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

sdmpulse

in this issue

MITsdm
system design and management

SDM approach sheds light on how culture affects consumers

By Vinay Deshmukh, SDM '06

Last spring, All Nippon Airlines (ANA), a leading Japanese airline and the 2007 winner of Air Transport World's Airline of the Year award, piloted an interdisciplinary project to investigate how culture influences U.S. consumers' perceptions and behavior. The effort, intended to inform ANA's plans to expand in the United States, was initiated by Patricia Gercik, managing director of the MIT International Science and Technology Initiatives–Japan (MISTI–Japan).

Vinay Deshmukh, SDM '06, far right, poses with his teammates on the All Nippon Airlines project. They are, from left, Daniela Reichert, program director for the MIT International Science and Technology Initiatives–Japan (MISTI–Japan); Patricia Gercik, managing director of MISTI–Japan; Sharmila C. Chatterjee, visiting professor at MIT Sloan; Zachary Smith, LFM '08; and Olivier Ceberio, MBA '08.

After submitting a marketing write-up and going through an interview process, three students were selected for the project—Zachary Smith LFM '08, Olivier Ceberio MBA '08, and myself.

We were asked to:

- Determine consumers' attitudes toward Japanese products and services versus U.S. products and services
- Perform a comparative analysis of these attitudes
- Assess what effect, if any, country of origin has on consumer perceptions and willingness to buy
- Assess what cultural influences, if any, affect consumer perceptions and willingness to buy
- Assess what factors are most important to consumer decision-making when choosing an airline, hotel or automobile

Taking a systems approach, the team laid out a general path diagram for the project (Figure 1, page 15). Marketing scales for measuring constructs of interest were compiled from research papers as well as from the American Marketing Association's *Marketing Scales Handbook* and SAGE Publications' *Handbook of Marketing Scales*. We used many SDM tools throughout the project.

To ensure that acculturation effects were taken into account, we used a three-dimensional model to rate customer preference for Japanese versus U.S.

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For further information on MIT's System Design and Management Program, visit sdm.mit.edu.

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system design and management

Welcome

The *SDM Pulse* has a fresh new look! This redesign should make it even easier for you to keep up with the latest news and research from the System Design and Management Program. Let me know what you think.

We have a series of very special articles for you in this edition. You will start off with an intriguing study described by Vinay Deshmukh, SDM '06. He and his team used systems techniques to investigate the cultural issues that impact the marketing of All Nippon Airlines. This article is followed by the latest in our series reviewing the core of SDM's curriculum, this time focusing on project management. The teaching assistant for that course, Mark Davis, SDM '07, gives us an inside view of the subject.

We are also providing you with advance notice of an important conference cosponsored by SDM, Strategies for Balancing Risks and Opportunities in Global Product Delivery, which will take place March 11–12, 2008, at MIT. As a prelude to some of the conference content, Harry H. Ayubi, SDM '06, who works at The Boeing Company, discusses the need to consider the full life cycle of a product during design and development. He illustrates this approach with a discussion of the design of a modern aircraft.

We are fortunate to have Professor Warren Seering join the ranks of faculty codirectors of the Leaders for Manufacturing and SDM programs, and the *Pulse* includes a short bio on Warren. We also introduce our audience to three women graduates of the SDM program with a snapshot of their professional development.

Shawn Quinn, an SDM '06 who works at NASA, offers a detailed look into SDM's course on product design and development, describing how his team progressed from concept to prototype to win the course competition. We continue to track Ragu Bharadwaj, SDM '07, as he moves through the SDM program gaining insights applicable to the pharmaceutical industry.

In a final group of articles we note SDM and SEA[RI]'s involvement in the recent INCOSE symposium and the flexibility of the SDM program to meet a company's strategic needs for technical leadership development. We are also providing you with a handy calendar of future SDM activities and events. Enjoy!

As always, I encourage your comments and thoughts on current content as well as your suggestions for future topics.

Best regards,

John M. Grace

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The core of SDM: Inside system and project management

By Mark J. Davis, SDM '07

Mark J. Davis
SDM '07

Editor's note: *The core courses for the MIT System Design and Management Program are:*

- ***System architecture**, which focuses on artifacts themselves and includes concept, form, function, and decomposition*
- ***Systems engineering**, which targets the processes that enable successful implementation of the architecture, and includes QFD, Pugh Concept Selection, and Robust Design*
- ***System and project management**, which involves managing tasks to best utilize resources and employs tools such as CPM, DSM, and System Dynamics*

This article, the second in a series on the SDM core, introduces system and project management. The author, Mark J. Davis, is a major in the Air Force, an SDM student and a teaching assistant for the course.

SDM's required course in system and project management (SPM) focuses on the management principles, methods, and tools needed to plan and implement successful development projects. Always highly rated by SDM students, this popular course is led by Professor Olivier de Weck, who is refreshingly smart and down to earth (when he isn't working on space systems). Taking into account the extensive project management experience that is typical of the SDM cohort, the course builds on SDM students' understanding of the tensions among technical scope and performance, cost, schedule, and risk, and offers instruction in how to manage these tensions to meet customer expectations.

As outlined in the course syllabus, the objective of SPM is to:

"…introduce advanced principles, methods, and tools for project management in a realistic context, such that they can be taken back to the workplace to improve your ability to manage complex product and system development projects."

Classic techniques such as critical path method (CPM) and program evaluation and review technique (PERT) scheduling tools are reviewed, but the central tools this course focuses on are critical chain, design structure matrix (DSM), stochastic project simulation, and system dynamics. Case studies, both successful and unsuccessful, show project management tools and methods in use on complex real-world projects. The topics are broken into six modules.

The first module covers critical chain and DSM. Critical chain is primarily a schedule management technique that allows managers to actively control and manage the overall project schedule with buffers instead of just responding to problems as they arise. Design structure matrix helps managers to visualize and manage the interaction and interfaces among the tasks and components of a project, ultimately ordering tasks more efficiently.

