

MESSAGE FROM THE RASIG CHAIR

INSIDE:

OR AT BNSF	2
HISTORICAL PERSPECTIVES	2
RAILROAD WORKSHOP	3-4
NEW FRONTIERS IN RAILROAD OR	5-6
RAILROAD TRIVIA	6
DENVER INFORMS SESSIONS	7
STUDENT PAPER AWARDS	7
RASIG OFFICERS	8
ADVERTISE- MENT	8

It seems only a short time ago that I assumed the responsibility of Rail Application Special Interest Group (RASIG) Chair. It has been a busy and eventful year so far working with the other RASIG officers to coordinate the events for the upcoming year. In addition to continuing our efforts to support student papers, paper sessions, and roundtables, we have decided to resume publication of the RASIG Newsletter.

This edition of the RASIG newsletter marks the 10-year anniversary of RASIG's existence within the Institute for Operations Research and Management Science (INFORMS). RASIG was created in April of 1994 by over 50 Operations Research professionals with the goal of fostering productivity improvements within the railroad industry through the use of innovative technology. Over the past decade, RASIG has grown to over 100 active members of Operations Research professionals from the railroad industry, consultants, academicians, and students.

To continue encouraging the application of Operations Research within the railroad industry, we are promoting the following few upcoming activities and initiatives:

- RASIG and Railway Age are again sponsoring a student research paper contest on Management Science in Railroad Applications. Details of this award are available at <http://www.informs.org/Prizes/RailroadApps.html#Student>.
- RASIG has built an online-database of research papers related to railroad operations to make research of current work in the railroad industry easier. The database is available at <http://www.innovativescheduling.com/ordb.asp>
- In our continuing effort to promote the interaction and exchange of ideas among OR personnel, consultants, and members of academia, we are organizing a workshop to be held December 5-7, 2004, at BNSF Railway in Fort Worth, Texas. Additional details about the workshop are provided elsewhere in this newsletter.

I am really excited about all the activities planned for this year and want to thank the RASIG officers for their hard work and dedication.

Now, more than ever, RASIG can play an important role in the Railroad industry. Railroads are an important mode of transportation and handle about a third of the freight in North America on a gross ton mileage basis. Historically, railroads have been the low cost, long-haul

carriers of bulk commodity goods such as coal, grain, and lumber. However, the freight industry in North America is entering into a new era driven by globalization market forces, with intermodal and international business is becoming an increasing percentage of railroad traffic. There is a growing need for time-sensitive shipments in the global supply chain. Opportunities for growth in the railroad industry lie in its ability to provide high quality freight service - especially increased reliability and flexibility. Today, railroads are focusing on providing seamless, high-quality transportation to a mix of customers with varying time and reliability needs. The complexity of the logistics product offering has increased. There is an increased importance of transit times and reliability in transit times along with the on-going emphasis on improving productivity and reducing costs to grow profitability and market share.

The past two quarters have seen substantial increases in railroad traffic volumes and are causing many railroads to re-evaluate their capacity. Capital expansion is very costly, but often relied upon, means of increasing capacity. A more cost-effective solution is to manage the existing capacity more effectively using decision support systems. Improved computer, communication, and location technologies provide a wealth of data. However, the decisions can be quite varied, complex, and require a wide range of analytical models. Despite the complexity, the opportunity for improvement is great since even the smallest percentage of improvement can result in substantial financial returns. I intend to explain the types of tools needed in the different areas in subsequent articles and encourage the research community to look into these challenging problems.

We look forward to your participation in future RASIG activities, and hope you will actively participate in promoting the use of Operations Research within railroads to move railroads to greater productivity and improved profitability.

Until next time ...

Pooja Dewan
BNSF Railway

"A man who has never gone to school may steal from a freight car; but if he has a university education, he may steal the whole railroad."



OR AT BNSF RAILWAY

Since deregulation in the 1980s, the railroad industry has realized its greatest productivity gains through reductions in labor, track, and equipment costs. While these cost-reduction efforts were highly profitable when the US economy was dominated by bulk-commodity production, they are no longer sufficient. As more businesses adopt a “just-in-time” inventory management philosophy in their efforts to cut inventory costs, and as the world of business moves toward an increased emphasis on globalization, railroads are witnessing an increased demand for reliable and flexible logistic services.

