

## SPINOFF SPOTLIGHT

## A Cheap Way to the Web

Meraki Networks builds systems that allow ordinary people to set up inexpensive wireless networks

In just a year, Sanjit Biswas and John Bicket have transformed a PhD project into a company with customers in 25 countries, who use its products to gain low-cost wireless Internet access.

Meraki Networks, based in Mountain View, CA, started life as Roofnet, a project in the lab of Robert Morris, an associate professor in the Computer Science and Artificial Intelligence Laboratory. Roofnet sought to establish a wireless mesh network in the area around the MIT campus, allowing people with Wi-Fi capability on their computers to tie into the Institute's Internet connection.

Biswas and Bicket, both PhD candidates in Morris's lab, were working on Roofnet when a representative of NetEquality, a Portland, OR, nonprofit group dedicated to providing free Internet access to low-income communities, contacted them. He wanted to know if there was a way NetEquality could use the MIT technology—but the routers originally used for Roofnet cost \$1,500.

"That got us thinking, 'Can we build Roofnet on a \$50 device?'" says Biswas, who is now CEO of Meraki. He and Bicket, now Meraki's chief technical officer, took a leave of absence from MIT and founded the company in September 2006 to do just that. They were joined by Hans Robertson, now chief operating officer, who has an SB and SM in computer science from MIT. After giving a presentation at a conference, the trio received angel funding from Google to develop the technology.

The result is a business that makes portable, plug-and-play devices, a group of which can be set up to create a mesh network. The Mini, a \$49 box that looks like a deck of playing cards with an antenna attached, can be stuck on a window, where it picks up Wi-Fi signals and relays them to a home computer equipped with a wireless card. A weatherproof out-



IMAGE: MERAKI NETWORKS

door version is slightly larger and costs \$99. One box in the network must be plugged into an Internet connection, but then other users can reach the Net via that single connection. "You can cover an entire apartment complex, or a small town, or a business district, just by plugging this in," Biswas says.

The key to the system is the mesh-networking software run by Meraki's boxes. Mesh networks are so called because each node can connect to several others, forming a web of links. If one link breaks—say, because someone unplugs a box or a passing truck disrupts the Wi-Fi signal—data can be sent across another link. A transmission can hop from one node to another until it finally reaches the one tied into the Internet. All this requires software to constantly monitor the conditions of each link and dynamically reroute data as those conditions change.

Biswas and Bicket developed the mesh software for Roofnet under an open-access license at MIT. So when they started Meraki, they created new algorithms they could patent. The company doesn't license any technology from MIT.

Each box contains an Ethernet port and uses the standard 802.11 Wi-Fi protocol for wireless trans-

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## MIT TECHNOLOGY INSIDER

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missions. The boxes can transmit over a distance of 30 to 50 meters indoors and offer line-of-sight transmission over 100 to 250 meters outdoors. With the addition of a directional antenna, the signal can cover more than 10 kilometers. The system doesn't care what method of Internet access is used: digital subscriber lines (DSL) and cable modems are both fine. A remote village, says Biswas, could even use a satellite system.

Meraki makes only a small profit on the boxes. Most of its revenue comes from encouraging small entrepreneurs to form their own networks—by purchasing a DSL connection from the local telephone company, say, and reselling the service to others—and then taking a cut of their profits. Meraki even provides a free, Web-hosted interface, called Dashboard, that allows administrators to monitor their networks, set rules about how much bandwidth each subscriber can use, and collect fees. The administrators don't even have to be technically savvy; they can just accept the default settings and let Dashboard do the work.

As an R&D experiment, Meraki is putting itself in its customers' shoes and providing a free network over one square mile of San Francisco. It's giving away Minis and even offering to pay to install DSL lines in people's homes. The company budgeted for 1,000 free boxes and has already deployed about 60; the network sees around 200 users a day. Biswas says the project helps the company figure out how to optimize the Dashboard. "What we're trying to do with Meraki is to deploy access that is an order of magnitude cheaper" than what currently exists, Biswas says. "We do it by sharing a small number of lines over a large number of people."

He says about 20 people can use a single DSL line simultaneously without noticing any slowdown in accessing the Internet, even with people using high-bandwidth applications such as YouTube. Since not all users are likely to be downloading large files at the same time, it's not difficult for one line to accommodate about 100 people.

Biswas doesn't see the system as a threat to Internet service providers, who could well view cheap and easy access as undermining their markets. For them, he says, it's a way to attract new customers who otherwise couldn't afford any access at all, particularly in poorer markets in Latin America or Eastern Europe. "We've actually seen a lot of interest from [telecommunications companies]" in such areas, he says.

The company is making other inroads overseas. For example, Blava.net, a nonprofit networking organization in Bratislava, Slovakia, deployed Meraki

repeaters in a dorm that houses 2,600 students at that city's Comenius University. That network hosts an average of 150 users and 3.5 gigabytes of traffic daily. Though nonprofits like this and NetEquality don't bring in any money, such philanthropic efforts help demonstrate the worth of the technology.

