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Wednesday, April 15, 2009

TechTalk
SERVING THE MIT COMMUNITY

music at

PHOTO / **HAYDEN TAYLOR**
The MIT concert choir

hitting all the right notes

Stephanie Schorow
News Office

Later this month, the MIT community will celebrate the 70th birthday of one of America's most prominent and prolific composers with a special tribute concert and symposium.

That the individual in question, Pulitzer Prize-winning musician John Harbison, has been a member of the MIT faculty for four decades may come as a surprise to many in the outside world who tend to equate the Institute with white coats, computer algorithms, rocket science, quantum physics and cutting-edge efforts to cure cancer and solve the energy crisis.

Harbison and the music scene at MIT are among the Institute's best-kept secrets, but they shouldn't be. Scientists and engineers have often been avid musicians — think of Albert Einstein and his violin or physicist Richard Feynman and his drums. The fact is, music at MIT plays a cathartic role in campus life and displays many of the bold characteristics — innovation, ingenuity, excellence and creativity — that lie at the heart of the MIT culture.

"Music at MIT is superb — and John is emblematic of that

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At MIT forum, Markey announces energy bill hearings

Congressman says energy research could address jobs, climate and security

David Chandler
News Office

At a policy forum hosted by MIT on Monday, April 13, Rep. Edward Markey (D-Mass.) announced that he and Rep. Henry Waxman (D-Calif.) will begin a series of high-level hearings next week in Washington to help refine the details of a clean energy bill they introduced two weeks ago.

The legislation, which was the focus of Monday's forum, 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.

"Our planet is sick, and there are no emergency rooms for sick planets," Markey said at the opening of the MIT event. He added that the hearings are due to begin next Tuesday, and three members

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PHOTO / **DONNA COVENEY**
John Holdren '65, SM '66, director of the White House Office of Science and Technology Policy, addresses an MIT clean energy policy forum on April 13.

MIT ballroom dance competition set for April 25-26

The 2009 MIT Open Ballroom Dance Competition, one of the best-attended competitions of its kind in the country, will take place April 25-26 at the Rockwell Gym.

More than 1,000 competitors from 60-plus schools and studios nationwide are expected to compete. As in previous years, the MIT Open will offer levels from beginner to championship in 19 dances — from waltz to samba and more.

The competition is free and open to the public, and will take place from 8 a.m. to 10 p.m. on Saturday, April 25, and from 8 a.m. to 8 p.m. on Sunday, April 26. Luca and Loraine Baricchi, a world-class professional dancing couple, will perform at the culmination of the competition. Tickets for that show are available through Brown Paper Tickets (www.brownpapertickets.com/event/580).

For more information on the competition, visit http://ballroom.mit.edu/comp.

Events at MIT

Today

• **2009 MIT IT and Communications Conference**. 8 a.m.-noon in W16, Kresge Auditorium.

• **"U.S. Foreign Policy after Bush: Can Bipartisanship and Liberal Internationalism be Revived?"** Speaker: Charles Kupchan, Georgetown University. Noon-1:30 p.m. in E38-615.

• **"What Can Psychoacoustics Reveal About the Sound of Music?"** Speaker: Josh McDermott, NYU. Noon-1:30 p.m. in 46-3189.

• **Massachusetts Space Grant Annual Distinguished Lecturer Talk.** Speaker: William Gerstenmaier, NASA associate administrator for space operations. 3-4 p.m. in 4-370. Gerstenmaier will talk on "Transitioning from the Space Shuttle to Constellation."

• **"Do Poor People Benefit from Wal-Mart?"** sponsored by the Undergraduate Economics Association. Speaker: Jerry Hausman. 5-6 p.m. in E51-115, Wong Auditorium - Tang Center.

Thursday, April 16

• **Energy 101: Energy Efficiency.** Noon-1 p.m. in E51-345. As part of the MIT Energy Club's "Energy 101" series, ESD PhD student Bryan Palmintier will present an introduction to energy efficiency.

Institute Professor John Deutch to be honored

Will be feted for 40 years of service

On the occasion of his 70th birthday, Institute Professor John Deutch is being honored with a symposium this Thursday in 10-250, featuring talks by leading figures from academia and government who have worked with him through the years.

In addition to his 40 years as a member of MIT's faculty, initially in the Department of Chemistry (which he chaired), and then as dean of science and as provost, Deutch served several stints in government, most notably as the director of central intelligence during the Clinton administration. He also has held leading posts in the Department of Defense and the Department of Energy. He earned his SB and PhD in chemical engineering from MIT.

The symposium in his honor, running from 2 p.m. to 5:30 p.m., will include talks by academics and former government officials including Professor George Whitesides of Harvard, former Secretary of Defense and Secretary of Energy James R. Schlesinger, former Secretary of Defense Harold Brown, former National Security Advisor Brent Scowcroft, and former White House Chief of Staff John Podesta.

The event will be followed by a reception in the Bush Room, and is being sponsored by the Office of the Provost, the School of Science, the Department of Chemistry, and the MIT Energy Initiative.

PHOTO / **DONNA COVENEY**

Institute Professor John Deutch

'Slice of MIT' blogs on Institute culture

Slice of MIT, a blog hosted by the MIT Alumni Association, presents daily doses of MIT culture — discoveries, alumni stories and campus happenings — gathered by staff, students, faculty and, soon, by guest alumni contributors such as photojournalist Owen Franken '68.

The growing Slice of MIT (alum.mit.edu/sliceofmit) blogroll includes the Running a Hospital blog by Paul Levy '72, MCP '74 as well as Climate Progress, an insider's view of science and politics by Joe Romm '82, PhD '87. Jesse Smithnosky '04 writes about making a living playing poker on Taking a Shot while Correlate by Lou Paglia MBA '05 focuses on technology and entrepreneurship.

Astronaut Mike Fincke '89 enjoyed the Slice posts about President Barack Obama's phone calls to him and his International Space Station crewmates so much, he called the MIT Club of South Texas webmaster from space!

Connect with the Alumni Association's ventures on Facebook, Twitter and LinkedIn at alum.mit.edu/socialmedia.

–Nancy DuVergne Smith, MIT Alumni Association

Awards&Honors

Professor Stephen Lippard to receive 2009 Pauling Medal

The 2009 Pauling Medal will be awarded to Professor Stephen J. Lippard, the Arthur Amos Noyes Professor of Chemistry. The Linus Pauling Medal is given annually by the Oregon, Portland and Puget Sound sections of the American Chemical Society. The award recognizes outstanding accomplishments in chemistry in the spirit of and in honor of Linus Pauling, a native of the Pacific Northwest.

