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ICS NEWS

INFORMS Computing Society Newsletter

Inside This Issue

"That's one active society! And that's what keeps it interesting. It's all about the people and their interactions over shared interests. Why not step up and get involved?"

ICS Biennial Conference, 2007

Ed Baker, University of Miami, Conference Chair

The tenth meeting of the INFORMS Computing Society was held January 3–5, 2007 in Coral Gables, Florida. The meeting featured the presentation of 65 papers submitted by 130 authors with special clusters in Networks and Graphs, Vehicle Routing and the TSP, Constraint Programming, Grid Computing, COIN-OR, Simulation, Integer Programming, Heuristic Search, Computational Complexity, and Decision Technologies.

ICS Conference continued on page 7

The Maryland Contingent, from left-to-right: Ian Frommer, Ed Wasil, Raghu Raghavan, Bruce Golden, Anito Joseph, Bill Stewart, Ed Baker, John Silberholz

Message from the Chair

John W. Chinneck
Carleton University
chinneck@sce.carleton.ca

It's been a while since our last newsletter, so believe me — the emphasis is definitely on news! I have to say that it's genuinely fun leading a society that is so full of life, energy and innovation. Sometimes it's hard just to keep up with all that's going on! Let me just outline some of the events since our last newsletter.

Changes in Leadership. Many thanks to Ariela Sofer for a fine job of leading us up to December 31, 2005. On January 1, 2006, I took up the reins as Chair while Jeff Linderoth took over from Robin Lougee-Heimer as Secretary/Treasurer when she became Vice-Chair/Chair-Elect. On December 31, 2006, Arne Drud and Alexander Martin finished their terms as members of the ICS Board (many thanks!), and on January 1, 2007, Matt Saltzman and Steve Dirkse took over after an election that featured six (!) candidates.

Chair Message continued on page 11

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Message from the Editor

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I am at once pleased and daunted by assuming the editorship of ICS News. It has evolved into a first-rate newsletter, giving all the latest news as well as some technical results in the OR/CS interface. Thanks to all previous Editors, from Gordon Bradley in 1978 to Ariela Sofer in 2006.

Our cover story reports our ICS Conference, given by the Chair, Ed Baker. His committee and the local help from University of Miami are congratulated for an excellent program and accommodations. John Chinneck's Message from the Chair is another example of his giving us information succinctly and with humor. We all appreciate John's diligence and making our work fun.

This issue comes with the launching of our partnership with COIN-OR; Robin Lougee-Heimer gives the first report, which is henceforth a standard section in ICS News. She is also the organizer of ICS sessions for the forthcoming Seattle INFORMS meeting, so she provides this issue with a call for participation. Jun Ma organized 15 sessions in the ICS cluster for the Puerto Rico meeting, and he too asks for your help.

Two more new projects are reported: Rob Dell describes Leading Edge Tutorials, and Allen Holder describes the ICS Mathematical Programming *Glossary*. Mike Ball issues the Call for Nominations for the ICS Prize, and Jonathan Eckstein does likewise for the Student Paper Award. I call for photos to be included in the next ICS News, and we want to begin a photo gallery at our web site. I report interviews I had with Larry Leemis (ICS Prize co-recipient) and Geng Deng (Student Paper Award recipient). Also, I have introduced a new item, ICS Members in the News, which contains short notes about awards, honors, and changes in position by our members.

As has been the practice, we include a technical article that reflects an interface between OR and CS. Kenneth Ryals gives us a glimpse into the use of simulation - an OR method dating back to its WW II origins.

Sadly, we mourn the sudden death of Peter Hammer. The obituary by Endre Boros, Yves Crama, and Bruno Simeone offers some tribute, but no words could fully express Peter's life of contribution and warmth.

Enroll your students in ICS for just $ 1!
http://computing.society.informs.org/join.php

Puerto Rico INFORMS Meeting

Jun Ma, Northwestern University

The ICS cluster for the INFORMS International Puerto Rico meeting, July 8-11, has the theme: *the interface between OR & CS is not only a fact of history, but also a matter of necessity!* So far, our cluster has 14 sessions with about 50 talks scheduled. Topics include modern applications of computer science, information technology, and other related areas. Information about the conference is at http://meetings.informs.org/PuertoRico2007/. Submit your suggestions and proposals directly to Jun Ma at maj@northwestern.edu, and be sure to attend.

COIN-OR

Robin Lougee-Heimer, IBM

The COIN-OR Foundation is an educational nonprofit established in 2004 to manage the Computational Infrastructure for Operations Research (COIN-OR) project, an initiative to spur the development of open-source software for the operations research community. In a move designed to further their mutual goals, ICS and COIN-OR have formed a strategic partnership. ICS has been a strong supporter of COIN-OR since its inception in 2000. ICS has regularly co-sponsored COIN-OR tracks at INFORMS meetings and included COIN-OR news updates on the agenda of the ICS business meetings. The partnership is a natural development, according to John Chinneck, Chair of the ICS: "The core concern of ICS is the interface between computing and operations research, and this is exactly where the COIN-OR project exists." For the most recent annual summary of COIN-OR activities, visit http://www.lionhrtpub.com/orms/orms-2-07/frcoin-or.html. More about COIN-OR can be found on the society's website under "Projects" at http://computing.society.informs.org/coin-or.php#.

A recent addition to COIN-OR is the GAMSlinks project. A brief summary is reported here by Stefan Vigerske (stefan@math.hu-berlin.de), Humboldt-University Berlin, Michael Bussieck (mbussieck@gams.com), GAMS Software GmbH, and Steven Dirkse (sdirkse@gams.com), GAMS Development Corporation.

The GAMS Development Corporation (http://www.gams.com) has a long history of collaborations with academic researchers, and it is the latest corporate sponsor of the COIN-OR Foundation. It licenses the proprietary General Algebraic Modeling System (GAMS). The GAMSlinks project (https://projects.coin-or.org/GAMSlinks) is devoted to developing links between the proprietary GAMS package and the open-source solvers and interfaces. The links are made public under the Common Public License (CPL).

How do users benefit from the GAMSlinks project?

