MITsdm

MIT System Design and Management

The SDM Pulse@MIT

The newsletter of the Massachusetts Institute of Technology System Design and Management Program

Systems engineering helps Whirlpool increase customer loyalty

By Timothy Aykroyd, systems engineer at Whirlpool Corporation and first-year SDM student

Developing new products requires a heavy investment of both time and money. At Whirlpool Corporation, systems engineering helps assure the best return on this investment by opening up new ways for the company to achieve a major competitive advantage—customer loyalty.

Systems engineering enables product developers to view a seemingly stand-alone appliance as part of an entire home system; they therefore design attributes that make each unit function in an expanded role as part of the whole. With a systems engineering approach, the architecture of this larger system becomes the central focus for understanding overall functionality, connectivity, interface definition and requirements of the subsystems, also known as appliances. This opens up vast global opportunities—and helps differentiate Whirlpool from its competitors.

Prototype testing in this environment has benefited Whirlpool in two ways. First, customers who tested prototypes within a home system discovered unexpected ways to tap overall system functionality. In addition, feedback from these "inventive users," as we call them, helps the company

to develop a lasting bond with its customers, since people appreciate having direct input into the development of the products they use.

Timothy Aykroyd

Whirlpool is also using systems engineering to devise methodologies to understand the genesis of the ideas that emerged through prototype testing so that we can incorporate them into our product development cycles. These findings could bring our company a fundamental competitive advantage in our design process. The better we understand our customers' motivations, the better we can design the linkages among our products.

New opportunities bring new challenges, in this case tying a new feature or product to the overall Whirlpool brand. Systems engineering helps unlock a product's performance potential while optimizing benefits and incorporating the flexibility to

Welcome

Welcome to the second issue of the *SDM Pulse@MIT*.

Students in the MIT System Design and Management (SDM) Program have authored many of the articles in this issue, focusing on the thinking, activities, challenges and opportunities they and their classmates experience. These articles offer insight into the breadth and capabilities of SDM students and demonstrate the tremendous resources the SDM program offers to professionals hoping to address the technical and managerial challenges of today's business environment.

This edition offers a glimpse of systems engineering in new product development at Whirlpool; the results of a team project in the product design and development class; and a report on several SDM student internships, including work on wind turbines and an experience applying systems engineering principles to the banking industry. A seasoned US Army company commander who has joined the SDM program shares his views of systems thinking and how it can help the US military; and an SDM staff member reports on a visit by SDM students, faculty and staff to NASA's Kennedy Space Center. You will also find information on a new systems engineering consortium, an overview of the 2007 SDM cohort, a summary of the 2006 SDM employment report and a calendar of future SDM events.

I hope you find the students' contributions to this issue of *SDM Pulse@MIT* as enjoyable and informative as I did. As always, your feedback and suggestions are welcome.

Best regards,

John M. Grace
Industry Codirector
MIT System Design and Management Program
jmgrace@mit.edu

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SDM internships provide value for students, companies

By Dhiman Bhattacharjee, SDM '07, with Lois Slavin

Internships are optional at SDM, but students sign up for them year after year because participating gives them the chance to conduct state-of-the-art research in a wide range of industries—from renewable energy to information warehousing to banking and high-tech.

Chris Aden, SDM '07, worked with Ampair (www.ampair.com), a renewable energy company in Berkshire, England, that is headed by SDM alumnus David Sharman. As Ampair's CEO and managing director, Sharman is working to define the micro-wind market, address the critical engineering expertise needed and ramp up the product line to maximize value to the environment and, of course, the bottom line.

"I worked with David and Ampair engineers at a high level to integrate platform manufacturing techniques into a scalable design practice, focusing on bringing the first 600-watt home energy system to market," Aden said.

He said he got the opportunity to work with world-class power engineers; he was exposed to an aggressive startup environment; and he spent several days in front of a homemade wind tunnel. He also worked with such downstream competencies as installation and service companies, and—in a key cultural exchange—spent several nights discussing renewable energy opportunities at the local English pub, the Stag and Hounds.