The second module, taught by visiting lecturer James Lyneis of the Engineering Systems Division, presents system dynamics methods and techniques within the context of project management. Students work with models to explore such project dynamics as the rework cycle, employee burnout, and the effects of project management policies.

Interspersed throughout the term, based on presenter availability, the third module centers on case studies from actual members of the teams that participated in the projects from which the studies were developed. Students learn a lot from this module, which demonstrates how SPM tools and methods are being applied in such fields as automotive, aerospace, oil and gas exploration, and software development.

The fourth module focuses on how to monitor cost, scheduling, and technical progress. Risk management concepts are explored and the earned value management system (EVMS) is taught. Uncertainty is introduced as a key concept in making projections in order to make more informed project management decisions. Further, the concept of real options in project management is explored. Real options is a method that allows project managers to quantitatively evaluate the potential risks and rewards for different decisions that are being considered.

Students are introduced to the "softer" aspects of project management during the fifth module, which addresses organizational structures, international and geographically dispersed projects, and the human aspects of project management.

The final module summarizes the available organizational and web resources for project managers. The class concludes with presentations of team projects that apply one or more tools and methods learned in class to a real-world problem. The project gives SDM students a great opportunity to apply new knowledge, to learn from fellow students, and to acquire cutting-edge skills that they can bring to their employers.

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SDM to cosponsor major conference on life-cycle approach to risk management

By Lois Slavin, communications director, MIT Engineering Systems Division

With the risks of launching new products and services greater than ever, companies are discovering that a life-cycle approach—one that incorporates all aspects of product design, development, manufacture, distribution, service, and end-of-life—is essential to success. Although this "systems" approach is being applied across industries around the globe, the complexities of cultural hurdles, safety, and ever-changing technologies make this life-cycle approach increasingly critical, yet unquestionably challenging to adopt.

On March 11-12, 2008, leading MIT researchers will join top industry experts to address the practical question of how to use a life-cycle approach to maximize opportunity while minimizing the risks of conducting business today. Strategies for Balancing Risks and Opportunities in Global Product Delivery will take place on the MIT campus in Cambridge, Mass.

The symposium will feature strategies and tactics drawn from organizations that are consistently achieving ever-greater levels of performance and prosperity in both new and existing markets. Keynote speakers include Nick Donofrio, executive vice president of innovation and technology at IBM, and Joan Cullinane, president of Velcro, USA. Senior executives from a wide range of industries will also share their companies' best practices and lessons learned.

MIT experts will highlight important research findings and provide insights into how companies can minimize risks using systems thinking, product design, network modeling, information technology, procurement/inventory strategies, and the flexible supply chain. Scheduled speakers include safety specialist Nancy Leveson, professor of aeronautics and astronautics and engineering systems; systems architecture expert Ed Crawley, professor of aeronautics and astronautics and engineering systems; and supply chain expert David Simchi-Levi, professor of civil and environmental engineering and engineering systems.

In addition, Wallace Hopp, the Herrick professor of manufacturing and a professor of operations and management science at the University of Michigan will be speaking. Additional speakers will be announced on the SDM website, sdm.mit.edu, as they are confirmed.

The conference is cosponsored by MIT's System Design and Management Program, Leaders for Manufacturing Program, Forum for Supply Chain Innovation, and Industrial Liaison Program. Several hundred senior executives from major corporations across a range of industries are expected to attend.

For further information, contact John M. Grace, industry codirector of SDM, jmgrace@mit.edu, 617.253.2081.

Professor Warren Seering

Professor Seering named engineering codirector for SDM, LFM

By Lois Slavin, communications director, MIT Engineering Systems Division

Professor Warren Seering has been named the new engineering codirector for the System Design and Management and Leaders for Manufacturing programs. Seering is stepping in for David Simchi-Levi, who is on sabbatical this year.

Seering, who took office July 1, is the Weber-Shaughness professor of mechanical engineering and engineering systems. He has been actively involved with LFM since its inception and served as LFM research codirector during the early 1990s.

In 1997, Seering helped design the product development track for the System Design and Management Program. He also helped start programs based on SDM at several other universities. Over the years, he has been an active supervisor of thesis projects for students in both the LFM and the SDM programs.

The former codirector of the MIT Center for Innovation in Product Development, Seering is a founding director of the Nissan Cambridge Basic Research Laboratory. He serves on the Board of Management of the International Design Society and recently received the Frank E. Perkins Award for Excellence in Graduate Advising.

Life-cycle approach improves product development process

By Harry H. Ayubi, SDM '06 and 787 wing integration project manager at The Boeing Company

Harry H. Ayubi
SDM '06

There is more to product development than design, build, test, and deliver. Even after the product is sold, long-term issues such as maintenance and disposal costs can affect profitability. That is why MIT's System Design and Management Program teaches a life-cycle approach to new product development—the same approach increasingly used by industry.

Many aspects of the early phases of development are well understood (e.g., concept selection, trade studies, requirements management), but those occurring later in the product life cycle often receive less attention than they deserve. A more complete product life-cycle approach means taking into consideration service, maintenance, decommissioning, and even dismantlement—at the design stage. This approach is consistent and commensurate with the systems viewpoint central to SDM.

Although this holistic approach is not a new idea, design teams have only recently learned how to address all of the related life-cycle needs during the early stages of product development, which is when the opportunity to satisfy these needs in the design still exists.

For example, a requirements-driven design process is necessary to ensure that all aspects of the product life cycle are considered and balanced as an appropriate design solution is selected. Service, maintenance, and environmental impact issues need to be managed as requirements of the design solution, in much the same way that more traditional performance and manufacturing issues are handled.