Currently, links to three open-source solvers are supported, with more to come. Based on the COIN-OR Open Solver Interface (OSI), we have already developed links to the GNU Linear Programming Kit (GLPK), from Andrew Makhorin, and two COIN-OR solvers: mixed-integer linear programming Branch and Cut (CBC), from John Forrest, and the nonlinear programming solver Interior Point Optimizer (Ipopt) from Andreas Wächter. With GAMS 22.4 these solvers are distributed free of charge in binary form for Linux and Windows platforms. A GAMS user specifies these solvers in the usual way with the options command. All you need to work with models exceeding the demonstration limit is a license for the GAMS base module. The GAMSlinks project helps developers to link their solvers to GAMS, and hence enables access to performance tools and large libraries of GAMS models (www.gamsworld.org) useful for development, testing, and quality assurance, and benchmarking. The GamsModel class provides all necessary methods to read a mixed-integer linear model from GAMS, to process an option file, and to return the solution to GAMS. In the bigger picture, this link between GAMS and any solver raises the bar for GAMS, thus making it increasingly useful for others.

What future developments are planned for the GAMSlinks project?

Currently in development is an interface to the COIN-OR mixed-integer nonlinear programming solver Bonmin, managed by Pierre Bonami. In addition to adding new interfaces, existing ones can be extended with new features to improve their flexibility and usability. For example, it is planned to extend the CBC interface with the GAMS Branch-and-Cut-and-Heuristic (BCH) facility, which allows users to speed up the solution of hard mixed-integer linear problems significantly by adding their own routines to generate cutting planes and good integer feasible solutions without requiring intimate knowledge about the inner workings of a specific solver system. If you have desire for a special link or some other feature that you would like to see in the GAMSlinks, just add your wish to the "wish list" at the GAMSlinks web site, and we will do our best.

Seattle INFORMS Meeting

Robin Lougee-Heimer, IBM

The upcoming INFORMS annual meeting will be held November 4-7, 2007, in Seattle, Washington (http://meetings.informs.org/Seattle07/). Its theme is right up our alley: *The Spirit of Technology*. The program of last year's annual meeting in Pittsburgh had a stellar array of ICS topics, including clusters in Heuristic Search, Data Mining, Constraint Programming, Computational Optimization & Software, and more. We're looking forward to having another fabulous, fun-filled, awe-inspiring track of computing-related talks at the upcoming Seattle meeting. If you're interested in speaking or organizing, contact the 2007 ICS Sponsor Chair, Robin Lougee-Heimer at robinlh@us.ibm.com, before May 15.

Leading Edge Tutorials

Rob Dell, Naval Postgraduate School

The informal motto of ICS is "INFORMS' Leading Edge for Computation and Technology." True to this spirit, ICS is starting to offer tutorials at INFORMS conferences on topics of interest to ICS members. We hope to build this into a major conference feature and catalog the presentations on our ICS web site, http://computing.society.informs.org/lEdge.php.

Dr. Vernon Austel, of IBM Thomas J. Watson Research

Center, will inaugurate this at the Puerto Rico meeting. In Seattle, Professor Leon Lasdon, of UT Austin, and Dr. Janos Pintér, President of Pintér consulting, will jointly present a 90 minute tutorial on computational global optimization, which will also appear in the INFORMS *TutORials in Operations Research* Series (http://tutorials.pubs.informs.org/). We plan to arrange two more tutorials to share an ICS session in Seattle. If you have additional suggestions, please email me at dell@nps.edu.

Mathematical Programming Glossary

Allen Holder, Trinity University

The *Mathematical Programming Glossary* became part of ICS's growing web presence during the summer of 2006. This valuable resource was the brainchild of Dr. Harvey Greenberg, who authored and edited the *Glossary* from its inception in 1999 to its celebrated status in 2006. Now, the *Glossary* has an Editor who serves as Chair of an Advisory Board:

Allen Holder (Chair), Trinity University, Department of Mathematics;

John Chinneck, Carleton University, Department of Systems and Computer Engineering;

Harvey Greenberg, University of Colorado at Denver, Department of Mathematical Sciences;

David Morton, University of Texas at Austin, Department of Operations Research & Industrial Engineering;

Henry Wolkowicz, University of Waterloo, Department of Mathematics.

The *Glossary*'s impact on our community is substantial, a fact validated by the tens-of-thousands of hits it receives per day, and hence its continued development is important. ICS members can assist by any or all of the following:

- Using the *Glossary* as part of your education pursuits;
- Citing the *Glossary* in your work;
- Suggesting a new or revised entry;
- Volunteering to add a Tour - a list of terms targeted at a specific topic;
- Authoring a Supplement - an article that augments a topic or term associated with the *Glossary*.

Suggestions are welcome and should be sent to Allen Holder at aholder@trinity.edu.[1]

Call for Nominations

[1] other ICS glossaries, such as for simulation and computational probability. If interested, contact the ICS Chair.

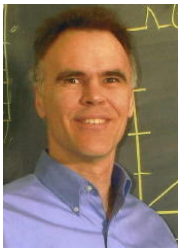
ICS Prize (Deadline: July 16, 2007). This is given annually for the best English language paper, or group of papers, that contributes to the OR/CS interface. The award is accompanied by a certificate and a $1,000 honorarium. The Committee members are Michael Ball (Chair), University of Maryland, Robert Fourer, Northwestern University, Michel Gendreau, University of Montreal, and Lawrence Leemis, College of William and Mary. Send your nomination to Professor Michael Ball, mball@rhsmith.umd.edu, following the guidelines given at http://computing.society.informs.org/prize.php.

Student Paper Award (Deadline: June 30, 2007). This is given annually to the best paper on computing and operations research by a student author. The award is accompanied by a plaque and a $500 honorarium. The winner will be invited to present his or her paper in an ICS-sponsored session at the Seattle INFORMS Meeting. The Committee members are Jonathan Eckstein (Chair), Rutgers University, Jeff Linderoth, Lehigh University, and Michael Trick, Carnegie Mellon University. Send your nomination to Professor Jonathan Eckstein, jeckstei@rci.rutgers.edu, following the guidelines given at http://computing.society.informs.org/prizeStudent.php.

