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TechTalk

S E R V I N G T H E M I T C O M M U N I T Y

Revised MIT climate model sounds alarm

New analysis shows warming could be double previous estimates

David Chandler
News Office

The most comprehensive modeling yet carried out on the likelihood of how much hotter the Earth's climate will get in this century shows that without rapid and massive action, the problem will be about twice as severe as previously estimated six years ago — and could be even worse than that.

The study uses the MIT Integrated Global Systems Model, a detailed computer simulation of global economic activity and climate processes that has been developed and refined by the Joint Program on the Science and Policy of Global Change since the early 1990s. The new research involved 400 runs of the model with each

run using slight variations in input parameters, selected so that each run has about an equal probability of being correct based on present observations and knowledge. Other research groups have estimated the probabilities of various outcomes, based on variations in the physical response of the climate system itself. But the MIT model is the only one that interactively includes detailed treatment of possible changes in human activities as well — such as the degree of economic growth, with its associated energy use, in different countries.

Study co-author Ronald Prinn, the co-director of the Joint Program and director of MIT's Center for Global Change Science, says that, regarding global warming, it is important "to base our opinions and policies on the peer-



IMAGE COURTESY OF THE MIT JOINT PROGRAM ON THE SCIENCE AND POLICY OF GLOBAL CHANGE

To illustrate the findings of their model, MIT researchers created a pair of 'roulette wheels.' The wheel on the left depicts their estimate of the range of probability of potential global temperature change over the next 100 years if no policy change is enacted on curbing greenhouse gas emissions. The wheel on the right assumes that aggressive policy is enacted.

reviewed science," he says. And in the peer-reviewed literature, the MIT model, unlike any other, looks in great detail at the effects of economic activity coupled with the effects of atmospheric, oceanic and biological systems. "In that sense, our work is unique," he says.

The new projections, published this month in the American Meteorological Society's *Journal of Climate*, indicate a median probability of surface warming of 5.2 degrees Celsius by 2100, with a 90 percent probability range of 3.5 to 7.4 degrees. This can be compared to a

median projected increase in the 2003 study of just 2.4 degrees. The difference is caused by several factors rather than any single big change. Among these are improved economic modeling and newer economic data showing less chance of low emissions than had been projected in the earlier scenarios. Other changes include accounting for the past masking of underlying warming by the cooling induced by 20th century volcanoes, and for emissions of soot, which can add to the warming effect. In addition, measurements of deep

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Robotic therapy promising for cerebral palsy

Devices can help children with brain injuries learn to grasp and manipulate objects

Anne Trafton
News Office

Over the past few years, MIT engineers have successfully tested robotic devices to help stroke patients learn to control their arms and legs. Now, they're building on that work to help children with brain injuries and disorders such as cerebral palsy.

"Robotic therapy can potentially help reduce impairment and facilitate neuro-development of youngsters with cerebral palsy," says Hernano Igo Krebs, principal research scientist in mechanical engineering and one of the project's leaders.

Krebs and others at MIT, including professor of mechanical engineering Neville Hogan, pioneered the use of robotic therapy in the late 1980s, and since then the field has taken off.

"We started with stroke because it's the biggest elephant in the room, and then started to build it out to other areas, including cerebral palsy as well as multiple sclerosis, Parkinson's disease and spinal cord injury," says Krebs.

The team's suite of robots for shoulder-and-elbow, wrist, hand and ankle has been in clinical trials for more than 15 years with more than 400 stroke patients. The Department of Veterans Affairs has just completed a large-scale, randomized, multi-site clinical study with these devices.

All the devices are based on the same principle: that it is possible to help rebuild brain connections using robotic devices that gently guide the limb as a patient tries to make a specific movement.

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“*Robotic therapy can potentially help reduce impairment and facilitate neuro-development of youngsters with cerebral palsy.*”

Hernano Igo Krebs
principal research scientist



PHOTO / PETER LANG

A young stroke patient tests an MIT-developed robotic therapy device at Blythedale Children's Hospital in Westchester County, N.Y.

Energy research is the key, Chu says

Energy secretary says new technology is essential to avert climate catastrophe

David Chandler
News Office

Steven Chu, the newly appointed secretary of the Department of Energy, said in a talk on May 12 at MIT that a major increase in basic research is necessary in the United States in order to provide the new energy technologies needed to avert catastrophic climate change.

Chu gave the Compton Lecture, the Institute's most prestigious lectureship, to a packed audience in Huntington Hall (10-250) and a packed overflow room (26-100) where people watched on closed-circuit television.

In introducing Chu, MIT President Susan Hockfield described the problem of addressing global climate change as "the challenge of a lifetime," requiring a national effort "like

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PEOPLE

Entrepreneurs, energy innovators

Ksplice, Husk Innovation win MIT \$100K Competition, \$200K Clean Energy Prize.

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RESEARCH & INNOVATION

Recession lessons

A watershed moment in economics and finance opens new avenues for scholarship.

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NEWS

Walking the talk with caulk

Students, faculty and staff from the MIT Sloan School of Management take the initiative to conserve energy.

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Events at MIT



Today

• **MIT Endicott House annual spring plant sale.** 9 a.m.-2 p.m. in McDermott Court. A selection of flowering plants, perennials, herbs, vegetables, earth boxes, fertilizers and upside-down tomato planters will be offered for sale. All items are reasonably priced and nurtured at our greenhouse. Members of the MIT Garden Club will be available to answer your gardening questions. The sale will continue on May 21 in Kresge Oval.

Thursday, May 21

• **Tech Community Crafters Spring Craft Fair.** 9 a.m.-5 p.m. in Lobby 10. Tech Community Crafters sale of hand-made soaps, wooden puzzles, jewelry, scrapbooking supplies and more.

• **Nanomaterials Manufacturing for Mechanical and Energy Applications.** Speaker: Dr. Z. F. Ren, Department of Physics, Boston College. 3-4 p.m. in 3-370.

• **The MIT Energy Club End-of-Year BBQ.** 6-8:30 p.m. in Sidney-Pacific Multipurpose Room. Come and celebrate a year of learning, networking, research, and entrepreneurship in energy with your friends in the MIT Energy Club. The theme for this year's event will be "free" energy devices and associated energy conspiracies.

• **Artist Talk with Duncan Campbell.** 7-8 p.m. in E15, Bartos Theater. Campbell will discuss his filmic work "Bernadette," which presents an unconventional yet insightful portrait of Irish dissident and political activist Bernadette Devlin.

Friday, May 22

• **Perspectives in Mathematics and Physics Conference.** 1-6:15 p.m. in 32-123. 'Perspectives in Mathematics and Physics' is in celebration of I.M. Singer's 85th birthday and his legendary contributions to mathematics and physics.

Tuesday, May 26

• **MIT Produce Market.** Noon-6 p.m. East Campus Courtyard, near Walker Memorial. The MIT Produce Market aims to make better nutritional options available by providing access to affordable, high-quality fruits and vegetables.