Three professors honored with Billard award

Lotte Bailyn, professor of management, emerita; Institute Professor John Deutch; and Gerald Wilson, Vannevar Bush Professor and professor of electrical engineering and computer science and mechanical engineering, have been named the 2009 recipients of MIT's Gordon Y Billard Award. This award is presented annually for "special service of outstanding merit performed for the Institute," with a fund established by Gordon Y Billard '24.

Morton wins regional field honors

Stephen Morton, a junior in the Department of Mechanical Engineering, was recently selected as the 2009 Division III Indoor Track & Field New England Region Men's Field Athlete of the Year.

Two wrestlers named Academic All-Americans

Grant Kadokura and Joseph Silverman, both members of the MIT wrestling team, were named Academic All-Americans for 2009. Kadokura, a sophomore in mechanical engineering, and Silverman, a junior in mechanical engineering, received the honor for maintaining a 3.2 GPA.

News in brief

Conrad, Doyle named Guggenheim fellows

Professor Janet Conrad of physics and Associate Professor Patrick Doyle of chemical engineering are among the 180 artists, scientists and scholars awarded fellowships by the John Simon Guggenheim Memorial Foundation.

The foundation selects fellows on the basis of "stellar achievement and exceptional promise for continued accomplishment." The latest fellows, announced this week, come from a field of almost 3,000 applicants and range in age from 29 to 70.

Conrad will use her fellowship to work on a new detector for large liquid argon experiments at MIT and Fermilab in Batavia, Ill., while Doyle will work on the development of soft functional microparticles.

Each fellow receives a grant adjusted to his or her needs, taking into consideration other resources and the purpose and scope of his or her plans.

Faculty meeting agenda for April 15

A regular meeting of the faculty will take place at 3:30 p.m. Wednesday, April 15, in Room 10-250. The agenda includes:

- Vote to change Section 1.91 of the Rules and Regulations of the faculty
- Vote to approve a new version of 8.02 and changes to Section 2.84 of the Rules and Regulations of the Faculty
- Motion to implement changes to the HASS Requirement
- Presentation on the new interdisciplinary minor in energy and motion on the governance structure
- Report from the Committee on Discipline
- Presentation on changing the September student holiday
- Report from the Edgerton Award Selection Committee
- Motion to untable the April 16, 2008, motion on speaking privileges
- Remarks from the president
- Topics arising and questions for the president, the provost, and the chancellor

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'Diversity Dialogues' to focus on unconscious bias

This spring, MIT is offering faculty, staff and students the chance to participate in Diversity Dialogues, a series of conversations on unconscious bias and its unintended consequences.

The sessions, organized in response to requests made during the small group discussions at November's Diversity Leadership Congress, are based on a model developed and used by Robbin Chapman, manager of diversity recruitment for the School of Architecture and Planning. They include a 15-minute workshop followed by hands-on practice and facilitated discussion.

The goal of the dialogues, which begin April 16 and continue into May, is to increase self-awareness in order to more-effectively communicate with others. The dialogues will be facilitated by MIT volunteers trained by Chapman.

Debbie Berechman, executive director of the MIT Sloan MBA program and one of the workshop facilitators, said the dialogues represent a powerful means of engaging all constituencies across the MIT community.

"I'm thrilled that this model is evolving across MIT and I strongly encourage everyone — especially those who might not ordinarily choose to engage — to take advantage of this opportunity to explore a topic that affects us all," Berechman said.

In the future, organizers plan to offer similar dialogue opportunities on other topics related to diversity and inclusion.

For a schedule of the sessions and other information on MIT's diversity initiatives, visit web.mit.edu/diversity.

The dialogue opportunities are jointly sponsored by the Committee on Race and Diversity, Council on Staff Diversity, Student Activities Office, Graduate Student Council and Undergraduate Association.

FORUM: Markey announces energy bill hearings at policy forum

Continued from **Page 1**

of President Barack Obama's cabinet will be among the initial witnesses.

President Susan Hockfield, in introducing Markey at the event, noted that the new bill "frames the problem vividly and proposes the kind of comprehensive, large-scale, market-based answers that the situation demands." She added that it contains "powerful levers for change" that "we hope will support clean energy research, development and deployment."

Given that solving the intertwined issues of energy, climate change, security and economic growth represents what is "perhaps the greatest challenge of this century," Hockfield said MIT is an especially appropriate place to be launching such a discussion.

"At MIT, we like hard problems," she said. "We are ready and eager to help in the invention and implementation of solutions."

The event also featured remarks by John Holdren '65, SM '66, Obama's new director of the Office of Science and Technology Policy, and by Carol Browner, Obama's assistant forr energy and climate change. They were joined by bestselling author on energy issues Daniel Yergin, and by MIT Energy Initiative Director Ernest J. Moniz.

Holdren said "the world is getting most of the energy it requires from sources that are wrecking the environment it requires." But he added that "the energy challenge we face is actually a more difficult one than putting a man on the moon was."

Already, he said, carbon dioxide emissions and concentrations, temperatures and sea level "are all rising at rates at or above those of the IPCC's 'high' scenarios," based on the 2007 report of the Intergovernmental Panel on Climate Change. "Disastrous results could occur sooner rather than later," he said.

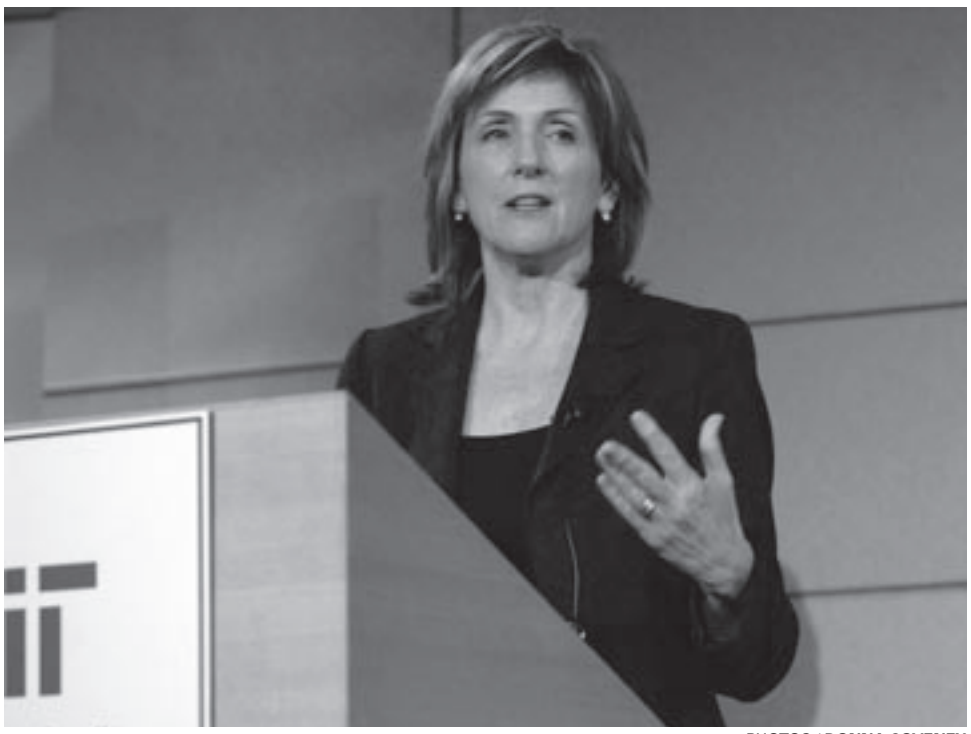
While it is already too late to "stop climate change in its tracks," he said, measures to slow its progress and adapt to the now-unavoidable impacts are essential. "Some of these are win-win: things that would make sense to do even without climate change." These include improvements in energy efficiency in buildings and vehicles that would, over time, pay for themselves through the energy they would save.