Call for Photos

Do you fancy yourself a photographer? Do you attend ICS events with a digital camera? Then, read on! ICS News needs photos of ICS people at events. The next is the Puerto Rico meeting, and I want to include photos of the happenings in our Fall News. Even if your photo is not used in the newsletter, it may appear in a forthcoming photo gallery at our web site. Please contact harvey.greenberg@cudenver.edu for more information.

Interview with Larry Leemis, Co-recipient of the 2006 ICS Prize



Lawrence ("Larry") Leemis was co-recipient, along with John H. Drew, Diane L. Evans, and Andrew G. Glen, for their "body of work in five papers" that "form the core of an innovative body of work on computation in applied probability with operations research applications" [*ICS News*, Fall 2006].

I interviewed Larry February 7 by phone. His background is simulation, having received his Ph.D. in 1984 from Purdue under the mentorship of Bruce Schmeiser. He is currently Professor of Mathematics at the College of William & Mary, where he served as Department Chair 1999–2002. Larry holds many other awards, including the 2003 Simon Prize for Excellence in Mathematics Instruction.

Q. I note that your background is Mathematics and CS and

that you were a Ph.D. student under Bruce Schmeiser at Purdue. Was this your entrance into the OR/CS interface?

A. *Essentially it was. My Ph.D. dissertation included a simulation of the time to failure of a system of independent components.*

Q. Do you agree with the Committee's choice of 5 papers to cite for the "body of work"?

A. *Yes, they give a representative range of the algorithm development and applications.*

Q. The 5 papers are nearly chronological, except the first (APPL) is 2001, while the others descend as 2006, 2004, 2000, 1997. Is there some significance to the first being APPL, out of chronological order?

A. *The APPL paper is listed first because it is about the language and how someone can use it. The other papers are about specific algorithms for particular problems.*

Q. The papers cited suggest that this body of work began in 1996 (leading to the 1997 publication). Is this correct?

A. *Yes. I suggested a research project to implement the transform technique for continuous random variables, so we would not have to repeatedly do transformations of random variables by hand. Andy Glen, my Ph.D. student at the time, did the implementation and that evolved into a chapter in his Ph.D. thesis (1998).*

Q. In 1995 you published a book, *Reliability: Probabilistic Models and Statistical Methods*. Did that work have any influence on the development of APPL?

A. *Yes and no. My work in reliability surfaced the problem of doing some of these transformation computations, notably for the Kolmogorov-Smirnov test statistic. However, I believe the need would have arisen if I had worked on another problem area that required the capability of APPL. So, yes the work described in my book had an influence on the project, but APPL would probably have been developed anyway.*

Q. How did APPL evolve?

A. *The roots are with the early papers, particularly with my colleague, John Drew. His mathematical strength was crucial in getting early results, most notably for finding the distribution of the Kolmogorov-Smirnov test statistic. Once we had an algorithm for the change-of-variable transformation technique, Andy Glen met the challenge of implementing it. We chose Maple because of its symbolic processing capability, allowing us to use the built-in symbolic differentiation and integration. At this point, a rudimentary version of APPL was working for continuous distributions. Diane Evans joined the project and extended the scope to include discrete random variables. Certain aspects of the language, such as data structures and finding the distribution of order statistics, are more difficult for discrete random variables.*

Q. How do you feel about winning the Prize?

A. *Thrilled, particularly for the former Ph.D. students [Diane Evans and Andrew Glen].*

Q. What does the Prize mean to you?

A. *I am honored to have peers acknowledge the significance of a decade's work.*

Q. Who has influenced your research?

A. *The entire Simulation Group at Purdue [1980-4], which included Bruce Schmeiser, Alan Pritsker, Lee Schruben, and Steve Roberts.*

Q. What do you like to do when you are not working?

A. *I enjoy being with my three children, ages 7, 15, and 17. I am also into photography.*

Q. What are your plans to extend this work?

A. *Nothing immediate. If a student becomes interested, we can work from the current [2004] version and add some new capabilities.*

Q. Your APPL paper calls the software a "prototype." Do you have any plans to go beyond this and distribute it?

A. *I have had requests by email, and I respond by sending the program plus some basic documentation. Anyone interested can obtain APPL, but they must be mindful that this is from an academic and does not have any support, as one might expect from a commercial system.*[2]

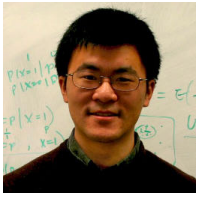
Q. What advice would you like to give to other researchers who might get into this?

A. *Consider computing analytical solutions rather than simulating when the equations can be written in some tractable form. Some problems, such as bootstrapping with a small sample size, are often better solved analytically.*

Q. Is there anything else you wish to add?

A. *I am interested in learning about stochastic problems, notably in physics, chemistry, or biology, that are unsolvable because of mathematical tractability issues. If the problem is amenable to the capabilities of APPL, there might be an exact solution available. Also, APPL was truly a team effort, and I really enjoyed working with Diane, Andy, and John on the project.*

Interview with Geng Deng, Recipient of the 2006 ICS Student Paper Award



Geng is pursuing a Ph.D. in Mathematics and Computer Sciences at the University of Wisconsin at Madison, advised by Michael Ferris. His research is simulation-based optimization, focusing on deriving a two-phase optimization framework. Geng holds an M.S. in Statistics, M.A. in Mathematics, and B.S. in Applied Mathematics. Besides receiving the first ICS Student Paper Award [*ICS News*, Fall 2006], Geng received the I-Sim/ACM-SIGSIM Best Ph.D. Student Paper Award at the 2006 Winter Simulation Conference. I interviewed him February 7 by phone.

[2] Editor's note: I suggested he look at COIN-OR.

