

## Operations Research Center

The [Operations Research Center](#) (ORC), established in 1953 as a first-of-a-kind interdepartmental graduate degree program, completed its 59th year of operation in academic year 2011–2012. The ORC administers its own graduate programs and a varied research program of methodological and applied projects. It maintains a reading room with a small library as well as state-of-the-art computational workstations and a conference room equipped with distance-education equipment. This report summarizes ORC's AY2012 activities and briefly reviews its educational, research, and outreach programs.

### Faculty, Students, Staff

Professors Dimitris Bertsimas and Patrick Jaillet continue to serve as co-directors of the center.

During AY2012, the ORC had 53 affiliated faculty and senior staff, with faculty drawn from the MIT Sloan School of Management and the Departments of Electrical Engineering and Computer Science, Civil and Environmental Engineering, Economics, Mathematics, Aeronautics and Astronautics, Mechanical Engineering, Nuclear Science and Engineering, and Urban Studies and Planning.

The ORC offers two interdepartmental graduate degree programs, a PhD and a master's degree. During the past year, these programs enrolled 54 students—43 PhD candidates, 10 SM candidates, and one special student. The ORC conferred four master's degrees and nine PhDs. Several other PhD theses were in the final stages of completion in summer 2012.

The ORC had a record year in terms of yield in admissions, with 189 applications for the PhD program. We made 26 offers; and 21 were accepted. The ORC had 52 applications for the SM program; the center made 13 offers and eight were accepted. Four National Science Foundation (NSF) predoctoral fellows are enrolled at the ORC in addition to one US Department of Energy fellow, one National Defense Science and Engineering Graduate (NDSEG) fellow, and 3 Natural Sciences and Engineering Research Council of Canada (NSERC) fellows.

### Academic Programs

The ORC's academic programs continue to be recognized as among the very best nationally and internationally. Moreover, the programs are repeatedly cited as achieving an excellent balance between application and methodological domains.

### Research Activities

Research activities spanned a wide spectrum of methodological topics and applications, ranging from small, unsponsored projects involving a single faculty member supervising a student's thesis, to larger sponsored programs involving several faculty members, staff, and students.

Methodological research includes such topics as linear, nonlinear, and combinatorial optimization; solution methods for integer programming; interior point methods for linear and nonlinear programming; dynamic programming; cluster analysis; parallel and distributed computation and algorithms; network flow algorithms; network design; probabilistic combinatorial optimization; online optimization; deterministic and stochastic facility location; queuing theory, including queuing networks; risk analysis; stochastic processes; classical and Bayesian statistics; game theory; and decision analysis and statistical decision theory.

ORC faculty currently contributes to application domains as wide ranging as manufacturing, communications, transportation, public services, logistics, marketing, financial services, health care, and nuclear engineering. Current projects address topics such as air traffic control; epidemiology; AIDS testing; life-cycle modeling of municipal solid waste; safety and risk analysis and network design in air transportation; telecommunication network design; supply chain management; production scheduling; and transportation logistics, diseases and disasters. Several organizations sponsored research projects at the ORC during AY2012, including the NSF, Charles Stark Draper Laboratory, General Motors, MIT's Lincoln Laboratory, ISO New England, the Air Force Office of Scientific Research, the Office of Naval Research (ONR), and the Singapore–MIT Alliance Program.

### **Outreach and Professional Service**

During academic year 2012, the ORC held a number of faculty meetings to discuss issues of interest to the center, including the following topics:

- Changes to the general examination format involving the critical presentation of a research paper related to the student's area of research, chosen by the student's general examination committee
- Implementation of the new operations management and networked systems tracks
- A proposed enhanced (and larger) SM program in decision analytics
- Proposed collaboration with the Skolkovo Institute of Science and Technology in Moscow
- The newly established annual ORC Best Student Paper award

### **Ability to Support Graduate Students**

The ORC has increased its efforts to submit research proposals directed at obtaining collaborative research grants of significant size. One example is the ONR grant group submission, Decentralized Online Optimization in Multi-Agent Systems in Dynamic and Uncertain Environments; professors Dimitris Bertsimas, Costis Daskalakis, and Patrick Jaillet are the principal investigators. Discussions are continuing about submitting a proposal to the NSF's Integrative Graduate Education and Research Traineeship program, which could provide funding for up to 10 US doctoral students a year.

## Seminar Series

The ORC weekly seminar series was privileged to have many distinguished speakers from industry and academia this year. The operations research professionals who made presentations included Izak Duenyas (University of Michigan); Garud Iyengar (Columbia University); Amin Saberi (Stanford University); Barry Nelson (Northwestern University); Russell Barton (NSF); Andrew Lo (MIT); David Simchi-Levi (MIT); Sampath Rajagopalan (University of Southern California); Bernd Sturmfels (University of California, Berkeley); Mykel J. Kochenderfer (Lincoln Laboratory); Jon Lee (University of Michigan); Antonio Conejo (Universidad de Castilla–La Mancha); Nir Halman (Hebrew University of Jerusalem); Nils Rudi (INSEAD); Dimitris Bertsimas (MIT); Peter Bartlett (University of California, Berkeley); Andrea Montanari (Stanford University); Ward Whitt (Columbia University); Gérard Cachon (University of Pennsylvania); Santanu Dey (Georgia Institute of Technology); Daron Acemoglu (MIT); Ebrahim Nasrabadi (MIT).