Meraki is already planning a second generation of boxes in the fall, with an extra Ethernet port and, for the outdoor models, a sturdier casing; manufacturing is contracted out to China. Biswas also plans to update the control system so it can accept prepaid cards as well as the credit cards it accepts now. In much of the developing world, people have less access to credit and use the prepaid model for cell phones, so they're more used to paying that way, he says. And the company has had preliminary talks with equipment makers such as Linksys and Netgear, which would build their own repeater boxes and license the software from Meraki.

The company has 18 full-time employees, mostly engineers; that number may grow to 30 or 35 by year's end. In January, it closed a Series A round of venture funding, led by Sequoia Capital.

Chris Silva of Forrester Research says the ease of creating a mesh network with Meraki's system, combined with the sophisticated software that keeps things running, makes such networks interesting to a lot of customers. "You can have this thing deployed in hours and generate revenue in days," he says. One caveat, he says, is that the networks may not scale up very well, because there's no technical support for users and no control over how many people can tie into a single Internet connection. And users in less densely populated areas or on the fringe of a network may find the connection less reliable. But within those limits, Silva says, Meraki does a great job of creating low-cost wireless mesh networks. "It does what it does well," he says. "They've created this elegant level of simplicity."

IN BRIEF

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Meraki Networks

**CEO**  
Sanjit Biswas

**CONTACT**  
meraki.net

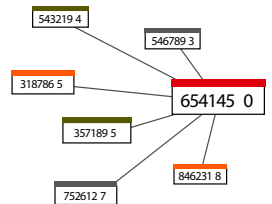
**MAJOR PRODUCTS**  
Plug-and-play wireless repeaters

Online network management system

**FUNDING**  
Funding: \$2 to \$10 million

**PATENT STRENGTH**  
No core patents

**TIMETO MARKET**  
Now



**PATENT MAP**  
For a graphical analysis of Meraki Networks' patent position, go to [www.ipvisioninc.com/techinsider/06/07](http://www.ipvisioninc.com/techinsider/06/07).

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## Quantum Hack

Quantum cryptography, generally considered unhackable, holds the promise of perfect communication. But now, a group led by MIT electrical-engineering professor Jeffrey Shapiro is putting the method to the test.

All encryption employs a secret key, used by the sender to encrypt a message and by the receiver to decipher it. In quantum encryption, the key is created by sending a random sequence of 1s and 0s in the form of polarized photons, or light particles. Eavesdropping necessarily alters photon orientation and results in detectable errors, so if the sender's and receiver's keys do not match up, they know they're being overheard.

Shapiro and his colleagues built a sort of makeshift quantum wiretap that let them alter the trade-off between the amount of coded information captured and the resulting error rate. Using a technique known as entanglement, the researchers entwined a photon's polarization with its momentum. Then, by measuring its momentum, they were able to determine its polarization without changing its orientation. So far, they've managed to capture up to 90 percent of the key while generating a 30 percent error rate—detectable, but a start. Using this system in the real world, Shapiro says, would require a “quantum nondemolition box,” a nonexistent device that could detect a photon without disturbing its polarization. Quantum cryptography is still safe—for now.

## Bayou Aerie

When Hurricane Katrina struck, much of the damage outside New Orleans was due to coastal storm surges and strong winds. So architecture research associate Reinhard Goethert held a workshop in which he gave participants a challenge: design a house that could survive a hurricane strike on a Louisiana bayou. The result—the Lift House—was presented in April at the MIT EcoExpo by Goethert and project coordinator Zachary Lamb, a graduate student in architecture, after a year of planning and construction.

The prototype house in Chauvin, LA, built with partners TRAC and Oxfam America, is nearly complete. The design, which calls for local materials, enables the house to be built on the ground by volunteers and then raised onto pilings eight or more feet high. Thick, functional shutters can be closed to prevent wind from entering the house and lifting the roof. Vine-covered trellises absorb gusts, making casualties of leaves rather than shingles. Exterior panels are made of a fiberboard-cement composite that is waterproof and resists airborne debris. “It's low-tech, commonsense stuff,” Lamb says. “We really wanted it to be reproducible.”

## Laser Leap

MIT engineers have built a laser that allows them to create high-resolution 3-D images of the retina, a process that could help improve diagnosis of glaucoma and other eye diseases. Electrical-engineering professor James Fujimoto and his group had developed a laser for use in a diagnostic technology called optical coherence tomography (OCT)—a technique he helped invent that creates two-dimensional images of the eye by measuring echoes of light. Now, visiting scientist Robert Huber and Fujimoto have created a laser that achieves imaging 10 times as fast, which should enable OCT to acquire enough data for 3-D images.

The faster a laser can tune wavelengths, the faster an image can be generated. But the laser must be tuned rapidly, sweeping across a broad band of wavelengths, and that requires light to first build up inside the laser. Fujimoto and Huber amped up that speed by spooling a kilometer-long optical fiber within their laser's cavity; the fiber stores the light's wavelength sweep, allowing it to be regenerated very quickly. Fujimoto believes that 3-D OCT imaging will help doctors detect retinal diseases before vision is lost.

## Discriminating Vision

How the human brain discriminates between matte and glossy surfaces has been a mystery—until now. Researchers at MIT and the NTT Communication Science Labs in Japan have found that images of the two textures have unique statistical properties. Those properties appear to be related to the way neurons in the brain compute asymmetry, or “skewness,” between light and dark.