Q. What attracted you to Mathematics and Computer Science?

A. *I came to Wisconsin with a Mathematics background in pursuit of a Ph.D. in Mathematics. I took a course in linear programming by Dr. Stephen Wright, which is combined-listed as Math/CS. I liked the subject, so I continued to take nonlinear programming from Dr. Michael Ferris. The two courses motivated me to study optimization, and I asked Michael to be my advisor. To do so I had to become a double major, pursuing a Ph.D. in Mathematics and Computer Science. That is what I did.*

Q. How did this relate to OR?

A. *Getting into CS was a matter of where optimization is taught — namely, the CS Dept. To me, therefore, the CS I studied is OR in that mathematical programming is a part of OR.*

Q. How did you happen to choose the topic of your paper?

A. *Michael had me join a project he had with the medical school to improve computational efficiency to run their Breast Cancer Epidemiology Model. The problem was to determine the simulation parameters, but the computation depended heavily on how many paths were evaluated. With Michael's advice I pursued the idea of using Bayesian estimates to reduce the number of paths computed.*

Q. How does your topic fit into the OR/CS interface?

A. *Simulation is a heavily used tool in OR, involving extensive use of computation; both OR and CS issues arise when improving its efficiency and applicability.*

Q. Why did you decide to submit your paper for the ICS Student Paper Award?

A. *I happened to reach the ICS website (by accident) and learned of the Award. I consulted with Michael, and he thought my paper would be an ideal submission.*

Q. Why do you think the Committee selected your paper for the Award?

A. *The Bayesian ideas have been applied in discrete optimization, but their use in continuous optimization was new. We also created a clever way to estimate accuracy of the algorithm. It has further applications to optimize white noise functions.*

Q. How do you feel about winning the Award?

A. *Excited. I shared this excitement with Michael, my wife and parents.*

Q. What does the Award mean to you?

A. *It is a great honor, which the Department enhanced by listing my award at their home web site. On a practical note, the Award adds to my resume, which helps in my job search.*

Q. Who has influenced your research?

A. *My advisor, Michael Ferris.*

Q. What do you like to do when you are not working?

A. *I am fond of playing soccer and I play weekly with my buddies. I also like taking photos, using an introductory digital SLR camera, which my wife gave me for a wedding gift three years ago.*

Q. What are your plans after graduation?

A. *I have applied to both academia and industry, and I do not yet know what will be the best opportunity.*

Q. Do you have a preference between academia and practice?

A. *I want to do research, including some theoretical optimization and implementation of new algorithms in a practical setting. I will choose the opportunity that best fits these goals.*

ICS Members in the News

Rob Dell received the Naval Postgraduate School's Richard Hamming Award for Interdisciplinary Achievement, given for his teaching excellence and innovation.

Fred Glover was awarded an Honorary Doctor of Sciences by the Institute of Cybernetics of the National Academy of Sciences of Ukraine. He just retired from the University of Colorado, Leeds School of Business, and became an Adjunct Professor in the School of Engineering.

Donald H. Kraft is a Distinguished Visiting Professor at the US Air Force Academy; he will return next year to LSU, Department of Computer Science.

Panos Pardalos was inducted as an INFORMS Fellow. He also organized a conference on Data Mining, Systems Analysis and Optimization in Biomedicine, which was held at the University of Florida.

János D. Pintér published two new books, both dealing with applications of global optimization. The first is *Global Optimization: Scientific and Engineering Case Studies*, published by Springer. The second is *Global Optimization with Maple: An Introduction with Illustrative Examples*, published by Pintér Consulting Services, Inc.

Ghaith Rabadi became the Graduate Program Director for the Ph.D. Program at the Engineering Management & Systems Engineering, Old Dominion University.

Tadashi Nakano has been appointed to Adjunct Assistant Professor of Information and Computer Sciences (from Postdoctoral Researcher) at the University of California, Irvine.

Pascal Van Hentenryck received the 2006 Association for Constraint Programming (ACP) Award for Research Excellence in Constraint Programming.

David Woodruff at UC Davis is visited by Fulbright Fellow, Johan Oppen, who is a PhD student of **Arne Lokketangen** in Molde Norway, to study VRP applications for animal transport.

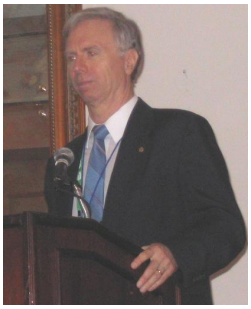
ICS Biennial Conference, 2007

(continued from p. 1)

People congregating in the foyer of the Colonnade Hotel.

The meeting featured the presentation of 65 papers submitted by 130 authors with special clusters in Networks and Graphs, Vehicle Routing and the TSP, Constraint Programming, Grid Computing, COIN-OR, Simulation, Integer Programming, Heuristic Search, Computational Complexity, and Decision Technologies. All those attending received a copy of the conference volume, *Extending the Horizons: Advances in Computing, Optimization, and Decision Technologies*, edited by the conference co-chairs, Ed Baker, Anito Joseph, Anuj Mehrotra, and Mike Trick. The volume was published by Springer Science+Business Media, LLC, as part of their Operations Research/Computer Science Interfaces series.

In addition to the exciting program of academic and practitioner presentations, the conference featured several highlights. The attendees were welcomed to South Florida with a reception on Wednesday evening in the Colonnade Rotunda. The Rotunda, modeled on the Palladian villa, featured a classic fountain at the center of marble colonnade supporting a second floor gallery and a large domed ceiling with oval skylight. The architectural ambience was complemented with good food and beverages, as well as, the jazz renderings of local keyboard artist Ryan Ellis, allowing the members to meet and greet their fellow attendees in a casual and relaxed setting.



On Thursday morning, Dr. Robert Atlas, Director of the NOAA Atlantic Oceanographic and Meteorological Laboratories located on nearby Virginia Key, gave the plenary address. Dr. Atlas presented some of his recent work on vortex (hurricane) modeling that employed the NASA Columbia supercomputer.

Dr. Atlas predicted that given the current rate of increase in computing power and modeling complexity of atmospheric phenomena, very accurate two-week forecasts of hurricanes and other weather phenomena should be available within the next decade.

Immediately following the plenary address was the conference luncheon. After the delicious Tastes of South Florida menu that featured grilled chicken, black beans and rice, and Key Lime pie, Dr. Harvey Greenberg shared some remarks on "Operations Research/Computer Science Interfaces" and their relevance to the INFORMS Computing Society. Harvey challenged the Society to be more proactive in the development of course curricula at colleges and universities to foster support for the mission and goals of the ICS.