The usefulness of life-cycle design can be seen in the development of new commercial airplanes. Consider the Boeing 787 commercial jetliner. Officially launched in 2004, the 787 is the first all-new commercial airplane produced by Boeing in more than 20 years (the last was the Boeing 777, with a program launch in 1990 and the first airplane delivered in 1995). Affectionately referred to as the "Twenty-First-Century Jet," the 777 offered innovative design features and set new standards in commercial airplane development. But much has changed in the world and in the commercial airline industry since the early 1990s, and while the 777 is still popular, airplane product development has had to adapt.

With increasing awareness of an airline's total operating expenses, design teams are able to address such issues as maintenance cost by designing for serviceability and repair, as well as for performance (e.g., low weight, low aerodynamic drag) and manufacturability (e.g., fewer parts, ergonomic installations). For example, when considering the spatial constraints necessary to integrate structural components and systems during the design phase of the product, adding additional space for the installation and removal of components in the field improves product serviceability. And choosing materials that are less susceptible to corrosion, while perhaps not optimal for minimizing weight or manufacturing costs, might substantially reduce total maintenance costs over the life of the product. The life-cycle approach calls for a risk benefit analysis at every stage of development.

As an added benefit, there is often synergy between some of these considerations. For example, a product with fewer parts results in improved manufacturability, and fewer spares are needed for service and maintenance. Ergonomic considerations during the manufacturing process (i.e., making it easier for the mechanic to access assembly areas) can also help the service technician maintain the product in the field.

Attention to the impact of materials on the environment is another characteristic receiving increased consideration from today's product development teams. For example, some metals and chemicals used to treat the surfaces of metal components are no longer used in new products because of the risks they pose to the environment—despite any short-term benefits they might have for the design.

Within SDM, this more complete life-cycle view of the product development process is seen in courses on system architecture, systems engineering, product design and development, technology strategy, and risk and cost benefit analysis. Those who would like to learn more about taking a life-cycle approach might be interested in SDM's upcoming conference, Strategies for Balancing Risks and Opportunities in Global Product Delivery, to be held March 11–12, 2008, on the MIT campus (see related story on page 4).

Alumnae reflect on the benefits of their SDM education

By Kathryn O'Neill, editor of the SDM Pulse

Editor's note: *This is the second in a series of articles spotlighting women in the SDM program.*

The women who have completed MIT's System Design and Management Program are a diverse group of highly skilled individuals who have learned to comprehend and to integrate whole systems for the benefit of their companies and their industries.

Three SDM graduates recently took the time to describe what they got out of the program for the *SDM Pulse*.

Lisa M. Cratty, SDM '01

Monica L. Giffin, SDM '06

Shelley A. Hayes, SDM '00

Lisa M. Cratty, SDM '01, came to SDM as a program management analyst at Ford Motor Company and later worked as an engineering supervisor at Lear Corporation. She is now an engineering director at Evenflo Company.

Monica L. Giffin, SDM '06, was a radar systems engineer for Raytheon when she joined SDM, and she still is. Recently, she took on a new role as deputy lead for a project to incorporate advanced algorithms into existing systems.

Shelley A. Hayes, SDM '00, came to SDM with a background in software development and was part of an IT systems strategy group at a major document management company. She now works for the same firm as a line of business product manager. Her responsibilities include defining new products to bring to market and managing the achievement of the business results.

Q: What first attracted you to the SDM program?

LC: I was working on an MBA at a local university until I applied to SDM, but I felt that curriculum lacked a systematic, technical approach to solving the problems that present themselves in a product development environment. The "system" part of SDM is critical because although product development is a system in and of itself, it's also affected by outside influences (purchasing, finance, engineering, manufacturing, logistics, the consumer, etc.). And each of those parties is also a system.

MG: I've always been interested in the way things work together—or don't. SDM's integrated approach to the curriculum really meshed with the way I think about problems: you can't engineer a product in isolation from political and cost considerations, and you can't manage a program without taking the technical issues into account.

SH: The SDM program dealt with the full value-chain of defining, developing, and managing a product. Upon graduating, I took a new position at my firm out of my area of expertise, and one of the first assignments my boss gave me was to lead a supply chain and manufacturing workshop. I was able to do it based on the competency I gained in SDM.

Q: What was your best SDM experience?

SH: It is hard to pick a best. It is impossible to be surrounded by such fabulously talented people and not have a great experience every day.

LC: I'd have to say meeting and having intense interactions with such an eclectic and interesting group of people. The depth and breadth of experience that SDM students bring into the program was as educational, on a certain level, as the course work. The automotive sector is such an established industry that the tendency has been to look inward to solve recurring problems. It was enlightening to find better, faster, and newer solutions by looking at seemingly disparate industries or companies.

MG: That's a tough choice, but I think the winner was the behind-the-scenes tour of NASA's Kennedy Space Center. It really was a once-in-a-lifetime experience.
Editors note: *To learn more about this tour, visit the SDM website at sdm.mit.edu/NasaVisit.html*

Q: What advice do you have for professionals currently going through the SDM program?

LC: Take this time to identify qualities you think you lack, or want to develop further, and use the time and your colleagues to help you do so. You will go back to your company with much more to offer.

MG: Start early on your thesis, and make sure it's something you're really truly interested in and that will offer value to industry. Your thesis is an opportunity to synthesize all of the information thrown at you in the different classes and treat a problem from a lot of different perspectives.

SH: During the program, go to everything you can on campus and email/talk to your cohort as much as possible. Move to a new, stretch position immediately after graduating in order to maximize your contributions to your employer and keep your SDM learnings fresh. And stay in touch with your classmates. They will be an invaluable resource, both professionally and personally.

Q: How has your SDM education enabled you to contribute in ways that are different from colleagues with an MBA or an MS in engineering?

MG: I work in an industry that is grappling daily with larger and more complex problems. The ability to step back and consider the big picture—and all of the different interactions—with knowledge of both the technical and managerial concerns is priceless.