Edward Adelson, professor of brain and cognitive science at MIT, found that an object's skewness affects the way people perceive it. Study subjects were more likely to identify a surface as glossy when the asymmetry between light and dark was greater. The researchers think this finding could be quite helpful for developing vision systems in robots such as autonomous vehicles, which would need to distinguish among wet, dry, and icy surfaces. “Humans can do these things easily, and by imitating the way the brain works we should be able to give robots similar capabilities,” Adelson says.

### NEWS LINKS

#### **DNA-damage test could aid drug development**

[web.mit.edu/newsoffice/2007/dna-damage.html](http://web.mit.edu/newsoffice/2007/dna-damage.html)

#### **Team discovers hottest planet**

[web.mit.edu/newsoffice/2007/hot-planet.html](http://web.mit.edu/newsoffice/2007/hot-planet.html)

#### **Daylight device lightens electricity cost**

[web.mit.edu/newsoffice/2007/energy-daylight-0509.html](http://web.mit.edu/newsoffice/2007/energy-daylight-0509.html)

#### **Team unearths genetic risk factors for diabetes**

[web.mit.edu/newsoffice/2007/diabetes-gene.html](http://web.mit.edu/newsoffice/2007/diabetes-gene.html)

### MULTIMEDIA LINKS

#### **Bruce Sterling on Design**

[www.technologyreview.com/video/design](http://www.technologyreview.com/video/design)

#### **What's New at the Media Lab?**

[mitworld.mit.edu/video/442/](http://mitworld.mit.edu/video/442/)

#### **Geeks and Chiefs: Engineering Education at MIT**

[mitworld.mit.edu/video/449/](http://mitworld.mit.edu/video/449/)

# A Helping Hand

Newman Laboratory builds robots designed to help people regain mobility after they've suffered strokes

MIT's Newman Laboratory for Biomechanics and Human Rehabilitation looks a bit like a cluttered museum of robot parts and prototypes. But its director, Neville Hogan, wants us to look past the disorder and envision a sleek, efficient physical-therapy room of the future. Piece by piece, Hogan is building that room—a “robotics gym” of highly sensitive machines designed to help patients regain motion after suffering a stroke.

These robots are not meant to replace traditional therapists, but Hogan believes the machines have distinct advantages over their human counterparts. Typically, physical therapists help stroke patients through a series of stretching and strengthening exercises to improve flexibility and motor control. It's a slow and exhausting process for both parties, and therapists need to be tuned in to patients' movements, being careful not to rush or impede their progress. It's a task that requires great responsiveness and carefully calibrated force on the part of the therapist—exactly the sort of chore at which robots excel, says Hogan, who is a professor in the Department of Mechanical Engineering and the Department of Brain and Cognitive Sciences. “If we know what we want the robot to do, the robot is capable of being continuously interactive, and with more precision than I think a human can match,” he says.

Over the last decade, engineers in the Newman Lab have designed a number of machines to help patients improve wrist rotation, arm extension, hand grasp, balance, and gait. The robots are not only strong enough to guide a patient through various motions but also sensitive enough to know when to get out of the way as patients learn to move on their own again.

One of the lab's first prototypes, MIT-Manus, is designed to exercise a patient's arm. To use the machine, a patient sits facing a video display, with his or her arm strapped to a robotic “arm.” The display shows one of a number of different exercises; for example, it might prompt the patient to draw a straight line between two dots. If the patient fails to move after a given period of time, the robot initiates the movement, following a trajectory similar to that of unimpaired motion.

As the patient regains motor control, the robot gradually offers less assistance, providing slight adjustments as necessary. Exercises become progressively faster and more complex through the course of therapy. The team created a series of algorithms that

peg the robot's position and force to the forces exerted by the patient, enabling the robot to adapt gently to patients' often unpredictable movements through a system of sensors and actuators.

To date, Hogan and his colleague Hermano Krebs, the lab's principal research scientist, have tested MIT-Manus and other robots on more than 300 patients in various clinical settings, including an extended trial in four VA hospitals. They found that patients who underwent robot-assisted therapy regained twice as much motor control as those prescribed traditional therapies. The patients also experienced fewer of the common side effects of traditional physical therapy, such as joint pain and repetitive-stress injuries.

“Prior to this work, robots had been used not as a rehabilitative technology but primarily as an assistive technology,” says Hogan. “It's not really training a person.”

David Reinkensmeyer, associate professor of biomedical engineering at the University of California, Irvine, says robotic therapy may have cost-saving benefits as well as therapeutic potential. “Robot-based therapy automates some of the repetitive, time-consuming parts of therapy, possibly giving patients more therapy at reduced cost,” he says. “Hopefully, we will make slow and steady progress in improving patient outcomes by using these new tools to optimize training techniques.”

In 1998 the team created a spinoff company, Interactive Motion Technologies, which builds the robots for sale to hospitals and rehab centers. In the future, Hogan and his fellow engineers hope to make all their robots smaller, cheaper, and more suitable for home use, allowing patients to do accurate rehab exercises outside a hospital for the first time—and perhaps even to interact with a doctor remotely. When Hogan and colleagues at Georgetown University set up two shoulder-arm robots, one at each university, scientists were able to “arm-wrestle” over the Internet. Using the technology, a doctor might be able to check on the progress of a patient using the robot at home, suggesting new exercises or modifications to existing ones. Or patients could log on to a website and “exercise” with a friend.