• **Opening Reception: Schnitzer Prize** in the Visual Arts Award Winners Exhibit. 4-6 p.m. in W20. Wiesner Student Art Gallery (2nd floor, Stratton Student Center). First Prize to Matthew Mazotta (G, Visual Arts Program); Second Prize to Jay Silver (G, Media Arts and Sciences); Third Prize to Jess Wheelock (G, Visual Arts Program) and Honorable Mention to Leah Brunetto '12.

Armed with caulk, they walk the talk

Showing that they can "walk the talk" on reducing the Institute's carbon footprint, students, faculty and staff from the MIT Sloan School of Management spent May 8 caulking windows in E52 in a bid to help conserve energy.

Organized by John Sterman, the Jay W. Forrester Professor of Management and director of MIT System Dynamics Group, a group of students, faculty and staff used 60 tubes of caulk to fill gaps between the sashes and frames of windows throughout the building. Among those participating were Dean David Schmittlein and Deputy Dean JoAnne Yates.

Sterman noted that the windows in E52 are original and in quite poor shape, and should be replaced with state-of-the-art high-performance glazing — something that likely won't happen until a full reno-

vation of the building is done.

"In the meantime, caulking saves energy and also creates a great opportunity to involve the entire Sloan community in a project that truly expresses the 'Mens et Manus' spirit of MIT," Sterman said. "Everyone had a great time, and those with no prior experience learned a skill they can use to save energy in their own homes."

Working until they exhausted their supply, group members caulked all of the windows on the fourth and sixth floors and some on the first and fifth floors — efforts that should save MIT at least \$4,400 per year in natural gas costs, according to an estimate by MBA student Adam Siegel.

Sterman hopes to organize another caulking party in the fall to finish the rest of the windows.

Sterman noted that while he organized the event, many others were responsible for making it happen, including Joe Vella, Paul Motroni, Bernie Richards and John DiFava of the Department of Facilities, and Robert Planutis of the Faculty Club. Sterman credited Schmittlein for his support and "for letting the group practice their caulking skills on the windows in his office first."



PHOTO / SARAH FOOTE

MIT Sloan School of Management Dean David Schmittlein uses caulk to seal up the windows in E52 to help conserve energy.

'Babylon 5' creator visiting MIT on May 22

J. Michael Straczynski, the creator of the cult science fiction series "Babylon 5," will deliver this year's Julius Schwartz Lecture, an annual event held to honor an individual who has made significant contributions to the culture, creativity and community of comics and popular entertainment.

The second-annual lecture, hosted by the Comparative Media Studies program, will take place at 7 p.m. on Friday, May 22, in 10-250.

Straczynski was one of the first television producers to actively engage his fan community online and has consistently explored the interface between digital media and other storytelling platforms. He wrote most of the 110 "Babylon 5" episodes, including an unbroken 59-episode run.

Tickets are required for the event, and can be purchased online at <http://cms.mit.edu/juliuschwartz/tickets.html> or at Hub Comics in Somerville and Comicopia in Boston's Kenmore Square. For more information, visit <http://cms.mit.edu/juliuschwartz/>.

Faculty meeting today

A regular meeting of the faculty will begin at 3:30 p.m. today in Room 10-250. The agenda is as follows:

- A vote on the nominations slate;
- A vote on the motion to implement changes to the HASS requirement;
- A vote on the motion on the governance of minor in energy;
- A vote on the motion to change Section 1.32 of "The Rules and Regulations of the Faculty";
- Motion to change the September student holiday;
- A collaborative education and research opportunity in Singapore;
- Election of the members of the faculty Ex Officiis;
- Recognition of faculty members moving to the rank of professor emeritus;
- A report from the Killian Award Selection Committee;
- Motion on the elimination of varsity sports;
- Remarks/questions from and for the president and provost.

Obituaries

Phokion Karas, RLE staff photographer, 88

Phokion Karas, a noted architectural photographer and a staff photographer who spent 18 years at the Research Laboratory of Electronics died March 25 at his home in Newburyport. He was 88.

Karas was known for his photography of landmark buildings in New England, and his photos were published worldwide. He was born in Haverhill, Mass., to Greek immigrants and was educated in area schools. He served with the U.S. Army during World War II in U.S.-based POW camps and worked for MIT before opening his own photography studio.

He is survived by three daughters, Thessaly Karas of Quincy, Katina Stuart of Waukegan, Ill., and Miriamne Karas of Boston; and a son, Michael Karas, of Redding, Calif.

Sharon Trohon, AO in mechanical engineering, 62

H. Sharon Trohon, administrative officer of the Department of Mechanical Engineering, died May 11 after a courageous battle with cancer. She was 62.

Trohon began her career at MIT in 1974 in the Office of Sponsored Programs and in 1980 transferred to the Lab for Architecture and Planning, where she was promoted from financial administrator to administrative officer (AO). In 1989, she joined the School of Engineering as AO in the Department of Ocean Engineering. Since 2001, Trohon served as AO in the Department of Mechanical Engineering.

Trohon was recognized for her excellence in 2004 when she received an SoE Infinite Mile Award. She consistently demonstrated an enviable ability to perfectly balance kindness and assertive-

ness. Trohon believed firmly that the sole objective of department administration was to support the faculty and students and she constantly reminded the staff of this goal by her personal example. She was a great teacher and methodically ensured that all who supported faculty and students had the tools and the training they needed to do so in the best way possible.

Trohon is survived by her children, Miranda and Nick, of Danvers; her daughter-in-law, LeeAnne; grandchildren Brendan and Zachary; her three sisters, Doreen, Paula, and Becky; a brother, Robert; and numerous nieces, nephews, cousins, aunts and uncles.

Donations may be made in Trohon's name to Hospice of the North Shore, 75 Sylvan St., Suite B-102, Danvers, MA 01923, or to the American Cancer Society, 30 Speen St., Framingham, MA 01701.

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PHOTOS / JUSTIN KNIGHT

ABOVE: Sen. Tom Carper, D-Del., hosts a nuclear waste discussion at MIT on May 18. BELOW: The panel discussion included nuclear experts (from left): Charles Forsberg, MIT; Matthew Bunn, Harvard; Ernest Moniz, director of MIT Energy Initiative; Andrew Kadak, MIT; and Carper.

Waste, or energy resource?

Panel weighs options on disposal of spent nuclear fuel

David Chandler
News Office

A panel of nuclear power experts met on Monday, May 18, at MIT to discuss how to address nuclear waste recycling or disposal, which many analysts consider the biggest obstacle to building a new generation of nuclear power plants across America.

The meeting, convened by Sen. Tom Carper (D-Del.), came on the heels of last week's decision by the Obama administration to end the planning for Yucca Mountain, Nev., as the final repository for high-level radioactive material from all of the nation's nuclear power plants. The planned facility had drawn strong opposition in Nevada, but some of the panelists questioned that decision and suggested that Yucca Mountain should at least remain as an option for possible use.