"Aden's work allowed us to move at four times the speed and with far more confidence, compared with our traditional approach," said Sharman, who was Aden's internship supervisor.

Peter Burton, Ampair's technical director and chief technology officer, said, "The results of the simulation work undertaken by Chris gave us the confidence to proceed with development work on the project. Without it we would have been wary of investing more time and effort with no guarantee of success."

Dhiman Bhattacharjee

Strategy for a startup

Nick Cravalho, SDM '07, worked as a marketing intern at Kiva Systems (www.kivasystems.com), a warehouse automation company located in Woburn, Mass.

"My passion is technology-based startups. Working for Kiva gave me the opportunity to immerse myself in a dynamic startup environment and cross the chasm from engineering to business development and marketing," he said.

Cravalho's primary responsibilities included creating a go-to-market strategy to penetrate the manufacturing sector and a return-on-investment calculator to justify a future product extension. He credits part of his success to the SDM community, whose members shared both their time and contacts so he could better understand the manufacturing market at top-tier companies.

Cravalho reported to Kiva Systems' vice president of business development, Rob Stevens, who said, "In a

Chris Aden

Nick Cravalho

Product design and development at SDM

By Sorin Grama, SDM '07

Sorin Grama

I was attracted to MIT's SDM program because its curriculum focuses on product design and systems engineering. One course that features prominently in this curriculum is Product Design and Development (PDD), ESD-40, which I enrolled in because I was eager to augment the knowledge I had acquired during my 13-year professional career as a project manager and consultant in the test and measurement industry.

While I expected a theoretical approach to product design, I was pleasantly surprised by the additional focus on practical applications. The PDD class was one of the most fun classes I took at MIT because we not only learned how to structure a product design process, but we also executed it by designing and building a new product of our own choosing.

That's right! During this course, students come up with a product idea and then, throughout the rest of the semester, work together to turn their ideas into reality.

The semester begins with an introduction to several successful products that have come out of this class, including ones that have been commercialized. Among them are the new and improved paint-pouring can, the ultra-quiet bird-watching tripod and the sugar dispenser that dispenses the right amount of sugar into your coffee every time. We then got to work on our own projects by first forming teams of four to five people, then brainstorming product ideas that we felt were relevant to our team members' knowledge and expertise. Each team received a $1,000 budget to reach its goal: a working prototype.

We conducted user surveys, prioritized the customer needs and translated them into product features.

Concurrently, the class lectures introduced concepts that could be immediately applied to our projects, such as demographic survey methods, Pugh concept selection and industrial design.

We used the classic textbook by Professors Karl Ulrich and Stephen Eppinger, *Product Design and Development*, the bible of product design and development at MIT. Classes were a mix of traditional lectures and guest lecture presentations from industry experts. Last year, Design Continuum, a product design firm in Boston, provided an excellent introduction to customer survey methodologies, and Professor Michael Cusumano from MIT's Sloan School of Management introduced us to the secrets of software product development at Microsoft.

The course also includes lectures on intellectual property rights, business planning and project financing, and, of course, many hours of good old-fashioned elbow grease trying to get the prototype ready for the final presentation. Instructors, TAs and invited guests review and grade the project from engineering, business and academic perspectives.

I enjoyed the class very much because it was much more than just an engineering course. I enjoyed the teamwork, especially learning how to navigate the team dynamics through moments of despair (when we realized that our drawings would take much longer to finish) followed by moments of joy (when our prototype worked for the first time). Overall, we had a lot of fun in this class and we learned a great deal in the process.

I enjoyed the class so much that I'm taking it again. I am a teaching assistant in the class for the spring 2007 term, along with one of my SDM colleagues. I am looking forward to seeing what the new SDM cohort devises. Maybe one idea will make it big, and I'll be able to say I helped them with it!