To address these issues, the new energy bill contains provisions to promote energy efficiency in buildings, appliances, transportation and industry, Markey said. It will also provide funding for research in cutting-edge areas such as carbon capture and sequestration, low-carbon fuels, electric vehicles and electricity transmission.

Browner stressed that climate change issues are often framed as a false choice between economic interests and environmental ones, but said that in fact each depends on the other, and improvements in energy technology provide great economic opportunities. "A new energy future and reduced global warming are two sides of a coin," she said.

Browner said that while renewable energy now accounts for about 3 percent of U.S. electricity production, "we hope we can double that in the next three to four years." And the new energy bill would help to make that possible.

But such rapid growth in new technology presents a big challenge, Moniz said. To make a dent in climate change, "these technologies must go to very large scale very quickly," he said. That means it's essential to be working on a multiplicity of options, and it will also be essential to bring about "better integration of the entrepreneurial community with the existing energy companies. We need to get scale-up on a timescale much shorter than has tended to be the case."



PHOTOS / **DONNA COVENEY**

ABOVE: Carol Browner, assistant to President Barack Obama for energy and climate change, gives the keynote address at the MIT clean energy policy forum.

BELOW: MIT President Susan Hockfield and U.S. Rep. Edward Markey (D-Mass.) answer questions from the press after the MIT clean energy policy forum.

Hockfield also said that "Congressman Markey's bill takes direct aim at climate change by pricing carbon, an approach that we anticipate will provide a sustained source of funding for the R&D needed for new energy technologies… We will never make it to a carbon-free energy landscape as long as carbon is free."

At the colloquium, Markey was asked whether this pricing, which is based on a cap-and-trade program for greenhouse gas emissions, should include auctioning of all emission permits as a way of raising funds for energy initiatives, rather than issuing some of the permits without cost to existing greenhouse-gas emitters. He stressed that such a system would initially put critical U.S. industries, such as steel and paper manufacturing, at a disadvantage in relation to companies in China and other nations, unless such a plan were universally adopted.

While he aims to get the new energy bill through Congress before the summer recess this year, he said, the details can evolve over time. As for the cap-and-trade component, "the goal would be over time to move toward, at the end of the process, 100 percent" auction-based system, he said. However, "we have to begin somewhere."

Right away, he said, this legislation "will create jobs by the millions, save money by the billions, and unleash energy investment by the trillions."

Events at MIT

Thursday, April 16

• **The Price of Oligopolistic Competition**. Speaker: Georgia Perakis. 4:15-5:15 p.m. in E51-057. Part of the ORC Spring Seminar Series.

Friday, April 17

• **Seventh Annual Prokopoff Concert.** Noon-1 p.m. in 14E-109, MIT Lewis Music Library. The annual Prokopoff Concert honors the extraordinary collection of violin music collected by Stephen Prokopoff and donated to the Lewis Music Library by Lois Craig in 2001 and is performed by some of MIT's finest student musicians.

• **Warren K. Lewis Lecture: "**The Impact of Mega Economic Trends on the Chemical Industry and Chemical Engineering Profession." Speaker: William F. Banholzer, executive VP and chief technology officer, Dow Chemical Company. 3-4 p.m. in 66-110.

• **Campus Preview Weekend Concert/ Open Forum**. 7-9 p.m. in 14W-111, Killian Hall. At 7 p.m., an open forum: "Music at MIT" with Dr. Frederick Harris Jr., director of the MIT Wind Ensemble and Festival Jazz Ensemble. At 7:30 p.m., MIT Wind Ensemble chamber musicians perform Little Symphony for Winds by Schubert and MIT Festival Jazz Ensemble performs music by Ellington, Mingus, Monk and Guillermo Klein.

Wednesday, April 22

• **2009 $30,000 Lemelson-MIT Student Prize Winner Presentation.** Noon-1:30 p.m. in W20, West Lounge. Come learn about the $30,000 Lemelson-MIT Student Prize and hear a presentation by Geoff Von Maltzahn, this year's Lemelson-MIT Student Prize winner, on his research in the biomedical realm.

• **2009 Broad Distinguished Lecture in Computational Biology and Bioinformatics.** Speaker: Professor Uri Alon, Weizmann Institute of Science. 4-5 p.m. in NE30-1154. Alon will discuss recent ideas on understanding why biological circuits are built the way that they are and present new mechanisms that allow signaling systems to provide perfectly robust input-output relationships despite variations in their protein levels.

• **"Climate Change in a Changing World: Meeting the Needs of Humanity and the Planet."** Speaker: Steven Hamburg. 7-9 p.m. in W79, Simmons Hall, MPR room.

Thursday, April 23

• **Communications Forum: Global Media**. Speaker: Carolina Acosta-Alzuru, Jonathan Gray, Aswin Punathambekar, Abderrahmane Sissako. 5-7 p.m. in E51-070. This panel will explore theoretical, methodological, and practical issues surrounding the study of media circulation in an age of increasing global connectivity.

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.

Drawing inspiration from nature to build a better radio

New radio chip mimics human ear

Anne Trafton
News Office

MIT engineers have built a fast, ultra-broadband, low-power radio chip, modeled on the human inner ear, that could enable wireless devices capable of receiving cell phone, Internet, radio and television signals.

Rahul Sarpeshkar, associate professor of electrical engineering and computer science, and his graduate student, Soumyajit Mandal, designed the chip to mimic the inner ear, or cochlea. The chip is faster than any human-designed radio-frequency spectrum analyzer and also operates at much lower power.

"The cochlea quickly gets the big picture of what's going on in the sound spectrum," said Sarpeshkar. "The more I started to look at the ear, the more I realized it's like a super radio with 3,500 parallel channels."