Carper, who chairs the Senate Subcommittee on Clean Air and Nuclear Safety, said that "over the last 30 years, the American public has dramatically shifted its views on nuclear power" and is now much more receptive to it as an option. But, he added, waste disposal is the "elephant in the room" in discussions of nuclear power.

"We need another Manhattan Project to figure out what to do with all of the spent fuel," he said. The 104 existing U.S. power reactors are expected to generate a total of more than 105,000 metric tons of high-level waste over their operating lifetimes, which under currently planned disposal methods would require a subsurface storage facility of more than 1,700 acres — about twice the size of New York's Central Park. At present, all of the waste is stored at the sites of the plants that produced it.

All four of the panelists — Charles Forsberg, director of the Fuel Cycle Study in MIT's Department of Nuclear Science and Engineering, Matthew Bunn, associate professor of public policy at Harvard's JFK School of Government, Ernest Moniz, director of the MIT Energy Initiative, and Andrew Kadak, professor of the practice of nuclear engineering at MIT — agreed that contrary to much public perception, the issue of waste disposal is not urgent. The present system of storing spent fuel in "dry casks" on the sites of the power plants can safely be left in place for several decades, perhaps even for a century, they said.

"There is no significant technological reason to implement permanent fuel disposal now," Moniz said. "We have time."

But deciding on the best policy for storing this material depends on reaching a clear decision as to what the nation ultimately wants to do with it, said Forsberg. "We do not know today if spent fuel is waste, or the nation's most important energy resource," he said, pointing out that current reactor operations, using a "once through" fuel cycle, only extract about 1 percent of the fuel's energy, and that it could be reprocessed to harness much more of that potential.

Deciding the best course of action for dealing with nuclear waste in the long run has at least as much to do with politics as with technology. "Siting and operation of a repository is as much an institutional challenge as a scientific challenge," Forsberg said. And Kadak suggested that even though President Obama has called for canceling the Yucca Mountain repository, "Yucca is still available. Do we really want to start over?" The process of studying and selecting that site has taken "a generation," he said, and starting again could create a similar delay.

Confusing the issue?

But Moniz cautioned that any effort to move toward nuclear fuel reprocessing today could seriously hamper efforts to stimulate the construction of a new generation of nuclear power plants. "The number one issue now is the first-mover nuclear plant construction," that is, the first new plant to break the more than 25-year hiatus in construction of any new plants in this country.

While new designs for safer, more efficient plants have been developed, it will require actually going through the process of permitting, building and operating the

first new plant to convince investors the new systems are practical, Moniz said. "What will it take?" to get a new plant approved, he asked. "What will it cost? We don't know that yet." And, he said, "any discussion of moving to reprocessing now only confuses the issue."

Bunn added that even though reprocessing systems may be developed that would allow the efficient reuse of nuclear fuel, that is not the case today. Using today's reprocessing technology, he said, "I think it would be wasteful to proceed. Today, reprocessing is more expensive than not reprocessing," and also presents greater risks for nuclear proliferation and terrorism, and would actually decrease the nation's energy security.

"Those who are in favor of a new future for nuclear power should oppose reprocessing," he said. But, he added, things might change in the future if new reprocessing methods are developed: "Today, we don't know what the best fuel cycle might be down the road. Further research on advanced fuel cycles is called for."

Moniz said that MIT's in-depth study on the future of nuclear power, originally issued in 2003, said that in order to make a serious contribution to alleviating global climate change, the world would need new nuclear plants with a total capacity of at least a terawatt (or one million megawatts). With current policies, "we are not on a trajectory toward a terawatt," he said. A new, updated version of the 2003 study has just been posted on the MIT Energy Initiative's web page, he said.

What is most needed now, Moniz said, is "a robust research program on advanced fuel cycles" as well as other aspects of nuclear technology, totaling \$500 million per year.



Events
at MIT



Wednesday, May 27

- **"Plant Adaptogens in Modern Medicine."** Speaker: Mahtab Jafari, U.C. Irvine. Noon-1 p.m. in 68-181. Adaptogens are natural products synthesized by plants under stress that may have medical benefits for humans. Dr. Jafari will discuss general characteristics of adaptogenic plants and using *Rhodiola rosea* as an example will present data on their health benefits.

- **"Graduate Research Symposium in Organic and Bioorganic Chemistry."** 1-5 p.m. in 6-120.

Thursday, May 28

- **The Third International Conference on Complementarity, Duality, and Global Optimization.** 7 a.m.-6 p.m. in 32-123, 32-124, 32-141. The primary goal of this conference is to bring together mathematicians, engineers, and scientists from a variety of scientific disciplines who are working on complementarity, duality, convex and nonconvex optimization in nonlinear systems, engineering mechanics, and computational methods, with an emphasis on applications in science and engineering.

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.

Deadline approaching to submit awards for inclusion in the Institute Awards issue

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 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.

No Tech Talk until June 3

There will be no Tech Talk next week on Wednesday, May 27, because of the Monday Memorial Day holiday. We will resume publishing on Wednesday, June 3, which will include the annual Institute Awards supplement.

RECESSION LESSONS

A WATERSHED MOMENT IN ECONOMICS AND FINANCE
SPARKS NEW DIRECTIONS FOR SCHOLARSHIP

Stephanie Schorow
News Office

A year ago, MIT economics graduate student Alp Simsek was suffering from low spirits and burn-out as he struggled to determine his PhD thesis topic. He wanted a meaningful research project that explained something important about real-world economics, but he couldn't seem to develop an innovative research framework. Then the economic crisis hit, and Simsek saw significant new avenues for scholarship opening up. His energy returned.

Simsek's experience — or something akin to it — is not unique among the faculty and students in MIT's Department of Economics and the MIT Sloan School of Management. While acknowledging the public pain of the credit crunch, mortgage crisis and banking failures, many acknowledge that it's an exciting time to study economics. The prolonged recession has opened up new areas for research and encouraged innovative approaches to teaching economics.

"This is intellectually fascinating for many of us," says Ricardo Caballero, head of the Department of Economics and the Ford International Professor of Economics, describing the market shocks and subsequent policy moves of the past six months. "My financial wealth has declined, but my human wealth has increased."

The recession may be prompting more people to seek graduate degrees in economics or MBAs. Applications to Sloan last fall rose 28 percent from the previous year, while the Department of Economics saw a more than 10 percent increase in graduate applications last fall and expects applications to jump again this year.

Moreover, the urgent questions now squarely facing economists are affecting how economics is taught, says Kristin J. Forbes, associate professor of international management at Sloan.