SH: I am able to look at a decision or activity and frame the set of impacts it can have across the business as well as within engineering. These complex and sometimes emotional tradeoffs across organizations and functional silos are never easy. For example, we were recently working options for product packaging. The decision impacted everything from sales to supply chain. I literally added value because no one else could identify and structure a process to resolve all the assumptions that had to be managed around price, technology, supplier relationship futures, sales, and service.

LC: From my experience, the emphasis placed on the holistic, systems-based approach just isn't there with the other types of advanced degree programs. As a supplier working with Japanese auto manufacturers, I've learned that the most effective way to get work done is to act as a single point of contact with the customer. They don't want to interface with finance, purchasing, program management, engineering, and so on to get answers.

The Alumnae of SDM

8.4 percent of SDM's 448 graduates are women
52.6 percent entered the program with advanced degrees
73.6 percent were company-sponsored
15 came with a degree in electrical engineering
6 were international students
1 came with a degree in French literature

Current alumnae titles include:

- Vice President
- Vehicle Integration Supervisor
- Software Process Improvement Manager
- Process and Requirement Integration Engineer
- Operations Engineering Manager
- Manager of Technical Design
- Senior Product Manager

Q: How has your experience in the SDM program helped you to advance your career?

MG: I'm a lot more confident about approaching strategic questions as a result of my time in SDM, and that's important when you're dealing with technology development. My SDM degree definitely expanded the set of options available to me at my company.

LC: At my current employer, very few people have been afforded the opportunity to attend an institution as highly regarded as MIT. So, at a basic level, just having completed the SDM program helped advance my career because of the prestige associated with the school.

SH: The SDM program gave me an official and prestigious degree. SDM also provided such fabulous multidisciplinary training that I am able take on any assignment in the organization. I've had so many opportunities that have broadened my expertise and at a faster rate than I would have without the SDM base of learning.

SDM course employs industry processes to nurture product development

By Shawn Quinn, SDM '06

By Shawn Quinn
SDM '06

In Product Design and Development (PDD), a required foundation course in SDM, students create new products using actual processes common in industry today.

Within the first weeks, students form teams and propose a concept for a new product. About midway through the course, these teams present their concepts and compete for the opportunity to continue development. A $1,000 budget is provided to each selected team to design, fabricate, and demonstrate a working prototype. The course culminates in the PDD "trade show" where teams compete for cash prizes by presenting business cases and demonstrating products.

My teammates and I won the 2007 PDD design competition and $1,000 with a product that allows a standard 35 mm camera to take long-exposure wide-field images of stars. The product, which we called Star-Cam-Tracker (SCT), compensates for the rotation of the Earth so that a star field can be photographed without blurring. Our target market is amateur astronomers and adventure travelers.

Initially, the team considered creating an advanced toothbrush or a tire chain system for winter driving. We chose the SCT because we liked the idea and our preliminary research indicated a clear market and a lack of competitive products.

As is often the case in industry, we began by developing a vision statement and identifying customers' needs. We had one lead user on our team and interviewed 19 potential users via email, telephone, newsgroups, and in person. Our questionnaire solicited opinions on demand, price, potential use, and technical requirements. We eventually identified 12 needs, including portability, accuracy, power, ease of setup, and price.

We categorized potential customers using the customer classifications in Geoffrey A. Moore's book *Crossing the Chasm*: early adopter, early majority, late majority, and laggards. Based on our discussions with customers, we determined that there was a clear need in the amateur astronomy market for 1,000+ units per year, and we assumed most of these sales would fall into the early adopter category. We believed that if the product could also reach the adventure traveler market, sales could reach 10,000 units annually.

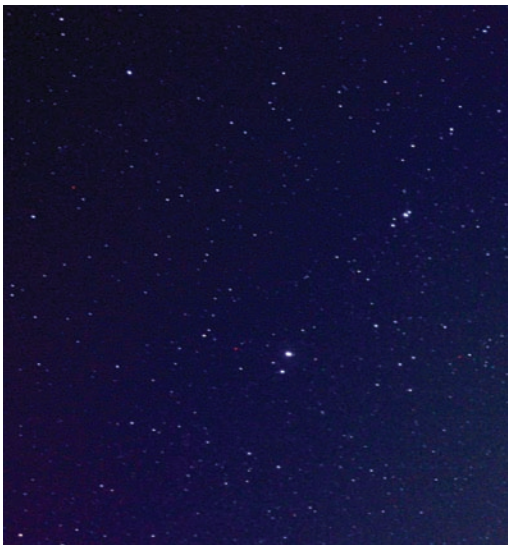
A customer needs analysis led us to 16 technical specifications. We evaluated 13 designs using Pugh concept selection processes. We synthesized two more designs based on the best features of the original set and ultimately chose the tangential rocker with curved gear (electric) and wedge.

Members of the winning Star-Cam Tracker team pose with their prototype (attached to a tripod and camera) at the Product Design and Development Trade Show held in the Tang Center at MIT last spring. The are, from left, Rehan Asad, Paul Gomez, Shawn Quinn, Andrew Gillespy, and Kamran Shahroudi. Matthew Aquaro is not pictured.

We presented our design concept and preliminary need assessment, and course faculty members selected our team to proceed to development. With the welcome addition of new team members culled from teams not selected to progress to the PDD trade show, we spent the next several weeks developing engineering drawings, reviewing the design with a metal fabricator, ordering parts, developing an SCT web page, and producing a business plan.

Each of these tasks was allocated to one or more members of the team: Matthew Aquaro, SDM '06; Rehan Asad, SDM '07; Andrew Gillespy, SDM '06; Paul Gomez, SDM '06; Shawn Quinn, SDM '06; and Kamran Shahroudi, SDM '06. Since our team members were geographically dispersed in Colorado, Michigan, Florida, and Massachusetts, we conducted meetings via telecon and made heavy use of Webex. Initially, we met weekly. As the deadline neared, we met two to three times a week.

Designed to be attached to a tripod and camera, the Star-Cam Tracker allows a standard 35 mm camera to take long-exposure wide-field images of stars.



