck, purchased for him by MIT. Although he has focused on schools in eastern New England, his truck has traveled as far as New Orleans, and he has made yearly appearances at the U.S. Department of Energy National Science Bowl in Washington.

In 1995, MIT President Charles Vest wrote to Thomas, "Outreach programs like yours are invaluable, and I'm sure there are more than a few youngsters out there who may prowl the halls of MIT because of their experiences with Mr. Magnet." In fact, Thomas has met several students at MIT who remember his visits to their schools. This is not surprising considering that Mr. Magnet has visited almost half a million students over 17 years.

The decision to leave the road was made when recurring knee problems, and subsequent surgery, raised concerns about Thomas regularly moving so much heavy equipment in and out of a truck. Thomas says he will miss the unique experience each school presented, particularly working with the special needs students. "In one school, I asked a young girl, Katherine, to assist me, along with some of her classmates. She carried out all my instructions, pushing buttons and performing a real experiment with an electromagnet. After the presentation was over her teacher came up to me to say she was amazed at what I was able to do. She told me 'Katherine is severely autistic, and just does not participate like that. You were able to get her up there doing what all the other kids do.'"

Although the show will no longer travel, Thomas is not giving up his nickname. He will continue to be Mr. Magnet for education events at the Plasma Science and Fusion Center, and for special occasions, like the annual Plasma Sciences Expo at the American Physical Society – Division of Plasma Physics Meeting.

Acumen Fund founder to give Legatum Lecture April 9

The MIT Legatum Lecture series continues on April 9 with Jacqueline Novogratz, CEO and founder of Acumen Fund, a nonprofit global venture fund supporting market-based solutions to poverty. Novogratz will discuss the role of entrepreneurship in combating social problems.

Prior to founding Acumen Fund, Novogratz founded and directed the Philanthropy Workshop at the Rockefeller Foundation and founded a microfinance institution in Rwanda. Novogratz serves on the advisory board of Innovations, a journal published by MIT Press. Her memoir, "The Blue Sweater: Bridging the Gap between Rich and Poor in an Interconnected World," was published in March 2009.

The Legatum Lecture series exposes the MIT and neighboring communities to entrepreneurship in emerging markets.

The lecture begins at noon in the Twenty Chimneys Room on the third floor of the Stratton Student Center (W20). Light refreshments will be provided, but attendees may also bring a lunch to eat during the lecture.

Visit http://legatum.mit.edu/NovogratzLecture for more information.

PHOTO COURTESY OF JACQUELINE NOVOGRATZ

HOW TO REACH US

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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.

SA+P team wins major urban design competition

Proposal for Denver district's redevelopment is awarded top prize of $50,000

Scott Campbell
School of Architecture and Planning

A School of Architecture and Planning team's plan to redevelop a 75-acre parcel of land within the city of Denver has won the Urban Land Institute's seventh annual Gerald D. Hines Student Urban Design Competition.

The victory was announced on April 2 following presentations by finalists during a public forum at the University of Denver. The MIT-led student team, which will share the top prize of $50,000, includes MCP candidates Blair Humphreys, Jesse Hunting and Sarah Snider, MArch candidate Duncan McIlvaine, and Eric Komppa of the University of Wisconsin, an MBA and MRED student. The team's advisor was Tunney Lee.

The annual interdisciplinary contest, which is open to graduate students pursuing real estate-related studies at a North American university, challenges teams to craft practical, workable solutions to revitalize or develop an urban site.

For the 2009 competition, students were asked to present schemes for the Denver Design District (DDD), an area just south of downtown that is home to a large commercial design center. The competition charged the teams with redeveloping the entire site and creating a landmark, transformative mixed-use community without losing the current, valuable roster of tenants.

As an added challenge this year, students were asked to consider the massive demographic, climate and financial changes that will likely alter the parcel in coming decades and how their plans would position the DDD in 2050 and beyond.

The SA+P team competed against 91 teams from 42 universities, a field that was then narrowed to the four finalists. The jury selected MIT team's entry over plans submitted by finalists from Columbia, Kansas State and the University of Miami.

The winning entry, "Panorama Station, Proposal for Transit-Oriented Development and Public Space at Alameda Station," incorporates five key objectives: to provide view-oriented public space, to support a 15-minute car-free lifestyle, to create a sense of place, to anticipate future flexible uses for big box spaces and to integrate water-conserving landscapes.

According to Dennis Frenchman, head of SA+P's interdisciplinary City Design and Development Program, the scheme is "stunningly beautiful, sustainable, humane, intellectually rigorous and incredibly innovative — all in the MIT tradition of city design."

The Gerald D. Hines Student Urban Design Competition is part of an ongoing effort on the part of the Urban Land Institute to raise interest among young people in creating better communities, improving development patterns and increasing awareness of the need for multidisciplinary solutions to development and design challenges.

The contest is an ideas competition, and there is no guarantee or expectation that any of the submitted schemes will be applied to the site. Rather, it aims to encourage cooperation and teamwork — necessary talents in the planning, design and development of sustainable communities — among future land use professionals and allied professions, such as architecture, landscape architecture, urban planning, historic preservation, engineering, real estate development, finance, psychology and law.

IMAGE / **BLAIR HUMPHREYS, JESSE HUNTING AND DUNCAN MCILVAINE**

A rendering of the MIT team's proposal for the Denver Design District, which won first place in the annual Gerald D. Hines Student Urban Design Competition.

BAMIT event highlights black achievement in arts and sciences

Liv Gold
Alumni Association

Honoring what Chancellor Phillip Clay PhD '75 called "a deep and relevant history," members of Black Alumni at MIT (BAMIT) held a semi-formal dinner in the Picower Institute Atrium on Saturday to celebrate its 30th anniversary as an organization.

The event's theme, "Where Art Meets Science: Celebrating Past, Present, and Future BAMIT Accomplishments," highlighted the breadth of black alumni achievement in the arts and sciences and the 30-year history of BAMIT.

Approximately 100 alumni and students attended the event, which featured a panel discussion moderated by Bayer Professor of Chemical Engineering Paula Hammond '84, PhD '93. Panelists included Samuel Nixon Jr. '80, a minister from Washington; visual effects artist Greg Anderson '94, SM '96; Hollywood writer/director Saladin Patterson '94; Nelly Rosario '94, an author and Texas State University professor; and professional saxophonist Louis Fouché '07.

The discussion touched on a range of subjects related to art and science, including how an engineering approach can benefit work in the arts and humanities and the relationship between science and literature. "If science is about discovery and fiction is possibility, then I'm interested in discovering possibilities," said Rosario.

Kerry Bowie '94, who organized the event, noted that the panel was designed to showcase a mix of different career paths and demographics — reflecting the varied nature of the black community at MIT.

"Our group is diverse," Bowie said. "We've got Caribbeans, Africans, Caribbean Americans, African Americans — if we don't get together, we might not understand each other. But when we meet and spend time together, we see that our cultures, cuisines, and family dynamics are similar, all originating from a shared experience."

Finding acceptance in an affinity group like BAMIT, which celebrates black history and accomplishment, has been a source of inspiration for those black students at MIT who, as Bowie described, "might have made it to the school only to find themselves stuck in survival mode."

By campaigning for a greater presence of black role models on campus and focusing on career development, networking, black student retention, and scholarship fundraising, BAMIT nurtures a culture that supports black students and alumni.