During the January independent activities period, the ORC offered a full-day session titled Analytics in Internet Business, in which several talks focused on revenue management, email marketing, cloud services, and sponsored search advertising. The speakers included professor Vivek Farias (MIT); Steve Clark (Analytics Operations Engineering, Inc.); David Krikorian (Google); and professor Nicole Immorlica (Northwestern University).

## Future Plans

The ORC program is stable and does not face any unusual challenges. Additional tracks may be added to the doctoral program in the future, depending on the success of the two new PhD tracks (operations management and networked systems). The ORC plans to continue exploring possible synergies and collaborations with other units within MIT. The ORC will work toward the establishment of the proposed enhanced and larger SM program in decision analytics and is considering a major redesign of the center's physical space. This redesign will become essential as plans for the larger SM program move forward. The ORC intends to play a greater role in decision analytics and statistics within the Institute.

## Diversity

The ORC has always attempted to provide an environment that is not only responsive to the varied professional and personal needs of its community but that also builds diversity. Eleven of the ORC's current graduate students are women. Over the past years, the ORC has made efforts to attract qualified women and underrepresented minorities to its graduate programs by targeting outreach to mathematics departments in liberal arts colleges and by sending information to historically black colleges.

## Professional Activities

### Faculty

Hamsa Balakrishnan was awarded the Kevin Corker Award for Best Paper of ATM-2011 (the ninth USA/Europe Air Traffic Management R&D Seminar) for "Demonstration of Reduced Airport Congestion through Pushback Rate Control." Balakrishnan also

received the American Institute of Aeronautics and Astronautics Lawrence Sperry Award (2012) “for the development and implementation of advanced air traffic management techniques leading to significant environmental improvements.” The award recognizes notable contributions by a person under 35 to the advancement of aeronautics or astronautics.

Cynthia Barnhart was elected as an INFORMS Fellow, Class of 2011. INFORMS Fellows are individuals who display outstanding lifetime achievements in operations research and the management sciences. These individuals have demonstrated exceptional accomplishments and made significant contributions to the advancement of those fields over a period of time.

Vivek Farias won first place in the INFORMS Junior Faculty Interest Group (JFIG) paper competition, 2011. The JFIG Forum, which invites submissions to the JFIG paper competition, was created in 2001 to promote the career development of tenure-track faculty in INFORMS. The goals of the competition are to encourage research among junior faculty and to increase the visibility of research conducted by junior faculty within the fields of operations research and management science. The winning paper (coauthored with Vijay Desai and Ciamac Moallemi, both of Columbia University), “Approximate Dynamic Programming via a Smoothed Linear Program,” *Operations Research*, Vol. 60, No. 3, May–June 2012, pp. 655–674.

David Gamarnik was the recipient of the 2011 Best Publication Award from the Applied Probability Society of INFORMS. David received the award with Dmitriy Katz-Rogozhnikov for the following papers: “On Deciding Stability of Constrained Homogeneous Random Walks and Queueing Systems,” Gamarnik, D., *Mathematics of Operations Research*, 2002, Vol. 27, 272–293; “On the Undecidability of Computing Stationary Distributions and Large Deviation Rates for Constrained Random Walks,” Gamarnik, D., *Mathematics of Operations Research*, 2007, Vol. 32, 257–265; and “On Deciding Stability of Multiclass Queueing Networks under Buffer Priority Scheduling Policies,” Gamarnik, D., and D. Katz, *The Annals of Applied Probability*, 2009, Vol. 19, 2008–2037.

Retsef Levi, along with co-authors Kelsey McCarty (Massachusetts General Hospital) and Jeremie Gallien (London Business School; formerly of MIT Sloan), won the European Case Clearing House Case Awards 2012 New Case Writer competition. Their winning case is titled, “Massachusetts General Hospital’s Pre-Admission Testing Area.” Retsef Levi was also awarded the 2012 Jamieson Prize for Excellence in Teaching, Sloan School of Management.

Andrew Lo was recognized by TIME Magazine as one of the 2012 “100 Most Influential People in the World.” Lo was also named the Sloan School Teacher of the Year.

Eytan Modiano was elected a fellow of the Institute of Electrical and Electronics Engineers (IEEE) as of January 2012. This is a distinction reserved for IEEE members who have achieved extraordinary accomplishments in any of the IEEE fields of interest.