A star field photographed without the assistance of the Star-Cam Tracker shows star trails caused by the motion of the Earth. The photograph at right was taken using the Star-Cam Tracker, which compensates for the Earth's motion to show each star in focus.

Our winning business plan included our marketing approach, estimates for return on investment, competitor profiles, SCT competitive advantages, development strategies, and a financial model with sensitivities analysis. We examined various business strategies and recommended self-financing the initial manufacture of up to 500 units.

We worked closely with a fabricator in New Jersey to produce and assemble the prototype. This was very much an iterative process and required several updates to the original engineering drawings. The SCT team benefited greatly from the real-world fabrication expertise provided by the vendor.

In our busy final week, we completed the controller software, packaged the electronics, and field-tested the SCT. Finally, we were ready for the trade show, which consisted of a product demonstration and a presentation to mock investors.

SCT's tough competition included iPod earphone holders, a high-tech ironing board, a removable tractor snow plow, and a new temperature-sensing coffee mug. In the end, the judges named the SCT team the winner of this year's PDD design competition.

A critical component of the entire effort was teamwork. We established roles and responsibilities early and met often to ensure everyone was in sync. We also inserted schedule slack in the product development cycle as a risk mitigation strategy. We spent several late nights getting everything to work, but having a great team helped, and the excellent results of field tests made the effort worthwhile.

Perhaps more than any other single required SDM course, PDD captures all phases of real-world product development. As in industry, teams are linked into the voice of the customer, concept definition, initial product development work, business case considerations, prototype development, and testing. A successful launch in industry depends on all these activities, and this course places team members squarely in the driver seat.

For more photos, visit this story online at: sdm.mit.edu/sdmpdd.html.

Sheffi appointed director of MIT's Engineering Systems Division

Professor Yossi Sheffi

Professor Yossi Sheffi has been appointed director of the Engineering Systems Division (ESD), effective Nov. 15, Dean of Engineering Subra Suresh announced on September 24, 2007.

Sheffi received his B.Sc. from Technion in Israel in 1975, his S.M. from MIT in 1977, and his Ph.D. from MIT in 1978; he holds faculty appointments in ESD and the Department of Civil and Environmental Engineering. An expert in systems optimization, risk analysis, and supply chain management, Sheffi serves as director of the MIT Center for Transportation and Logistics, a position he will continue to hold as ESD director. Under his leadership, the center has experienced substantial growth, launching many educational, research, and industry/government outreach programs.

Sheffi is the author of numerous research articles and two books, including the bestseller *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*, published by the MIT Press in 2005. *The Resilient Enterprise received* rave reviews from the *New York Times, Wall Street Journal*, and *Economist*, as well as dozens of trade publications. *The Financial Times* chose it as one of the best business books of 2005; and it was named the 2005 Book of the Year in the category of Business and Economics by *Forward Magazine*.

Since 1998, Sheffi has served as director of MIT's Master of Engineering in Logistics program, which he founded. The program grew from 17 applications at its inception to hundreds of applications today, and has inspired the creation of dozens of similar programs worldwide.

In 2003, Sheffi founded and has since led the MIT-Zaragoza International Logistics Program, an global collaboration among academia, industry, and government. This program has led to substantial economic growth in Aragon, and in 2006, Sheffi received Aragon's presidential award for "the most substantial contribution to the regional economy."

In his announcement, Dean Suresh thanked Institute Professor Joel Moses, who has graciously served as ESD's interim director since January 2006, and added that he is looking forward to working with Sheffi and colleagues in ESD.

SDM invites industry partners to get involved

SDM invites current and potential industry partners to the MIT Faculty Club on October 17, 2007, for a discussion of how best to satisfy their technical leadership needs and requirements via SDM's educational and research offerings. The meeting is just one of the ways SDM stays tuned into the needs of industry.

Representatives from a variety of industries and the program staff will share their insights on creating high-value working relationships between a company and SDM's students, faculty, and researchers. The agenda includes a review of all aspects of the SDM and certificate programs, including curriculum, thesis projects, the distance option, the intensive January program requirement, and business trips. A student and alumni panel will also provide direct feedback to company representatives on creating value from their perspective.

This meeting is designed to help SDM identify industry trends, issues, and requirements and continue to evolve its "product offerings" for the benefit of its partners.

A review of concepts developed by MIT SDM faculty for increasing the benefits of partnership to companies, as well as financial obligations of partnership will be included. For more information, contact John M. Grace, SDM industry codirector, at jmgrace@mit.edu or 617.253.2081.

Systems thinking may be the Rx for some of pharma's woes

By Ragu Bharadwaj, SDM '07

Ragu Bharadwaj
SDM '07

Editor's note: *This is the second article in a series following Ragu Bharadwaj's progress through the System Design and Management Program. Bharadwaj, a computational chemist, previously discussed areas within the pharmaceutical industry that might be improved through systems thinking. In this article, Bharadwaj reveals what he's learned from SDM so far.*

In just one SDM semester, I have been exposed to a mountain of ideas that I am still processing. Already I'm impressed by the ways in which systems thinking could transform and improve the pharmaceutical industry.

SDM looks at the big picture—what is a business's ecosystem and why do companies fail? But it also goes to the root of problems that pharma and other industries confront every day—for example, what's the best way to compare risks and benefits for optimal decision-making? Through it all, SDM maintains its focus on the people skills needed to make any business succeed.

SDM began with the month-long January program, affectionately known as SDM "boot camp," which gave my leadership and management skills a workout. Students undertake two design challenges while also attending lectures on ethics, leadership, public speaking, and negotiation. Lessons are immediately put to use on assigned teams, as tight deadlines and a heavy workload drive home the importance of using each person's unique skills and experience.

