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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

MIT GEARS UP FOR 143RD COMMENCEMENT



Deval Patrick, governor of Massachusetts, will deliver the principal address at MIT's 143rd Commencement exercises Friday morning, June 5, in Killian Court.

Patrick was the first in his family to attend college; he graduated from Harvard University with honors in 1978 and entered Harvard Law School in 1979. President Bill Clinton appointed Patrick assistant attorney general for civil rights in 1994, and he was elected as the first African-American governor of Massachusetts

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PHOTO / DONNA COVENEY

New collaboration to strengthen nanotechnology research

The International Iberian Nanotechnology Laboratory (INL) and the Massachusetts Institute of Technology began on Saturday, May 30, a major new collaboration that will enrich each institution's research activities in nanoscience and nanotechnology.

The two institutions will create MIT-INL, a new education and research enterprise focusing on nanotechnology. The collaboration will create 10 senior research positions for scientists who will launch an aggressive new nanotechnology research agenda, and it will enable approximately \$35 million (25 million euro) of new sponsored research at MIT in its first five years. José Rivas, director-general of INL, and Subra Suresh, dean of engineering at MIT, formalized the agreement at a signing ceremony on Saturday in Lisbon.

This is the INL's first major alliance with an American academic institution. Conceived in 2005–06, founded in 2007, built in 2008–09 and opened in 2009, INL is an international research facility located in Braga, Portugal, and is a joint project of the governments of Portugal and Spain. The MIT-INL agreement leverages the Institute's especially strong reputation in materials science, engineering, nanotechnology and biotechnology.

"INL is the first nanotechnology laboratory in the world with international legal status," said INL Council President, Luis Magalhães. "We offer in nanotechnology an open and flexible environment for researchers of any nationality to work together in world-leading projects." Models for the MIT-INL collaboration can be found in other international laboratories such as CERN in

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MIT Alumni Association names new executive vice president

Judith M. Cole, associate vice president for university advancement and director of alumni relations at Carnegie Mellon University, is set to become the next executive vice president and chief executive officer of the MIT Alumni Association in early August.

"The Alumni Association volunteer leadership and I could not be happier that Judy has agreed to take on the position of EVP," says Kenneth Wang '71, who begins his tenure as president of the MIT Alumni Association July 1. "We believe that the yearlong selection process has led us to an outstanding candidate for this key position. Judy's wealth of experience at the highest level of the educational community will hold her, and us, in good stead as we move into a changeable, yet exciting, future."

Cole has worked in roles of increasing responsibility in alumni relations for two respected institutions, first at Yale University for 17 years and then at Carnegie Mellon University (CMU) for the past five years. At CMU, she revitalized the alumni relations program in anticipation of a major fundraising campaign. She worked to strengthen the alumni board and to increase alumni engagement. As the director of education and services of the Association of Yale Alumni, she focused on educational programs, graduate school alumni relations, liaisons with alumni offices in Yale's 11 professional schools and the development of revenue-producing programs.

Throughout these experiences, Cole has sought to

strengthen the connection between an institution and its alumni by increasing participation in social and intellectual events, encouraging activities such as mentoring students, and reaching out during annual giving campaigns.

"Alumni relations is about community building. Through the partnership of volunteers and staff, the

campus community is expanded to become a university community that incorporates alumni into the life of the institution. Alumni are not an external audience—they are part of the family," says Cole, who was a colleague of President Susan Hockfield's when both held positions at Yale. "President Hockfield is an extraordinary community builder. The opportunity to work with her again and to contribute to this remarkable educational community is a great gift. I am honored and humbled by the confidence of the Alumni Association Board."

Cole earned a master's degree in public and private management at the Yale School of Management and a bachelor's in business administration at the University of Colorado. She held positions at the Boston Consulting Group, AT&T Bell Laboratories and Texas Commerce Bank early in her career.

"The news that Judy Cole agreed to be the CEO and executive vice president of the Alumni Association made my day!" says MIT Alumni Association President

Toni Schuman '58. "After a long search, I know we've found absolutely the best person to lead our incredible staff and engage the 120,000 living alumni around the world."



PHOTO COURTESY OF JUDITH COLE

Judith Cole, the incoming EVP and CEO of the MIT Alumni Association.

PEOPLE

Jaenisch wins Killian Award

Biology professor, pioneer in mammalian developmental genetics awarded annual honor.

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RESEARCH & INNOVATION

Early listening

MIT researchers develop earlier and easier way to hear a fetal heartbeat.

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NEWS

MIT returns to the moon

Institute celebrating the 40th anniversary of the Apollo moon missions on June 10-12.

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Awards & Honors

MIT Press director on list of top women in book publishing

Ellen W. Faran, director of MIT Press, was named among Book Business magazine's first list of the "50 Top Women in Book Publishing", which recognized and honored industry leaders who affect and transform how publishing companies do business. Faran has led MIT Press' exploration of open-access publishing and the expansion of its programs in digital media, information science and life sciences.

CEE's Buyukozturk named corresponding fellow of the RSE

In recognition of his multidisciplinary work in fundamental fields, including the mechanics of structures and materials for sustainable civil infrastructures, Professor Oral Buyukozturk has been elected a Corresponding Fellow of the Royal Society of Edinburgh, Scotland's national academy of science and letters. Corresponding Fellows are internationally distinguished non-resident fellows of the society.

The award citation mentioned Buyukozturk's leading role in the improvement and advancement of engineering education in the U.S. and abroad; and his pioneering research in the mechanics of concrete and advanced composite materials, the mechanics of infrastructure deterioration and assessment, and on the remote non-destructive testing of bridges and other structures using electromagnetic waves.

Mei honored at symposium

Colleagues, friends and former students honored Chiang C. Mei, the Ford Professor of Engineering in the Department of Civil and Environmental Engineering, at a special symposium June 1-2 during the 28th International Conference on Ocean, Offshore and Arctic Engineering in Honolulu. Designed as a celebration of his accomplishments over the last 45 years, the C.C. Mei Symposium on Wave Mechanics and Hydrodynamics included 10 sessions and more than 50 papers.

EAPS PhD student wins CFUW award

The Canadian Federation of University Women awarded Kate Harris, a PhD candidate in the Department of Earth, Atmospheric and Planetary Sciences, with this year's CFUW 1989 École Polytechnique Commemorative Award, valued at \$7,000.

Jaenisch wins faculty's Killian Award

Stephanie Schorow
News Office

Rudolf Jaenisch, professor of biology and a founding member of the Whitehead Institute, is MIT's James R. Killian Jr. Faculty Achievement Award winner for 2009-2010.

The award was announced at the Wednesday, May 20, faculty meeting.