At the conclusion of Harvey's remarks, John Chinneck, Chair of the ICS, announced that, by unanimous vote of the Board of the Society, the recently established ICS Service Award would hereafter be known as the *Harvey J. Greenberg Award* for Service to the ICS. John then presented Harvey with a certificate commemorating the naming of the award in his honor.

A final presentation to Harvey was made by Dr. Shihab Asfour, Chair of the Industrial Engineering Department at the University of Miami. Harvey, a 1962 graduate from the University of Miami, was recognized by the University of Miami's Industrial Engineering Department for his distinguished career of academic achievement and government service.

The conference was fortunate to enjoy the support of several local sponsors. The organizers wish to thank the School of Business at the University of Miami, the NOAA Atlantic Oceanographic and Meteorological Laboratories, the Transportation Research Institute of Miami, and the South Florida Chapter of INFORMS for their very generous support in helping to make the tenth INFORMS Computing Society meeting a great success.

Modeling and Simulation: An Underused Tool in Operations Research

Kenneth T. Ryals, The Johns Hopkins University Applied Physics Laboratory

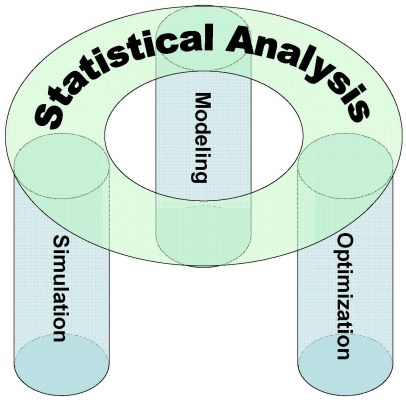
I recently attended my first meeting of the INFORMS Computing Society (ICS) and was struck by the paucity of talks focused on the modeling and/or simulation (M&S) topics. Having been engaged in Operations Research (OR) related pursuits for more than 20 years at the Johns Hopkins University Applied Physics Laboratory, I expected to see a much greater number of simulation-related presentations. My personal

experience (in mostly DoD-related activities) is that simulation is an essential tool in examining complex activities and in forming fundamental understandings of the behaviors of components of large-scale systems. I would like to offer a few examples that (I hope) will stimulate a resurgence of simulation-related research in the ICS.

The figure on the right depicts the general relationship I have observed among the four major components of OR — simulation, modeling, optimization, and statistical analysis. Although optimization is both a personal favorite topic and an essential tool for OR (some consider it the defining aspect differentiating OR from similar disciplines), it should not be used in a vacuum. Before applying optimization to a model in order to determine a course of action, the model should be carefully examined (and subjected to verification, validation, and accreditation in many cases) to assure that the solution generated by optimization is appropriate. Basic statistical analysis tools, such as fractional factorial experimental design and general linear modeling, can aid in identifying which model input parameters are the most critical in determining the behavior of the model output. This is a good, and often necessary, starting point for generating confidence in a model, but it is not capable of revealing all of the model characteristics needed to implement the model as the basis for decision optimization. In order to develop the necessary confidence in a model as describing the problem correctly and completely, the model should be exercised in a simulation wherein the behavior being studied interacts with other competing and dependent activities. It is this contextual examination that can reveal unexpected relationships, unintended consequences, and incomplete behavior instantiation. I offer a couple of examples in the following paragraphs.

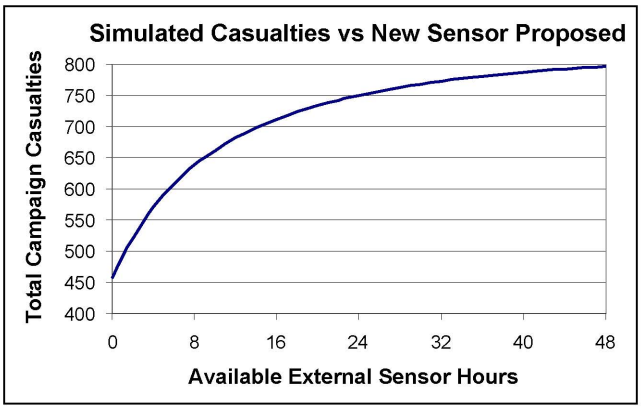
One use of M&S that is familiar to most OR practitioners is in simulating large-scale systems of systems whose relationships are nonlinear and/or complex. Such simulations often represent the function being optimized in the investigation of alternative design changes. For example, the function being optimized might be the probability of successfully interdicting a hazardous person or object entering some area. The components being evaluated could include a variety of detection, apprehension, and deterrent systems. In a Cost-As-Independent-Variable (CAIV) analysis, the optimal implementation would be determined at various funding levels, with the point of diminishing marginal returns aiding in selecting the components to select for further consideration.

In such an analysis, one might find that the addition of a new component, which performed exactly as expected, produced a diminished overall performance through the "law of unexpected consequences," where it is interfered with the performance of other systems. In the example indicated by the graph below, the proposed new battlefield sensor system increased the overall number of casualties through a combination of loss of momentum (where the advancing force stops to gather information, while the responding force regroups) and through a redirection of supporting assets from an attacking role to one of information validation. Only through the use of reasonably high fidelity simulations would such interactions be uncovered. A model of the proposed sensor system alone could not reveal these interactions. In addition to the benefit



of revealing previously unknown relationships, simulations as a function to be optimized present several avenues that warrant research.

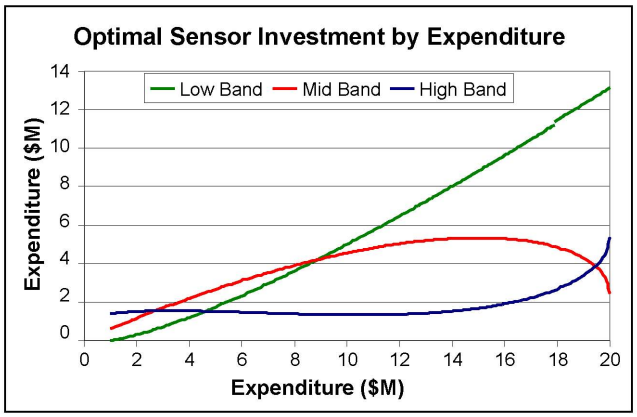
Frequently, the simulations are sufficiently time-consuming that traditional optimization schemes, requiring many function evaluations, can not be used effectively. Moreover, it is extremely rare that derivatives are available for large-scale simulations, which further reduces the scope of available optimization tools. These are aspects of optimization research that seem sorely in need of attention.