The spring semester armed me with SDM tools: engineering risk benefit analysis (ERBA), marketing, and technology strategy. ERBA and decision analysis are of paramount import to the pharmaceutical industry because projects have such long lead times. Scientists often make decisions based on gut instinct when even a rudimentary risk-benefit analysis would help. I've been involved with several biotech startups where the risk of decisions was tacitly known but never quantified. What I've discovered through SDM is that even when there is great uncertainty, quantification stimulates the discussion of risk and inspires contingency planning.

The pharmaceutical industry could use SDM tools to improve laboratory design, high-throughput screening, company strategy, and disease-fighting strategy. In laboratory design, the mean time between failures and criticality can be used to make decisions on how much redundancy to allocate for equipment, employee resources, and suppliers.

High-throughput screening (HTS) involves screening available libraries of up to a million compounds for potentially active compounds ("leads") to follow up for development. HTS yields good starting points but is expensive, and results depend on factors like assay quality and selection method. Quantifying the probability of missing leads because of errors should improve the usefulness of HTS.

On a larger scale, ERBA should help companies make better strategic decisions about which projects to pursue and which diseases to target. The tools taught in SDM could help answer key questions, such as:

- Given a fixed budget, would developing treatments against multiple mechanisms in a single disease area have a greater chance of success than developing treatments for different diseases via a single mechanism?
- For a single disease area, would attacking the same mechanism with different compound scaffolds be more successful than attacking different mechanisms?

Scientists often make decisions based on gut instinct when even a rudimentary risk-benefit analysis would help.

These kinds of questions are vital to a company's very survival—a point driven home in SDM's technology strategy course. This is an absolute must for those interested in product strategy or business development in pharma. While such analyses are sometimes used in large pharmaceutical companies, they have yet to seep into biotech startups.

I know many a startup that could have been saved by this kind of analysis. I hope more industry errors can be avoided as SDM tools begin to spread throughout the industry.

Industry Faculty Research Forum slated

On November 8, 2007, MIT's System Design and Management and Leaders for Manufacturing programs will hold a daylong session for companies interested in establishing or deepening their involvement with SDM and LFM.

The purpose of the Industry Faculty Research Forum is to match up industry and faculty research interests as well as to develop structured internships for LFM students and thesis projects for SDM students.

Featured speakers will include Professor of the Practice Debbie Nightingale of aeronautics and astronautics (aero/astro) and engineering systems; research associate Eric Rebentisch of the Center for Technology, Policy and Industrial Development and the Lean Aerospace Initiative; Associate Professor Olivier de Weck of aero/astro and engineering systems; Professor Roy Welsch, director of the Center for Computational Research in Economics and Management Science; Stephen Graves, the Abraham Siegel professor of management; and Warren Seering, the Weber-Shaughness professor of mechanical engineering and engineering systems and the engineering codirector of SDM and LFM.

Breakout session topics will include call center operations optimization, global supply chain modeling, strategic sourcing, product platforms, and lean assessment process and tools.

The meeting will be held at the MIT Faculty Club, and lunch will be served. For more information or to RSVP, contact John Grace, SDM industry codirector, at jmgrace@mit.edu or 617.253.2081.

The core of SDM: Inside system and project management

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Examples of past class projects

- DSM and Analysis of Technology Development Process at UTC Power
- Analysis of the Oracle E-Business Suite 11i Project
- Project Management in Open Solaris: Analysis of Tools and Processes
- DSM for Multi-Core Microprocessor Case: Intel
- Multi-Industry Survey of Project Management Tools and Techniques
- DSM in Design Studio Processes at Ford
- Apache Tomcat Open Source Software Project
- Modeling the System Dynamics of a Government Development Project
- Wireless Mesh Deployment Using System Dynamics Optimization of DNA Sequencing at the Broad Institute
- Joint Strike Fighter Concept Demonstrator Engine Development
- Internal Competition During Product Development
- The Theory of Constraints in a Critical Path World
- Efficient Production Management of an Oil Field
- Managing U.S. Navy Shipyard Programs: A Survey of Tools and Methods
- Survey of Methods and Tools at the Federal Emergency Management Agency
- Big Dig Success and Failures: Stakeholders' Views
- Project Management of SpaceShipOne: The Quest for the X-Prize

Flexible SDM programs advance corporate strategies

By John M. Grace, industry codirector of SDM

I fielded a series of questions about the flexibility of SDM's various programs during the International Council on Systems Engineering (INCOSE) symposium held in San Diego in July 2007. In order to help companies get the most out of SDM, here is a quick look at how SDM's offerings can be tailored to meet your specific strategic needs. Keep in mind that it takes teamwork between the company and SDM to capitalize on the program's flexibility—we need to know your goals if we're going to help you reach them.

SDM's portfolio of programs consists of the following:

The SDM certificate program, with class sessions available at a distance or on campus, includes three courses from the SDM master's curriculum, a capstone project, and two weeklong seminar sessions on the MIT campus. Graduates receive a certificate of graduate studies in systems engineering in one year.

The SDM master's program is available as a part-time program at a distance or, in the local area, in a commuter and full-time on-campus format. This program consists of a 14-course curriculum with elective tracks and course options, a thesis requirement, and flexible on-campus requirements consisting of weeklong "business trips" to campus each semester and one semester on campus sometime during the program. Graduates receive an SM in engineering and management granted jointly by MIT's School of Engineering and MIT Sloan School of Management.

The PhD program, offered through MIT's Engineering Systems Division (ESD), focuses on developing cross-disciplinary knowledge from many of MIT's departments and divisions. About 10 percent of SDM students typically continue to the PhD level. The ESD PhD leads to a doctorate in engineering systems, but will not be discussed further in this article. For more information, visit esd.mit.edu/phd/default.htm.

All of these programs have been developed by faculty from MIT's School of Engineering, MIT Sloan School of Management, and industry.