A pioneer in the field of mammalian developmental genetics, Jaenisch helped found the area of transgenic science, the science of gene transfer for making mouse models, which is now widely used for studying human genetic diseases.

"This work became the foundation for his subsequent research and discoveries in stem cell biology, mammalian cloning, and the epigenetic regulation of gene expression — work which has opened up new horizons in stem cell therapy and regenerative medicine," said Terry Knight, professor of design and computation and chair of the Killian Award selection committee, reading from the award citation.

Established in 1971 as a tribute to MIT's 10th president, the Killian Award recognizes extraordinary professional accomplishment by an MIT faculty member. The winner is asked to deliver a lecture in the spring term.

The award was "totally unexpected," Jaenisch said. "I think recognition from your colleagues, from your institution, is in a totally different category than an award from outside. It's much more of a honor."

Jaenisch received his doctorate in medicine from the University of Munich in 1967. Before coming to the Whitehead Institute in 1984, he was head of the Department of Tumor Virology at the Heinrich Pette Institute at the University of Hamburg. He has co-authored more than 375 research papers and has received numerous awards, including the Boehringer Mannheim Molecular Bioanalytics Prize in 1997, the first Gruber Prize in 2001, the Koch Prize in 2002, the Brupbacher Foundation Cancer Research Prize in 2003, the Max Delbrück Medal in 2006, the Vilcek Prize in 2007, and the Massry Prize in 2008.

Jaenisch "has made landmark contribu-

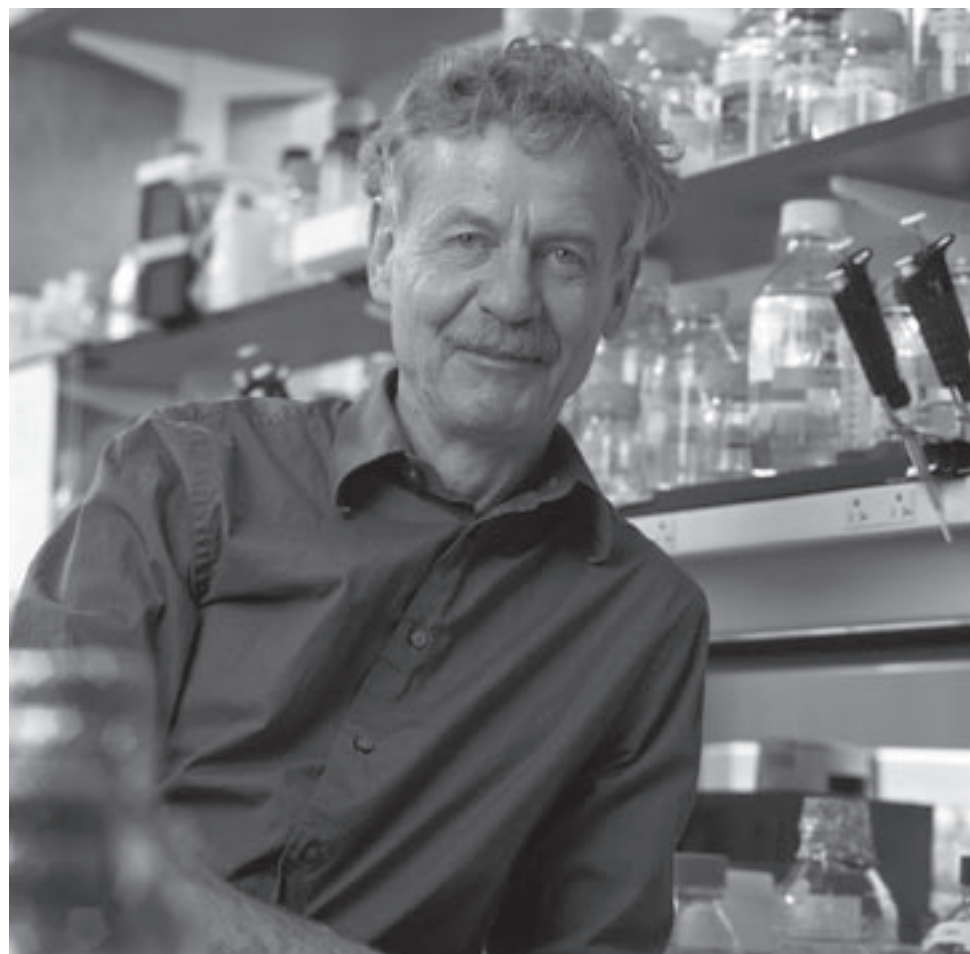


PHOTO / SAM OGDEN/WHITEHEAD INSTITUTE

Rudolf Jaenisch, professor of biology and founding member of the Whitehead Institute.

tions to his field year after year, decade after decade, throughout his 40-year career," Knight said.

His most recent breakthrough is in cellular reprogramming. He has developed strategies for reprogramming fully differentiated adult cells into induced pluripotent stem cells, or IPS cells, which have the capability to grow into any cell type in the body. This work has enormous potential for the study and possible treatment of human diseases, through the possibility of growing healthy cells from a patient's own cells, according to the award citation.

Jaenisch has taken part in the debates

surrounding cloning, and has helped to educate the public on the distinctions between therapeutic cloning, which involves the use of stem cells for curing disease, and reproductive cloning.

In addition to Knight, the Killian Award selection committee for 2009-2010 included faculty members Thomas J. Greytak, the Lester Wolfe Professor of Physics; Rebecca M. Henderson, the George Eastman Kodak LFM Professor of Management in the MIT Sloan School of Management; John J. Hildebidle, professor of literature; and Alan V. Oppenheim, the Ford Professor of Engineering.

Obituaries

Swami Sarvagatananda, former chaplain for MIT Hindu students, 96

Cyrus Mehta
Office of Religious Life

Swami Sarvagatananda, a former chaplain for Hindu students at MIT who touched the lives of thousands of community members during his 45 years at the Institute, died on May 4. He was 96.

Swami Sarvagatananda was born in 1912 in Andhra Pradesh, India, and joined the Ramakrishna Order as a monk in 1935. He came to the United States in October 1954, a time in which religious activity on most American campuses was confined to Christianity and Judaism. At the time, MIT President James Killian had initiated the construction of a chapel in which all the religions of the world were invited to worship. Swami Sarvagatananda was invited to the chapel's dedication ceremony on May 8, 1955, and subsequently began his long tenure as an MIT chaplain.

For the next 45 years, until he retired in 2000, the swami faithfully served the MIT community with great love and dedication. The swami's Friday evening classes at the MIT Chapel on the Bhagavad Gita, a sacred Sanskrit Hindu scripture, provided a fresh outlook, much-needed balance and respite from a week of MIT's grueling course work.