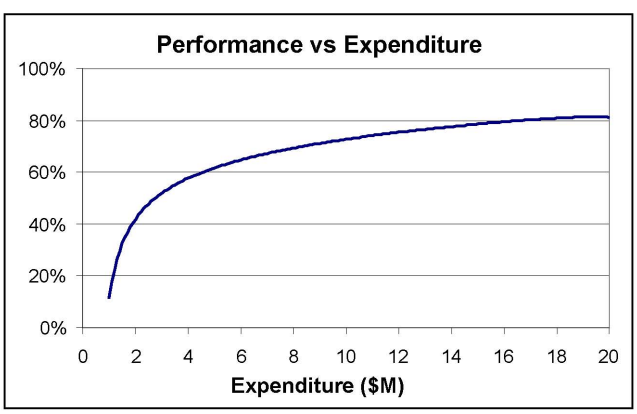


Simulation can also be used in OR to permit a reduction of the scope of high-dimensional problems. In a system-of-systems (SoS) framework, similar to that of the previous paragraph, each of the components in the overall system might have hundreds of parameters describing their behavior. Com-

bined, the dimensionality of the problem could quickly grow to the point of being virtually intractable. However, a combination of simulation with OR analysis techniques, such as a fractional factorial experimental design, could reveal which of the many low-level parameters are capable of producing a statistically significant effect on the overall system when varied over their range of operation. This technique can permit a winnowing-down of the parameters studied to a much smaller subset of the whole problem. Presently, such an examination is not an integral part of must available simulation or optimization tools. Research into methods for partially automating this analysis could significantly enhance the productivity of large-scale simulation-based investigations.

Another use of simulation that seems to have become obsolete is in the construction of parametric models of systems. By combining simulation with modeling (and optimization to fit the necessary parameters), a parametric model can often be constructed that permits rapid evaluation (as opposed to a large, slow simulation) and even closed-form theoretical analysis. Constructing such a parametric model often requires the generation of macros to execute the desired set of simulation executions with differing parameters, followed by the export of simulation results to external analysis environments to determine how the parameters impact the overall system behavior.





Then, the hypothesized model is transferred to an optimization tool to determine the best set of parameter values to represent the simulation behavior and to estimate the validity of the constructed model. Such a hybrid analysis process is rife with opportunities for improvement.

Once the necessary parametric models have been created and vetted, investment decisions can be made to optimize the final system as shown in the CAIV study of three different sensor bands. Research into techniques for the construction and evaluation of simulation-guided parametric models could prove beneficial to investigators trying to understand or manage large complex systems.

There are many more uses of simulation in OR than these, but it was my desire to stimulate a discussion and, hopefully, a resurgence of attention on the use of simulation in OR. Comments, suggestions, and (polite) criticisms are welcome to: kenneth.ryals@jhuapl.edu.

Obituary: Peter Ladislaw Hammer

December 23, 1936 – December 27, 2006

Endre Boros, Rutgers Center for Operations Research
Yves Crama, University of Liége
Bruno Simeone, University La Sapienza

Peter Ladislaw Hammer was born in Timisoara, Romania, on December 23, 1936. He earned his Ph.D. in mathematics under Academician Grigore C. Moisil at the University of Bucharest in 1966. He defected to Israel in 1967 where he became a professor at the Technion in Haifa. After moving to Canada, he taught from 1969 to 1972 at the University of Montreal and from 1972 to 1983 at the University of Waterloo. In 1983, he moved to the USA and became a professor at Rutgers University, where he founded RUTCOR — the Rutgers Center for Operations Research. He remained the director of RUTCOR until his untimely death in a tragic car accident, on December 27, 2006.

For more than 40 years, Peter Hammer has ranked among the most influential researchers in the fields of operations research and discrete mathematics. He has made numerous major contributions to these fields, launching several new research directions. His results have influenced hundreds of colleagues and have made a lasting impact on many areas of mathematics, computer science, and statistics.

Most of Peter Hammer's scientific production has its roots in the work of George Boole on propositional logic. More than anyone else, Peter Hammer has used and extended Boole's machina universalis to handle questions relating to decision making, analysis and synthesis as they arise in natural, economic and social sciences. Over the span of his scientific career, he has conducted eclectic forays into the interactions between Boolean methods, optimization, and combinatorial analysis, while adapting his investigations to the most recent advances of mathematical knowledge and of various fields of application. Among the main research topics which have received his attention, one finds an impressive array of methodological studies dealing with combinatorial optimization, some excursions into logistics and game theory, numerous contributions to graph theory, to the algorithmic aspects of propositional logic, to artificial intelligence and, more recently, to the development of innovative data mining techniques. His publications include 19 books and over 240 scientific papers. (See the Web site rutcor.rutgers.edu for a complete bibliography.)

At the very onset of his career, as a researcher at the Institute of Mathematics of the Academia of Romania, Peter Hammer wrote several important articles on transportation problems, jointly with Egon Balas. At the same time his advisor, Grigore Moisil, directed him to the study of Boolean algebra. In this field, a central role is played by functions depending on binary variables, and taking either binary values (i.e., Boolean functions) or real values (i.e., pseudo-Boolean functions). In a series of papers, Peter Hammer demonstrated that a large variety of relevant problems of operations research, combinatorics and computer science can be reduced to the optimization of a pseudo-Boolean function under constraints described by a system of pseudo-Boolean inequalities. A further main conceptual step in his work was the characterization of the set of feasible solutions of the above system as solutions of a single Boolean equation (or, equivalently, of a satisfiability problem). This led him, in joint work with Ivo Rosenberg and Sergiu Rudeanu, to the development of an original approach inspired from classical Boolean methods for the solution of a large variety of discrete optimization problems.