PHOTO / **LIV GOLD**

At an event celebrating the 30th anniversary of the Black Alumni at MIT, Bayer Professor of Chemical Engineering Paula Hammond '84, PhD '93 (far right) moderates a discussion with panelists (from right) Greg Anderson '94, SM '96; Louis Fouché '07; and Samuel Nixon Jr. '80. Not pictured are Saladin Patterson '94 and Nelly Rosario '94.

Toward the end of the evening, Darryll Pines SM '88, PhD '92 told the attendees that he believed BAMIT's greatest accomplishment over the past three decades has been its service as the social conscience of MIT.

"[BAMIT] ensures a positive environment is created for all students at MIT, not just a few. But," he cautioned, "our work is not done yet."

In a call to action, Pines urged attendees to reach out to the next generation by rededicating their commitment to K-12 education, one-on-one tutoring, and poverty-alleviating technologies. "We are MIT," he said. "It's in us, in our blood. We can do this."

Events at MIT

Today

• **MIT produce stand.** The new, weekly produce stand on the East Campus Courtyard has been moved to today because of inclement weather on Tuesday. It is open from noon-6 p.m. The MIT Produce Market aims to make better nutritional options available by providing access to affordable, high-quality fruits and vegetables. Regular, weekly operation is planned for Tuesdays.

• **The Charles L. Miller Lecture: "Great Leaps, Persistence, and Innovation: The Evolving Story of Hyundai."** Speaker: John Krafcik, Acting President and Chief Executive Officer of Hyundai Motor America. 4-5:30 p.m. in E15, Bartos Theatre (Lower Atrium). The lecture will discuss the current crises facing the global automobile industry in general and the U.S. industry in particular. It will explore future challenges and opportunities with a particular emphasis on future technology options.

• **"When Science, Technology, and Politics Meet"** — a discussion with Professor Gene Skolnikoff. 5-6 p.m. in 4-231.

Thursday, April 9

• **"Logistics Transformation in Afghanistan and Iraq."** Speaker: Army Lieutenant General Mitchell Stevenson. Noon in Room 145, Building E-51 (Tang Center). Refreshments will be served.

• **"Sustainable Renewable Fuels Seminar."** Speaker: Professor Amy Landis from the Department of Civil and Environmental Engineering, University of Pittsburgh. Noon-1 p.m. in E51-149.

• **MIT Sloan Dean's Innovative Leader Series.** Speaker: Martin Madaus, Chairman of the Board, President, & CEO, Millipore Corporation. Noon-1 p.m. in E51-115.

• **MIT Writers Series presents Amitava Kumar.** 7-9 p.m. in 32-141. Amitava Kumar is the author of several works of literary non-fiction.

Friday, April 10

• **"Life Beneath the Sea Floor."** Speaker: Professor David C. Smith, Graduate School of Oceanography, University of Rhode Island. 3:15-4:15 p.m. in E25-605.

• **"Chasing Heparin: How an MIT professor solved the 2008 Heparin Crisis."** Speaker: Prof. Ram Sasisekharan. 6-7 p.m. in W79. Simmons Hall Multi-Purpose Room. Come hear a 30-minute talk (not overly technical) about the detective work that led to restoration of the quality of the Global heparin supply.

• **MIT Chamber Chorus: Harbison Tribute Concert.** 8-10 p.m. in W16, Kresge Auditorium.

CORRECTION

In an article in the April 1 edition of Tech Talk titled "3 MIT affiliates named HHMI Early Career Scientists," the use of the word "affiliates" in the headline was incorrect. All three of the individuals named in the article are MIT faculty members. Tech Talk regrets this error.

Wearable blood pressure sensor offers 24/7 continuous monitoring

Device could help diagnose hypertension, heart disease

Anne Trafton
News Office

High blood pressure is a common risk factor for heart attacks, strokes and aneurysms, so diagnosing and monitoring it are critically important. However, getting reliable blood pressure readings is not always easy.

Visits to the doctor's office can provoke anxiety that distorts blood pressure readings, and even when accurate, such visits provide only one-time snapshots of the patient's condition. To overcome these obstacles, MIT engineers have built a wearable blood pressure sensor that can provide continuous, 24-hour monitoring.

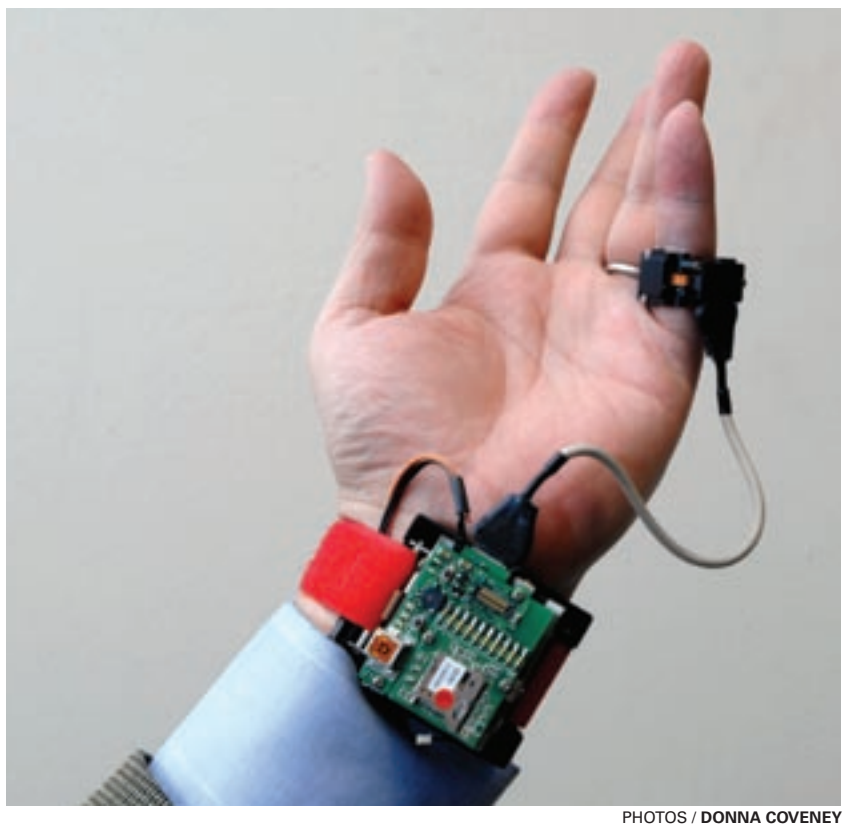
Blood pressure can change from minute to minute, so continuous monitoring offers a much broader picture of cardiovascular health. The new monitor, which loops around the wrist and the pinky finger, is just as accurate as traditional cuff devices but much less cumbersome, allowing it to be worn for hours or days at a time.

"The human body is so complex, but the cuff gives only snapshot data," says Harry Asada, an MIT mechanical engineer who led the development of the new monitor. "If you get signals all of the time you can see the trends and capture the physical condition quite well."

Such devices could be used to keep tabs on hypertension as well as sleep apnea, which causes sufferers to stop breathing many times throughout the night. Eventually, doctors may be able to use data gathered from continuous monitoring to predict when a heart attack may occur, says Asada, the Ford Professor of Engineering and director of MIT's d'Arbeloff Laboratory for Information Systems and Technology.

CardioSign, a company launched by Asada's former student, is working on commercializing the device and hopes to start clinical trials soon. Asada said he believes a commercial version of the device could be available within five years, once it becomes easier to use, more reliable and cheaper to manufacture.