The swami gave the inaugural prayer for the investiture of President Paul Gray, and the invocation for several MIT Commencement exercises. On Oct. 4, 1996, MIT organized a



Swami Sarvagatananda, a former chaplain for Hindu students at MIT, delivers the invocation at the 1998 Commencement ceremonies.

PHOTO / L. BARRY HETHERINGTON

special celebration in his honor, recognizing the spiritual leader for being, among many attributes, "a store of wisdom and strength for this community."

Prior to coming to the United States, Swami Sarvagatananda served the Ramakrishna Order for several years in various capacities; in a hospital in the foothills of the Himalayas serving poor and illiterate people; in Karachi, offering shelter to victims of the Hindu-Muslim violence at the time of the partitioning of India and Pakistan; and as warden of students at a major university in southern India.

During his time in America, Swami Sarvagatananda also served as the head of the Ramakrishna Vedanta Societies of Boston and Providence. Harvard University invited him to join its Harvard-Radcliffe United Ministry in 1984.

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MIT teams win U.S. Department of Defense grants

A pair of major grants from the U.S. Department of Defense will support MIT research on building ultra-fast microchips for computation and communications, as well as research on new electronic surveillance systems.

The grants, given out under a program called the Multidisciplinary University Research Initiative, were among 41 awarded nationwide with a total value of \$260 million.

Five MIT researchers, led by Principal Investigator Michael Strano, the Charles and Hilda Roddey Associate Professor of Chemical Engineering, along with colleagues at Harvard and Boston University, received a \$5 million, five-year grant from the Office of Naval Research (ONR) for work on building a new

generation of ultra-fast (terahertz) microchips from graphene, a form of carbon. Co-directors of the project are Assistant Professor of Physics Pablo Jarillo-Herrero, on the physics side, and Assistant Professor of Electrical Engineering Tomas Palacios on the engineering side. The project also includes Assistant Professor of Electrical Engineering Jing Kong, and Institute Professor Mildred Dresselhaus, as well as physicists Charles Marcus and Amir Yacoby of Harvard and physicist Antonio Castro Neto of BU. This grant, says Palacios, will make MIT and its collaborators "one of the strongest multidisciplinary teams working on graphene in the world."

The other MIT team to receive a grant, also from ONR, is headed by Daniela Rus, professor of computer science and engineering and associate director of the Computer Science and Artificial Intelligence Laboratory. Rus' team, which also includes researchers from Boston University, University of California, Berkeley, and University of Pennsylvania, will focus on a project called Smart Adaptive Reliable Teams for Persistent Surveillance (SMARTS).

In addition to the two major, MIT-led teams receiving grants, seven other DoD grants went to teams that also include MIT researchers.



MIT's youngest graduates

When the Technology Children's Center opened in the Stata Center in the summer of 2004, it was the first center to offer infant care on campus — and these four children were among its first enrollees. Now, almost five years later, they are graduating to kindergarten. From left to right they are Ness Hoch, Alexander Ferguson, Henri Richter and Katheryn Anne Prather.

PHOTO / DONNA COVENEY

MIT-INL: School of Engineering launches research collaboration

Continued from Page 1

Geneva, for particle physics, and EMBL in Heidelberg, for molecular biology.

"The INL aims to promote nanoscience and nanotechnology through strategic collaborations that can lead to practical applications," said Rivas. "This bilateral co-operation between MIT and INL represents a watershed for both institutions, and it opens a number of opportunities for increasing competition, new research projects, and the potential for mobility and exchange between researchers."

"This new collaboration provides a unique opportunity for faculty and students at MIT to engage in exciting new fundamental research with the potential for great societal impact," said Suresh, who is a bio-nanotechnology researcher as well as the Ford Professor of Engineering at MIT. "This enterprise will build on MIT's world-renowned expertise in nanotechnology, and it will help create a major new international research center that will draw talent from all over Europe and beyond."

As part of the first step in their collaboration, the organizers of MIT-INL have already selected a number of current MIT research projects, in the Microsystems Technology Laboratories and the Materials Processing Center, to benefit from MIT-INL. These projects include research on nanoparticles that can selectively adsorb water contaminants, autonomous microsystems that can move around water supplies and sense contaminants (while sustaining themselves on power scavenged from their environments), new materials for energy storage, revolutionary tools and technologies for monitoring our food supply, and others.

There will be an Institute-wide call for additional proposals in the near future. MIT faculty will also play a key role in helping develop new capabilities at the INL facilities, and in the training programs for scientists and students on the MIT campus and at the INL. In addition, INL will immediately begin recruiting senior researchers to work in new applications and technologies in nanoscience and nanotechnology.

Professor Anantha Chandrakasan, director of the Microsystems Technology Laboratories, will serve as MIT's inaugural director of MIT-INL; Professor Carl Thompson, director of the Materials Processing Center, will serve as co-director. They will work closely with Paulo Freitas, deputy director-general of INL.

Small materials, big potential

MIT-INL to tackle several nano-research projects

Imagine a future where tiny systems much smaller than the head of a pin help monitor our water supply for pollutants and, if such pollutants are detected, remove them. Engineering nanoparticles for environmental applications such as this is one of the research projects to be tackled by the MIT-International Iberian Nanotechnology Laboratory, a new collaboration formally launched on May 30.

"This program will bring together researchers in materials, devices, circuits and systems. Such an interdisciplinary approach will allow the realization of fully self-powered microsystems that demonstrate unprecedented levels of performance ... and power in a variety of emerging applications such as biomedical devices, detection of toxins in water, and food quality control," said Anantha P. Chandrakasan, MIT's inaugural director of the MIT-INL. Chandrakasan, the Joseph F. and Nancy P. Keithley Professor of Electrical Engineering, is also director of MIT's Microsystems Technology Laboratories.

Other projects to be enabled through the collaboration, which Chandrakasan emphasizes will explore not only nanomaterials and devices but also how to integrate them in systems, include:

- Creating new microsystems based on graphene, a form of the element carbon that is just a single atom thick. The material's unique physical properties — for example, it has a very high electron mobility, a measure of how easily electrons can flow within it — could allow advanced sensors for the detection of single molecules of pollutants and more.
- Coaxing nanoparticles or biomolecules to self-assemble into complex nanostructured devices with precisely tailored chemical or biological responses. Key to this particular work: engineered templates to guide the process.
- Developing ways to process and package lead zirconate titanate (PZT), a material that could allow nanodevices to harvest minute sources of energy from their environment. Such devices could then power themselves.

LFM renamed 'Leaders for Global Operations' program

Broadened focus builds upon strengths in operations

The MIT Leaders for Manufacturing (LFM) program is being renamed the Leaders for Global Operations (LGO) program, reflecting an expansion from its historically broad understanding of manufacturing to encompass all aspects of operations. The program will continue to build on its strengths in production and logistics, as well as on the consistent number one rankings given to MIT School of Engineering and the MIT Sloan School of Management's Operations Management Group in U.S. News & World Report magazine's annual evaluation of graduate programs.