Success is a working prototype

Our team came up with an idea for a plastic bag dispensing system after noticing that the grocery produce bags are always hard to open, frustrating many people. Our product combined ideas from paper towel dispensers and laser printers to provide easy, one-handed bag opening. A critical design feature is to provide a shear to the layers of the plastic bag during dispensing.
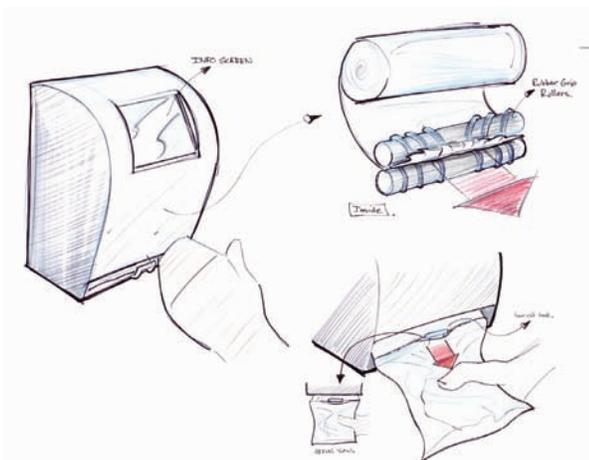
Concept sketch
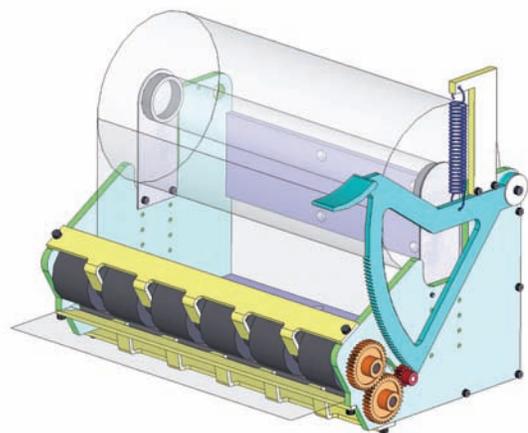
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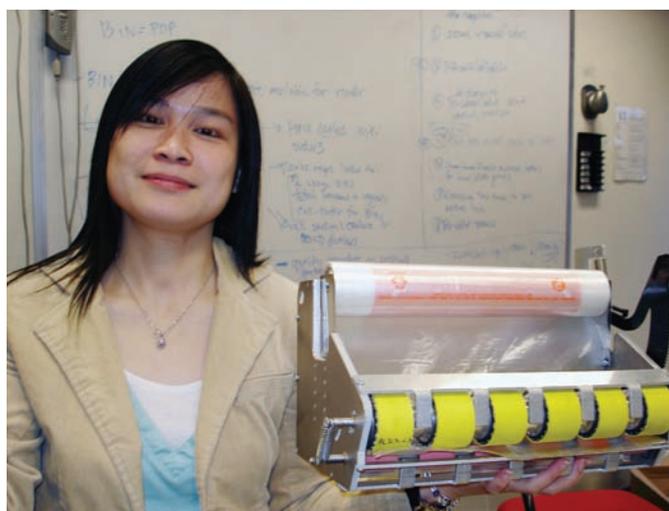
Team member Shelley Lau proudly shows our final prototype.

New SDM class shows diversity, commonality

By Patty Eames, SDM-LFM communications assistant, and Lois Slavin, ESD communications director

The members of SDM's newest class, who matriculated in January 2007, hail from a diverse range of educational and professional backgrounds, bringing a wealth of knowledge and experience to share with each other.

According to Pat Hale, director of the SDM Fellows Program, the SDM admissions committee continually seeks to enhance diversity in cultures and product domains. "Diversity creates a rich experience base for the program, enabling the students to learn as much from each other as they do from the professors," he said. "In fact, the professors often remark that they learn a lot from the diversity of the SDMs too."