Sarpeshkar and his students describe their new chip, which they have dubbed the "radio frequency (RF) cochlea," in a paper to be published in the June/July issue of the IEEE Journal of Solid-State Circuits. They have also filed for a patent to incorporate the RF cochlea in a universal or software radio architecture that is designed to efficiently process a broad spectrum of signals including cellular phone, wireless Internet, FM, and other signals.

Copying the cochlea

The RF cochlea mimics the structure and function of the biological cochlea, which uses fluid mechanics, piezoelectrics and neural signal processing to convert sound waves into electrical signals that are sent to the brain.

As sound waves enter the cochlea, they create mechanical waves in the cochlear membrane and the fluid of the inner ear, activating hair cells (cells that cause electrical signals to be sent to the brain). The cochlea can perceive a 100-fold range of frequencies — in humans, from 100 to 10,000 Hz. Sarpeshkar used the same design principles in the RF cochlea to create a device that can perceive signals at million-fold higher frequencies, which includes radio signals for most commercial wireless applications.

The device demonstrates what can happen when researchers take inspiration from fields outside their own, says Sarpeshkar.

"Somebody who works in radio would never think of this, and somebody who works in hearing would never think of it, but when you put the two together, each one provides insight into the other," he says. For example, in addition to its use for radio applications, the work provides an analysis of why cochlear spectrum analysis is faster than any known spectrum-analysis algorithm. Thus, it sheds light on the mechanism of hearing as well.

The RF cochlea, embedded on a silicon chip measuring 1.5 mm by 3 mm, works as an analog spectrum analyzer, detecting the composition of any electromagnetic waves within its perception range. Electromagnetic waves travel through electronic inductors and capacitors (analogous to the biological cochlea's fluid and membrane). Electronic transistors play the role of the cochlea's hair cells.

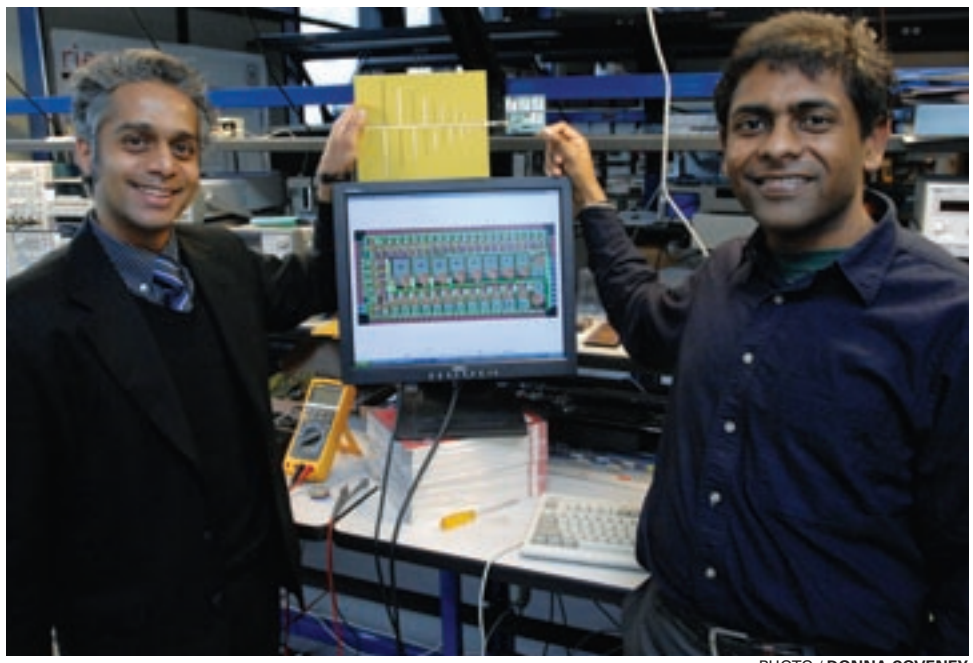


PHOTO / **DONNA COVENEY**

Associate Professor of Electrical Engineering Rahul Sarpeshkar, left, and graduate student Soumyajit Mandal display their RF (radio frequency) cochlea, a low-power, ultra-broadband radio chip. The chip, held by Mandal, is attached to an antenna, held by Sarpeshkar. The diagram on the computer monitor shows the wiring layout of the chip.

The analog RF cochlea chip is faster than any other RF spectrum analyzer and consumes about 100 times less power than what would be required for direct digitization of the entire bandwidth. That makes it desirable as a component of a universal or "cognitive" radio, which could receive a broad range of frequencies and select which ones to attend to.

Biological inspiration

This is not the first time Sarpeshkar has drawn on biology for inspiration in designing electronic devices. Trained as an engineer but also a student of biology, he has found many similar patterns in the natural and man-made worlds (http://www.rle.mit.edu/avbs). For example, Sarpeshkar's group, in MIT's Research Laboratory of Electronics, has also developed an analog speech-synthesis chip inspired by the human vocal tract and a novel analysis-by-synthesis technique based on the vocal tract. The chip's potential for robust speech recognition in noise and its potential for voice identification have several applications in portable devices and security applications.

The researchers have built circuits that can analyze heart rhythms for wireless heart monitoring, and are also working on projects inspired by signal processing in cells. In the past, his group has worked on hybrid analog-digital signal processors inspired by neurons in the brain.

Sarpeshkar says that engineers can learn a great deal from studying biological systems that have evolved over hundreds of millions of years to perform sensory and motor tasks very efficiently in noisy environments while using very little power.

"Humans have a long way to go before their architectures will successfully compete with those in nature, especially in situations where ultra-energy-efficient or ultra-low-power operation are paramount," he said. Nevertheless, "We can mine the intellectual resources of nature to create devices useful to humans, just as we have mined her physical resources in the past.

Q&A with Joseph Coughlin

The MIT AgeLab was created to creatively translate technologies and insights from behavioral sciences into practical solutions to improve the quality of life of older people and those who care for them. As part of that work, the AgeLab has created the Age Gain Now Empathy System, or AGNES, a suit that when worn mimics the physical restrictions of age. For example, elastic bands, kneepads, wrist guards and a neck collar restrict movement in ways that mirror arthritis and spinal problems. Earplugs reduce hearing, yellow glasses diminish sight, and gloves hinder touch. AGNES' goal, says AgeLab Director Joseph F. Coughlin, age 47, is to help product and system designers, who are often in their 20s and 30s, gain insight into how older people negotiate the world, from kitchen to living and from shopping to cooking. Coughlin recently discussed AGNES and aging issues.