James Orlin was awarded the 2011 IEEE Bennett Prize for his paper “Oblivious Routing of Highly Variable Traffic in Service Overlays and IP Backbones” (*IEEE/ACM Transactions on Networking*, Vol. 17, No. 2, pp. 459-472, April 2009). His co-authors included Murali Kodialam, T. V. Lakshman, James B. Orlin, and Sudipta Sengupta. The IEEE Bennett Prize is given annually to the best original paper published in any journal financially sponsored or co-sponsored by the IEEE Communications Society in the previous three calendar years.

Georgia Perakis was awarded the Samuel M. Seegal Prize, an award that the Sloan School shares with the School of Engineering. In May 1992, Paula Seegal-Thompson and her family established the Samuel M. Seegal Prize Fund in honor of their father, a member of the Class of 1922. They requested that the prize be awarded every other year and be given to a professor who “inspires students in pursuing and achieving excellence.”

Andreas Schulz was awarded the Humboldt Research Award by the Alexander von Humboldt Foundation (June 2011). The award is given to academics whose fundamental discoveries, new theories, or insights have had a significant impact on their own disciplines and beyond, and who are expected to continue producing cutting-edge achievements in the future.

### **ORC Students**

Allison Chang was a finalist for the INFORMS Data Mining Student Paper Award, 2011. The award is given to the best paper, as judged by a panel of members of the section, on any topic related to data mining by a student author.

Virod Chiraphadhanakul, current ORC student, received the United Parcel Service Doctoral Fellowship for AY2012, awarded by MIT’s Center of Transportation and Logistics.

Maxime Cohen, current ORC student, received the MIT Energy Initiative Fellowship.

Juliane Dunkel was awarded honorable mention in the INFORMS George Nicholson Student Paper Competition, 2011. The George Nicholson Student Paper Competition is held each year to recognize outstanding papers in the field of operations research and the management sciences that are written by a student. The prize is awarded at the INFORMS national meeting if there is a suitable recipient.

Iain Dunning, along with Andrew Mason, was awarded the 2011 edition of the COIN-OR INFORMS Cup for the paper “OpenSolver: Open Source Optimisation for Excel using COIN-OR.” COIN-OR is a project to spur open-source activities in operations research.

Paul Grigas, current ORC student, received an NSF Fellowship for graduate studies.

Jerry Kung, incoming student to the ORC (fall term, AY2012), received an NSF Fellowship for graduate studies.

Andrew Li, incoming student to the ORC (fall term, AY2012), received an NDSEG Fellowship for graduate studies.

Ngai-Hang Leung received the runners-up award for the Production and Operations Management Society's (POMS) Humanitarian Operations and Crisis Management Best Paper Competition for "Rationality and Transparency in the Distribution of Essential Drugs in Sub-Saharan Africa: Analysis and Design of an Inventory Control System for Zambia." The authors included Jérémie Gallien, Zachary Leung, and Prashant Yadav, and the award was given at the 2012 POMS conference.

Miles Lubin, incoming student to the ORC (fall term, AY 2012), received a DOE Fellowship for graduate studies.

Velibor Misic, incoming student to the ORC (fall term, AY2012), received an NSERC Fellowship for graduate studies.

Alexander Remorov, incoming student to the ORC (fall term, AY2012), received an NSERC Fellowship for graduate studies.

John Silberholz, current ORC student, received an NSF Fellowship for graduate studies.

Xu (Andy) Sun was awarded second prize in the INFORMS George B. Dantzig Dissertation Award, 2011. This award is given for the best dissertation in any area of operations research and the management sciences that is innovative and relevant to practice.

Wei Sun was awarded second prize in the INFORMS Service Science Section Best Paper Competition, 2011. Wei Sun received the award with Georgia Perakis for the paper, "Congestion Pricing for Service Industries." The awards program brings prestige to the Services Science section as well as to the recipients honored.

Yehua Wei was awarded second prize in the INFORMS George Nicholson Student Paper Competition, 2011. The George Nicholson Student Paper Competition is held each year to honor outstanding papers in the field of operations research and the management sciences written by a student.

Yuan Zhong won the Best Student Paper Award at Sigmetrics 2012 for the paper titled "Optimal Queue-Size Scaling in Switched Networks."

**ORC Alumni**

Louis Anthony (Tony) Cox Jr. was elected to the National Academy of Engineering in February 2012 for applications of operations research and risk analysis to significant national problems.

Douglas Fearing was awarded first prize in the INFORMS Aviation Applications Dissertation Prize, 2011. The Aviation Applications Section of INFORMS awards a prize for the best dissertation in any area related to aviation operations research (air traffic management and airline operations research).

Garrett van Ryzin, with Guillermo Gallego, was awarded the INFORMS Revenue Management Historical Prize, 2011. The INFORMS Revenue Management and Pricing Section Prize for Historical Works was created to recognize critical contributions to the science of pricing and revenue management published in English prior to 1999.

**Dimitris Bertsimas****Codirector****Boeing Professor of Operations Research****Patrick Jaillet****Codirector****Donald C. Jackson Professor of Electrical Engineering and Computer Science**