That's not surprising. This year's class boasts five members who have earned PhDs. Amarnath Arvind holds a doctorate in electrical engineering; Radu Bharadwaj in biochemistry and molecular biophysics; Kevin Liu a PhD and a postdoctoral degree in computer science; Parthsarathy Seshadri holds his PhD in chemical engineering; and Charles Ufongene in computer science. Both Seshadri and Ufongene are also graduates of SDM's one-year certificate program.

Thirty-one new SDM fellows earned master of science or MBA degrees prior to matriculating. SDM fellow Wayne Liu holds two—an MS in computer science and an MS in biochemistry and molecular biology. SDM fellows earned their degrees at universities around the globe, in China, India, Lebanon, Pakistan, the United Kingdom, Turkey, Japan, Taiwan, Nigeria, New Zealand, France, Mexico and the United States.

While most SDMs have experience in product design and development or in engineering, they've earned their stripes in diverse industries, including consumer goods, software, aerospace, defense, networking, wireless communications and more. Nevertheless, virtually all members of the new class cite a common reason for choosing the SDM master's in engineering and management—the impact SDM's interdisciplinary approach to leadership, innovation and systems thinking can have on their careers.

Kelly Yedinak, deputy program manager at Northrup Grumman Corporation, said that although she enjoys team-building, leadership and management, she is also passionate about technology and engineering design. "An MBA wouldn't be enough," she said, adding that she is also looking forward to more training in product development and innovation.

Ufongene, an avionic systems integration engineer at United Technology Corporation's Sikorsky Aircraft Company, said the broad scope of SDM's master's offerings motivated him to enroll. "I hope to expand my knowledge beyond the technical aspect of my work and apply my interdisciplinary SDM learnings in the area of technology strategy," he said.

Kelvin Lim received a scholarship to attend SDM from his employer, the Defence Science and Technology Agency of the Republic of Singapore. He said the holistic education that is SDM's hallmark will equip him with "the systems thinking and managerial skills necessary to take on greater and more complex systems management responsibilities in my career."

Hale said that during SDM's intensive monthlong session in January, the new cohort proved to be a group of extremely bright and talented individuals. "They will certainly maintain the standard of excellence in performance and engagement in lifelong learning that has characterized MIT's SDM program since its beginnings."

Profile: Nathan Minami, SDM '07—a soldier's journey to MIT

By Patty Eames, SDM-LFM communications assistant, and Lois Slavin, ESD communications director

Nathan Minami's career has taken him to 23 countries on five continents, but the Army major says he came to SDM because it teaches what the US Army and the world at large need—people who understand systems thinking and can manage and lead in complex situations.

If one had to use a single word to describe Minami, it would have to be "patriotic." While his commitment to the American people shows in his words and actions, it is best exemplified by his career in the US armed forces.

During high school, perhaps because his father served in Vietnam and his grandfather in WWII, Minami applied and was accepted to the US Military Academy at West Point. There he enrolled in the first of three higher education programs supported by the Army—earning a BS in Arabic and French language with a focus on systems engineering. Later, Minami graduated with an MA in national security studies with a Middle East concentration from American Military University.

Minami has spent 14 years in the military, but he said his deployment in Iraq as infantry company commander for the 25th Infantry Division led to his biggest accomplishments. He and his troops assisted with reconstruction projects, governance and training soldiers in the Iraqi army—in addition to participating in combat operations. "I deployed to Iraq with 146 soldiers and brought 146 soldiers home," he said, humbly acknowledging that he had help from many others. "Not one died and not one had to be medically evacuated."

At SDM, Minami says he has benefited most from his system dynamics classes, which have taught him how to understand and manage the complexity of different socio-technical systems.

"A single soldier and his equipment can be seen as a complex system," Minami said. "He must be prepared to quickly assess a situation and determine how to communicate effectively with a wide range of stakeholders, from fellow soldiers, to officers, to Iraqi citizens, in environments that are often hostile and deadly. Deepening my understanding of complex systems will help me better serve my troops and my country. I also believe it's something all of us everywhere could use in order to learn to work together peacefully and effectively in many different endeavors."