Q. We've been told that 60 is the new 40 and 70 is the new 60, even if all of us eventually age. How will aging differ in the future?
A. Studies indicate cognitive decline may begin by our late 20s, certainly by 30. We know from our own work here on driving that you need twice the light to see at age 40 than you did at age 20. So aging is profoundly younger than people think. Aging is really about your life tomorrow. So how will aging be different in the future? The obvious difference is that, demographically, there are going to be far more older people. But I don't think you can deny, no matter the class, gender or education level, that a 40-, 50- or 60-year-old today is far different than a 40-, 50- or 60-year-old when we were kids. So one of the big changes we see changing is the attitude of what to expect in old age. The baby boomers have moved from the once referred to generation gap in their youth, to an expectations gap in their later years. There will be products and service technologies to facilitate those expectations and to translate them into reality. AGNES will provide the insights to create everyday environments that are youthful, fun, but accessible to all ages.

Q. When did the AgeLab start creating AGNES? Why was it created?
A. AGNES 1.0 was created in 2005. Today we have AGNES 2.0. We put together a multidisciplinary effort that included engineering, medicine, ergonomics and psychology input under the direction of AgeLab colleagues Roz Puleo, an exercise physiologist, and Katie Godfrey, who has a background in psychology. AGNES is a way of getting the designer or engineer to empathize with the consumer. This is not just about what it feels like to be old but it is meant to give insights to designers and engineers as to how to develop what's new. Chances are the lead adopters of new products and services are going to be older than they ever have been before. The adopter of a new iPod might be in his 20s but the lead adopter of the next-generation high-tech, high-style and high-price sedan or home appliance will not be a 20- or 30-year-old.

PHOTO / **NATHANIEL SALAZAR**

AgeLab Research Associate Katie Godfrey checks her watch while waiting for the bus in the AGNES suit. The suit is designed to allow younger people to experience life as an older person.

Q. Recently, representatives from companies as diverse as Siemens, Daimler and General Mills visited the AgeLab, put on the AGNES suit and performed tasks such as using a cell phone, getting in a car, and mixing a batch of cupcakes. What was their reaction?
A. There was a bit of surprise — is it really this bad? It's interesting most of us can see ourselves one day admitting we'll be dead. None of us can admit that some day we'll be old and losing the full capacity that many of us enjoy everyday. Wearing AGNES gave industry researchers insight into something that reading a study or even a focus group or interview is not going to give you. AgeLab is pioneering innovative methods in user-centered design. AGNES is one part of a growing laboratory knowledgebase of simulation, in-field and laboratory protocols to help everyone at MIT improve the quality of life of older people. After all, aging is not just about the old, it's about all of us.

Q. What's next for AGNES?
A. The next stage is developing more quantitative metrics. It's one thing to "feel their pain," so to speak. It's quite another to be able to start saying to industry, to government and to designers in general, these are the metrics you need to think about as you design our lives tomorrow — we think aging requires a new box of tools.

Q. Who named AGNES?
A. It was a student and research team collaborative effort powered by pizza.

It's a fine line

New method could lead to narrower chip patterns

David Chandler
News Office

Researchers at MIT have found a novel method for etching extremely narrow lines on a microchip, using a material that can be switched from transparent to opaque, and vice versa, just by exposing it to certain wavelengths of light.

Such materials are not new, but the researchers found a novel way of harnessing that property to create a mask with exceptionally fine lines of transparency. This mask can then be used to create a correspondingly fine line on the underlying material.

Producing such fine lines is crucial to many new technologies, from microchip manufacturing that is constantly seeking ways to cram more components onto a single chip, to a whole host of emerging fields based on nano-scale patterns. But these technologies have faced fundamental limits because they tend to rely on light to produce these patterns, and most techniques cannot produce patterns much smaller than the wavelengths of light itself. This method is a way of overcoming that limit.

The key is using interference patterns, in which different wavelengths of light sometimes reinforce each other and in other places cancel each other out. The researchers exposed the photochromic material -- one that changes its color, and therefore its transparency, in response to light — to a pair of such patterns, each of a different wavelength, simultaneously. When the bright lines at one wavelength coincide with the dark lines at the other wavelength, extremely narrow lines of clear material are formed interspersed with the opaque material. This banded layer then serves as a mask through which the first wavelength illuminates a layer of material underneath, similarly to the way a photographic negative is used to make a print by shining light through it onto a sheet of photo paper underneath.

A new technique to create narrower chip patterns could 'have a significant impact on chip making.'

Rajesh Menon
research engineer

The research was carried out by research engineer Rajesh Menon of the Research Laboratory of Electronics and graduate students Trisha Andrew in the Department of Chemistry and Hsin-Yu Tsai in the Department of Electrical Engineering and Computer Science, and was reported in a paper published in the April 10 issue of Science.

Remarkably, the new technique, which the researchers call absorbance modulation, makes it possible to create lines that are only about one-tenth as wide as the wavelength of light used to create them. Part of the trick was to find a suitable photochromic material whose clear and opaque parts would remain stable after the initial exposure to light.

Using this method, the team produced lines just 36 nanometers wide, and say they could also place many such lines spaced a similar distance apart.

Such a technique "could have a significant impact on chip making," Menon says, and could also help to enable new work in a variety of emerging fields that rely on nano-scale patterning, including nanophotonics, nanofluidics, nanoelectronics, and nano-biological systems.

Already, a company has been formed to develop this technology, and Menon says he expects it to lead to commercial production within five years.

But that's not the only potential application of the approach. Menon says his team is pursuing possible use of the same system for imaging systems, which could enable new kinds of microscopes for observing at nanoscale resolution, with possible applications in biology and in materials science. At the same time, he is pursuing ways of using the technique to create even smaller patterns, down to the scale of individual molecules.

The work was partly funded by grants from LumArray Inc., where Menon is co-founder, the MIT Deshpande Center for Technological Innovation, and DARPA.

More to the waterfall illusion than meets the eye

Motion illusions reveal new insights into perception: How you feel the world impacts how you see it

Cathryn Delude
McGovern Institute

In the classic waterfall illusion, if you stare at the downward motion of a waterfall for some period of time, stationary objects — such as rocks — appear to drift upward. MIT neuroscientists have found that this phenomenon, called motion aftereffect, occurs not only in our visual perception but also in our tactile perception, and that these senses actually influence one another. Put another way, how you feel the world can actually change how you see it — and vice versa.

In a paper published in the April 9 online issue of Current Biology, researchers found that people who were exposed to visual motion in a given direction perceived tactile motion in the opposite direction. Conversely, tactile motion in one direction gave rise to the illusion of visual motion in the opposite direction.

"Our discovery suggests that the sensory processing of visual and tactile motion use overlapping neural circuits," explained Christopher Moore of the McGovern Institute for Brain Research at MIT and senior author of the paper. "The way something looks or feels can be influenced by a stimulus in the other sensory modality."