The latest prototype was developed jointly with industrial sponsor Sharp Corporation, and Dr. Andrew Reisner of Massachusetts General Hospital took the lead in clinical applications and human subject tests.



PHOTOS / **DONNA COVENEY**

Harry Asada (pictured at right), the Ford Professor of Engineering, models the wearable blood pressure monitor developed by his group.

No cuff required

Traditional blood pressure monitoring requires a cuff, wrapped around the upper arm and inflated until blood flow is completely cut off. The examiner then gradually releases the pressure, listening to the flow until the pulse can be detected.

With the new monitor, no cuff is required. Instead, the device takes advantage of a method called pulse wave velocity, which allows blood pressure to be calculated by measuring the pulse at two points along an artery.

In early models, the researchers used the heart as one of the points, with a heart monitor measuring the EKG. However, EKGs aren't always accurate, and a heart monitor can be uncomfortable, so the researchers decided to use two points on the hand instead.

That posed a challenge because blood pressure in the hand varies depending on its position: If the arm is raised above the heart, the pressure will be higher than if it is below the heart. The researchers solved that dilemma by incorporating a sensor that measures acceleration in three dimensions, allowing the hand position to be calculated at any time.

This not only compensates for the error due to height changes, but also allows them to calibrate the sensor for more accurate calculation of blood pressure. As the wearer raises the hand up and down, the hydrostatic pressure changes at the sensor. Correlating the change of pulse wave velocity to the hydrostatic pressure change, the system can automatically calibrate its measurement.

Once the blood pressure information is gathered, the data can be transmitted via radio signals or wireless Internet. The device runs on a tiny battery, about the same size as the ones that power watches.

The wearable blood pressure sensor was born from a collaboration called the Home Automation and Healthcare Consortium, which launched in 1995 and included several MIT faculty members and about 20 companies.

The team's first project was a ring that measures pulse rate and the amount of oxygen present in the blood. After developing the ring, Asada decided to move on to blood pressure sensing, which offers even more valuable information about a patient's health.

The project was funded by the National Institutes of Health, National Science Foundation and the Sharp Corporation.

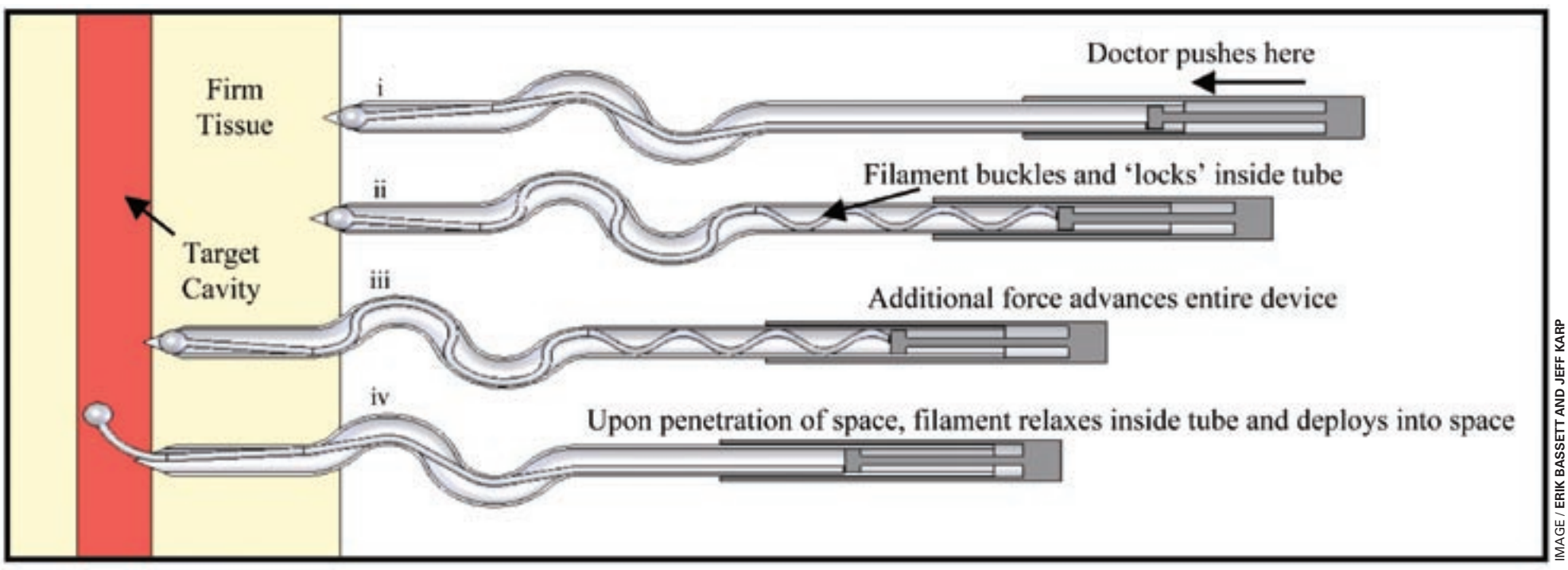


IMAGE / **ERIK BASSETT AND JEFF KARP**

Novel needle could cut medical complications

Device borrows from oil industry to keep jabs on target

Elizabeth Thomson
News Office

Each year, hundreds of thousands of people suffer medical complications from hypodermic needles that penetrate too far under their skin. A new device developed by MIT engineers and colleagues aims to prevent this from happening by keeping needles on target.

The device, which is purely mechanical, is based on concepts borrowed from the oil industry. It involves a hollow S-shaped needle containing a filament that acts as a guide wire. When a physician pushes the device against a tissue, he or she is actually applying force only to the filament, not the needle itself, thanks to a special clutch.

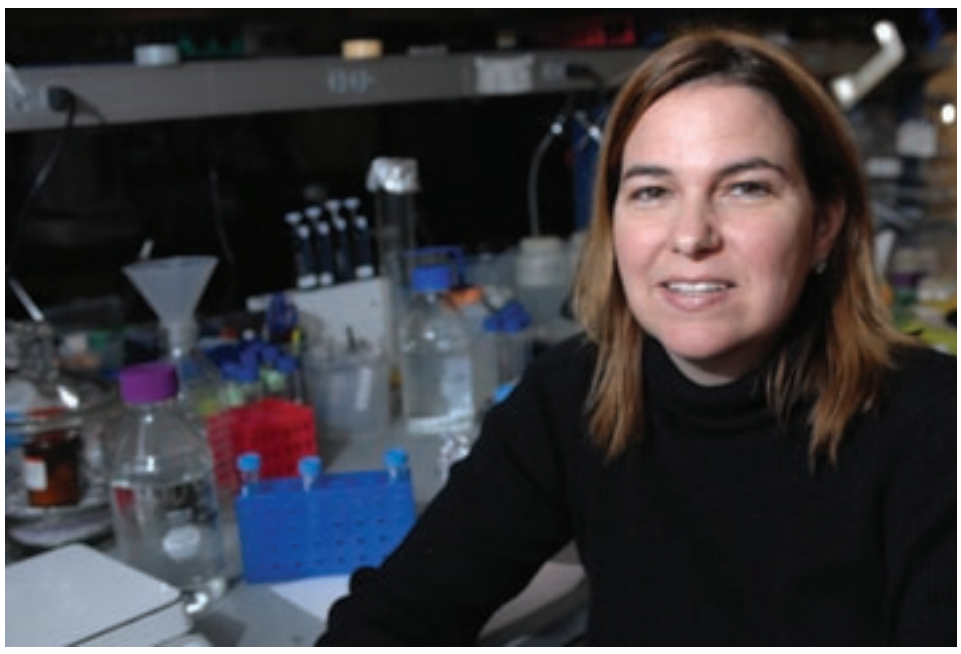
When the filament, which moves through the tip of the needle, encounters resistance from a firm tissue, it begins to buckle within the S-shaped tube. Due to the combined buckling and interactions with the walls of the tube, the filament locks into place "and the needle and wire advance as a single unit," said Jeffrey Karp, an affiliate faculty member of the Harvard-MIT Division of Health Sciences and Technology (HST) and co-corresponding author of a recent paper on the work in the Proceedings of the National Academy of Sciences.