“There's a lot of information you could communicate with touch,” says Hogan. “It's a very primate thing, and I think that's something robots have to be good at. And as we get better at doing that, we'll find new uses for the technology.”

## IN BRIEF

### LAB

Eric P. and Evelyn E. Newman  
Laboratory for Biomechanics  
and Human Rehabilitation

### DIRECTOR

Neville Hogan

### CONTACT

[web.mit.edu/hogan/www/](http://web.mit.edu/hogan/www/)

### MAJOR PROJECTS

Robotic technology for  
rehabilitation

Study of human sensorimotor  
performance

## Combined Resources

A startup built around a technology designed to deliver drugs to women has received early venture funding. Combinent BioMedical Systems, of Lexington, MA, received the investment from Cytoc Development, which did not disclose the amount of financing.

The company is developing new drug combinations and new formulations of existing drugs for use with its transvaginal delivery system. The system, licensed from MIT, is a compartmentalized, drug-permeable polymer, shaped into a ring that fits comfortably in a woman's vagina. The company says the vaginal wall absorbs drugs better than the skin, allowing for lower doses and more controlled release than with transdermal patches. Combinent's first project is to test combinations of three hormones for treating endometriosis and polycystic ovarian disease, providing hormone replacement therapy, and delivering a contraceptive that contains microbicides to fight HIV or human papillomavirus. Combinent has permission from the U.S. Food and Drug Administration for a phase I trial.

Robert Langer, Institute Professor and professor of chemical engineering at MIT, and William Crowley, chief of the Reproductive Endocrine Unit at Massachusetts General Hospital, cofounded the company.

[www.combinentbms.com](http://www.combinentbms.com)

## Plugged In

A company that uses MIT technology to build more powerful batteries has acquired a company that makes aftermarket kits allowing owners of hybrid electric vehicles to add additional batteries to their cars. A123Systems, of Watertown, MA, bought Hymotion for an undisclosed amount.

With Hymotion modules, hybrid-car owners can add rechargeable lithium-ion batteries that enable their vehicles to travel 100 miles or more on a gallon of gasoline. A123Systems uses nanotechnology to improve the material inside the batteries, allowing them to hold more energy, run longer, and recharge faster than traditional lithium-ion batteries. Two weeks after the early-May acquisition, the company announced a new line of batteries that can be installed in hybrid vehicles either as original equipment or as aftermarket plug-ins. The batteries are designed to last more than 10 years or 150,000 miles.

A123 was cofounded in 2001 by Yet-Ming Chiang, the Kyocera Professor of Ceramics in MIT's Department of Materials Science and Engineering; Ric Fulop, a fellow at MIT's Sloan School of Management; and Bart Riley.

[www.a123systems.com](http://www.a123systems.com)

## Bright Ideas

Luminus Devices, of Woburn, MA, a company with a method to make LEDs shine brighter, has received five new U.S. patents for its PhlatLight technology. The company now has a total of 11 issued patents.

PhlatLight is the trade name for Luminus's photonic-lattice light-source technology. The company inscribes photonic lattices into its LED chips; these nanostructures have features about the same size as the wavelengths of visible light. The lattices redirect light produced within the chip so that more of it exits the chip, making the LED brighter. Samsung and NuVision are using the LEDs as light sources in their large-screen projection televisions, and LG Electronics is building them into a small, portable projector. Luminus is exploring licensing agreements with various companies for other applications of its technology.

Alexei Erchak developed the technology as a student in the Integrated Photonic Devices and Materials Group of MIT's Research Laboratory of Electronics. Erchak, who earned his PhD in 2002 and cofounded Luminus in August of that year, is now the company's chief technology officer. His cofounder was John Joannopoulos, the Francis Wright Davis Professor of Physics; Erchak studied in his lab.

[www.luminus.com](http://www.luminus.com)

## Cabbage for Corn

An MIT spinoff working on ways to make ethanol more cheaply has received a Small Business Innovation Research grant from the National Science Foundation to pursue its technology. Agrivida received \$100,000, the third such grant the company has won.

The company says it will use the money to continue testing its technology and screening the enzymes it is developing to improve ethanol production. Agrivida manipulates the genes of corn plants to get them to produce enzymes that, when triggered by high temperature or pressure, break down the cellulose in the stalks and leaves. Ethanol producers, which currently use only the kernels of corn to make the gasoline substitute, would like to use other parts of the plant, but the processes required to break down cellulose into simple sugars that yeast can digest are too expensive and complex to be practical. Agrivida hopes its genetically modified corn will simplify the process and bring cellulosic ethanol closer to reality.

Agrivida was founded in 2002 by three people who at the time were PhD candidates at MIT: R. Michael Raab, now CEO; Jeremy Johnson, who still works for the company; and Kyle Jensen.