Volunteers watched visual motion on a computer screen while placing their right index fingertip on a tactile stimulator directly behind the screen. The stimulator consisted of a centimeter-square array composed of 60 pins to deliver precisely controlled vibrations to the fingertips. This stimulator, the only one of its kind in the world, was developed by Qi Wang, now at the Georgia Institute of Technology, and Vincent Hayward, now at the Université Pierre et Marie Curie in France.

To test the effect of visual motion on the subjects' perception of touch, the monitor displayed a pattern of horizontal stripes moving upward or downward for 10 seconds. After this visual pattern had disappeared, a single row of horizontal pins simultaneously vibrated the subjects' fingertips. Although the pins delivered a static burst of vibration, all eight subjects perceived that the row of pins was sweeping either upward or downward, in the direction opposite to the movement of the preceding visual pattern.

To test the effect of tactile motion on visual perception, adjacent rows of pins vibrated in rapid succession, creating the sensation of a tactile object sweeping up or down the subjects' fingertips. After 10 seconds of this stimulus, the monitor displayed a static pattern of horizontal stripes. Contrary to the prevailing assumption that vision always trumps touch, subjects perceived the stripes as moving in the opposite direction to the moving tactile stimulus.

Demos of the motion stimuli used in this study can be seen at http://web.mit.edu/~tkonkle/www/CrossmodalMAE.html.

"Aftereffects were once thought to reflect fatigue in the brain circuits," said Konkle, "but we now know that pools of neurons are continuously coding motion information and recalibrating the brain to its sensory environment. Our neurons are not tired, they are constantly adapting to the world around us."

Recent studies have found that a region of the visual cortex known as MT or V5 — long thought to play a major role in the perception of motion — may also process tactile motion. Moore's team intends to explore this brain region in future studies to determine whether it contributes to these cross-modal motion aftereffects.

"Neuroscientists study perceptual illusions because they help reveal how the brain gives rise to conscious experience," Moore said. "We don't experience the world through isolated senses, and our data support the emerging view that the brain is organized for cross talk among different sensory modalities."

The research was supported by the McGovern Institute for Brain Research at MIT, Mitsui Foundation, National Defense Science and Engineering Graduate Fellowship, Eric L. Adler Fellowship, Natural Sciences and Engineering Research Council of Canada, and McGill University.

PHOTO / JEROME PASQUERO, MCGILL UNIVERSITY

Above right: This stimulator was used in a study to show that how humans feel the world can actually change how they see it — and vice versa. The device consists of a centimeter-square array composed of 60 pins to deliver precisely controlled vibrations to the fingertips.

Cambridge Science Festival keeps on growing

Annual event, now in its 3rd year, begins April 25

Patrick Gillooly
News Office

The organizers of the rapidly growing Cambridge Science Festival — which will kick off its third year on April 25 — have ambitious plans for the future that include expanding the festival's outreach beyond just nine days each spring.

"There is every sign that the festival has become an established part of the calendar in Cambridge," says John Durant, director of the MIT Museum, which organizes the festival. "We're now talking about tens of thousands of people engaging with science and technology through the festival."

The festival, which aims to showcase and make accessible the wide range of scientific research going on across Cambridge, began in 2007, when approximately 15,000 people attended. In 2008, attendance ballooned to an estimated 28,000. That rapid growth has put a demand on physical space to house the festival's 200-plus events, and a desire to shift the scope of the festival's mission.

This year, for example, organizers have moved the popular Science Carnival — a free, all-ages event offering hands-on science experiments and live stage performances — from Cambridge City Hall to MIT's more spacious Kresge Auditorium. But Durant also envisions a future that goes beyond Cambridge: mobile units that bring interactive science and technology to schools around the state.

"It's about spreading curiosity. It's about engaging young people who maybe don't think of themselves as potential scientists and engineers of the future," he says. "If you have curiosity, then you have the key ingredient to be a scientist in the future."

The festival aims to encourage curiosity by featuring science and engineering celebrities such as Sally Ride, the first American woman in space. The former astronaut will lead a series of workshops for middle school students on Saturday, May 2 — an event organized by MIT's Department of Aeronautics and Astronautics.

With the world focusing on energy-related issues, the festival will also host "Meltdown: What Everyone Needs to Know and Do About Energy" (7 p.m., April 30, Cambridge City Hall), which will bring together experts from a variety of fields for a town hall forum on how to create a sustainable energy future. The forum will be led by Broad Institute Founding Director Eric Lander, a co-chair of the President's Council of Advisors on Science and Technology, and include MIT professors Ernest Moniz, Henry (Jake) Jacoby and Ronald Prinn, as well as Steve Morgan of the Cambridge Energy Alliance and Stephen Ansolabehere of Harvard.

As attendance has grown, so, too, has the number of MIT researchers willing to open their labs to the public during the festival, says P.A. d'Arbeloff, director of the festival.

PHOTO / **L. BARRY HETHERINGTON**

Harriette Crawford, left, Venola Bynoe, and Harriette's son Malik Crawford check out an intriguing vechicle in front of Cambridge City Hall during the first Cambridge Science Festival in 2007.

"There are so many wonderful things that are happening at MIT, and people sometimes have no clue," she says, adding that the festival "showcases some globally significant and remarkable research that is going on here. The people in those labs want to show the world what they are doing."

The festival's success has even spawned imitators. Organizers of San Diego's first citywide science festival, which took place several weeks ago, looked to MIT and the CSF for guidance in their planning, d'Arbeloff says.

Some of the festival's other highlights this year include:

- "The Brain Experience: Speaking of the Brain (6-9 p.m., April 28, 43 Vassar St.)
- "The Science of Baseball" (noon, May 3, Broad Institute);
- "NOVA: Meet the producers" (6:30 p.m., April 29, WGBH Yawkey Theater)
- "Third Annual Trivia Challenge!" (6-9 p.m., April 29, Stata Center)

Festival events, many of which are free, run daily from April 25 until May 3. For a complete list of events, visit http://cambridgesciencefestival.org/.

Are you smarter than a fifth-grader?

The Science Trivia Challenge, a contest hosted by the MIT Club of Boston, is a staple of the annual Cambridge Science Festival. It's a live team trivia quiz where contestants are challenged on their knowledge of science, technology and other subjects. This year, the event will be held from 6-9 p.m. on Wednesday, April 29, in the Stata Center.

The following are a series of questions from previous years in both the youth division (under 18) and the open division (any age).

YOUTH DIVISION #1

In 1984, two doctors in Perth, Australia, published their discovery that most stomach ulcers are caused not by stress but by a common spiral-shaped bacterium now known as Helicobacter pylori. This bacterium is able to survive in the human stomach because it releases enzymes that produce what?