The SDM certificate program

This one-year option provides seasoned engineers with the most current thinking on systems engineering, system architecture, and product design and development—at a very reasonable cost to their employers

The certificate program is ideally suited to helping companies cascade systems thinking throughout their organizations. While students attend the same classes as SDM master's students, they are typically also on the job—which means they can apply what they've learned directly and immediately. Capstone projects that apply SDM methods and techniques can also address specific company problems and involve a team of students from the same organization.

The SDM master's program

The centerpiece of SDM, the master's program helps companies develop future technical leaders, build a cadre of systems thinkers, and enhance technical and business competencies. The program also links companies into faculty and research networks and provides a valuable source of highly talented and trained individuals. The program consists of three core, seven foundation, and four elective courses. Corporations closely linked to SDM may help create unique program tracks for their students.

For all companies, the thesis requirement provides a range of strategic opportunities. Companies may mentor self-sponsored students, support self-sponsored students in areas of interest, support their own students in selected corporate research, or develop a portfolio of theses to examine critical problem areas. The thesis requirement can also help companies tap into current MIT research and technology.

Building networks

SDM establishes a network of students, faculty, and corporations that can become a continual resource for both individuals and companies. The excellence of SDM participants, the quality of students in closely associated programs within ESD, as well the extraordinary faculty and staff of MIT all ensure that corporations linked to SDM enjoy a wealth of beneficial associations.

Corporations wishing to maximize the benefits of SDM can also partner with the program to have an impact on content and program options, as well as to recruit students.

Without a doubt, SDM's flexible family of programs is well suited to enhance a corporation's strategic position, leadership cadre, and even product offerings. For further discussion on any or all of the above topics, contact John M. Grace, SDM industry codirector, at jmgrace@mit.edu or 617.253.2081.

SDM approach sheds light on how culture affects consumers

> continued from page 1

goods and services. This enabled us to plot the preferences of a consumer with dual loyalties—for instance, someone of French origin who had lived in the United States for a long time and feels a high degree of association with both French and American cultures. Such a customer would be plotted in a 3-D space somewhere between "wholly associated with French" and "wholly associated with American" culture, with the third factor being "cosmopolitanism," the degree of association with global culture.

We anticipated that if culture played a significant role in a consumer's decision, then there would be an inverse relationship between cultural distance and preference for products and services from that culture. Thus, the greater the distance of a consumer from the Japanese culture, the lower the likelihood of this consumer preferring Japanese products and services and vice versa.

We designed the survey to measure both dependent variables, such as willingness to buy a product or a service and preference for Japanese goods and services, as well as independent variables, such as product and service attributes and cultural identification.

The survey was designed with extreme care. We obtained approval from the Committee on the Use of Humans as Experimental Subjects (COUHES), followed sampling guidelines, assessed scale reliability and validity, and used simple, crisp, and unambiguous language.

About 170 people completed the survey. After data cleaning, we had 134 respondents. Five were living in Japan, 129 in the United States. There were 81 U.S. citizens and 53 noncitizens.

After taking steps to assess construct reliability and validity, we conducted a regression analysis to identify statistically significant factors. Key findings were that Japanese products and services were generally perceived to excel U.S. products and services in all dimensions (although there are market segments that favor American products). In addition, attributes such as price, performance, and safety were found to be the key drivers of buying decisions (see Figure 2).

Our findings indicate that although Japanese products and services are considered slightly more expensive, they are also perceived to be better. Deeper analyses showed that perceptions vary by demographics.

Our team concluded that price, performance, and safety influence the initial decision to buy a product or service. However, once the decision to buy has been made, cultural effects come into play, dominating wherever there is a high "human touch." Culture matters more in the airline and the hotel industries, for example, than in the automobile industry. Cosmopolitanism is a key element; the greater the degree of association with global culture, the greater the likelihood that a consumer will favor Japanese products and services.

Combining our analysis with informed judgment, our team recommended a strategy that capitalizes on the perceived strengths of Japanese products and services while addressing the needs of the global world. We recommended a primary focus on the "must have" attributes of price, performance, and safety with a secondary focus on "the more the better" attributes such as congruence with U.S. culture (an order winner for the American consumer).

Our team presented its results using systems engineering tools such as radar plots, Kano analysis, and multivariate graphs. Sharmila C. Chatterjee, visiting professor of marketing at MIT Sloan School of Management, served as our project advisor. Daniela Reichert, director of intern placements for MISTI-Japan, supported the team operationally. We presented our findings at a workshop at the ANA headquarters in Tokyo. The workshop was attended by senior executives of the ANA strategic institute, managers, and several other employees. Overall, I am pleased to report that SDM tools and methods were useful at every phase of this project.

To download the complete presentation on this project, go to sdm.mit.edu/docs/vinayteam.ppt.