[www.agrivida.com](http://www.agrivida.com)

## DATEBOOK

### June 12

Lean Aerospace Initiative:  
Architecting Future  
Enterprises  
MIT  
[http://lean.mit.edu/index.php?option=com\\_content&task=view&id=336&Itemid=268](http://lean.mit.edu/index.php?option=com_content&task=view&id=336&Itemid=268)

### June 15

Sixth Annual Center  
for Cancer Research  
Symposium  
Kresge Auditorium, MIT  
<http://web.mit.edu/ccr/news/symposium.htm>

### June 20-22

InvenTeams Odyssey  
MIT  
[web.mit.edu/inventeams/odyssey.html](http://web.mit.edu/inventeams/odyssey.html)

### September 25-27

Emerging Technologies  
Conference at MIT  
Kresge Auditorium, MIT  
[www.technologyreview.com/events/tretc/index.aspx](http://www.technologyreview.com/events/tretc/index.aspx)

# MIT \$100K Entrepreneurship Competition

Since 1990, MIT's student-run \$100K Competition (\$50K until last year) has encouraged MIT students and researchers to develop ideas that could lead to successful companies. This year, more entrants focused on renewable energy than ever before. The Business Venture Prize goes to high-technology ventures aimed at specific markets. The new Development Prize is for projects creating technologies for low-income communities.

PRIZE	COMPANY	TECHNOLOGY	FOUNDERS
Business Venture Robert P. Goldberg Grand Prize (\$30,000)	Robopsy	A remote-controlled biopsy needle lets doctors sample possibly cancerous tissue during a CT scan, allowing finer targeting and earlier diagnosis while reducing the patient's discomfort and exposure to CT radiation.	Ravi Gupta, Department of Radiology, Massachusetts General Hospital; Nevan Hanumara, PhD candidate, Precision Engineering Research Group; John Harthorne, MBA candidate, Sloan School of Management; Alexander Slocum, professor, Mechanical Engineering; Conor Walsh, PhD candidate, Mechanical Engineering
Business Venture Runner-up (\$10,000)	C3BioEnergy	A novel process turns biomass into propane using high-pressure, high-temperature water to control the reaction; the technology makes propane a renewable fuel.	Curt Fischer, graduate student, Chemical Engineering; Tracy Matthews, student, Harvard Business School; Andy Peterson, graduate student, Chemical Engineering
Business Venture Runner-up (\$10,000)	ImmuneXcite	The company is developing products to fight bacteria and fungi that have developed resistance to current medical treatments.	Yaniv Bejerano; Jason Fuller, research affiliate, Broad Institute of MIT and Harvard; Ifat Rubin-Bejerano, Whitehead Institute for Biomedical Research
Development Grand Prize (\$30,000)	Bagazo	A concentrated cooking fuel made of agricultural wastes such as corn cobs and sugarcane residue provides developing countries with an affordable substitute for more expensive fuels.	Amy Banzaert, graduate student, Mechanical Engineering; Felicita Holsztein, graduate student, Sloan School of Management; Gerthy Lahens, research fellow, Urban Studies and Planning; Kendra Leith, graduate student, Urban Studies and Planning; Johan Lofstrom, graduate student, Sloan School of Management; Jules Walter, undergraduate, Electrical Engineering and Computer Science
Development Runner-up (\$10,000)	Promethean Power	A turbine made of car parts and plumbing supplies runs on solar energy, producing heating, cooling, and electricity—unlike a solar photovoltaic panel, which produces only electricity.	Sorin Grama, graduate student, System Design and Management; Bryan Urban, graduate student, Mechanical Engineering; Sam White
Development Runner-up (\$10,000)	Saafwater	A cartridge loaded with a dose of chlorine provides a day's worth of treated water for a family, fighting disease caused by poor sanitation in the developing world.	Sarah Bird, graduate student, Engineering Systems Division



## ILP REPORT: TOP STORY

# Enterprise Makeover

From factory floor to executive suite, Lean Aerospace Initiative helps organizations cut waste and add value

by Mark Dwortzan

Somewhere in America there is a company that misunderstands what its suppliers value, fails to involve them upfront in product design and changes requirements mid-stream with little warning. Its policies require countless signoffs at every decision-point, and the metrics it uses to gauge success don't align well with its business goals.

Such shortcomings can wreak havoc on a company's bottom line. But firms can turn things around by carefully analyzing their operations across functional and administrative boundaries, and implementing a strategic plan to streamline the enterprise. Championing this kind of analysis and planning for the past 15 years, an MIT program has led numerous companies to cut waste and add value to their operations. Many have experienced higher profits and stock prices, reduced product cycle times, significant market growth and increased employee satisfaction. And in some cases, cost savings in the neighborhood of \$100 million.

Known as the Lean Aerospace Initiative (LAI) and organized by MIT as a consortium of more than 30 representatives from academia, industry and government, the program has enabled member organizations to apply principles that result in a "Leaner" enterprise. Key principles include responding dynamically to change, reducing waste in order to add value, engaging all enterprise stakeholders, synchronizing production and distribution schedules, building relationships across the enterprise and adopting a continuous improvement mindset. Codifying these and other Lean principles in its Enterprise Value Stream Mapping and Analysis (EVSMA) and other tools, LAI has helped many companies to understand the problems that impede their progress, and to design a roadmap from their current position to one that better aligns with their core objectives.