This research project culminated in 1968 with the publication of the book Boolean Methods in Operations Research and Related Areas (Springer-Verlag, 1968), co-authored by Sergiu Rudeanu. This landmark monograph, which founded the field of pseudo-Boolean optimization, has influenced several generations of students and researchers, and is now considered a "classic" in Operations Research.

In a sense, Peter Hammer's early work can be viewed as a forerunner of subsequent developments in the theory of computational complexity, since it was in effect demonstrating that a large class of combinatorial optimization problems is reducible to the solution of Boolean equations. However, this purely "reductionist" view of his work would be quite narrow. In fact, Peter Hammer has systematically used the "canonical" representation of various problems in terms of Boolean functions or Boolean equations to investigate the underlying structure, the "essence" of the problems themselves. More than often, this goal is met through a simplifying process based, once again, on the tools of Boolean algebra. This approach provides, for instance, a simple way to demonstrate that every system of linear inequalities in binary variables is equivalent to a set of inequalities involving only 0,1,-1 coefficients, as observed in a joint paper by Frieda Granot and Peter Hammer (1972). It also led Peter Hammer, Ellis Johnson and Uri Peled (1975) to early investigations into the facial structure of knapsack polyhedra.

In a related stream of research, Peter Hammer has established numerous fruitful links between graph theory and Boolean functions. In a famous joint paper with Vašek Chvátal on the aggregation of inequalities in integer programming (1977), he introduced and characterized the class of threshold graphs, inspired by threshold Boolean functions. Threshold graphs have subsequently been the subject of scores of articles and of a book by Mahadev and Uri Peled, two of Peter Hammer's former doctoral students. Other links between graphs and Boolean or pseudo-Boolean functions have been explored in joint work with Claude Benzaken, Dominique de Werra, Stephan Foldes, Toshihide Ibaraki, Alex Kelmans, Vadim Lozin, Frédéric Maffray, Bruno Simeone, etc.

Quadratic 0-1 optimization has been one of Peter Hammer's main fields of investigation. The theory of roof-duality (1984), jointly developed with Pierre Hansen and Bruno Simeone, builds on concepts from linear programming (linear relaxations), Boolean theory (quadratic Boolean equations) and networks (maximum network flow problems) to compute best linear approximations of quadratic pseudo-Boolean functions and tight bounds on the maximum value of such functions. Further research along similar lines has been conducted by Peter Hammer in collaboration with Endre Boros, Jean-Marie Bourjolly, Yves Crama, David Rader, Gabriel Tavares, X. Sun, etc.

Peter Hammer has also shown interest for the application of Boolean models in artificial intelligence and related fields, as witnessed by numerous joint papers with Gabriela and Sorin Alexe, Martin Anthony, Tiberius Bonates, Endre Boros, Yves Crama, Oya Ekin, Toshi Ibaraki, Alex Kogan, Miguel Lejeune, Irina Lozina, and other collaborators. His contributions bear on automatic theorem proving, compression of knowledge bases, algorithms for special classes of satisfiability problems, etc. About 20 years ago, he launched an innovative approach to data mining based on a blend of Boolean techniques and combinatorial optimization. The basic tenets of this approach were presented in a joint paper with Yves Crama and Toshihide Ibaraki (1988) and were subsequently developed by Peter Hammer and his co-workers into a new broad area of research, which he dubbed Logical Analysis of Data, or LAD for short. The effectiveness of the LAD methodology

has been validated by many successful applications to real-life data analysis problems. In particular, some front-of-the line medical centers are increasingly using LAD in the actual practice of medical diagnosis for a variety of syndromes.

Many aspects of Peter Hammer's immense contribution to the study of Boolean functions and their combinatorial structure are to be found in a forthcoming monograph entitled *Boolean Functions: Theory, Algorithms, and Applications*, co-authored by Yves Crama and several other close collaborators of Peter Hammer, to be published by Cambridge University Press in 2007.

Beside his scientific production, Peter Hammer will undoubtedly be remembered for his vigorous contribution to and promotion of discrete mathematics and operations research. He was the founder and editor-in-chief of several highly-rated professional journals, including *Discrete Mathematics*, *Discrete Applied Mathematics*, *Discrete Optimization*, *Annals of Discrete Mathematics*, *Annals of Operations Research*, and the *SIAM Monographs on Discrete Mathematics and Applications*. At Rutgers University, Peter Hammer was the founding Director of the operations research programme, and he was largely responsible for developing RUTCOR into an internationally recognized center of excellence and an open institute, where seminars, workshops, graduate courses, and a constant flow of visitors create a buzzing and stimulating research environment. He was also a tireless organizer of professional conferences and workshops, where he always made sure to provide opportunities for interactions between experienced scientists and younger researchers.

The importance of Peter Hammer's scientific contribution was acknowledged by the award of numerous international distinctions, including the *George Tzitzeica Prize* of the Romanian Academy of Science (1966), the *Euler Medal* of the Institute of Combinatorics and its Applications (1999), and honorary degrees from the Swiss Federal Institute of Technology in Lausanne (1986), the University of Rome "La Sapienza" (1998), and the University of Liége (1999). He was a Fellow of the American Association for the Advancement of Science since 1974, and a Founding Fellow of the Institute of Combinatorics and its Applications. Several conferences were organized in his honor, including the First International Colloquium on Pseudo-Boolean Optimization (Chexbres, Switzerland, 1987), the Workshop and Symposia Honoring Peter L. Hammer (Caesarea Rothchild Institute, University of Haifa, 2003), and the International Conference on Graphs and Optimization (GO V, Leukerbad, Switzerland, 2006).

Peter Hammer was not only an outstanding scholar and a tireless organizer, but also a kind, generous and humorous human being. He relished the interaction with students and colleagues, and made everybody feel comfortable to work with him, be it on a mathematical question (which he was always keen to formulate) or on planning a conference. He supervised numerous graduate students with respect and fatherly understanding, considering each one of them as his "best student". He was also a true 'citizen of the world.' Born in Romania from a Hungarian family, he subsequently took the Canadian citizenship, then the US one, wrote joint papers with co-authors of 28 different countries, fluently spoke six languages (or more), travelled the world extensively, spent extended periods of time in Belgium, France, Israel, Italy, Russia, Switzerland and many other countries, and developed an extended network of friends and co-workers on all continents.