"As LFM has succeeded over the 20 years since it was founded by MIT Sloan, the MIT School of Engineering, and industry, our understanding of manufacturing has broadened considerably to include critical operations across the entire supply chain," said David Simchi-Levi, professor of civil and environmental engineering and engineering systems and LGO co-director from the MIT School of Engineering. "We believe operations excellence to be a core element of national competitiveness and the basis for advancement in developing countries."

After an extensive research process involving all the program's constituencies, the LGO Governing Board approved the change in name and mission. The board also directed LGO to address operations challenges beyond such traditional manufacturing sectors as automotive, aerospace, and high-tech manufacturing, to include supply chain retailers such as Amazon.com and Inditex, S.A. (Zara).

COMMENCEMENT:

Mass. governor to deliver address

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in November 2006. As governor, Patrick is a member of the MIT Corporation.

Admission to MIT's Commencement exercises for ticketed guests begins at 7:45 a.m. Graduates will robe and assemble on the second floor of Johnson Athletic Center beginning at 7:30 a.m.

Following the exercises, a reception will be held for graduates and their guests on the Kresge Oval.

In all, 937 undergraduate students and 1,342 graduate students are scheduled to receive 1,082 undergraduate degrees and 1,441 graduate degrees.

A special hooding ceremony for PhD recipients will begin at 11 a.m. on Thursday, June 4, in the Johnson Athletics Center.

For guests attending the Commencement exercises on Friday, complimentary parking will be available in the Albany Garage, the N10 Annex Lot and the N10 Lot.

Employees with West Garage area permits are urged to use alternate modes of transportation on the day of Commencement. For those who must drive, parking will be in the 158 Massachusetts Ave. Lot, N42 Lot, 70 Pacific St. Lot, 65 Waverly St. Lot, the Albany Garage, and N10 lots.

In the event the Commencement exercises in Killian Court are canceled due to severe weather conditions, the speeches will be held in Rockwell Cage for the stage assembly and graduates only. Guests may view the speeches on closed-circuit television in viewing locations throughout the campus.

Complete Commencement information is available at <http://web.mit.edu/commencement/2009>.

New system allows earlier monitoring of fetal heartbeat

Noninvasive technique could prevent complications

Elizabeth Thomson
News Office

Tiny fluctuations in a fetus's heartbeat can indicate distress, but currently there is no way to detect such subtle variations except during labor, when it could be too late to prevent serious or even fatal complications.

Now, a new system developed by an MIT scientist and colleagues including an obstetrician could allow much earlier monitoring of the fetal heartbeat. The additional researchers are from the Institut National Polytechnique de Grenoble, Sharif University, the Tufts University School of Medicine, and E-TROLZ Inc.

Among other advantages, the system is expected to be less expensive and easier to use than current technologies. It could also cut the rate of Cesarean deliveries by helping clinicians rule out potential problems that might otherwise prompt the procedure. Finally, the device used today to monitor subtle changes in the fetal heartbeat during labor must be attached to the fetus itself, but the new product would be noninvasive.

"Our objective is to make a monitoring system that's simultaneously cheaper and more effective" than what is currently available, said Gari Clifford, PhD, a principal research scientist at the Harvard-MIT Division of Health Sciences and Technology. Clifford expects that the system could be commercially available in two to three years pending FDA approval.

While only a minority of pregnancies suffer from fluctuations in the fetal heartbeat, the issue is nonetheless critical because those that do can result in bad outcomes. These problems include certain infections and a loss of oxygen to the baby if it is strangled by its own umbilical cord.

Two techniques

Doctors today actually have two ways to detect the fetal heartbeat.

Ultrasound, in which a doctor moves a device that looks roughly like a hockey puck over a woman's abdomen or she wears a belt fitted with sensors, can detect the heartbeat quite early in a pregnancy. However, it is not sensitive enough to catch variations in the rhythm that could indicate problems.

Electrocardiography (better known as ECG or EKG), which records the electrical activity of the heart, can indeed catch subtle changes in the fetal heartbeat. The problem: until now there has been no way

to reliably use the technique to that end except by attaching an electrode to the baby's scalp during labor.

Doctors can monitor the fetal ECG signal noninvasively through electrodes on the mother's abdomen, but it is weak compared to the maternal heartbeat and surrounding noise. Further, it has not been possible to separate the three signals without distorting characteristics of the fetal heartbeat key to identifying potential clinical problems.

"The dominant signal turns out to be the mother's heartbeat, so teasing out a tiny fetal signal in the background noise without altering the clinical meaning of the fetal signal is a problem that has proved virtually insoluble," said Clifford.

The new system separates the maternal ECG signal from the fetus's and background noise thanks to a complex algorithm derived from the fields of signal processing and source separation. Together, these fields work to break any signal into its source components.

Clifford's principal colleagues on the signal-processing work include Dr. Reza Sameni (whose PhD work focused on this problem), Professor Christian Jutten of Institut National Polytechnique de Grenoble, and Professor Mohammad B. Shamsollahi of Sharif University. The researchers have described their approach in papers published in journals including the IEEE Transactions on Biomedical Engineering and the EURASIP Journal on Advances in Signal Processing.

To use the system, which the team believes could be deployed during the second trimester of pregnancy (around 20 weeks) and perhaps earlier, a woman would wear a wide belt around her abdomen fitted with several ECG electrodes. (The prototype has 32, but that number will be lower in the final device.) The data collected from those electrodes are then fed to a monitor and analyzed with the new algorithm, which in turn separates the different signals.

Multidimensional View

Clifford notes that "one of the nice things about monitoring the fetal ECG through the mother's abdomen is you're getting a multidimensional view of the fetal heart" because its electrical activity is recorded from many different angles. The single probe now used to monitor the heartbeat during labor gives data from only one direction.

"So with our system it's like going from



PHOTO / ISTOCKPHOTO

a one-dimensional slice of an image to a hologram," Clifford said.

That better view could help catch problems that might have gone unnoticed before. "If you're looking in just one direction and an abnormality is occurring perpendicular to that direction, you won't see it," Clifford said.

The large amounts of 3-D data captured with the new system could also open up a new field of research: fetal electrocardiography. "The world of fetal ECG analysis is almost completely unexplored," Clifford said, because the current monitoring system can only be used

during labor and "essentially gives only a monocular view."

Clifford's key collaborator on the clinical work is Dr. Adam Wolfberg, an obstetrician and instructor at the Tufts University School of Medicine. To validate the algorithm and build the system, he turned to E-TROLZ.