Minami praises SDM for its emphasis on group assignments and collective learning. "Everything is teamwork in the military, and SDM is all about teamwork. I will be returning to service in June 2007 with a better understanding of how to incorporate a variety of diverse perspectives for the collective good of the whole. I am very grateful to be part of the SDM community."

Nate Minami, far right, conferring with fellow soldiers in Iraq

SDMs tour Kennedy Space Center

By Lois Slavin, ESD communications director

SDM students, alumni, faculty and staff toured NASA's Kennedy Space Center (KSC) in January to see how the experts process launch vehicles for spaceflight.

SDM student Shawn Quinn, who serves as future elements manager for the Constellation Ground Operations Project Office at KSC, designed the two-day tour specifically for this group. He said he thought it would be useful for SDMs to visit the center because so much of SDM's master's program involves learning to understand and synthesize large-scale engineering systems.

"KSC offered a close-up look at three distinct approaches to the ground processing of some of the world's largest launch vehicles in service today—the space shuttle, Delta IV and Atlas V," Quinn said.

SDMs saw elements of the International Space Station being prepared and saw a number of areas and activities vital to space shuttle missions, including firing rooms in the launch control center, launchpad 39B, the crawler–transporter, and solid rocket boosters, which were undergoing stacking operations in the 525-foot-tall Vehicle Assembly Building.

The group also watched the Space Shuttle Atlantis undergoing final preparations for a March launch in the Orbiter Processing Facility. They visited Atlas V and Delta IV launch processing facilities and pads used for uncrewed missions for NASA, the Department of Defense and commercial companies. The tour concluded at the Apollo Saturn V facility, where an actual unused Saturn V is on display, along with historical artifacts from America's first journey to the moon.

"We compared and contrasted three different vehicle processing architectures and got an up-close look at the scale and scope required to process launch vehicles and spacecraft for flight," Quinn said. The group also saw what it takes to process International Space Station elements prior to launch. (The station is the largest man-made system in orbit.)

Professor Olivier de Weck of aeronautics and astronautics and engineering systems said he was particularly impressed by the dedication and knowledge of the local workforce, the detailed work required on the thermal protection system in the Orbiter Processing Facility, and the reconditioning of the space shuttle's main engines and solid rocket boosters. "The KSC tour was especially valuable for SDM because we are trying to emphasize these life-cycle issues in our curriculum," de Weck said.

New consortium expands scope of ESD initiative

MIT ESD's Systems Engineering Advancement Research Initiative (SEARI), which works to address complex socio-technical challenges through sponsored systems-engineering research, recently established a new consortium to broaden its reach.

"Our sponsored research program has proven successful in targeting specific problems of a single sponsor," said Donna H. Rhodes, the director of SEARI. "The new consortium is designed to tackle problems that are both appropriately and more feasibly undertaken as broader, collaborative endeavors for the benefit of the community."

The consortium membership structure is tiered (Platinum, Gold, Silver, Bronze), offering a variety of benefits and opportunities for engagement commensurate with sponsorship type. Strategic partners of the MIT SDM program and members of the Lean Aerospace Initiative, groups that have been major sponsors and advocates for systems engineering research at MIT, will automatically receive Bronze-level benefits. Naturally, some may also elect to participate in the SEARI consortium at an enhanced sponsorship level.

The consortium will bring academia, industry and government experts together for collaborative learning and joint research on advanced systems engineering topics, such as designing systems for changeability; cost modeling and leading indicators for effectiveness; systems engineering practices for commercial products and services; and enablers for collaborative distributed systems engineering.

Through the new consortium, MIT seeks to engage with many more systems engineering leaders to better understand the way they work and the problems they face so that research programs can deliver practical and effective solutions. By sponsoring the consortium, systems leaders can guide research priorities; gain early access to research findings; and participate in research summits and deep technical exchanges. Since industry and government have limited resources to invest in systems research, the consortium provides a structure for pooling talent and resources in order to address significant problems that affect the broader systems community.