The needle and wire proceed through the firm tissue. But once they reach the target cavity (for example, a blood vessel) there is no more resistance on the wire, and it quickly advances forward while the needle remains stationary. Because the needle is no longer moving, it cannot proceed past the cavity into the wrong tissue.

Karp believes that the device could reach clinics within three to five years pending further pre-clinical and clinical testing.

First author Erik K. Bassett, now at Massachusetts General Hospital (MGH), developed the device for his MIT master's thesis. He did so under Alexander Slocum, the Neil and Jane Pappalardo Professor of Mechanical Engineering, with guidance from Karp and Omid Farokhzad of HST, Harvard Medical School (HMS) and Brigham and Women's Hospital. Additional authors are also from HMS and MGH.

The work was funded by the Deshpande Center for Technological Innovation at MIT and the Center for Integration of Medicine and Innovative Technology (CIMIT).


PHOTOS / **DONNA COVENEY**

From left to right, MIT reseachers Gerbrand Ceder, Angela Belcher and Michael Strano have worked together to genetically engineer viruses that can be used to make high-powered batteries.

VIRUS: New battery, built with bacteriophages, could power cars, electronic devices

Continued from **Page 1**

date materials for cathodes are highly insulating.

To achieve that, the researchers, including MIT Professor Gerbrand Ceder of materials science and Associate Professor Michael Strano of chemical engineering, genetically engineered viruses that first coat themselves with iron phosphate, then grab hold of carbon nanotubes to create a network of highly conductive material.

Because the viruses recognize and bind specifically to certain materials (carbon nanotubes in this case), each iron phosphate nanowire can be electrically "wired" to conducting carbon nanotube networks. Electrons can travel along the carbon nanotube networks, percolating throughout the electrodes to the iron phosphate and transferring energy in a very short time.

The viruses are a common bacteriophage, which infect bacteria but are harmless to humans.

The team found that incorporating carbon nanotubes increases the cathode's conductivity without adding too much weight to the battery. In lab tests, batteries with the new cathode material could be charged and discharged at least 100 times without losing any capacitance. That is fewer charge cycles than currently available lithium-ion batteries, but "we expect them to be able to go much longer," Belcher said.

The prototype is packaged as a typical coin cell battery, but the technology allows for the assembly of very lightweight, flexible and conformable batteries that can take the shape of their container.

On March 24, MIT President Susan Hockfield took the prototype battery to the White House where she and U.S. President Barack Obama spoke about the need for federal funding to advance clean-energy technologies.

Now that the researchers have demonstrated they can wire virus batteries at the nanoscale, they intend to pursue even better batteries using materials with higher voltage and capacitance, such as manganese phosphate and nickel phosphate, said Belcher. Once that next generation is ready, the technology could go into commercial production, she said.

Lead authors of the Science paper are Yun Jung Lee and Hyunjung Yi, graduate students in materials science and engineering. Other authors are Woo-Jae Kim, postdoctoral fellow in chemical engineering; Kisuk Kang, recent MIT PhD recipient in materials science and engineering; and Dong Soo Yun, research engineer in materials science and engineering.

The research was funded by the Army Research Office Institute of the Institute of Collaborative Technologies, and the National Science Foundation through the Materials Research Science and Engineering Centers program.

YEAST: Game theory study in yeast shows how cooperative behavior meshes with evolution

Continued from **Page 1**

no emotions or thoughts that interfere with rational decision-making; their actions are solely driven by their genetic response to the environment.

"You can apply game theory to biological interactions and in some ways it's more broadly applicable than it is in humans," says Gore, the paper's lead author.

Game theory, traditionally employed by economists and military strategists, uses mathematics to predict individuals' behavior in certain situations.

Cooperators and cheaters

Working with MIT physics professor Alexander van Oudenaarden, also an author of the paper, Gore developed an experimental setup involving yeast sucrose metabolism. Sucrose is not yeast's preferred food source, but they will metabolize it if no glucose is available. To do so, they must secrete an enzyme called invertase, which breaks sucrose into smaller sugars that the yeast can absorb.

Much of that sugar diffuses away and is freely available to other yeast cells in the environment. In this scenario, yeast that secrete invertase are known as cooperators, while those that don't secrete invertase and instead consume the simple sugars produced by others are called cheaters.

If all of these simple sugars diffused away, with no preferential access to the yeast that produced it, then it would always be better to cheat, and the cooperators would die out.

The researchers observed that cooperating yeast have preferential access to approximately 1 percent of the sucrose they produce. That benefit outweighs the cost of helping others, allowing them to successfully compete against cheaters.

In addition, no matter the initial starting numbers of yeast in a given population, the microbes always come into an equilibrium state, with both cooperators and cheaters present. "It doesn't matter where you start. You always end up with equilibrium," says Gore.

This suggests that the yeast are playing what game theorists call a snowdrift game. The name of the game comes from a situation in which two drivers are trapped in cars behind a snowdrift. Each one can choose to get out and clear a path or stay put. If one driver does not shovel, the other must.

The best option is to "cheat" by staying in the car while the other driver shovels. However, the worst-case scenario occurs if both drivers cheat and no one gets home. Therefore, the best strategy is always the opposite of your opponent's strategy.

The same rules apply to the cheating and cooperating yeast: Like the driver who grudgingly gets out and shovels so that both she and her fellow motorist — snug inside his car — may continue on their journeys, the yeast who cooperate do so because there is a slight benefit for themselves. However, when most of the yeast are cooperating, it becomes advantageous for some individuals to cheat, and vice versa, which allows co-existence between cheaters and cooperators to arise.

Studies have shown that in the wild, yeast carry different numbers of copies of the invertase gene. This genetic diversity in the wild may be similar to the long-term coexistence of cooperators and cheaters observed in the laboratory, says Gore.

Hyun Youk, an MIT graduate student in physics, is also an author of the paper. This research was funded by the National Institutes of Health and the National Science Foundation.