Recently, several patent applications on the work were licensed by MindChild Medical Inc.

The original development of the device was funded by the Center for Integration of Medicine and Innovative Technology (CIMIT).

Long-distance brain waves focus attention, McGovern study finds

Cathryn Delude
McGovern Institute

Just as our world buzzes with distractions — from phone calls to e-mails to tweets — the neurons in our brain are bombarded with messages. Research has shown that when we pay attention, some of these neurons begin firing in unison, like a chorus rising above the noise. Now, a study published in the May 29 issue of *Science* reveals the likely brain center that serves as the conductor of this neural chorus.

MIT neuroscientists found that neurons in the prefrontal cortex — the brain's planning center — fire in unison and send signals to the visual cortex to do the same, generating high-frequency waves that oscillate between these distant brain regions like a vibrating spring. These waves, also known as gamma oscillations, have long been associated with cognitive states such as attention, learning

and consciousness.

"We are especially interested in gamma oscillations in the prefrontal cortex because it provides top-down influences over other parts of the brain," explains senior author Robert Desimone, director of the McGovern Institute for Brain Research and the Doris and Don Berkey Professor of Neuroscience at MIT. We know that the prefrontal cortex is affected in people with schizophrenia, ADHD and many other brain disorders, and that gamma oscillations are also altered in these conditions. Our results suggest that altered neural synchrony in the prefrontal cortex could disrupt communication between this region and other areas of the brain, leading to altered perceptions, thoughts, and emotions.

To explain neural synchrony, Desimone uses the analogy of a crowded party with people talking in different rooms. If individuals raise their voices at random, the noise just becomes louder. But if a group of individuals in one room chant together in unison, the next room is more likely to hear the message. And if people in the next room chant in response, the two rooms can communicate.

In the *Science* study, Desimone looked for patterns of neural synchrony in two "rooms" of the brain associated with attention — the frontal eye field (FEF) within the prefrontal cortex and the V4 region of the visual cortex. Lead authors Georgia Gregoriou, a postdoctoral associate in the Desimone lab, and Stephen Gotts of the National Institute of Mental Health, trained two macaque monkeys to watch a monitor displaying multiple objects, and to concentrate on one of the objects when cued. They moni-

tored neural activity from the FEF and the V4 regions of the brain when the monkeys were either paying attention to the object or ignoring it.

When the monkeys first paid attention to the appropriate object, neurons in both areas showed strong increases in activity. Then, as if connected by a spring, the oscillations in each area began to synchronize with one another. Desimone's team analyzed the timing of the neural activity and found that the prefrontal cortex became engaged by attention first, followed by the visual cortex — as if the prefrontal cortex commanded the visual region to snap to attention. The delay between neural activity in these areas during each wave cycle reflected the speed at which signals travel from one region to the other — indicating that the two brain regions were talking to one another.

Desimone suspects this pattern of oscillation is not just specific to attention, but could also represent a more general mechanism for communication between different parts of the brain. These findings support speculation that gamma synchrony enables far-flung regions of the brain to rapidly communicate with each other — which has important implications for understanding and treating disorders ranging from schizophrenia to impaired vision and attention. "This helps us think about how to approach studying and treating these disorders by finding ways to restore gamma rhythms in the affected brain regions."

Huihui Zhou, a research scientist in the Desimone lab, contributed to this study. The NIH/National Eye Institute and National Institute of Mental Health supported this research.

Engineered circuits can count cellular events

Anne Trafton
News Office

MIT and Boston University engineers have designed cells that can count and “remember” cellular events, using simple circuits in which a series of genes are activated in a specific order.

Such circuits, which mimic those found on computer chips, could be used to count the number of times a cell divides, or to study a sequence of developmental stages. They could also serve as biosensors that count exposures to different toxins.

The team developed two types of cellular counters, both described in the May 29 issue of *Science*. Though the cellular circuits resemble computer circuits, the researchers are not trying to create tiny living computers.

“I don’t think computational circuits in biology will ever match what we can do with a computer,” said Timothy Lu, a graduate student in the Harvard-MIT Division of Health Sciences and Technology (HST) and one of two lead authors of the paper.

Performing very elaborate computing inside cells would be extremely difficult because living cells are much harder to control than silicon chips. Instead, the researchers are focusing on designing small circuit components to accomplish specific tasks.

“Our goal is to build simple design tools that perform some aspect of cellular function,” said Lu.

Ari Friedland, a graduate student at Boston University, is also a lead author of the *Science* paper. Other authors are Xiao Wang, postdoctoral associate at BU; David Shi, BU undergraduate; George Church, faculty member at Harvard Medical School and HST; and

James Collins, professor of biomedical engineering at BU.

Learning to count

To demonstrate their concept, the team built circuits that count up to three cellular events, but in theory, the counters could go much higher.

The first counter, dubbed the RTC (Riboregulated Transcriptional Cascade) Counter, consists of a series of genes, each of which produces a protein that activates the next gene in the sequence.

With the first stimulus — for example, an influx of sugar into the cell — the cell produces the first protein in the sequence, an RNA polymerase (an enzyme that controls transcription of another gene). During the second influx, the first RNA polymerase initiates production of the second protein, a different RNA polymerase.

The number of steps in the sequence is, in theory, limited only by the number of distinct bacterial RNA polymerases. “Our goal is to use a library of these genes to create larger and larger cascades,” said Lu.

The counter’s timescale is minutes or hours, making it suitable for keeping track of cell divisions. Such a counter would be potentially useful in studies of aging.

The RTC Counter can be “reset” to start counting the same series over again, but it has no way to “remember” what it has counted. The team’s second counter, called the DIC (DNA Invertase Cascade) Counter, can encode digital memory, storing a series of “bits” of information.

The process relies on an enzyme known as invertase, which chops out a specific section of double-stranded DNA, flips it over and re-inserts it, altering the sequence

in a predictable way.

The DIC Counter consists of a series of DNA sequences. Each sequence includes a gene for a different invertase enzyme. When the first activation occurs, the first invertase gene is transcribed and assembled. It then binds the DNA and flips it over, ending its own transcription and setting up the gene for the second invertase to be transcribed next.

When the second stimulus is received, the cycle repeats: The second invertase is produced, then flips the DNA, setting up the third invertase gene for transcription. The output of the system can be determined when an output gene, such as the gene for green fluorescent protein, is inserted into the cascade and is produced after a certain number of inputs or by sequencing the cell’s DNA.

This circuit could in theory go up to 100 steps (the number of different invertases that have been identified). Because it tracks a specific sequence of stimuli, such a counter could be useful for studying the unfolding of events that occur during embryonic development, said Lu.