The largest systems problems are unlikely to be solved by the single-sponsor research investment model, Rhodes noted, adding that a consortium is a better model for achieving benefits for the systems community at large. "A key part of our strategy is to offer combined SDM and SEARI events, and to make SEARI one of the key intellectual homes for SDM thesis research," she said.

For further information on consortium membership, visit web.mit.edu/seari or contact the leadership team at seari@mit.edu.

Employment report highlights

By Helen Trimble, director of SDM Career Development

Helen Trimble

SDM takes pride in educating future technical leaders, innovators and systems thinkers for employment in industries and organizations as diverse as nonprofits, aerospace and financial services. Our graduates also take on technology consulting and leadership roles in product development, business strategy and operations.

Although many students come to SDM through company sponsorship, for those who do not, SDM publishes an employment report each year. As in past years, our 2006 self-funded graduates were highly successful in securing employment: many accepted top technical and managerial positions.

Employers recognize that the prior work experience of our graduates (who have an average of 10 years upon entering SDM), the rigor of the SDM academic program and the diversity of thought and experience among SDM colleagues equip SDM fellows to communicate and lead across disciplines and to solve complex problems throughout organizations. Also for these reasons, SDM's 2006 self-funded graduates earned a base salary of nearly $8,000 more then their MBA peers from Sloan.

Following are some results from an employment survey of 2006 SDM self-funded graduates:

> 100 percent of the SDM fellows who responded to the survey were employed before graduating in May 2006.

> The average number of job offers for an SDM graduate is 2.2.

> SDM fellows received an average base salary of $109,800 (median $109,000), representing an increase of $32,040 or 41 percent over the average base salary prior to entering the SDM program.

> Consulting and strategy job functions drew 25 percent of the 2006 SDM graduates, followed by engineering/management and operations/project management both at 20 percent, general management/leadership and IT/software each at 15 percent and marketing/sales at 5 percent.

> 45 percent of the SDM graduates received an annual performance bonus averaging 17 percent of salary.

To view the complete 2005-2006 SDM Employment Report, go to: sdm.mit.edu/docs/sdm_employment_report06.pdf.

For information on recruiting and hiring SDM graduates, contact Helen Trimble, director of SDM Career Development, at htrimble@mit.edu or 617.258.8256.

Systems engineering helps boost customer loyalty *(cont'd from page 1)*

design for multiple product lines. Delivering a flexible system for implementing future technologies prevents legacy customers, critical to the continued growth of any business, from getting blindsided by a dramatic switch in technology (as happened in the computer industry). Properly constructed systems allow for a technology evolution that will keep Whirlpool innovative, while maintaining and hopefully increasing its customer base.

Whirlpool's future embraces a systems engineering–based approach because solid engineering must be combined with a holistic understanding of the full range of "systems within the system." Building on its history of innovation and success and grounded in systems engineering, Whirlpool is creating innovative products that will remain the industry benchmark, help it maintain and strengthen its global lead, and increase customer loyalty over the short and long term.

SDM internships provide value for students, companies

(cont'd from page 3)

startup you rarely have time to step back and do nalysis—you tend to be running as fast as you can. Having Nick as an intern in the marketing group gave us a chance to look ahead and analyze upcoming market and product opportunities."

Although the internship is over, the relationship is not. Kiva will be Cravalho's base case for his master's thesis on new venture formation.

Systems approach to banking

Vinay Deshmukh, SDM '07, conducted his internship at Bank of America in Boston.

"My work involved exploring the question of whether systems engineering principles can be applied in the banking sector to achieve both radical and incremental improvements in operational efficiency," he said.

Deshmukh explored how concepts and tools, such as quality functional deployment, signal-to-noise ratio, lean thinking, rapid experimentation, multivariate regression analysis, Kano analysis and process modeling and simulation could be applied to the financial processes and products of the bank's Global Wealth and Investment Management Division.