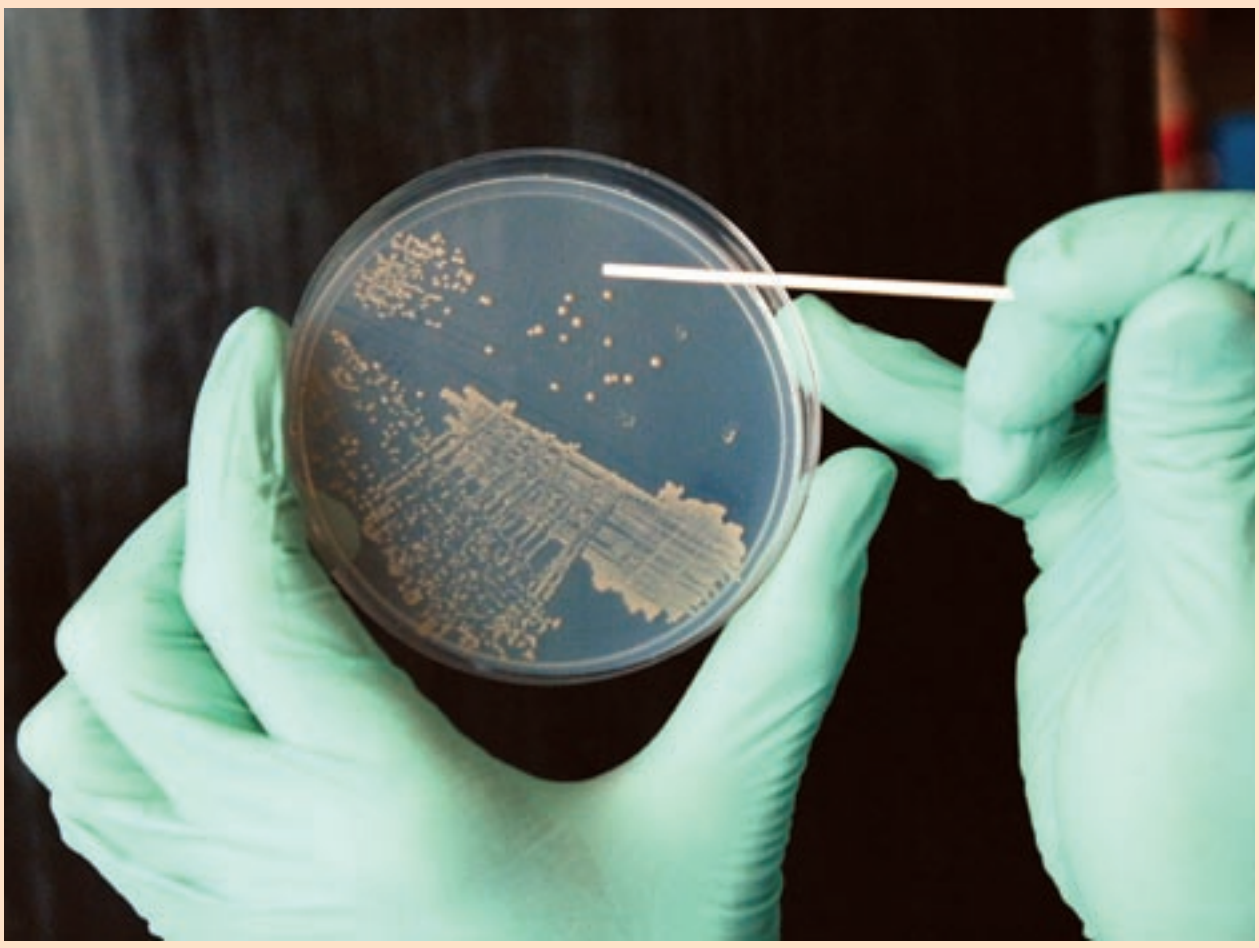


PHOTO / **DONNA COVENEY**

Yeast cells, shown here being harvested, were used to demonstrate how cooperative behavior can be compatible with evolution.

GARDEN: MIT staffers work to organize first-ever community garden

Continued from **Page 1**

those in need: At least 2 percent of all harvested produce will be given to Food for Free, a local charity that finds and distributes fresh food to pantries, meal programs and shelters. Food for Free already collects fresh fruit and vegetables from a local farm that delivers to campus in the summer, an initiative that Gray helped launch last year.

Going green, giving back

Each plot will consist of one EarthBox, a low-cost, compact and water-efficient growing container that's about the size of a large suitcase. The EarthBoxes will be available for purchase, at a discount and complete with soil and fertilizer, through MIT's Endicott House. While there is no fee for a plot, gardeners must supply the EarthBox, soil and plants.

There will be approximately four plots per parking space, and several more on the grass next to the garage. Obtaining a plot requires an entry into an online lottery that begins today. The lottery can be accessed at http://web.mit.edu/surveys/garden/.

It's a wonderful opportunity to reduce our carbon footprint and do great outreach.

Sgt. Cheryl Vossmer

In the program's first year, plots will only be made available to faculty and staff — but Gray notes that opening up the program to students is an "absolute possibility" in subsequent years. Vossmer says the program would be well suited to graduate students, who are around campus during the summer months.

Only one plot will be awarded per faculty or staff member, and those chosen get to have it for three years.

Gardeners may grow whatever they wish in their individual gardens, though the EarthBox web site (www.earthbox.com) recommends certain fruits and vegetables over others. The Endicott House will be selling plants for use in the garden during its annual sale on May 20 and 21. Gardeners are encouraged to buy from the Endicott House, for sustainability reasons, but may provide their own plants.

And for those who might not consider themselves green thumbs, don't worry, Vossmer says. "We will have some workshops for people that have never gardened before."

The growing season will last from Memorial Day, May 25, through Labor Day, Sept. 7, at which point all the boxes will have to be removed from the garage by their plotholders. And gardeners may want to hope for rain this summer — there is currently no water supply on hand at West Garage, so gardeners will have to carry water up to their plots. The EarthBoxes, however, can regulate the water in the soil, making it almost impossible to over-water.

Gray calls the community garden perfect for "building community when it is most necessary. Anything that gets people to think about something other than [the economy] is a good thing."

For more information on the community garden project e-mail communitygardens@mit.edu or visit the lottery web site at web.mit.edu/surveys/garden/.

Minding their ps and qs about kwhs

MIT dorms vie for greatest energy reductions

David Chandler
News Office

GreeningMIT is an occasional series focusing on the broad efforts to improve energy efficiency on campus.

If you're living in a dormitory and not paying a separate bill for electricity, there's little incentive to be frugal about your power usage — other than, you know, helping to prevent global climate change. But students here do thrive on competition, so for the third year they are now pitting dorm against dorm to see which can achieve the greatest savings.

This year, for the first time, in addition to the 11 undergraduate dorms, all seven graduate dorms are also competing. Prize money of $10,000 will be split among the winning dorms, to be used for improvements of their choosing including energy-efficiency retrofits.

For MIT, it's definitely a win-win proposition: The Housing Office of the Division of Student Life, which put up the prize money, actually saved 261,414 kwh of electricity — or about $34,000 in energy costs — during the eight weeks of last spring's competition. Retrofits paid for with the winnings will save money year after year.

For the students, the contest comes down to finding ways to encourage each other to change behavior. This includes simple actions such as remembering to switch off lights in empty rooms, choosing to study in groups in a common area with a couple of overhead lights rather than each having individual lights burning as they study in their own rooms, or taking shorter, cooler showers, for example.

"It takes a lot of persuasion to get people to change their behavior," says organizer Timothy Grejtak, a junior in energy conversion engineering. To help keep students motivated, each dorm has at least one student, a dorm coordinator, in charge of motivating his or her fellow residents.

Other measures can have a more lasting impact, such as moving power strips to a more visible position. This can help serve as a reminder to switch the strips off, thereby preventing the phantom power usage that occurs even when computers and other devices are individually turned off.

To allow for the fact that the dorms have very different patterns of energy usage, each dorm's performance is calculated relative to a baseline period for that dorm — which is measured during an unannounced period to prevent anyone from trying to "game" the system. This year, the contest's organizers are using three different systems for comparing energy use during the contest's eight weeks with that of the baseline period.