"For example, I started a new class, 'Global Economic Challenges,' this year that was initially going to focus on longer-term challenges for the global economy such as aging populations, global warming, the rise of emerging markets, and oil and commodity markets," Forbes says. "As the crisis started to unwind last year, I adjusted the course so that this winter we spent about half the course studying financial crises — the causes, solutions, consequences and ways to predict and avoid them. Students were very interested in the course and it provided the tools to help evaluate the current global crisis."

Simon Johnson, the Ronald A. Kurtz Professor of Entrepreneurship at Sloan, structured a fall semester class around "The Baseline Scenario," an economics blog he had launched with James Kwak, a consultant and Yale Law School student. The only assigned reading for the class was the blog, which tracked the deepening financial crisis. "People from outside MIT could post questions that we would then take up in our classes, which were webcast so that anyone in the world could watch," Johnson says. The result was a spirited and informative dialogue available to both students and a public becoming increasingly aware of economic issues, he says.

"Economists recognize how painful and wrenching the experiences of an economic downturn like the one we are currently experiencing can be for households and firms, but they also find that times like this create a lot of new research questions," says James M. Poterba, the Mitsui Professor of Economics and president of the National Bureau of Economic Research.

Many of those research questions are related to the banking sector, because recent events have challenged conventional wisdom about the operation of banks, Poterba says.

"Ever since the end of World War II, the opinion got spread around that the financial system had learned to protect itself against the risk of instability. I think what we've now learned is that we haven't yet succeeded in doing that," says Robert Solow, Department of Economics professor emeritus.

Economics graduate student Jennifer La'O is among those examining the new pressures facing banks. For her

thesis, she is analyzing how predatory trading — trading that exploits the need of other investors to reduce their asset positions — may make it almost impossible for large banks to raise capital in times of financial distress. This may explain why, for example, now-bankrupt Lehman Brothers waited so long to look for extra capital, she says.

Today, ailing banks that are actually solvent or could be

saved may fail because of predatory behavior, says La'O, whose interest in this area was triggered by the collapse of Bear Stearns in March 2008.

"It is still too early to say how much predatory trading has contributed to the current financial crisis," she says. "I do, however, feel that this type of strategic behavior is likely playing a large role in exacerbating the current crisis."

Caballero said at least seven economics faculty and graduate students, including Simsek, are pursuing research topics inspired, in part, by current events.

Before the financial crisis hit, Simsek had been considering a thesis on the effect of entrepreneurship on economic growth. "Then came the

economic crisis and brought with it new issues which could be studied using the economic methodology," he says. Among the questions he asked in the wake of last year's chaos on Wall Street was whether new financial instruments such as sub-prime mortgage-backed securities and their derivatives — assets created ostensibly as a way to decrease market risk — had actually increased risk.

"An economic model reveals that these instruments may lead to so much speculative betting that they may actually increase the risk in financial markets," he says. "It's like Wall Street goes to Vegas."

“ECONOMISTS RECOGNIZE HOW PAINFUL AND WRENCHING THE EXPERIENCES OF AN ECONOMIC DOWNTURN LIKE THE ONE WE ARE CURRENTLY EXPERIENCING CAN BE FOR HOUSEHOLDS AND FIRMS, BUT THEY ALSO FIND THAT TIMES LIKE THIS CREATE A LOT OF NEW RESEARCH QUESTIONS.”

James Poterba
Mitsui Professor of Economics, NBER president

Small RNAs yield great amounts of data from ocean microbe samples

Denise Brehm

Civil and Environmental Engineering

An ingenious new method of obtaining marine microbe samples while preserving the microbes' natural gene expression has yielded an unexpected boon: the presence of many varieties of small RNAs — snippets of RNA that act as switches to regulate gene expression in these single-celled creatures. Before now, small RNA could only be studied in lab-cultured microorganisms; the discovery of its presence in a natural setting may make it possible finally to learn on a broad scale how microbial communities living at different ocean depths and regions respond to environmental stimuli.

"Microbes are exquisite biosensors," said Edward DeLong, a professor of civil and environmental engineering (CEE) and biological engineering. "We had developed this methodology to look at protein-encoding genes, because if we know which proteins the microbes are expressing under what conditions, we can learn about the environmental conditions and how these microbes influence those. The unexpected presence and abundance of these small RNAs, which can act as switches to regulate gene expression, will allow us to get an even deeper view of gene expression and microbial response to environmental changes.

DeLong and co-authors Yanmei Shi, a graduate student in CEE, and postdoctoral associate Gene Tyson described this work in the May 14 issue of *Nature*. The team used a technique called metatranscriptomics, which allows them to analyze the RNA molecules of wild microbes, something that previously could be done only with lab-cultured microbes.

Microbes are ultra-sensitive environmental sensors that respond in the blink of an eye to minute changes in light, temperature, chemicals or pressure and modify their protein expression accordingly. But that sensitivity creates a quandary for the scientists who study them. Sort of like the observer effect in quantum physics, by entering the environment or removing the microbes from it, the observer causes the microbes to change their protein expression. That same sensitivity makes some of these creatures exceedingly difficult to grow in lab cultures.

To overcome the hurdle of quickly collecting and filtering microbial samples in seawater before the microbes change their protein expression, the research team — collaboratively with CEE Professor Sallie (Penny) Chisholm and her research team, which has successfully grown and studied the photosynthetic microbe, *Prochlorococcus*, in the lab — created a method for amplifying the RNA extracted from small amounts of seawater by modifying a eukaryotic RNA amplification technique.

When Shi began lab studies of the RNA in their samples, she found that much of the novel RNA they expected to be protein-coding was actually small RNA (or sRNA), which can serve as a catalyst or regulator for metabolic pathways in microbes.

"What's surprising to me is the abundance of novel sRNA candidates in our data sets," said Shi. "When I looked into the sequences that cannot be confidently assigned as protein-coding, I found that a big percentage of those sequences are non-coding sequences derived from yet-to-be-cultivated microorganisms in the ocean.

This was very exciting to us because this metatranscriptomic approach — using a data set of sequences of transcripts from a natural microbial community as opposed to a single cultured microbial strain — opens up a new window of discovering naturally occurring sRNAs, which may further provide ecologically relevant implications."

"We've found an incredibly diverse set of molecules and each one is potentially regulating a different protein encoding gene," said DeLong. "We will now be able to track the protein expression and the sRNA expression over time to learn the relevance of these little switches."

If we think of marine bacteria and their proteins as tiny factories performing essential biogeochemical activities — such as harvesting sunlight to create oxygen and synthesize sugar from carbon dioxide — then the sRNAs are the internal switches that turn on and off the factories' production line. Their discovery in the ocean samples opens the way to learning even more detailed information in the lab: the researchers can now conduct lab experiments to look at the effects of environmental perturbation on microbial communities. These new sRNAs also expand our general knowledge of the nature and diversity of these recently recognized regulatory switches.