Vinay Deshmukh

Taking a "system of systems" approach, Deshmukh used process modeling and simulation to examine people, products and processes, then suggested holistic solutions that harmonized the voices of the customers, employees and the shareholders within specific areas. One of the projects dealt with retaining the funds of institutional clients and another dealt with improving the account review process.

"In Bank of America's Global Wealth and Investment division, we are working on many projects with an end-to-end view. Vinay's contributions helped clarify the value of applying a systems engineering approach in six sigma applications and other tools and methodologies," said Rajesh Jugulum, the bank's vice president and quality and productivity engineer for the division.

Helping Cisco with compliance

Dhiman Bhattacharjee, SDM '07, interned in the advanced sourcing department of Cisco Systems' manufacturing division, focusing on developing processes to help Cisco comply with upcoming production regulations. Working with SDM '02 alumna Carol Ann McDevitt and several members of the manufacturing, compliance, engineering and sales staffs, he helped identify forthcoming regulations and their potential impact on the company, then crafted compliance processes.

"I was able to apply my SDM learnings at Cisco, then take my learnings from Cisco and apply them when I returned to SDM," said Bhattacharjee. "I used a systems approach to examine challenges from a broad perspective and offer suggestions and solutions to help Cisco continue to be a proactive world-class leader in compliance."

Learn more about SDM

Want to learn more about the MIT System Design and Management Program? Visit our website at sdm.mit.edu for details on SDM's academic offerings, to catch up on news and to find out how you can get involved, whether as a student or as an industry partner.

SDM Calendar
Spring 2007–Winter 2008

If you or your colleagues are interested in attending any of the events listed below, please contact SDM Industry Codirector John M. Grace at jmgrace@mit.edu or 617.253.2081.

April 5, 2007

Charles L. Miller Lecture
Speaker: Professor Yossi Sheffi, Civil and Environmental
    Engineering and Engineering Systems
Title: Geeks and Chiefs: Engineering Leadership at MIT
Location: Bush Room, MIT
Time: 4 pm
Details: esd.mit.edu

May 3, 2007

The IBM-MIT/Engineering Systems Division Innovation Lecture Series
Title: Engineering Systems Solutions to Real World
    Challenges in Law Enforcement
Location: E51-345
Time: 4 pm, with reception to follow
Details: esd.mit.edu

June 5, 2007

SDM Information Evening
Time: 6:30 pm
Location: Framingham Sheraton

June 12, 2007

SDM Information Evening
Time: 6:30 pm
Location: MIT Faculty Club

July 16–July 20, 2007

SDM Business Trip
Location: MIT

August 14, 2007

SDM Information Evening
Time: 6:30 pm
Location: MIT Faculty Club

September 11, 2007

SDM Information Evening
Time: 6:30 pm
Location: Burlington Marriott

September 17, 2007

SDM-LFM Midstream Review
Location: MIT

Late September/Early October 2007

SDM Partners Meeting
Systems Engineering Exchange

October 15-19, 2007

SDM Business Trip
Location: MIT

October 16, 2007

SDM Information Evening
Time: 6:30 pm
Location: MIT Faculty Club

October 17, 2007

Open House for Incoming SDM Students
Time: 10 am –5 pm
Location: MIT Faculty Club

October 18-19, 2007

SDM Conference
Location: MIT

November 8, 2007

Industry-Faculty Research Forum
Location: MIT Faculty Club
Sponsors: MIT System Design and Manufacturing Program
    and MIT Leaders for Manufacturing Program

January 31-February 1, 2008

SDM-LFM Knowledge Review
Location: MIT

Spring 2008

2008 MIT Manufacturing Conference
Sponsors: MIT Industrial Liaison Program (ilp-www.mit.edu),
    MIT System Design and Management Program
    (sdm.mit.edu), MIT Leaders for Manufacturing Program
    (lfm.mit.edu), MIT Forum for Supply Chain Innovation
    (supplychain.mit.edu)

Event information includes all details available at press time.

For more current event information, go to sdm.mit.edu and esd.mit.edu.