First, as in past years, for the initial three weeks they will do a straight percentage comparison of the electricity used. Then, for the next three weeks, they will do a comparison of the actual kilowatts used per capita, to take into account the different sizes of dorms. And in the final two weeks, they will use an algorithm that combines these two and other measurement systems.

Grejtak dreams of expanding the contest in future years. "It would be wonderful to have the entire campus involved — classrooms, labs, offices," he says. In addition, since other universities around the country have had similar competitions, next year it's possible there will be a head-to-head contest with another campus such as Harvard, he says.

And for the students who take part, there is one solid lesson to be learned from the experience, Grejtak says: "You have the power to make a difference, at no cost."

The MIT Energy Initiative's Campus Energy Task Force is again supporting this year's competition, with additional prize money for the newly added graduate dorms. "This competition is a terrific example of what the Task Force is looking to encourage all across campus," says Steven Lanou, deputy director for environmental sustainability. For more information on the Task Force's campus greening activities, see mit.edu/mitei/campus.

MIT economists see a few bright spots

Six months after panel's initial warnings, 'we're not doomed'

Stephanie Schorow
News Office

Nearly six months after a panel of five MIT faculty experts in economics and business warned that the financial crisis would get much worse, the same group re-convened and identified a few bright spots on the economic horizon.

Opening a March 31 panel discussion with the remark, "Don't take it personally — I really hope this is the last of these panels," moderator and organizer Ricardo Caballero, the Ford International Professor of Economics, Macroeconomics and International Finance and head of the economics department, sounded cautiously optimistic at times.

"Despite the many horror stories, we're not doomed. We're not even close to that," he said.

But Caballero was also careful not to minimize problems, saying, "Main Street and Wall Street are entangled in a very perverse downward feedback loop."

In the October panel, William Wheaton, professor of economics and urban studies and director of research for the Center for Real Estate, spoke pessimistically about a possible recovery of the housing market because of the large amount of housing inventory from foreclosures and overbuilding.

Recent data, however, point to a dramatic turnaround in some housing markets, he said. Investors and first-time homeowners "have stepped up to the plate" and started to buy property. "There is this big pool of capital willing and able to buy up distressed houses," often for investment purposes, he said.

Also upbeat was Andrew Lo, the Harris & Harris Group Professor of Finance and director of the MIT Laboratory for Financial Engineering at the Sloan School of Management. He argued that hedge funds — loosely regulated pools of capital that engage in a broad array of activities — would play a large role in the economic recovery by taking over so-called toxic assets from banks' balance sheets.

"The hedge fund industry will lead the charge for creating additional investment opportunities and liquidity for more banks and more traditional institutions," he said.

Hedge funds have been unfairly maligned as "shadow banking systems" that helped cause the crisis, Lo said. He instead blames a "shadow hedge fund system" — the banks, money market funds and insurance companies that invested in risky securities.

Bengt Holmstrom, the Paul A. Samuelson Professor of Economics, expressed frustration over the public outrage aimed at the financial services industry. He said the public is blaming "fools, idiots and crooks" in a system it perceives as fundamentally flawed. "If you start with that premise, I don't think you'll ever really get to the bottom" of the problem, he said.

Holmstrom particularly criticized calls for transparency, an issue that emerged when subprime mortgages were bundled together in investments that were given high ratings despite their risk. "Liquidity is fundamentally about not having things very transparent," he said. "If you start questioning, the music will stop, as they say."

So how to stabilize the fiscal system? Here panelists were less optimistic. Six months ago, the general consensus was the federal government's "deep pockets" could stimulate the economy without too much pain; that perception has dramatically changed, said James Poterba, the Mitsui Professor of Economics and president of the National Bureau of Economic Research. With the stimulus package, the federal deficit is now projected to run to $1.7 to $1.8 trillion for fiscal 2009, about 12 percent of GDP, a rate higher than any time since 1945. In 2010, the deficit will improve "a bit" to 8 percent of GDP and additional forecasts indicate more sustainable deficits of 2 or 3 percent of GDP until 2019.

But if the Obama administration proceeds with tax reforms and other program expenditures, the deficit could rise to 4 percent of GDP through 2019. Add in other proposed expenditures, like health-care reform, and projections run as high as 82 percent of GDP, Poterba said.

"At 82 percent of GDP, you start to get into a range where there are questions about the long-term fiscal health of a country," he said.

Efforts to find new sources of revenue are "not encouraging," Poterba said. The Obama administration plans to raise tax rates for about 1.4 million households that make more than $390,000 a year, who now account for about 40 percent of the federal income tax liability. However, many of these people have been hard-hit by the financial crisis and may see their taxable incomes drop. That would force the government to look for new revenues — possibly through introducing a national value-added tax.

The one silver lining is that with low interest rates on U.S. treasury notes, "the United States remains the port in the storm in many of the global financial markets," Poterba said.

'FUZZY LOGIC' reveals cells' inner workings

Anne Trafton
News Office

Living cells are bombarded with messages from the outside world — hormones and other chemicals tell them to grow, migrate, die or do nothing. Inside the cell, complex signaling networks interpret these cues and make life-and-death decisions.

Unraveling these networks is critical to understanding human diseases, especially cancer, and to predicting how cells will react to potential treatments. Using a "fuzzy logic" approach, a team of MIT biological engineers has created a new model that reveals different and novel information about these inner cell workings than traditional computational models.

The team, led by Doug Lauffenburger, head of MIT's Department of Biological Engineering, reports its findings in the April 3 issue of the journal Public Library of Science (PLoS) Computational Biology.

This is the first time that scientists have used fuzzy logic to model cell biochemistry, and the approach should be applicable to any kind of cell signaling pathway, said Lauffenburger.

Developed in the 1960s, fuzzy logic can take inexact inputs and produce accurate predictions, based on sets of rules rather than mathematical equations. It has been applied in auto-focusing cameras, automobile cruise control and home appliances.

Fuzzy logic mimics the way humans make everyday decisions — for example, deciding when to eat lunch. The decision depends on what time it is, what is in the refrigerator, how hungry you are, etc. All of this information is integrated to come up with a decision, with no math required.

The new MIT model works the same way. Each component of the cell-signaling network (which could be a receptor, enzyme or transcription factor) has its own set of rules that determine how it responds to a particular stimulus. Adding up all of these stimuli and responses leads to an outcome, such as death, cell division or migration.

Using a 'fuzzy logic' approach, a team of MIT biological engineers has created a new model that reveals different and novel information about these inner cell workings than traditional computational models.

In contrast, traditional computational models use physics-based equations to calculate precise values for each interaction. To create such models requires more specific biochemical knowledge and they do not offer the same insights as the fuzzy logic models.

While both types of model accurately predict outcomes of a pathway, fuzzy logic models also generate a graphical representation of each step along the way, allowing scientists to visualize what is happening inside the cell. With fuzzy logic models, "you can actually see the drawing and say, 'Aha, I see what this enzyme is doing,'" said Lauffenburger.

The researchers' model allowed them to discover some previously unknown interactions in a pathway regulating programmed cell death. The pathway, called MK2, is generally believed to promote cell death and produces cell-to-cell communication factors involved in inflammation-based tissue destruction. However, the model showed that inhibiting MK2 can actually favor cell death, because it indicated that the pathway may also control another signal that is pro-survival.