"Being able to track the dynamics of small RNA expression in situ provides insight into how microbes respond to environmental changes such as nutrient concentration and physical properties like light and pressure," said Shi. "A very interesting question to follow up in the lab is how much fitness advantage a small RNA confers to microbes. Can the microbes with a specific small RNA perform better in competing for nutrients in a tough situation, for instance? The discovery of naturally occurring small RNAs is a first step towards addressing such questions."

This work was supported by the Gordon and Betty Moore Foundation, the National Science Foundation and the U.S. Department of Energy.

ROULETTE: Climate change odds worse than thought

Continued from Page 1

ocean temperature rises, which enable estimates of how fast heat and carbon dioxide are removed from the atmosphere and transferred to the ocean depths, imply lower transfer rates than previously estimated.

Prinn says these and a variety of other changes based on new measurements and new analyses changed the odds on what could be expected in this century in the "no policy" scenarios — that is, where there are no policies in place that specifically induce reductions in greenhouse gas emissions. Overall, the changes "unfortunately largely summed up all in the same direction," he says. "Overall, they stacked up so they caused more projected global warming."

While the outcomes in the "no policy" projections now look much worse than before, there is less change from previous work in the projected outcomes if strong policies are put in place now to drastically curb greenhouse gas emissions. Without action, "there is significantly more risk than we previously estimated," Prinn says. "This increases the urgency for significant policy action."

To illustrate the range of probabilities revealed by the 400 simulations, Prinn and the team produced a "roulette wheel" that reflects the latest relative odds of various levels of temperature rise. The wheel provides a very graphic representation of just how serious the potential climate impacts are.

"There's no way the world can or should take these risks," Prinn says. And the odds indicated by this modeling may actually understate the problem, because the model does not fully incorporate other positive feedbacks that can occur, for example, if increased temperatures caused a large-scale melting of permafrost in arctic regions and subsequent release of large quantities of methane, a very potent greenhouse gas. Including that feed-

back "is just going to make it worse," Prinn says.

The lead author of the paper describing the new projections is Andrei Sokolov, research scientist in the Joint Program. Other authors, besides Sokolov and Prinn, include Peter H. Stone, Chris E. Forest, Sergey Paltsev, Adam Schlosser, Stephanie Dutkiewicz, John Reilly, Marcus Sarofim, Chien Wang and Henry D. Jacoby, all of the MIT Joint Program on the Science and Policy of Global Change, as well as Mort Webster of MIT's Engineering Systems Division and D. Kicklighter, B. Felzer and J. Melillo of the Marine Biological Laboratory at Woods Hole.

Prinn stresses that the computer models are built to match the known conditions, processes and past history of the relevant human and natural systems, and the researchers are therefore dependent on the accuracy of this current knowledge. Beyond this, "we do the research, and let the results fall where they may," he says. Since there are so many uncertainties, especially with regard to what human beings will choose to do and how large the climate response will be, "we don't pretend we can do it accurately. Instead, we do these 400 runs and look at the spread of the odds."

Because vehicles last for years, and buildings and power plants last for decades, it is essential to start making major changes through adoption of significant national and international policies as soon as possible, Prinn says. "The least-cost option to lower the risk is to start now and steadily transform the global energy system over the coming decades to low or zero greenhouse gas-emitting technologies."

This work was supported in part by grants from the Office of Science of the U.S. Dept. of Energy, and by the industrial and foundation sponsors of the MIT Joint Program on the Science and Policy of Global Change.



PHOTO / DONNA COVENEY

From left to right, Mort Webster, professor in the engineering systems division; Adam Schlosser, principal research scientist at the Center for Global Change; Ronald Prinn, director of MIT's Center for Global Change Science and the TEPCO Professor of Atmospheric Chemistry; and Sergey Paltsev, principal research scientist, MIT Energy Initiative.

THERAPY: Robots help children learn

Continued from Page 1

When the researchers first decided to apply their work to children with cerebral palsy, Krebs was optimistic that it would succeed, because children's developing brains are more plastic than adults', meaning they are more able to establish new connections.

The MIT team is focusing on improving cerebral palsy patients' ability to reach for and grasp objects. Patients handshake with the robot via a handle, which is connected to a computer monitor that displays tasks similar to those of simple video games.

In a typical task, the youngster attempts to move the robot handle toward a moving or stationary target shown on the computer monitor. If the child starts moving in the wrong direction or does not move, the robotic arm gently nudges the child's arm in the right direction.

Krebs began working in robotic therapy as a graduate student at MIT almost 20 years ago. In his early studies, he and his colleagues found that it's important for stroke patients to make a conscious effort during physical therapy. When signals from the brain are paired with assisted movement from the robot, it helps the brain form new connections that help it relearn to move the limb on its own.

Even though a stroke kills many neurons, "the remaining neurons can very quickly establish new synapses or reinforce dormant synapses," says Krebs.

For this type of therapy to be effective, many repetitions are required — at least 400 in an hour-long session.

Results from three published pilot studies involving 36 children suggest that cerebral palsy patients can also benefit from robotic therapy. The studies indicate that robot-mediated therapy helped the children reduce impairment and improve the smoothness and speed of their reaching motions.

The researchers applied their work to stroke patients first because it is such a widespread problem — about 800,000 people suffer strokes in the United States every year. About 10,000 babies develop cerebral palsy in the United States each year, but there is more potential for long-term benefit for children with cerebral palsy.

"In the long run, people that have a stroke, if they are 70 or 80 years old, might stay with us for an average of 5 or 6 years after the stroke," says Krebs. "In the case of cerebral palsy, there is a whole life."

Most of the clinical work testing the device with cerebral palsy patients has been done at Blythedale Children's Hospital in Westchester County, N.Y., and Spaulding Rehabilitation Hospital in Boston. Other hospitals around the country and abroad are also testing various MIT-developed robotic therapy devices.

Krebs' team has focused first on robotic devices to help cerebral palsy patients with upper body therapy, but they have also initiated a project to design a pediatric robot for the ankle.

Among Krebs' and Hogan's collaborators on the cerebral palsy work are Dr. Mindy Aisen '76, former head of the Department of Veterans Affairs Office of Research and Development and presently the director and CEO of the Cerebral Palsy International Research Foundation (CPIRF); Dr. Joelle Mast, chief medical officer, and Barbara Ladenheim, director of research, of Blythedale Children's Hospital; and Fletcher McDowell, former CEO of the Burke Rehabilitation Hospital and a member of the CPIRF board of directors.

MIT's work on robotic therapy devices is funded by CPIRF and the Niarchos Foundation, the Department of Veterans Affairs, the New York State NYSCORE, and the National Center for Medical Rehabilitation Research of the Eunice Kennedy Shriver National Institute of Child Health and Human Development.

A renaissance in logistics for economic growth

Five years into program, MIT know-how continues to transform Zaragoza



PHOTO / ZARAGOZA ALTA VELOCIDAD; S.A.