Other potential applications include programming cells to act as environmental sensors for pollutants such as arsenic. Engineers would also be able to specify the length of time an input needs to be present to be counted, and the length of time that can fall between two inputs so they are counted as two events instead of one.

They could also design the cells to die after a certain number of cell divisions or night-day cycles.

“There’s a lot of concern about engineered organisms — if you put them in the environment, what will happen?” said Collins, who is also a Howard Hughes Medical Institute investigator. These counters “could serve as a programmed expiration date for engineered organisms.”

The research was funded by the National Institute of Health Director’s Pioneer Award Program, the National Science Foundation FIBR program, and the Howard Hughes Medical Institute.

“Our goal is to build simple design tools that perform some aspect of cellular function

Timothy Lu
graduate student, HST

Finishing touches: New alloys offer alternative to chrome

Anne Trafton
News Office

Ever since the 1940s, chrome has been used to add a protective coating and shiny luster to a wide range of metal products, from bathroom fixtures to car bumpers.

Chrome adds beauty and durability, but those features come at a heavy cost. Though it’s cheap to produce and harmless to consumers, the industrial process to create it is dangerous for workers and pollutes the environment.

“People have been trying to replace it for a very long time,” says Christopher Schuh, MIT associate professor of materials science and engineering. “The problem is that it’s the only plated metal coating that has all of these properties — hardness, long-lasting shine and corrosion protection.”

Until now, that is. Schuh and his collaborators have developed a new nickel-tungsten alloy that is not only safer than chrome but also more durable. The new coating, which is now being tested on the bumpers of a truck fleet, could also replace chrome in faucet fixtures and engine parts, among other applications.

Chromium risks

Manufacturers have long had a love/hate relationship with chromium plating, which is a \$20 billion industry.

Electroplating, the technique used to coat metal objects with chrome, involves running a current through a liquid bath of chromium ions, which deposits a thin layer of chrome on the surface of an object placed in the bath.



PHOTO / DONNA COVENEY
MIT materials scientist Christopher Schuh stands next to a truck bumper coated with a new nickel-tungsten alloy that could replace chrome plating.

The ions, known as hexavalent chromium, are carcinogenic if inhaled, and contact with the liquid can be fatal. Hexavalent chromium can pollute groundwater, and some of the original Superfund cleanup sites involved hexavalent chromium pollution. “It’s an environmental nightmare,” says Schuh.

Manufacturers have put up with the mess and the safety hazards, which require strict handling precautions, because of chrome’s unique properties.

Chrome’s hardness — it is considerably harder than steel — comes from its nanocrystalline structure. Schuh and his group set out to duplicate that structure with a material that could be easily and safely electroplated.

They started with nanocrystalline nickel, but nickel on its own, though very hard when first plated, loses its hardness as the crystals gradually expand from nanoscale to microscale. Using computer models developed to predict material properties,

Schuh settled on a nickel-tungsten alloy that is environmentally friendly and proved to be even more durable than chrome.

Nickel-tungsten alloys

Schuh’s team has shown that nickel-tungsten alloys remain stable indefinitely at room temperature and are highly resistant to decomposition when heated. They can also be made harder and longer lasting than chrome.

In addition, the electroplating process is more efficient than that for chrome, because multiple layers can be applied in one step, which could save money for manufacturers.

“Not only do you get rid of the environmental baggage but you make a better product as well,” says Schuh.

Schuh and his colleagues have described the new process in several journal articles published over the past few years, and Schuh recently gave an overview of the technology in the spring 2009 Wulff Lecture, sponsored by MIT’s Department of Materials Science and Engineering.

The technology could be used to coat other products including shock absorbers and print rolls. Recent tests showed that print rolls coated with the new alloy lasted 10 times longer than their chrome-plated counterparts.

Another field of potential applications is electronics, particularly connectors for portable electronics (the jacks where power cords, headphones and other accessories are plugged in). Those connectors are now coated with a layer of gold, which must be thick to help prevent the corrosion of an inner layer of brass. Layering the nickel-tungsten alloy between the gold and brass layers could reduce corrosion and offer significant savings for electronics manufacturers by allowing them to use thinner layers of gold.

Schuh’s collaborators on the new metal coating technology include Andrew Detor, a recent PhD graduate in materials science and engineering, and Alan Lund, a former MIT postdoctoral researcher and the current chief technology officer at Xtallic Corporation of Marlborough, Mass., which has commercialized the nickel-tungsten plating process.

The research was funded at MIT by the U.S. Army Research Office.

Preliminary reports submitted to Task Force

Recommendations due to be presented to leadership in late June

The nine working groups that comprise MIT's Institute-wide Planning Task Force have submitted their preliminary reports outlining the best ways to reduce costs, boost revenues and increase MIT's effectiveness in performing its mission.

Their initial findings will be discussed with Academic Council in early June. Following further refinement of the recommendations in the weeks ahead, a full preliminary report will be presented to Chancellor Philip Clay, Provost L. Rafael Reif and Executive Vice President and Treasurer Theresa M. Stone. A final report is expected in October.

"We are exactly where we hoped we would be in this process of building a better MIT," said Vice President for Finance Israel Ruiz, who is helping to coordinate the Task Force. "Many of the ideas presented will not simply improve the Institute's bottom line but will help us fundamentally evolve the MIT culture."

We are exactly where we hoped we would be in this process of building a better MIT

Israel Ruiz
vice president for finance

Vice Chancellor and Dean for Graduate Education Steven R. Lerman, Associate Provost Martin A. Schmidt and Ruiz are members of the coordinating team of the Task Force, which was set up in response to the decline in revenues as a result of the global economic crisis. The committee and its working groups are charged with identifying and assessing opportunities to reduce MIT's expenses by \$100 million over the next two to three years, starting with the 2011 fiscal year. These reductions will follow an initial \$50 million expense reduction already underway for FY 2010.

Over the course of the spring semester, the Task Force gathered more than 1,000 ideas from members of the MIT community on ways to cut costs and boost efficiencies. As the working groups weighed the various ideas, it became clear that most contained at least one of the following overarching themes: optimize, share, stop, fewer, leverage, simplify, digitize and reduce.

The work of the Task Force is expected to shift into a new phase between July and October as MIT's senior leadership offers feedback on the opportunities that make the most sense. The nine working groups that make up the Task Force may also be restructured during this phase.

To learn more about the Task Force, please visit <http://web.mit.edu/instituteplanning/taskforce.html>.



PHOTO / THE MITRE CORPORATION

Stephen Dodd, Jay Forrester, Robert Everett, and Ramona Ferez at Whirlwind I test control in the Barta Building,

Project Whirlwind comes home

Previously classified documents from first MIT digital computer being made public

Tom Rosko
MIT Libraries

The Project Whirlwind Computer collection — a compilation of pioneering digital computing research conducted at MIT in the 1940s and 1950s — has been transferred back to the Institute from the MITRE Corporation and its contents are being opened to the public for the first time.