Applying EVSMA to improve on its delivery of the C17 cargo plane to the U.S. Air Force, Boeing Corp. recently achieved significant enterprise-level transformations. "Boeing, the USAF C17 program office, government auditors and other stakeholders met for two to three weeks to do the analysis jointly," recalls Professor Deborah Nightingale, co-director of LAI. "They surfaced opportunities to cut waste and came up with new ways of doing things much more effectively and efficiently." As a result, Boeing reduced C17 production cycle time by 20 percent and the USAF program office cut its average contract proposal cycle time by more than nine months.

LAI also facilitated an activity for the Air Force's Global Hawk surveillance program which saved tens of millions of dollars in lifecycle costs for integrated sensor

and ground support systems. Essential to this success—and that of all Lean enterprise transformation—is LAI's emphasis on bringing manufacturing, engineering, executive and other functional and administrative team leaders together with suppliers.

"We look at the enterprise as a system and how different parties affect each other across the boundaries," says Nightingale. "By involving all stakeholders upfront in the process, all parties feel invested in solutions." LAI also provides a neutral forum on the MIT campus for customers, suppliers, competitors, partners and other industry and government stakeholders to solve challenges that cross boundaries.

Another key to LAI's effectiveness is its emphasis on transformation at the enterprise level. "A lot of programs address individual improvements within portions of process capabilities," says Robert Stow, an LAI Industry co-chair and chief technology officer at BAE Systems Inc., a major aerospace and defense contractor. "But LAI frames its process improvement and value stream analysis at the enterprise level, linking end-to-end process improvements to enterprise-wide strategic goals and objectives. In addition, LAI focuses not only on procedural changes, but also on the cultural changes needed to sustain them."

To fulfill its vision, LAI pursues three major objectives, each supportive of the others: Knowledge Creation (research), Relationships and Deployment. "From the beginning, the overarching goal of LAI has been to help the aerospace and other industrial communities draw on our research, tools and relationships within the Consortium to become more efficient and effective in delivering for all their stakeholders," says Tom Shields, LAI program manager.

### Knowledge Creation

Based at the MIT Department of Aeronautics and Astronautics in close collaboration with the Sloan School of Management, and managed in MIT's Engineering Systems Division, LAI originally investigated Lean thinking in an effort to apply efficiency improvements taking place at Toyota and other Japanese automakers to the aerospace industry. At today's LAI, seven teams of researchers develop frameworks and theories about enterprise-level design and behavior by studying best practices of organizations from many industries. Based on their findings, the research teams develop strategies to transform the enterprise into a "Leaner" operation and build these strategies into new LAI products, tools and publications.

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LAI's research effort addresses four main questions: (1) how can I understand how my enterprise currently operates within its larger context; (2) how can I define and evaluate the future possibilities for a more efficient and effective enterprise; (3) what are the most effective strategies and tactics to achieve these future possibilities; and (4) how can I best manage the enterprise transformation process? Question (4) can prove daunting for many organizations, notes Shields. "Relationships with people are the hardest things to deal with," he says, "and often they get the least amount of attention."

LAI's EVSMA is one product that has helped many enterprise leadership teams to respond to these questions and effect enterprise-wide transformations. The Initiative has also developed an enterprise self-assessment tool that poses 54 questions. For example, the tool asks: How well do you involve manufacturers and suppliers upfront in the product design process? Drawing on its latest research, LAI explains how this practice results in better design and implementation and lower costs and cycle times. Meanwhile, LAI has conducted six case studies on the role of leadership in enterprise transformation, and continues to consult with various companies to get the latest feedback on this subject. Finally, LAI has developed an advanced simulation training game for companies that wish to enable its employees to apply Lean thinking to functional areas, such as engineering or product development, as well as to enterprise-wide operations.

### Relationships

Through the Consortium, LAI provides a neutral forum to bring leaders in government, industry and academia together to network with their peers, share lessons learned, solve problems of common interest and spawn active communities of practice in areas such as product development and engineering. By working together this way at annual conferences and other events, the aerospace and other industries can boost productivity and performance in areas of common interest.

"We see great value in belonging to organizations such as LAI, to network, identify better practice, and as a thought partner," says Clayton M. Jones, CEO of Rockwell Collins. "Some of our best ideas were derived from other people who were struggling with their own Lean journey as we were, and who were graciously willing to share their successes and their failures."

### Deployment

In its early years LAI focused on applying Lean principles to manufacturing within the aerospace industry. But today the consortium is expanding its focus to the entire corporation and its customers and suppliers, and sharing its insights with a much wider range of industries. "Where LAI has focused on aerospace, I see this enterprise thinking applied much more broadly to the healthcare, auto, software and other industries," Nightingale says. "In addition, I expect that more and more organizations will recognize that to move forward, they'll need to make

changes not only within functional silos, but also at the enterprise level."

Informed by this vision, LAI facilitates an annual conference; monthly on-campus "knowledge exchange" events—workshops, seminars, roundtable discussions and tutorials—that impart the latest research, thinking and tools developed at LAI; and on-site trainings and consultations that equip member companies to develop a roadmap for implementing Lean transformation at the enterprise level.