Figure 1.
Survey structure and path diagram

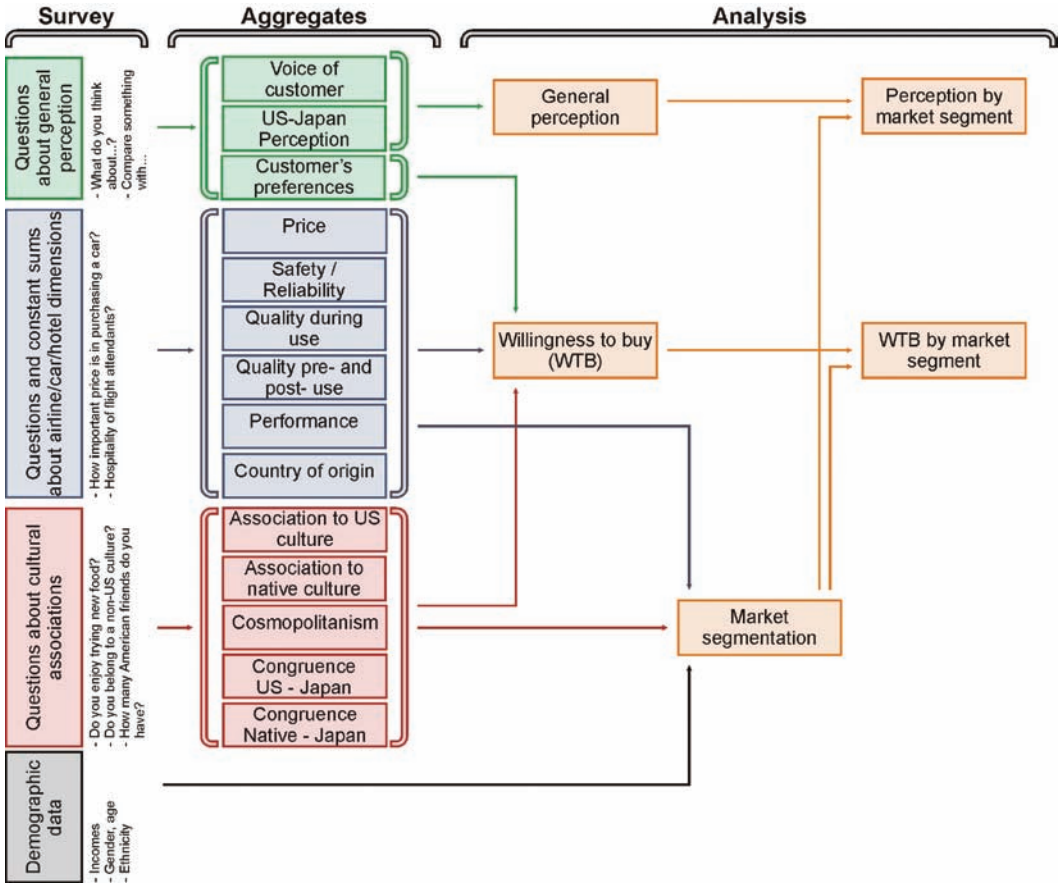
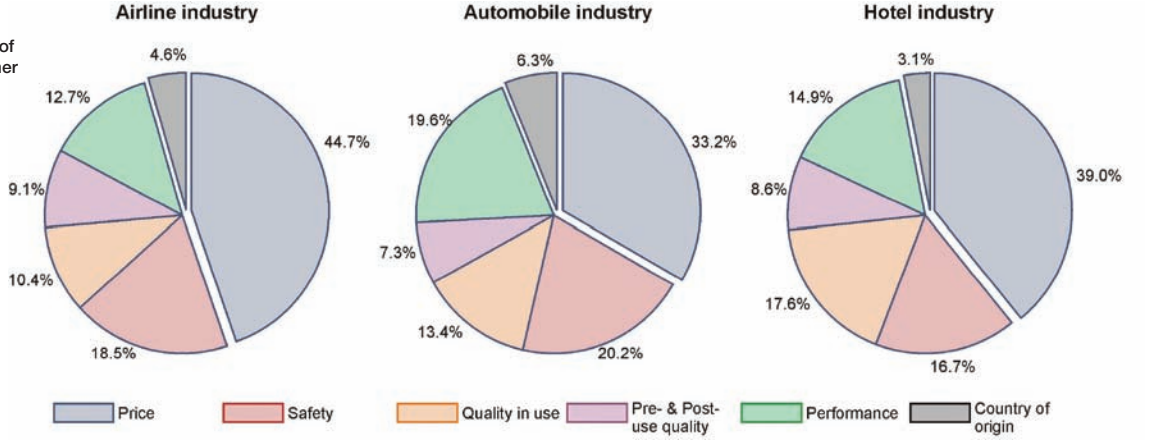


Figure 2.
Relative importance of attributes in consumer decision-making



Massachusetts Institute of Technology

SDM calendar fall 2007–spring 2008

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

October 15-19, 2007
SDM Business Trip
Location: MIT

October 16, 2007
SDM Information Evening
Location: MIT Faculty Club
Time: 6:30 pm

October 16, 2007
SEA[RI] Annual Meeting
Location: MIT Faculty Club

October 17, 2007
SDM Partners Meeting
Location: MIT Faculty Club

October 18-19, 2007
SDM Conference
Speakers include: Sir Tim Berners-Lee; Professors Richard de Neufville, Daniel Frey, and Paul Carlile; and SDM alumni
Location: MIT Broad Auditorium
Details: sdm.mit.edu/conf07/

October 19, 2007
Webseminar
Speaker: Professor Rebecca Henderson, specialist in technology strategy
Time: 12:15–1:15 pm
Registration link: https://sdmlfmmit.webex.com/sdmlfmmit/j.php?ED=92304277&RG=1

October 23, 2007
Brunel Lecture on Complex Systems
Title: Process Improvement in the Rarified Environment of Academic Medicine
Speaker: Paul F. Levy, president and chief executive officer of Beth Israel Deaconess Medical Center
Location: E25-111
Time: 4:30 pm

November 2, 2007
Webseminar
Speaker: Professor Kim Thompson, an expert in risk assessment and risk management
Time: Noon–1 pm
Registration link: https://sdmlfmmit.webex.com/sdmlfmmit/j.php?ED=92460102&RG=1

November 8, 2007
Industry-Faculty Research Forum
Location: MIT Faculty Club
Sponsored by: MIT System Design and Manufacturing Program and MIT Leaders for Manufacturing Program
Time: 8 am–3 pm
For more information, see story on page 13

November 16, 2007
Webseminar
Title: Design-Inspired Innovation
Speaker: Professor Jim Utterback, an expert in the dynamics of product and process development as well as emerging and disruptive technologies
Time: Noon–1 pm
Registration link: https://sdmlfmmit.webex.com/sdmlfmmit/j.php?ED=92304312&RG=1

January 31, 2007–February 1, 2008
SDM-LFM Knowledge Review
Location: MIT

March 11–12, 2008
2008 MIT Conference
Strategies for Balancing Risks and Opportunities in Global Product Delivery
Sponsored by: 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.