The research project, which included the creation of "Whirlwind I" — the first digital computer at MIT and the fastest of its time — began at the Institute and had been moved to Lincoln Lab and then later to MITRE. Materials in the collection were previously unavailable to researchers, but with its transfer to MIT, the collection is now accessible to the public. Key documents from the Whirlwind collection have also been digitized and will soon be made available online.

Whirlwind I was completed in 1951, the same year that

Project Whirlwind was detached from the Servomechanisms Lab to become the MIT Digital Computer Laboratory. Unclassified research projects using the computer were managed by the Digital Computer Lab staff on the MIT campus, where Whirlwind I occupied 3,300 square feet within the two-story Barta Building (N42).

The precursor to modern-day computers, Whirlwind's fingerprints are evident in today's software and hardware. Parallel digit processing, random-access and magnetic core memory made the initial launch of commercial computers, and interactive visual computer displays, possible. Its groundbreaking design also laid the foundation for simulation and real-time technology. In operation until 1959, Whirlwind formed the basis for the U.S. Air Force's Semi-Automatic Ground Environment (SAGE) air defense system.

The project materials have been transferred to the MIT Institute Archives and Special Collections. Documents on the project will soon be available through the MIT Libraries' web site at: libraries.mit.edu/archives/whirlwind. There will also be a reunion of the Project Whirlwind team at the Meridien Hotel (formerly the Hotel at MIT) on Tuesday, June 30.

APOLLO: To the moon, by way of MIT; astronauts, researchers return

Continued from Page 8

research, he says, are the ways that human perception, such as depth perception and sense of balance, are affected by such things as reduced gravity and the absence of an atmosphere, which can make distant objects appear much closer than they really are.

Such differences could become critical when people begin exploring the lunar surface, because they can affect "how they know they're going where they should be going," Young says. And such research will be important in learning enough to make possible later missions to Mars, where the distance from home is orders of magnitude greater and thus opportunities to get guidance from Earth far more limited.

Mars exploration is "filled with danger," Young says. "It would be terrible to try it and lose people right off the bat," he says, and therefore experience gained both on the moon and in the International Space Station could prove crucial.

One step in better understanding the possible effects of being on Mars could come from a research project headed by Erika Wagner SM '02, PhD '07, an instructor in the Deshpande Center for Technological Innovation. Wagner is the director of a project called the Mars Gravity Biosatellite, which aims to put a small satellite in Earth orbit that would simulate the one-third gravity of Mars, subjecting small test animals to that environment for long periods to learn about the physical effects.

Another forward-looking project is one led by former astronaut Hoffman, who is working with a team including MIT students that plans to compete in the Google Lunar X-Prize Competition. That

competition is offering a \$30 million prize to the first group to send a spacecraft to the moon, land safely and then move at least 500 meters across the surface. The MIT team's approach involves using a unique "hopper" design. The craft would land, like the Apollo module, using a retro-rocket to control its descent. But then it would re-light the rocket, rise a short distance and move across the surface before making a second landing.

In a sense, the mission would bring MIT full circle. After having provided the large team of experts that produced the guidance and control systems that made possible the culmination of a major national effort to reach the moon, a few decades later a similar feat of engineering is now at a point where it is at least possible that it could be achieved largely through the efforts of a small group of students, using off-the-shelf computer chips. A giant leap, indeed.

The Giant Leaps program begins on June 10 with a tribute to Robert C. Seamans Jr., former Aero-Astro professor and MIT dean of engineering, who was second in command at NASA headquarters during the Apollo years. Seamans, who died last June, will be celebrated with a program beginning at 2:30 p.m. at Kresge

Auditorium.

On June 11, a daylong symposium in Kresge will feature talks and panel discussions, including a panel on Apollo moderated by Hoffman and including Battin, flight director Chris Kraft, Apollo astronaut and geologist Harrison "Jack"

Schmitt, and speech-writer to President Kennedy Ted Sorenson. Afternoon sessions will include a look at energy policy featuring presidential science advisor John Holdren '65, SM '66, and a look at future space exploration chaired by EAPS department head Maria Zuber. That evening, a special Boston Pops concert will be narrated by Apollo 11 astronaut Buzz Aldrin. On Friday, there will be a tour of Apollo artifacts at the MIT Museum, as well as tours of Aero-Astro labs.

All events require advance registration, but are open to the MIT community on a first-come, first-served basis. A nominal registration fee will be charged (\$25 for faculty and staff, and \$10 for students); this will enable access to all the events including a ticket to the special Pops performance. Faculty and staff should use the registration code MIT-OS, students should use the code MIT-Student. Details are at <http://apollo40.mit.edu>.

Crawley to serve on human space flight panel

Ed Crawley, the Ford Professor of Engineering in the Department of Aeronautics and Astronautics and the Engineering Systems Division, has been selected to serve on an independent committee that will review the course of the U.S. human space flight program following the space shuttle's retirement. The panel will present its results in time to support a decision by the Obama administration on NASA's future by August 2009.

Chilled beams hit the roof

Deborah Halber
MITEI correspondent

Employees in a handful of MIT buildings might notice what look like slim, fin-tubed radiators in ceiling cavities. These cooling devices are a relatively recent innovation to make its way to the U.S. market. Called chilled beams, they use water, not air, to remove heat from a room.

If you peek under the cover of a baseboard heater, you'll see a pipe studded with many thin fins, looking like a car radiator. Chilled beams are based on a similar design, except instead of one long straight pipe, their pipes snake back and forth like the security line at the airport. And instead of heating air with hot water, they cool it with cold water.

The potential energy reduction of using chilled beams instead of a traditional air-conditioning system ranges from 20 percent to 50 percent, depending on the type of system, climate and building.

The recently completed expansion and renovation to the Main Group — the 49,000-square-foot infill project of the Building 6 courtyard — is one of the recipients of chilled beams. This energy-efficient air-conditioning system also has been successfully installed in buildings 4, 6 and 8.

Peter L. Cooper, manager of sustainability engineering and utility planning for the Department of Facilities, notes that chilled beams take one-tenth the volume of fresh air needed for traditional air conditioning — along with less ductwork, smaller ducts and smaller fans. When the entire Main Group expansion and renovation project is completed, energy savings tied to the smaller fans alone is expected to be around \$400,000 annually.

The new MIT Sloan School of Management expansion and the David H. Koch Institute for Integrative Cancer Research also will take advantage of some chilled-beam cooling. According to Cooper, the beams are useful in offices, laboratories and other spaces where equipment and sunlight generate a significant amount of heat.