In 2006 BAE Systems launched six pilot projects, each commissioned to apply Lean principles to an aspect of the firm's product development process. Objectives of these projects range from achieving a greater than 20 percent reduction in cycle time for hardware circuit board design to saving \$10 million in product development costs within a particular division. To reach these objectives, select BAE employees have participated in LAI's Lean for Product Development Simulation, and teams of stakeholders in each project have used value stream mapping to uncover opportunities for process improvements.

"We looked at the value streams end-to-end of how these processes operated and tied that to our strategic objectives," says Robert Stow. "The teams laid out the value stream, identified opportunities for 'leaning out'—reducing waste and increasing efficiency and effectiveness—in each of these process areas, and implemented changes in standard operating procedures and organizational structure to realize the benefits."

Other deployments of LAI research include certification of employee mastery of its enterprise-level products and tools; the "LAI Lean Academy®," which trains new employees about Lean principles and their application; and the emerging LAI Educational Network (EdNet), which is propagating these ideas within colleges and universities across the U.S.

For more information visit, <http://web.mit.edu/lean/>. ILP members receive a 10% discount on all LAI Knowledge Exchange events.

## LECTURES

### GEEKS AND CHIEFS: ENGINEERING EDUCATION AT MIT

Speaker: Yossi Sheffi, Professor of Civil and Environmental Engineering and Engineering Systems Director, MIT Center for Transportation and Logistics

With wit and candor -- including some jabs at engineering school traditionalists -- Yossi Sheffi questions the future value of the current MIT engineering education, and proposes an alternative. [MIT World, April 5, 2007]

<http://mitworld.mit.edu/video/449/>

### THE FUTURE OF NUCLEAR ENERGY

Moderator: John Durant, Director, MIT Museum

Panelists: Andrew Kadak, Professor of the Practice of Nuclear Engineering, MIT  
Allison Macfarlane, Associate Professor of Environment Science and Policy at George Mason University  
Victor Reis, Senior Advisor in the Office of the Secretary at the Department of Energy

Nuclear energy will emerge either as a solution to the twin crises of global warming and a secure energy supply, or global catastrophe. Within this panel at least, there doesn't seem to be a comfortable middle ground. [MIT World, March 1, 2007]

<http://mitworld.mit.edu/video/447/>

**ILP REPORT**

# Midcareer Acceleration Program Builds Career On-ramps for Returning Professionals

by William Manning

MIT Midcareer Acceleration Program to anxious workforce re-entrants: Regroup. Re-tool. Relax.

Sure, business moves fast, and technology moves even faster. But being out of the workforce for any length of time and trying to get back in doesn't have to feel like running for a train that's pulling out of the station.

That's why experienced professionals who have the will, but may not know the way, to quickly acquire new skill sets for more effective career transitions finally have an invaluable ally in MIT's year-old Midcareer Acceleration Program (MAP).

A new and not-so-secret weapon in the Professional Education Program's arsenal, MAP has assembled a holistic helping of career and personal development coaching, a technical skills refresher, a choice of semester-long MIT courses, and an internship or research project — all of which will add new sparkle to already distinguished resumes. Completion of the program elements, say MAP administrators, should give a welcome jolt to a professional's job trajectory that may be in state of suspended animation.

The program, notes MAP faculty director and associate dean of engineering Dick Yue, is custom tailored for professionals who want a new career direction, or whose careers have been put on hold for a variety of reasons. Those reasons may be family related, or perhaps due to professional interruptions such as job loss related to company closure or mergers.

Whatever the reason for enrolling in MAP, however, the goal for students who complete the 10-month, part-time program is to secure a new position, or to at least have a strategic plan to find one, that matches their talents and aspirations.

But the goal for professionals who may want to take advantage of MAP for the coming year should apply by July 1 to be included in the all-important August orientation, the kick-off event that precedes the selection of an MIT course for the fall. And the start of what will likely be a heady and occasionally hectic back-to-school experience.

## "A Bit of a Shock"

"It was a bit of a shock at first," admits Stephanie Bucci. A former IT manager at a pharmaceutical company, Bucci is one of four MIT alums, out of an inaugural class of nine program participants, who are wrapping up their program participation this year.

"On the one hand, getting back into a university environment was easier because your motivation is different as a mid-career professional — you have very specific

educational goals and interests that you might not have as an undergraduate, and as a result you can get more out of it," observes Bucci. "On the other hand, the learning tools and techniques that are used now are different. Plus, I also had to balance my MAP program demands with all of my family commitments. It took some extra discipline to get everything done."

For Stephanie Bucci, this has meant concentrating on family as well as on two Sloan School courses in the past year, one that covered management perspectives on clinical trials, and another on legal issues affecting biomedical enterprises. The refreshed academic grounding and practical internship experience gained from the program will add a product development and marketing perspective to an already impressive IT career.

Not as shocked, but no less gratified, is Charles McCauley, a principal engineer and 25-year veteran in manufacturing and product development in the electronics industry. His interest in nanotechnology and self-assembling structures, materials science disciplines that were non-existent at the start of his career, led him to MAP and new professional opportunities.