An aerial shot of part of the Plataforma Logística de Zaragoza (PLAZA), the largest logistics park in Europe, which was designed through a partnership with MIT. The Zaragoza Logistics Center, a new research institute established through the partnership with MIT, is also based in the middle of the logistics park.

Ken Cottrill

MIT Center for Transportation and Logistics

When it comes to stimulating economic growth, the key to future expansion can sometimes be found in the past. Earlier this decade, the government of Aragón in northern Spain realized that its economy had become too reliant on a small number of industries, such as auto manufacturing, and that it needed to diversify. Zaragoza, the capital city of Aragón, has been an international crossroads for commerce since it was founded in the year 24 B.C. by Caesar Augustus, and the new economic engine that the government chose to develop is rooted in this tradition: logistics.

The government's strategic plan was to transform the region into a logistics hub for Europe not only in terms of the physical movement of goods, but also in terms of education and research. Logistics is the lifeblood of international commerce, responsible for delivering the countless products that people need at the right time and in the right quantities in markets around the globe. According to the Council for Supply Chain Management Professionals, business logistics costs in the United States alone amounted to \$1.4 trillion in 2007, more than 10 percent of the country's GDP. Moreover, logistics is a major industry in its own right that employs many different types of service providers, supports costly assets such as ports and trucking fleets, and uses advanced technology such as radio frequency identification systems.

But Aragón needed domain expertise to help it bring its plan to reality, so in 2003 the government partnered with the MIT Center for Transportation and Logistics (CTL) to create the MIT-Zaragoza International Logistics Program.

In the five years since the plan was implemented, the region has developed Plataforma Logística de Zaragoza (PLAZA), the largest logistics park in Europe. The park covers an area of almost 13 million square meters — big enough to house 19 MIT campuses. PLAZA provides the infrastructure and services that companies need to distribute goods internationally. Global retailer Zara has built a state-of-the-art distribution center there. Other top companies that have located in PLAZA include toy retailer Imaginarium and worldwide logistics company DHL. A new intermodal hub has been constructed and more than 100 companies have set up operations in the park.

In addition, the partnership created the Zaragoza Logistics Center (ZLC), which has become one of Europe's leading centers for supply chain research and education. The ZLC master's degree, modeled on an MIT CTL Master of Engineering in Logistics (MLOG) program, has been expanding since its inception in 2003, and attracted more than 200 applications for the class of 2009, comprised of 33 students from 14

countries. The MIT-Zaragoza PhD program was launched in 2004 and now features a summer doctoral academy attracting professors and PhD students from top programs around the world.

A new ZLC building is being constructed in PLAZA that will house this "startup university" dedicated to studies in logistics and supply chain management. PLAZA's bustling logistics community amounts to a living laboratory for education and research, providing unique opportunities for experimentation and interaction. At the same time, the ZLC allows companies in the logistics park to stay on top of state-of-the-art supply chain management and training concepts and hire world-class graduates.

But perhaps most significant for the government of Aragón is the success of its strategy to harness logistics as a driver of economic performance. The 3.3 percent annual GDP growth rate for the region since 2003 is almost double that of the European Union overall, and has supported job growth of 23 percent during the same period. Even in a slowing global economy, Aragón's industrial sector remains stronger than the rest of Spain, the EU and the United States, with a growth rate of 1.5 percent in 2008. A more direct indicator of the growing logistics sector is the number of commercial trucks registered in Aragón, which more than doubled between 2002 and 2007.

MIT President Susan Hockfield visited the ZLC in 2007 and saw firsthand the impact MIT had on the growth of the Aragón community.

"This is an example of MIT making a significant positive change in the economics of an entire region through innovative research, education and partnership with industry and government," she said.

The strategy is also opening up opportunities not usually associated with the logistics of moving goods. Take just two examples: energy and health care. Renewable energy sources such as wind and solar are intermittent and tend to be located far away from population centers. A ZLC research project, which is supported by Spanish wind power company Acciona, is looking at ways to deliver this energy cost-effectively to end consumers. ZLC has also become a major center for research in global health, developing ways to improve the delivery of essential medicines for diseases such as malaria, HIV/AIDS, and TB in resource-constrained environments. The center recently won funding from the Bill & Melinda Gates Foundation to study the most effective way to forecast the demand for global health products.

In recognition of these achievements, the regional government has granted MIT the 2009 Aragón International Prize, one the two most prestigious awards given annually by the government. Professor Yossi Sheffi, director of MIT CTL, accepted the award on behalf of MIT on April 23.

CHU: Energy secretary discusses how technology is essential to avert climate catastrophe

Continued from Page 1

the Apollo program, but raised by a few orders of magnitude." And in addressing that challenge, she said, Secretary Chu is now "the director of mission control."

Chu, who won the Nobel Prize for his work on cooling and trapping atoms with laser beams, is the first Nobel laureate ever to hold a U.S. cabinet position, and the first working scientist ever appointed as head of the Energy Department. Already, his department has been charged with implementing "the largest and most significant investment in science and technology since Apollo," Hockfield said.

Chu began his talk by describing various measures of the pace of recent climate change, emphasizing that the changes being seen now — including the rate of decline in Arctic sea ice, and the rate of rise of global sea level — are already either at, or even beyond, the most extreme projections made by the Intergovernmental Panel on Climate Change of the United Nations.

"We're skirting the outer limits of the range" of predicted changes, he said. "Things that were said a decade ago are coming true, but a little bit faster" than had been expected.

The projections now say there is a "significant probability" of an increase of 6 degrees Celsius or more by the end of this century, he said. The difference between today's average temperatures and those during the last ice age, when much of North America and Europe were buried under more than a mile of ice, was about 6 degrees Celsius, he said. "Six degrees means a profound difference in climate."

And it could get even worse: Carbon has been getting stored in the frozen tundra for millions of years, he said, and if temperatures rise to a certain point, that carbon will begin to be released to the atmosphere as the ground thaws. That process could quickly reach a point where the carbon emissions from the thawing permafrost could exceed all the emissions from human activity, he said.

"Then it takes on a life of its own, it's out of our control. That's a tipping point you don't want to go near."

With that dire outlook, he said, "Is there a reason for hope? I think there is."

To explain that hope in the face of such bleak projections, he cited the example of Paul Ehrlich's 1968 book "The Population Bomb," which predicted that hundreds of millions of people would starve in the 1980s and 1990s because human population was growing too fast for food production to keep up. But technical advances — fourfold or better improvements in crop yields resulting from the "green revolution" — prevented the predicted food shortages from occurring.

Similarly, new technologies should be able to forestall the worst projections of climate change, he said, as long as they are developed soon enough.

To curb the emissions of greenhouse gases, he said, "energy efficiency and conservation are number one." He cited the example of how refrigerators have changed in the last few decades as a result of efficiency standards that were imposed, over the strenuous objections of the appliance industry. Even though people have been buying ever-larger refrigerators, their efficiency has improved by a factor of four, so their overall energy use has been cut in half — and so, contrary to the makers' claims, has their cost.