"One of its advantages over conventional air conditioning is that it can be retrofitted in buildings that can't accommodate conventional air-conditioning equipment," Cooper says of the chilled beams technology, which was deployed in buildings 4, 6 and 8 in part because those structures had neither enough ductwork nor enough space for new ductwork.

MIT will incorporate two types of chilled beams: active and passive. Active systems tie into the building's air supply ducts, mixing supply air with cooled air and distributing it through diffusers. Passive technology relies on warm air rising to the beams to be cooled. It then descends without the assistance of fans. In both cases, water cooled to between 59–65 degrees Fahrenheit is pumped from a chilled water system to the coiled piping inside the beam.

"There's a factor of eight improvement in cost of moving a Btu of air cooled by water versus air. If you can get the cooling energy into the space through water, you're way ahead," says Cooper. "The eight times factor is a very attractive alternative from an energy point of view."



PHOTO / ANDREW THOMAS RYAN

Passive chilled beams are used in the recently completed 49,000-square-foot infill project within the Building 6 courtyard. In the photo above, the chilled beams are the rectangular boxes between the light fixtures.

CLASSIFIED ADS

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PHOTO / DONNA COVENEY

Gordon-MIT Engineering Leadership Program kicks off

More than 100 guests attended a kick-off breakfast on Wednesday, May 20, for the Bernard M. Gordon-MIT Engineering Leadership Program. Launched through a \$20 million gift by The Bernard M. Gordon Foundation, the program's goal is to help MIT's undergraduate engineering students develop the skills, tools and character they will need as future leaders in the world of engineering practice.

Among those attending the breakfast were (from left to right): Ed Crawley, the Ford Professor of Engineering in the Department of Aeronautics and Astronautics and director of the Bernard M. Gordon-MIT Engineering Leadership Program; Bernard M. Gordon '52; MIT President Susan Hockfield; Raytheon CEO William Swanson; and Subra Suresh, dean of the School of Engineering.

"This is a critically important issue at a critically important time in our nation's history," Hockfield said. At this time, she added, "the Gordon-MIT Engineering Leadership Program certainly lands on fertile grounds."



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TO THE MOON

BY WAY OF MIT

Instrumentation Lab made Apollo landings possible 40 years ago

David Chandler
News Office

Many people consider the Apollo lunar landings one of the crowning achievements of human ingenuity. But not so many people realize that the epochal first steps by human beings on another world — which took place 40 years ago next month — likely would not have been possible without the technological experience and capabilities of MIT.

In celebration of that singular accomplishment and MIT's crucial role in it, the Institute is holding a three-day symposium and celebration on June 10-12 that will feature talks by astronauts, engineers, and others involved in that mission, as well as an examination of what lies ahead for the U.S. space program in the coming decades. The event's title, "Giant Leaps," evokes the famous first words spoken by astronaut Neil Armstrong after descending a ladder to the lunar surface on July 20, 1969: "That's one small step for a man, one giant leap for mankind."

The second person to walk on the moon just moments after Armstrong's "one small step" was Buzz Aldrin ScD '63. In the course of his studies at MIT, Aldrin took the class in astrodynamics (16.346) that was then, and still is today, taught by Senior Lecturer Richard Battin of the Department of Aeronautics and Astronautics. Of the 12 men who have walked on the moon, two others — David Scott SM '62, EAA '62 of Apollo 15, and Edgar Mitchell ScD '64 of Apollo 14 — also took Battin's class. And Charles Duke of Apollo 16 received his SM in 1964 under the guidance of Laurence Young, the Apollo Program Professor of Aeronautics and Astronautics and a professor of health sciences and technology.

But MIT's role in the Apollo program was much more crucial than just educating its astronauts. One of the most complex tasks required to make the lunar landing possible was the unprecedented feat of navigation required to guide a craft through a round-trip of more

than a half-million miles, and to achieve a controlled, precise landing on the lunar surface on the very first try — there was no fuel available for a wave-off and another attempt. If the landing didn't work as it was supposed to, there would be no second chances, and no return.

A feat of engineering

That navigational feat was accomplished by the team in Aero-Astro's MIT Instrumentation Lab, which has since become the Draper Laboratory. The lab was headed by Charles Stark Draper, and Battin and David Hoag led the hardware and software design and development for the Apollo Guidance and Navigation System. They developed both the hardware — small, special-purpose computers — and the software that enabled the onboard computer to control the actual descent and landing on the moon's craggy surface. William Widnall, the husband of Institute Professor Sheila Widnall, was also among the leaders in the lab at that time and was responsible for the digital flight control systems of both the Apollo Command Module and the Lunar Module.

The engineering accomplishment was all the more remarkable when you realize that the computer, designed by MIT and built by Raytheon, had less memory (74 kilobytes of ROM, and 4 kb of RAM) than today's low-end cell phones, and that its software was literally hard-wired, so that any changes required starting over with the manufacture of a whole new "rope memory." Built at a time when most computers filled large air-conditioned rooms, the one-cubic-foot Apollo Guidance Computer was a unique device that foreshadowed the advent of personal computers.

The story of that work on the guidance system is told in detail in a book published last year by MIT Press, "Digital Apollo," by David Mindell, the Frances and David Dibner Professor of the History of Engineering and Manufacturing and director of the Program in Science, Technology, and Society. The book explores

the interplay between automation and human control in the complex process of landing a craft on the moon, overcoming the dangers of boulders, craters, steep slopes and electronic malfunctions to accomplish Apollo's six successful landings.

But as critical as its role was in the great accomplishments of the Apollo program, MIT's involvement in the space program has extended far beyond that, and is likely to continue far into the future. As part of the June "Giant Leaps" symposium, speakers will be looking ahead at the future in space as much as recalling its past.

Mindell recently headed a team that completed a detailed study on the future of human space exploration, co-authored by a group that included MIT Aero-Astro professors Jeffrey Hoffman, Dava Newman, Annalisa Weigel and Laurence Young.

Giant leaps forward

Young '57, SM '59, ScD '62, who was the founding director of the National Space Biomedical Research Institute, which does research on the biological and psychological effects of space flight, consulted with NASA's Marshall Center on the Apollo project. He later became a qualified Payload Specialist for the U.S. space shuttle's Spacelab biological laboratory, though he never flew a space mission. Young is now actively working on research on issues of space motion sickness and eye-hand coordination in zero-gravity and spatial disorientation facing astronauts when they return to the moon.

Young says that the present NASA plan for returning to the moon by the end of the next decade, which is now being reassessed by the new administration, has the potential to provide important information about the biological effects of reduced gravity.

Even though we've been there before, Young says, "the challenges of going back to the moon are non-trivial." Among the areas that still require extensive

▶ Please see APOLLO, PAGE 6



PHOTO / NASA