"I've been working with a Ph.D. candidate this spring to provide material science support for his carbon nanotube research, so this has been very satisfying," reports McCauley, whose employer is accommodating his MAP participation. "From a personal development perspective, the workshops and seminars that had to do with networking and personal marketing were good. The "whole brain" leadership seminar, led by Chuck McVinney in January, was extremely valuable."

MAP was designed precisely for those, like Stephanie Bucci and Charles McCauley, who need a personalized learning path that's both professionally rigorous, yet flexible enough to accommodate individual interests and backgrounds, explains Jennifer Stine, executive director of the School of Engineering's Professional Education Programs (PEP).

The need to create a program like MAP, and for professionals to take advantage of it, has become all the more compelling as a result of two facts of business life.

## Eliminating Barriers, Navigating Trends

"There is research that examines the range of barriers faced by mid-career professionals who want to re-enter the workforce after an extended hiatus that may leave them behind the business or technology knowledge curve," notes Stine. "It found that many individuals have trouble re-entering a profession with gaps even as short as six months out of the workforce."

**PROJECTS, LABS AND CENTERS**
**BRAIN USES BOTH NEURAL 'TEACHER' AND 'TINKER' NETWORKS IN LEARNING**

While most people need peace and quiet to cram for a test, the brain itself may need noise to learn, a recent MIT study suggests. [MIT News Office, June 4, 2007].

<http://web.mit.edu/newsoffice/2007/noisy-brain-0604.html>  
<http://hebb.mit.edu/people/seung/>

**CUTTING FUME HOODS' HOURS SAVES ENERGY AND MONEY**

A device that sucks up noxious fumes also devours almost \$1.4 billion worth of potential energy savings each year. [MIT News Office, June 1, 2007].

<http://web.mit.edu/newsoffice/2007/fumehoods-0601.html>  
<http://web.mit.edu/mitei/>

**MODEL FOR TRACKING FLU PROGRESSION COULD REDUCE FLU PANDEMIC'S PERIL**

Engineer who survived pandemic of 1968 focuses on reducing influenza's death toll. [MIT News Office, May 31, 2007].

<http://web.mit.edu/newsoffice/2007/influenza-0531.html>  
[http://esd.mit.edu/Faculty\\_Pages/larson/larson.htm](http://esd.mit.edu/Faculty_Pages/larson/larson.htm)



The good news, however, is that as companies look at their needs and current demographics showing older workers retiring from the workforce, there is a growing need for capable mid-career hires of dedicated individuals to make contributions, Stine points out.

“So the idea behind MAP, and behind the strategic direction of professional education in general, is a type of intervention at key points in someone’s life,” says Stine.

“The objective is that someone with a significant degree can get the additional background and experience they need to re-enter the workforce, realize their full potential, and make contributions at the level at which they are capable.”

### Gotta New MAPtitude

From new domain expertise, to better time management skills, to improved resume writing and expanded networking opportunities, MAP’s first year graduates are clearly gaining the tools they need to get the career traction they want. Just as important, they appreciate the advice and support that helps to ensure success in their new fields of endeavor.

“What I liked most about the program was the opportunity to go back to school, sharpen some of the tools I hadn’t used in a while and pick up some new ones,” says the newly honed Charles McCauley. “I would recommend MAP broadly and I would choose to do it again.”

So would Stephanie Bucci, who expected an intense but somewhat isolated academic experience. She was pleasantly surprised, however, at the extent of mutual support among her MAP cohort as they advanced through their different programs and challenges.

“Although our interests were as different as they come, I was surprised and pleased that we became a really cohesive unit and professional support group for each other,” says Bucci, whose internship will be at a medical device company in New Hampshire this summer.

“I would recommend the MAP program to others,” Bucci affirms enthusiastically, “because they do a really good job. A really good job. It was great going back on campus after so many years. In a way, I’m sad that it’s over.”

More information on the MAP program is available at: <http://midcareer.mit.edu>

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[ilp-www.mit.edu/conferences](http://ilp-www.mit.edu/conferences)

### CONFERENCES

**JUNE 15, 2007**  
**6th Annual Center for Cancer Research Symposium: Systems Biology of Cancer**  
Kresge Auditorium, MIT Campus

<http://web.mit.edu/ccr/news/symposium.htm>

**JULY 12-13, 2007**  
**2nd Annual Methods in Bioengineering Conference**  
Kresge Auditorium, MIT Campus

<http://cem.sbi.org/MiB/>

**SEPTEMBER 25, 2007**  
**2007 MIT HomeCentric Conference: Technology-Enabled, Home-Centered Lifestyles**  
Wong Auditorium, MIT Campus

<http://ilp-www.mit.edu/events/HOME>

**OCTOBER 16, 2007**  
**Materials Day 2007**  
Kresge Auditorium, MIT Campus

<http://mpc-web.mit.edu/>

**NOVEMBER 14-15, 2007**  
**2007 MIT Research and Development Conference**  
Kresge Auditorium, MIT Campus

<http://ilp-www.mit.edu/events/RD2007>

**DECEMBER 5-6, 2007**  
**2007 MIT Innovations in Management Conference**  
Wong Auditorium, MIT Campus

<http://ilp-www.mit.edu/events/MGT2007>