Finally, last but certainly not least, Peter Hammer was a loving husband, father and grandfather. He is survived by his wife, Anca Ivanescu, whom he married in 1961 and whose family name he assumed for a few years, by his two sons Alexander and Maxim, and by four beloved grandchildren, Isabelle, Madeline, Annelise, and Oliver.

He will be missed by everyone who knew him, always and forever.

Message from the Chair

(continued from page 1)

COIN-OR link. COIN-OR is an online repository of tools, source code, models, data and examples for operations research, including solvers, modelling languages and supporting utilities. How useful for ICS members! No wonder several of the ICS officials are members of COIN-OR, including ICS Vice-Chair/Chair-Elect Robin Lougee-Heimer, ICS Secretary/Treasurer Jeff Linderoth, ICS newsletter editor Harvey Greenberg, and ICS Board members Lou Hafer and Matt Saltzman. In May 2006 ICS created a strategic partnership with COIN-OR in recognition of our many mutual interests. The agreement includes an exchange of web links, co-sponsored sessions at INFORMS meetings, and other ways of promoting interaction.

Brand new ICS Web site. The new ICS web site at http://computing.society.informs.org went live in May 2006. The brand new site is now hosted permanently on INFORMS servers instead of moving around with the current ICS Chair. Created by webmasters Pascal Van Hentenryck and Laurent Michel, it has a clean look and feel and many new features, including news, the Mathematical Programming Glossary (more later), a history archive (more later), a call for papers page (http://computing.society.informs.org/cfp.php), etc.

Mathematical Programming Glossary. Harvey Greenberg established the Mathematical Programming Glossary in 1996, and over time it has grown and become incredibly popular, averaging 15,000 hits per day. With his retirement, Harvey passed the day-to-day responsibility for the MPG to ICS, and we were only too happy to start hosting it on our web site as of May 2006. In addition we established a Board of ICS members to guide the future development of the MPG, headed by new Editor Allen Holder, and including John Chinneck, Harvey Greenberg, David Morton, and Henry Wolkowicz as mem-

bers.

ICS History Archive. Harvey Greenberg spearheaded the development of the new ICS History Archive, hosted on the website at http://computing.society.informs.org/archive.php. The first two items posted are Harvey's Personal History of ICS, and a copy of the petition for movement to Society status. Did you know that ICS started as the Computer Science Special Interest Group in 1976? It later became the Computer Science Technical Section in 1979, and eventually the INFORMS Computing Society that we all know and love in 1997. That's right, ICS is now 10 years old, with roots that go back 31 years. That's a lot of history that covers a fascinating time in the development of computing. The immediate past chair will take up the Historian role to make sure we capture important documents. If you have significant items from the past, by all means send them along to me. Right now I'm working on collecting all of the old newsletters (in soft form if you have them): Bruce Golden sent me a collection of golden oldies (sorry Bruce, couldn't resist) that I plan to scan and post.

Monthly News Email. When there is so much going on in ICS, we need a little more frequent contact than the twice-yearly newsletter. For this reason I instituted a monthly summary email bulletin to the membership that packages all the latest news into a single message (I'm trying to avoid becoming the King of Spam and this seems to be a good way to do that). This keeps us all up to date. The Newsletter, meanwhile, is the preferred forum for longer and more in-depth articles such as technical tutorials, member profiles, etc.

ICS Leading Edge Tutorial Series. As our motto says, ICS is "INFORMS' Leading Edge for Computation and Technology". That makes it our job to digest the latest technological and computational developments and make them understandable to the rest of INFORMS. To this end we've established the ICS Leading Edge Tutorial series under ICS Board member Rob Dell. The goal is to survey ICS members to determine the leading edge topics that they would like to know more about and to find appropriate speakers for our meetings. We also plan to archive the talks. Keep your eye on the page at http://computing.society.informs.org/lEdge.php as it develops over the coming months.

Co-sponsoring Tracks at INFORMS Meetings. Computing underlies just about everything we do in operations research. This insight led me to begin trying to arrange tracks that were cosponsored by ICS and other subdivisions, such as the Optimization Society, and has been hugely successful, culminating in well over 40 sessions at the Pittsburgh meeting in November 2006. This new approach received favourable comment at the Subdivisions Council, and will again be pursued by Seattle ICS sponsored sessions chair Robin Lougee-Heimer (robinlh@us.ibm.com).

New ICS Student Paper Award. First raised as a possibility at the ICS 2005 meeting in Annapolis, this award was officially established at the ICS Business meeting in San Francisco in fall 2005. The first award was made at the Pittsburgh meeting in fall 2006. Jonathan Eckstein is chairing the selection committee for 2007. See http://computing.society.informs.org/prizeStudent.php for details.

Harvey J. Greenberg Award for Service to ICS. Harvey himself proposed an ICS service award at the Business meeting in Pittsburgh in the fall of 2006, and it was subsequently passed via email vote. Best of all we were able to surprise Harvey with the renaming of the award in his honour at the ICS 2007 meeting in Coral Gables by unanimous vote of the Board of Directors. The first award will be made at the ICS 2009 meeting in Charleston. See http://computing.society.informs.org/service.php for details. To see why the award was renamed, check out Harvey's record of service to ICS in the announcement of his retirement at http://computing.society.informs.org/news.php?bite=9.

ICS 2007 in Coral Gables. Now that was fun. Great location, great weather, great talks. See http://computing.society.informs.org/pdf/ICS07MeetingReport.pdf for Conference Chair Ed Baker's report.

ICS 2009 in Charleston. We're getting organized early! Conference Chair is Matt Saltzman, assisted by Bjarni Kristjansson and John Chinneck. We are in the process of finalizing the date in early January 2009 as this goes to press.

That's one active society! And that's what keeps it interesting. It's all about the people and their interactions over shared interests. Why not step up and get involved? Let me hear about projects you'd like to lead. I'm at chinneck@sce.carleton.ca.

Acknowledgements

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