"They're cheaper, they use less energy and they got bigger," Chu said. As a result, the energy savings just from this one type of appliance already exceeds the total energy production from all renewable energy sources combined, he said.

"Can we do better? Yes, we can do much better," he said. For example, creating a set of energy standards for

new buildings, comparable to the refrigerator energy standards that were imposed in the 1970s and 1980s, has the potential to cut the nation's greenhouse emissions by about a third. "This is truly low-hanging fruit," he said.

In other areas, such as more cost-efficient solar cells, he said, "what we're looking for is transformative technology." He said what is needed is a massive research effort, comparable in approach to the innovative research produced in the past by private research facilities like AT&T's famed Bell Laboratories, which spawned some of the 20th century's most important advances such as the

transistor and helped usher in the modern computer age.

Similar large-scale focused research is now needed for the development of technologies that will have a direct, beneficial impact on the environment. "I am," he said by way of example, "very optimistic we'll get very good batteries in five years or so." Major efforts are also needed, he said, in biologically based energy, such as using microbes to produce fuel for transportation. "We need to use nature as inspiration, but go beyond nature."

By solving such technical challenges, he suggested, today's scientists and engineers could "win a Nobel prize, and save the world at the same time." Showing an image of the Earth taken by Apollo astronauts, he said, "It's our home. Let's take care of it."

The first step, he said, will be the massive work of evaluating the many proposals submitted for grants under the new funding for research that is part of the government's economic stimulus package. He suggested that students could take a leave of absence to work for the Energy Department in evaluating these proposals. "We need the best help we can get," he said.

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Can we do better?
Yes, we can do much better.
Energy Secretary Steven Chu
on making more energy-efficient goods

Ksplice software update project wins MIT \$100K competition

Global Cycle bike adapter is audience pick

David Chandler
News Office

Top honors this year in the 20th annual MIT \$100k Entrepreneurship Competition went to Ksplice, a system that promises to end the annoyance and delays of having to reboot a computer every time a new update is installed. The \$100,000 award was made, to thunderous applause, in a presentation at Kresge Auditorium on May 13.

In addition to the top prize, audience members voted for their top pick among the six finalists (selected from a record-breaking 260 initial entries) by texting their choice using their cell phones. The winner by a wide margin, announced just minutes after the voting, was a team called Global Cycle Solutions, which has devised a set of attachments that can be bolted onto an ordinary bicycle to perform useful tasks and earn money for farmers and village-level entrepreneurs in developing nations. The team received a \$10,000 Audience Choice prize.

The Ksplice project, which the five-member team incorporated as a business last summer, had its roots nearly three years ago when team member Jeff Arnold '07, MEng '08 was working on MIT's servers and had to deal with a security update that arrived midweek. He decided to delay installing it until the weekend to avoid downtime while the servers were in heavy use. Unfortunately, the delay resulted in a security breach that required reinstalling all the system software.

Team member Waseem Daher '07, MEng '08, co-founder and COO of Ksplice, described the evolution of the company in a column posted May 13 on the Boston business news web site Xconomy. After the unfortunate experience, Daher wrote, Arnold worked on developing a solution to the problem, which became the basis for his award-winning master's degree thesis. While rebooting after every update is an annoyance for individual computer users, it can have a significant impact in lost time for those

operating large server farms or for corporate or institutional IT departments, where hundreds or thousands of computers need to be updated at a time. "The need is ubiquitous," Daher said.

While the Ksplice updating system is currently only available for computers running Linux, Daher said the code is written in a way that should make it very easy to transfer to Mac and Windows operating systems. The company also includes Tim Abbott '07, SM '08, Anders Kaseorg '08, and current graduate student Nelson Elhage '09.



PHOTO / NASSIBU

Mwanafunzi Leyeyo pedals as Mwalimu Charles (teacher Charles) and Mwanafunzi Paul put maize through a mobile maize sheller developed by Global Bicycle Solutions. The team won the audience-choice award of \$10,000 for their project.

to village selling services, or renting out the specially equipped bicycles to farmers to use for processing their own crops. Besides Wu, the team includes Semyon Dukach SM '93, Caroline Hane-Weijman '11, Lisa Tacoronte '10, and graduate students Javier Lozano and Alex Shih.

Over the 20 years of its existence, the MIT \$100k Competition (which started as a \$5,000 contest and has grown over the years) has led to the creation of more than 120 companies with \$12.5 billion in market value, and created 2,500 jobs, the organizers say.

More than 900 people participated in this year's teams, and the winners garnered a total of \$265,000 in unrestricted prize money.

Global Bicycle Solutions, winner of the audience choice award, has developed a simple system that can be attached to an ordinary bicycle to enable its pedal power to be used for other functions, such as removing kernels from corn, grinding grain or charging cell phones. Team member Jodie Wu, a senior in mechanical engineering, started working on the idea during work in villages in Tanzania last summer, and developed it further last fall in an MIT class called Development Ventures, where the team came together.

By allowing a corn crop to be processed 40 times faster than with conventional hand shelling, the device can pay for itself within just two weeks. The system allows local entrepreneurs to make money in three different ways: Making and selling the add-on attachments for bicycles, using those attachments to go from village

Husk Insulation wins \$200,000 MIT Clean Energy Prize

University of Michigan team focused on advanced bio-based insulation; MIT's Levant Power is runner-up

A team from the University of Michigan has been selected from more than 100 student entries from 40 colleges and universities to receive the \$200,000 MIT Clean Energy Grand Prize, sponsored by NSTAR and the U.S. Department of Energy.

Husk Insulation, from the University of Michigan, plays in the rapidly growing market for advanced insulation, part of the \$7 billion U.S. insulation market. Husk's innovative and patented solution converts agricultural waste into cost-effective vacuum insulated panels, a type of high-grade insulation that delivers up to 10 times the insulative effectiveness of conventional insulation.

Husk answers the global demand for energy by delivering energy efficiency that could ultimately reduce U.S. energy consumption by more than 57 billion kilowatt-hours. Husk's products will ultimately serve a variety of markets, including refrigeration, housing and transportation.

Levant Power, an MIT team that has developed and patented a novel technology to improve a vehicle's fuel economy by harvesting waste energy in the suspension, was the runner-up in the MIT Clean Energy Prize competition. As the competition's top MIT team, Levant secured a spot in the finals of the MIT \$100K Entrepreneurship Competition, which were held the day after the MIT Clean Energy Prize results were announced (see story at left).

The MIT Clean Energy Prize competition is a national program focused on students to accelerate the pace of clean energy entrepreneurship. It provides capital resources and support to help the next generation of entrepreneurs jumpstart a business venture on an emerging clean energy innovation with significant market potential.