(a) ammonia
(b) ethyl alcohol
(c) hydrochloric acid
(d) sodium chloride
(e) valine

YOUTH DIVISION #2

The new definition of a planet contains three criteria. For 5 points each, pick which two of the following are NOT part of the IAU's final definition of a planet:

(a) has an orbit around the Sun
(b) is by far the largest object its local population
(c) has enough self-gravity to assume a nearly-round shape
(d) has cleared the neighborhood around its orbit
(e) does not produce energy by a nuclear fusion mechanism

OPEN DIVISION #1

One of the biggest controversies in the history of mathematics was over who "invented" the field of calculus. Ultimately, Isaac Newton and Gottfried Leibniz were co-credited with inventing it independently of one another, while each accused the other of plagiarizing their work. However, the word "calculus" to describe the field was coined by Leibniz, and modern calculus mainly uses Leibniz' notations. What "f-word" did Newton use to describe his version of calculus?

(a) fasciations
(b) fissions
(c) flections
(d) fluxions
(e) fractions

Answers are at the bottom of the page.

The cover of last year's Institute Awards issue.

It's awards season

The MIT News Office will publish the 2009 Institute Awards issue in print (MIT Tech Talk) and online on June 3 this year. The annual special section lists winners of annual awards, by department, along with photographs where available.

Complete information on how to submit awards is available at http://web.mit.edu/newsoffice/awards.html, but please note that the deadline is 5 p.m. on Friday, May 22, in order to be included in the awards issue. Do not submit Infinite Mile Awards or awards from outside organizations.

Any and all photographs are also welcomed and can be e-mailed to gillooly@mit.edu. Please send them as attachments, in .jpg format with a resolution of 300 dpi if possible. Please clearly identify the subjects and include the name of the photographer, as we cannot run them without that information.

TRIVIA ANSWERS: 1. a, 2. b and e, 3. d

Dialect Detectives

System that distinguishes among variants in spoken languages could enhance automated machine translation

Dorothy Ryan
Lincoln Laboratory

PHOTO / **JON BARRON; LINCOLN LABORATORY**

Pedro Torres-Carrasquillo, shown here, is working on techniques for machine-based identification of dialects in a spoken language.

A law enforcement agency intercepts an international phone call alerting a suspected drug dealer to a new shipment. While the translator listening to the message is confident the caller's Spanish carries a South American accent, he cannot pinpoint a more specific region for agents to put under surveillance. But technology under development by Pedro Torres-Carrasquillo and his colleagues at Lincoln Laboratory may lead to a dialect identification system that compensates for a translator's inexperience with multiple variants of a spoken language.

Language identification systems that can recognize as many as 29 languages from written text are already marketed, and systems that can identify a spoken language from a prescribed range of choices also exist. So far, however, no system that automatically discriminates one spoken dialect from another is available.

Lincoln Laboratory's earlier work on dialect identification focused on building models that mapped the audio-wave frequencies of phonemes — the individual sounds of a spoken language. Torres-Carrasquillo, an electrical engineer specializing in speech processing in the laboratory's Information Systems Technology Group, says his group has more recently moved from this phonetic-based approach to lower-level acoustic systems that use the basic spectral similarities of small pieces of spoken utterances. "We are not looking for the types of data linguists deal with — larger units such as phonemes and words," he says. "We're looking at the statistical distributions of basic frequency spectra of small pieces of sounds."

The laboratory researchers are building a model that classifies the training data, finding markers that discriminate the frequency characteristics of the data. Previously, Torres-Carrasquillo says, the approach was to "get a lot of examples, and then build a model that looks like your examples." But he is tackling the problem in a different way. "Our group's idea is that we don't need a model that looks like our data — we need a model that can classify our data," he explains. "We take very small pieces — snippets of speech — turn them into frequencies, add up all these contributions, and make a model that can tell them apart. We're looking for patterns from just milliseconds of speech."

The researchers are using pattern recognition and classification methods known as support vector machines (SVMs) and Gaussian Mixture Models (GMMs) that use models trained to emphasize the more distinctive tiny features seen in the frequency patterns of small pieces of the dialects in question. The trained GMMs have the edge in accuracy, but SVMs are "an order of magnitude faster than the GMM," according to Torres-Carrasquillo. Even more effective than either SVMs or GMMs alone, he says, is combining the two techniques. In a test to discriminate general American English from Indian-accented English, for example, the error rate was 10 percent when GMM was used alone, 15 percent for SVM alone — and only 7 percent for a fusion of GMM and SVM.

To be incorporated into an automatic machine translation system, a dialect identification system would have to be able to recognize a dialect without having to process lengthy strings of speech data. Torres-Carrasquillo's goal is to be able to determine a speaker's dialect by categorizing discrete, characteristic markers in the snippets, and then create a model without using large sets of training data. "We'd love to see a short-term spectrum characteristic that is a strong discriminator, is very pervasive in the dialect, and that could be reliably detected in a sample," he says.

Finding this characteristic is a tall order. "You're not going to have a single spectrum characteristic that gives away the identification," Torres-Carrasquillo says. The linguistic differences between dialects of a language are often small; for example, vowel sounds in Cuban Spanish are slightly longer than those of Puerto Rican Spanish. The subtle differences between the spectral pictures of dialects are difficult to detect, especially in the milliseconds of speech used in the Laboratory experiments. "But as you look at the data" says Torres-Carrasquillo, "the differences start to pile up and you have a profile." The Laboratory's work to classify dialect differences, which Torres-Carrasquillo presented at a September 2008 speech communication and technology conference in Australia, may lead to the discovery of a strategy for any dialect problem — a global approach that could be exploited for various classes of dialects instead of a method that works only for specific dialects.

The Lincoln Laboratory research on dialect identification may contribute to approaches for language identification more generally, but Torres-Carrasquillo offers a caveat: "The differences one can exploit within two dialects are very specific — maybe too specific to be applicable to language ID." Still, when a universal machine translation system arrives on the scene in some future decade, it may well depend on Lincoln Laboratory research to ensure that nuances of meaning conveyed in dialects are not lost in translation.

PHOTO / **DONNA COVENEY**

Professor Dava Newman, shown here modeling the next generation of spacesuits, will address a special film series.

High-flying films and facts

Lectures add real science to reel versions of space travel and aviation

Did Stanley Kubrick really foresee the future of space exploration? How does a woman fighter pilot find her way around the boys' club of military flight school? What really happened on the Apollo 13 mission? On three Wednesdays in April, MIT Aero-Astro faculty — including a former fighter pilot, a former space shuttle astronaut and a designer of future space suits — will answer these questions and more as part of a special film and lecture series cosponsored by the Lecture Series Committee and Giant Leaps, an MIT celebration of the 40th anniversary of the first Apollo moon landing.