This finding demonstrates that molecular components in the cellular network governing survival-versus-death decisions can promote diverse outcomes, so simple intuition cannot readily predict the effects of possible drug treatments.

Without the fuzzy logic model, "you wouldn't have found that connection and would not be able to properly understand what an anti-MK2 drug might do," said Lauffenburger.

This general modeling approach should be useful in identifying potential new targets for drugs against cancer, inflammatory diseases and infectious diseases, he said.

Lead author of the paper is Bree Aldridge, a recent MIT PhD recipient in biological engineering (BE). Other authors are Julio Saez-Rodriguez, research affiliate in BE and postdoctoral fellow at Harvard Medical School; Jeremy Muhlich, research scientist at Harvard Medical School; and Peter Sorger, Harvard Medical School professor of systems biology and MIT professor of BE.

Funding support was provided by the National Institute of General Medical Sciences Systems Biology Centers of Excellence program and the Department of Defense Institute for Collaborative Biotechnologies.

Awards&Honors

Four students named Goldwater scholars

Four MIT undergraduates are among the 278 students recently named Barry Goldwater Scholars.

This year's recipients are Alvin Chen, a junior in biological engineering who plans to obtain an MD/PhD in biomedical engineering; Sidney Edward Cruetz, a senior in chemistry who plans to earn a PhD; Vidya Ganapati, a junior in electrical engineering and computer science who plans to get a PhD; and Maria Jean Monks, a senior in mathematics who plans to get a PhD.

Goldwater Scholars receive up to $7,500 per year for each of their remaining academic years. The awards are given to sophomores and juniors planning careers in science and engineering.

Senior, two graduate students win Hertz fellowships

The Fannie and John Hertz Foundation recently awarded its prestigious fellowships to three MIT students, including one undergraduate and two graduate students. The fellowships, worth $250,000, support innovative young leaders in the applied sciences.

MIT had the largest number of recipients from one institution. The three students chosen were mathematics senior Alan Deckelbaum, biology graduate student Arvind Ravi and chemistry graduate student Darcy Wanger.

Selected from an elite pool of 543 applicants, the 2009-2010 Hertz Fellows are comprised of eight men and two women. The no-strings-attached fellowships allow exceptional applied scientists and engineers the freedom to innovate.

Swimming, diving named Academic All-American team

MIT's women's swimming and diving team was recognized this year as an Academic All-American Team for Spring 2008. The honor, awarded by the College Swim Coaches Association of America, is for maintaining a team average GPA of 3.0 or higher.

MIT to host clean energy policy forum

Markey, Browner, Holdren to make case for new federal rules at April 13 event

U.S. Rep. Edward Markey

Proposed federal rules aimed at promoting clean energy, combating climate change and creating new "green-collar" jobs will be the focus of a policy forum on April 13 at MIT featuring several of the key Washington players who are working to get them approved.

The event, "Clean Power: Building a New Clean Energy Economy," will feature remarks by U.S. Rep. Edward Markey of Massachusetts, chair of the Select Committee on Energy Independence and Global Warming and the Energy and Environment Subcommittee of the Energy and Commerce Committee; Carol Browner, the former Environmental Protection Agency administrator who is now President Barack Obama's assistant for energy and climate change; and John Holdren '65, director of the White House Office of Science and Technology Policy.

The forum comes ahead of what is expected to be a major debate in Congress over energy, global warming and economic policy. Last week, Markey and U.S. Rep. Henry Waxman of California introduced draft legislation in Congress that aims to spur the development of clean energy and reduce global warming emissions by establishing national standards for renewable energy and energy efficiency, and by putting a cap on carbon dioxide and other heat-trapping emissions.

In addition to the presentations by Markey, Holdren and Browner, the event will include remarks by MIT President Susan Hockfield, MIT Energy Initiative Director Ernest Moniz and Pulitzer Prize-winning author Daniel Yergin, chairman of Cambridge Energy Research Associates.

The forum, which is sponsored by MIT in cooperation with Markey, runs from 10 a.m. to 12:30 p.m. in the Wong Auditorium. It is free and open to the public.

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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North End 1 Bedroom, 1 Bath, on the quiet side of Hanover Street, 819 square feet, available immediately. $1650 a month. zorar@aol.com.

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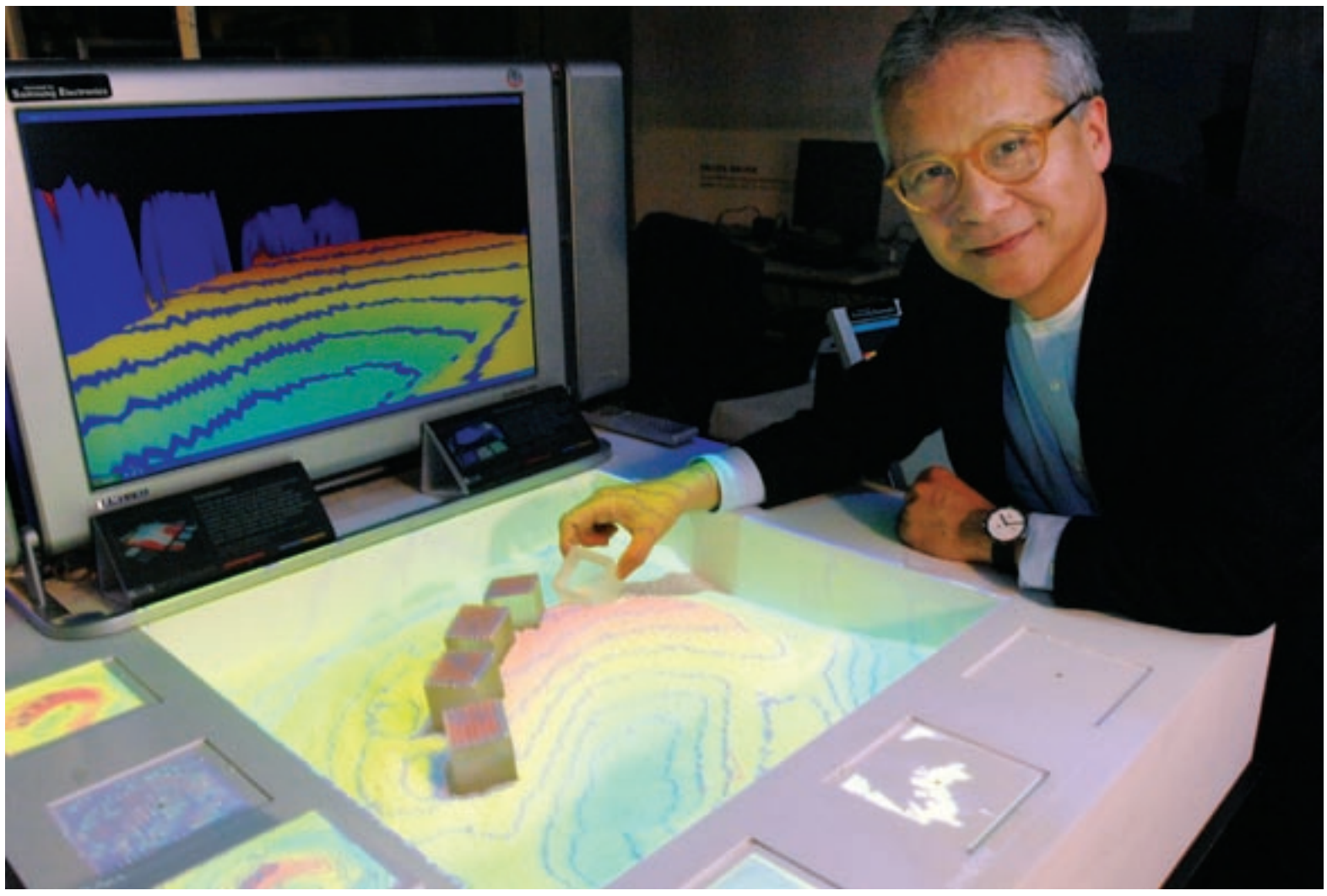
Technical Writer Wanted. We are looking for an engineering student with experience in circuit board design. We would need technical articles around 1,000 words for $200. Contact julie_lavallee@yahoo.com.