"The competition this year has really taken hold as the premier clean energy entrepreneurship competition in the world — run for and by students. Its role to accelerate the pace of clean energy innovation is the vision that MIT, NSTAR and the DOE had when the competition was founded just last year," said Bill Aulet, competition chairman and senior lecturer at the MIT Sloan School of Management.

The MIT Clean Energy Prize was administered in partnership with the MIT \$100K Entrepreneurship Competition, which has facilitated the birth of more than 85 companies and created more than 2,500 jobs since its launch 20 years ago.

For further information on the MIT Clean Energy Prize, go to www.mitcep.org.

MIT researchers make magazine's list of '100 most creative'

Fast Company magazine has named Joseph F. Coughlin, director of MIT's AgeLab, Neri Oxman, a graduate student in MIT's Media Lab, and Peter Senge, senior lecturer at the MIT Sloan School of Management, to its inaugural list of the "100 Most Creative People in Business."

In its June issue, the magazine lauds Coughlin's research as being "devoted to using smart technology to bolster older folks' quality of life." Oxman, who graces the magazine's cover, is described as an "artist, architect, ecologist, computer scientist and designer who is not just making new things but also coming up with new ways to make things."

Senge SM '72, PhD '78, the founding chair of the Society for Organizational Learning, is cited by the magazine as providing "the ultimate decoder ring for CEOs who wanted to apply collaboration and systems theory in the workplace."

Fast Company's list — which includes Jonathan Ive, senior vice president of Industrial Design at Apple, Melinda Gates of the Bill & Melinda Gates Foundation, and Michele Ganeless, president of Comedy Central — features at least three others with MIT connections.

They include chemist George Whitesides, formerly an MIT professor and now at Harvard; former MIT economics professor Susan Athey, now Microsoft's chief economist and a professor at Harvard University; and inventor Saul Griffith SM '01, PhD '04.

The list is "a snapshot of the range and depth of creativity across our business landscape — a remarkable and perhaps surprising source of strength in these times of turmoil," says Fast Company Editor Robert Safian.

The June issue of Fast Company is currently on the stands; profiles of those featured on the list can be viewed at www.fastcompany.com.

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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MISCELLANEOUS

Sidewalk Sale: Sat. May 23 from 9-1, 102 Hampshire St. (near Windsor): condo building Spring-cleaning, from junk to jewels. (rain date Sun.) mross@mit.edu.

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.



GOING FOR BROKE

PROFESSOR SAYS VEGAS GAMBLING MACHINES DESIGNED TO GET PEOPLE TO 'PLAY TO EXTINCTION'

Stephanie Schorow
News Office

Natasha Schull recalls how in the late 1990s she began observing people in Las Vegas transfixed for hours at video poker and slot machines. What, she wondered, kept them glued to machines until they lost all they had to lose?

After more than a decade of research that included lengthy observations and interviews focused on gambling machines, Schull is publishing her conclusions on how closely guarded, proprietary mathematical algorithms and immersive, interactive technology are used to keep people gambling until they — in the industry jargon — “play to extinction.”

Now an assistant professor in MIT's Program in Science, Technology, and Society, Schull believes her research underscores just how addictive today's sophisticated gambling machines have become, something to consider when states are increasingly looking to legalized gambling as a revenue source, often by allowing video poker or slot machines at bars, horse tracks or other locations. Indeed, estimates indicate that a large majority of the revenue from the U.S. gambling industry — reported as \$92.3 billion in 2007 by the American Gaming Association — come from such machines.

“I see Las Vegas as a kind of laboratory where experiments are going on between people and machines,” says Schull, a cultural anthropologist whose book on gambling, “Machine Zone: Technology Design and Gambling Addiction in Las Vegas,” is scheduled to be published by the Princeton University Press in 2010.

Key to understanding Schull's conclusions is what she calls “the zone,” a dissociative state or trance in which players lose a sense of time, space and physical embodiment, consumed totally by the spinning numbers, symbols or electronic card hands before their eyes. Because gambling machines

don't require social interaction (as is the case in table games such as poker), they let people get into and stay in a state that is not dissimilar to, but far more intense than, watching TV; players describe the zone as a compelling, mesmerizing condition of intense concentration — an almost out-of-body experience. Heavy machine gamblers come to crave this state, says Schull.

There's a “wrong-headed notion” that gambling addicts are motivated by the idea of winning, Schull says. While that may be part of the initial hook, the allure of winning soon fades. The allure of the zone doesn't. “It's about wanting to keep playing,” she says. “People will actually get disappointed or irritated if they win a jackpot because it may freeze up the machine and interrupt their flow. Then they have to sit there until they lose it. Walking away with the jackpot is not an option.”

Some players are content to not win for long dry stretches if there's a chance for a big jackpot. But what seems to be compelling to most people and thus most profitable to casinos, is play that produces a constant flurry of little wins, Schull says. Most players will stay on a machine longer if this is happening. One designer told Schull, “Some people want to be bled slowly.” To create a kind of game that renders a stream of small wins, designers build machines with increasingly complicated playing options, allowing players to bet on multiple one lines of cards or symbols — sometimes even diagonally, on zigzag lines, or in “scatter mode,” Schull says. Money in a single play can be spread out among dozens of bets, thus almost insuring that something will hit, even if the payback is only a few cents.

These high-intensity gambling machines are played with magnetic-stripe player cards instead of coins, and they no longer feature the pull-handles of traditional one-armed bandits. Instead, they have been upgraded with haptic touch screen technology that creates “a sense of transaction” and helps keep players in the zone, Schull says. Video poker

machines, which have been called the “crack cocaine” of gambling machines, further intensify this sense of transaction by adding an element of choice to the game.

And then there's the furniture. “Seats are a whole science unto themselves,” she says. Casino chairs are designed with the right tilt to reduce eye fatigue and to avoid cutting off circulation in limbs. Just as factories may seek ways to keep their workers on the assembly line, the aim of casino gambling technology is to keep people playing faster and longer, but instead of requiring them to bend their bodies and motions to its rhythm, this technology bends itself to the rhythm of the players, Schull says.

Schull says casinos soon will have machines that are the equivalent of a shell in which different games with different payout patterns and symbols can be quickly downloaded from an online server to more closely match the player demographic information that casinos routinely collect. “If you have a certain demographic coming in on Sunday morning that likes a certain kind of game, you'll be able to adjust your game offerings with the press of a button,” she says.

To write “Machine Zone,” Schull interviewed players and game designers and spent hours observing machine play in casinos, grocery stores and gas stations. She also spent time in an outpatient gambling addiction clinic and interned with an experimental drug trial for video poker addicts. She attended trade shows where game manufacturers freely discussed how to increase what they call “time on device.”

Schull emphasizes that the gambling industry's intent is, very simply, to generate revenue: “I don't think that the designers are sitting around, saying, ‘Let's addict people,’” she says. She insists she is not anti-gambling. But Schull believes that any community considering gambling should know how the technology works and how it affects behavior.