Professor Dava Newman, an aerospace engineering researcher who is working on designing the next generation of spacesuits, will lead off the series on April 15 with commentary on "2001: A Space Odyssey." Associate Professor Mary (Missy) Cummings, a former U.S. Navy fighter pilot, will be next, delivering her own perspective on "Top Gun" on April 22. The series will conclude on April 29 with former astronaut and current Professor of the Practice Jeffrey Hoffman's introduction to "Apollo 13." The introductions will start at 7 p.m., with screenings of the films to follow. All events will be held in 26-100 and are free and open to members of the MIT community.

The LSC is a student-run organization that has been bringing speakers and screened entertainment to the MIT community since 1944. For more information on Giant Leaps, visit http://apollo40.mit.edu.

CLASSIFIED ADS

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

HOUSING/FOR RENT

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

Belmont–Large elegant sunny furnished four bedroom with hardwood floors, dishwasher, disposal, two full baths (one with whirlpool tub), and front loading washer & dryer. Off-street parking and steps to public transportation. Easy commute to MIT. Excellent Belmont Schools. $3,250/month. Lease. No pets. Available September 1st. Contact 617-710-2724 or <stewart@wi.mit.edu>

2 Lakefront cabins for summer rental, Parker Pond, Casco, ME. Sandy beach,kayak, row boat, canoe, screen porch, 2bd1bath, kitchen, 125 miles from Boston. $700/week mid June-Sept. email chaplain@mit.edu.

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Maytag 45 pint dehumidifier. Can set humidity level and fan speed. Operating manuals available. $50. Call Ruth 3-4716

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Bread maker machine that can produce whole grain loaf. Please email me with details: make/model, condition, price. Thanks, tzh@mit.edu.

MUSIC: Celebration of Harbison's life showcases the importance of music at MIT

Continued from **Page 1**

quality," says Associate Provost and Ford International Professor of History Philip S. Khoury, who has known Harbison for nearly 30 years. "He is one of the world's most distinguished and musically versatile composers, and he has always been completely devoted to teaching and, as he would say, learning from our remarkably talented students."

An artist known for lucidity and logic in his compositions and performances, Harbison is equally adept at opera, choral and jazz. His Pulitzer Prize came in 1987 for his choral work "The Flight into Egypt," with text from the Gospel of Matthew. Two years later, he was awarded a MacArthur "genius" grant for his work, and in 1995 he became an Institute Professor — the highest honor MIT can bestow on a member of the faculty.

Harbison, who is currently working on music inspired by Alice Munro's short stories, says MIT students bring with them the right ingredients for studying, composing and performing music: high intelligence, logical thinking, interest in structure and a curiosity about how things are made. In true MIT spirit, he tells students to break new ground and take risks.

"Go out and write things that your teacher won't necessarily approve of," he advises.

Music on the Mind

Whether it's tinkering with music-editing software, performing in one of MIT's eight professionally led music groups or making brain waves audible, music at MIT can mean many things.

In the Department of Brain and Cognitive Sciences, associate professor Pawan Sinha and graduate students are working on way to create music and art from brainwaves.

Intrigued with the possibility of understanding how minds extract meaning from sounds, Sinha has charted the electroencephalographic (EEG) response of brain neurons to tone sequences. Using a form of video gaming headsets that pick up these brain signals and by associating them with specific sounds, Sinha eventually hopes to allow an individual to "perform" in an orchestra simply by thinking. Sinha is also designing a "Your Brain on Music" program in which a person would watch a shifting electronic projection of EEG signals that reflects his or her brain's response to a piece of music. And, in what is perhaps his most ambitious project, Sinha hopes to design a "Brain Jukebox" that would let listeners hear music through the transformational lens of another person's brain

Sinha's research is in line with MIT's emphasis on interdisciplinary collaborations — and he is not alone in melding music with basic or applied research. Elaine Chew SM '98, PhD '00, an engineer and pianist who has composed piano works based on mathematical models, says her engineering and music studies at MIT were entwined.

"There are deep connections between the way the human mind works when making music, and when it solves problems in the sciences," she says. "Asking if my music studies help my engineering studies is analogous to asking a computational biologist if her biological studies help her statistical studies."

Talented students, talented teachers

Chew's passion for music is fairly typical of the average MIT student. More than 60 percent of incoming freshmen declare advanced proficiency in a musical instrument, and at least 1,400 MIT students enroll each year in a music and theater arts class. As part of the Emerson Program for Private Instruction, the Institute offers scholarships each year to some 50 of its most talented scholar-musicians to pursue private instruction on their instrument with local master teachers.

While only a few MIT students eventually pursue a full-time career in music, many graduates incorporate performance or composing into their professional and private lives. Such alumni include Eran Egozy '95, MEng '95, and Alex Rigopulos '92, SM '94, who founded the company that created "Guitar Hero." This hugely popular video game emerged from the pair's interest in providing a way for average people to express themselves musically through technology.

"Students are engaged in music and the arts in general at MIT as they are with all their other academic work: with intensity, passion, commitment and rigor," says Fred Harris, director of wind ensembles and lecturer in music. "Over and over I am told by students and alums that it's the opportunity to explore, study, create and perform music that is among their most important, treasured and long-lasting experiences at MIT."

Janet Sonenberg, professor of theater arts and head of the Music and Theater Arts Section, says much of the credit for MIT's creative music spirit goes to Harbison, who made it possible to attract an "extraordinary" group of arts faculty to MIT. Harbison, in turn, praises MIT for seeking to hire faculty with new approaches instead of being merely content to hand the baton to professors cut from the same template.

Such hires include Evan Ziporyn, the Kenan Sahin Distinguished Professor of Music. In 1993, Ziporyn founded the Gamelan Galak Tika, a Balinese music ensemble, not because it was logical for the Institute to have such a group but because he thought it would fit the Institute's quirky, expansive nature. "The kind of person that is going to seek out a Gamelan is similar to the kind of person who is going to seek out a robot club to build robots," he says.

Teaching music at MIT was once thought to be about training the audiences of tomorrow, but today it's about letting students have all manner of musical experiences, says Ziporyn. Among other things, he has taught a course in computer music composition, in which students write music with computer-processed sound. Many of the students who take that course have little formal music training, but know far more about computers than he does, Ziporyn says.

"One of the things I always love about teaching a computer music course is I would have all students in there making pieces of really weird music," Ziporyn says. "They ended up realizing, 'I can write a piece of music. Maybe I'm not Mozart, but I can write a piece of music.'"

The Harbison celebration concert, which begins at 8 p.m., April 24 in Kresge Auditorium, is free and open to the public. For more information, please visit: http://web.mit.edu/arts/announcements/prs/2009/0212_Harbison.html

Some of MIT's music ensembles include, clockwise from top left, Rambax MIT, MIT Chamber Music Society, MIT Festival Jazz Ensemble, Gamelan GalakTika. Institute Professor John Harbison is shown in the top middle.

PHOTOS / **HAYDEN TAYLOR**