Cottage Park Yacht Club of Winthrop, Ma is accepting applications for membership. CPYC is active in sailing/power boating along with bowling/dart leagues, adult/youth sailing programs, billiards and more. Contact Marty @ 3-6728 or mobrien@mit.edu for more information.

MAKING THE VIRTUAL TANGIBLE

Ishii takes 'hands-on' approach to computers



PHOTOS / **DONNA COVENEY**

RIGHT: Hiroshi Ishii, the Muriel R. Cooper Professor of Media Arts and Sciences, works with a sand table, developed by students in his lab, that allows users to see instantly how changes in buildings and their surrounding topography will affect airflow, light and shadows.

BELOW: Ishii demonstrates 'g-speak' an interactive display controlled by hand gestures.

David Chandler
News Office

At a time when ever more aspects of our lives are moving toward the virtual, online world — stores, newspapers, games and even social interactions — Hiroshi Ishii seems to be swimming against that current: His aim is to bring the world of computers into more real and tangible form, seamlessly integrated with our daily lives.

Instead of just using flat screens, keyboards and mice, he wants people to be able to interact with their computers and other devices by moving around and by handling real physical objects. In short, by doing what comes naturally.

Ishii came to MIT's Media Lab 14 years ago, at the urging of the lab's founder and then-director Nicholas Negroponte, after having worked for the Japanese telephone company NTT for 16 years. "He was bursting with energy, even when you talked to him you felt he was going to burst with excitement," Negroponte recalls. "MIT was the place for him to release it, and he did." At NTT, Negroponte says, Ishii was "more or less in a closet. I urged him to basically step out of the closet, onto the world stage. He did so with excellence."

He immediately set about looking for ways to replace conventional Graphical User Interfaces (GUIs), exemplified by the Windows and Mac operating systems, with what he calls Tactile User Interfaces (TUIs).

That vision has sprung to life in Ishii's Tangible Media Group at the Media Lab. One early example was a tabletop system called the Urban Planning Workbench, where an architect or city planner can move framework models of planned buildings, and the tabletop instantly responds by displaying how the shadows and reflections from those buildings would appear at different times of day and how they would interact with the adjacent buildings. The same display can then be switched to show how air would flow around the buildings — a kind of virtual wind tunnel.

In this way, it becomes easy to see the impact of changes in the orientation or shape of buildings on the resulting play of light and wind patterns, without having to build detailed models for each possibility. Over the years, Ishii and his students have created a number of variations on this basic system, including sand and clay tables that allow for a three-dimensional version of such interactive displays, revealing how changes in the topography can also affect the behavior of light and wind.

Other students in his lab have developed similar concepts into systems in which manipulating physical objects on a surface can be used to work with such widely varied things as musical compositions, chemical formulas, business processes or electrical circuits. For example, wooden blocks may represent different electronic components, and when the blocks are arranged in a way that completes a circuit, they behave accordingly — with projected images causing a simulated motor to begin turning or a bulb to light up.

'Driven by art'

For Ishii, the underlying concepts that guide all these projects are more significant than the specific implementations. "For us, the most important thing is the vision, the philosophy, the principle," Ishii says. "I've never been driven by science or engineering. I'm driven by art. Technology gets obsolete in a year, and applications get obsolete in 10 years. But vision driven by art survives beyond our lifespan."

Part of that vision is Ishii's sense that aesthetic qualities matter. For him, it's not just about making something that works; in his careful attention to materials and design, he makes it clear that he believes the experience of interacting with devices should be pleasing, not just functional.

Already, Ishii's vision has had a broad influence. His first doctoral student, John Underkoffler '88, SM '91, PhD '99, calls Ishii "a luminous dynamo" who has been "father, mother and obstetrician to a whole new field" of computer interfaces. The key point, he says, was Ishii's "recognition that it's not about the electronic technology, but about the physicality, the human-centered aspects" of working with that technology.

In his years at the Media Lab, Ishii's basic vision has been played out in a variety of experiments that he and his students have carried out. Perhaps the most widely known is a system for controlling a computer display with three-dimensional gestures using both hands — a version of which was featured in the 2002 movie Minority Report. To prepare for that movie's computer-interaction scenes, actor Tom Cruise and the movie's special effects team worked closely with Underkoffler.

At the time, the technology was just a vision of what could be. Underkoffler coached Cruise in how to gesture in front of a blank screen, to which the computer graphics were added later. But in the years since then, the vision has gradually moved closer to becoming reality. Underkoffler, working with a startup company called Oblong Industries in California, has developed the gesture-controlled computer interface into a product called g-speak. Students in Ishii's group are working with that interface in the Media Lab, exploring its potential and adding to its capabilities.

"Everybody thought this movie was science fiction," Ishii says, "but it's not fiction, it's fact. The future is now. It came from the Media Lab, it went to the movie, and now it's reality."

From fantasy to reality

Just by moving one's hands, an image can be moved from one wall to another, or onto the tabletop. The system responds not just to hands moving from side to side or up and down, but forward and back as well, and it can also respond to multiple users simultaneously.

How would you use it? Say you've just taken hundreds of digital pictures and you want to select the best ones. You stand in front of the display looking at a pile of photos, and just by moving your hands you push them around, sort them into piles, and put the ones you choose into a box in the corner. Others can join the process, sorting one pile while you work with another. When dealing with large amounts of data and collaborating with others, this can be faster and easier than a traditional mouse-based point-and-click process.

That's not the only system from the Tangible Media Group that has spawned its own startup company. A simpler technology that also could change the ways people interact with information led to a company called Ambient Devices, which produces displays that continuously show anything from weather forecasts to the performance of the stock market or the use of energy in a home. One of these devices is a frosted-glass globe that glows in color, with the hue changing according to the information being displayed (such as red when the stock market goes down, green when it's up).

Ishii explains that these devices are designed to be part of the background of a room, unlike computer displays that are intended to be highly interactive. He compares them to an old-fashioned clock on the wall — always "on," little noticed, but capable of conveying useful information almost instantaneously at a glance.

Ben Resner SM '01, who started Ambient Devices and calls Ishii the "intellectual founder" of the company, says he is "a true teacher." Resner adds that "the thing about Hiroshi that really impresses me, that I didn't notice until later," after leaving the lab, was his "ability to find that nugget of newness in every student's work."

And that's the key thing. Ultimately, the influence Ishii hopes to have on the world is not measured just by the devices he and his students create — the interactive tables and display walls and glowing orbs. It's what happens inside the minds of his students and those influenced by his work. "Inspiring people, firing up the imagination," that's what matters, he says. "We try to defy gravity, to make things more engaging, more exciting."