To remain competitive, railroads, including Burlington Northern Santa Fe (BNSF), must find innovative ways to optimize capacity. BNSF Railway operates one of the largest railroad networks in North America, with 33,500 miles of track spread over 28 states and 2 Canadian provinces. The increased demand for reliable service,

combined with existing bulk-commodity moves, complicates BNSF’s network. To address these needs, BNSF is increasing its focus on optimizing capacity management (track, terminal, locomotives, crew, and equipment) to serve the diverse needs of its customer base while providing the highest returns to shareholders. In this time-sensitive transportation market, the use of innovative technologies, such as OR techniques, better positions BNSF to realize this growth. I am pleased to know that RASIG leadership is taking an active role in promoting the use of OR techniques in railroads. I convey to them my best wishes and hope that in the upcoming few years, US railroads will significantly benefit from the use of OR techniques in their planning and scheduling processes.

Jeff McIntyre
AVP, Technology Services
BNSF Railway

SOME HISTORICAL PERSPECTIVES

In this article, I would like to share with you the history of the RASIG Newsletter. On April 25, 1994, the Operations Research Society of America (ORSA) Council approved a petition signed by over fifty Operations Research (OR) professionals in the rail industry to create the *Rail Applications Special Interest Group (RASIG)*. This event filled a long overdue need for a professional organization that focuses on improving railroad productivity and service through the use of OR-based decision support tools.

Railroad OR personnel, consultants, and members of academia are significant contributors to the OR applications in railroads. The goal of RASIG is to improve communication among railroad OR personnel, consultants, and members of academia with the understanding that improved communication leads to a greater understanding of railroad problems. We thereby hope to facilitate in the cooperative development of new decision technology tools for the rail industry. RASIG concentrates on two key objectives to pursue this goal. The first objective is to arrange a roundtable and several invited technical paper sessions at the INFORMS National Meeting. The second objective is to publish a newsletter to keep the RASIG members informed about the group’s activities. From 1994 through 1996, two RASIG Newsletters were published every year under the direction of David Hunt, the newsletter editor. These newsletters contained:

- RASIG sessions for the next annual INFORMS National Meeting;
- in-depth articles on the roundtable discussion topics for the next annual meeting; and

- summaries of the roundtable discussions and papers presented at the previous annual meeting.

As a result, the RASIG Newsletter kept members updated about activities of the past meeting and prepared members for an active dialogue for the upcoming meeting. Therefore, it became an essential tool for achieving the RASIG goal of facilitating the exchange of information among members. The newsletter also valued the interest of RASIG’s members and played a vital role in the sustained high attendance at the INFORMS annual meetings. However, after 1996, the newsletter’s publication became irregular and eventually it completely stopped a year later. Predictably, since 1996, the attendance at the annual INFORMS meetings has been steadily declining.

To reinvigorate the RASIG and to increase its members’ interest in RASIG activities, the current RASIG leadership has decided to publish the newsletter every six months. I am very pleased with the newsletter’s reinstatement, which is a direct result of the vision and energy of the new leadership. With the forthcoming publication of the newsletter, I am confident that we will soon observe an increase in RASIG member participation at the annual INFORMS meetings .

Ajit Wijeratne
Founding Chairman, RASIG
Norfolk Southern Corporation

OR PAPERS DATABASE

RASIG, in collaboration with Innovative Scheduling, has developed an on-line database of papers related to Operations Research in railroads. This database contains references and abstracts of hundreds of papers in railroad OR published in the past fifty years. It will allow users to search for papers using key words or find papers on specific railroad decision problems. We hope that this database will assist in the literature survey and thus promote the use of operations research techniques in railroads. This database is available at the website: www.InnovativeScheduling.com.

— RASIG Editorial Board

OPERATIONS RESEARCH IN RAILROADS: CHALLENGES AND OPPORTUNITIES

A RASIG-Sponsored Industry-Academic Collaborative Workshop

December 5-7, 2004, BNSF Railway, Fort Worth, TX

The Rail Application Special Interest Group (RASIG) under the auspices of the Institute for Operations Research and Management Science (INFORMS), was created a decade ago by over fifty operations research professionals to foster productivity improvements through innovative technology within the rail industry. RASIG has over 100 active members who are operations research professionals from the railroad industry, consultants, academicians, and students. Over the past decade, RASIG has facilitated various activities, including paper sessions, roundtables, a newsletter, an operations research forum, and student paper competitions. This year, as part of continuing efforts to promote interaction and an exchange of ideas, RASIG is organizing a workshop for industry and academic collaboration among operations research personnel, consultants, and members of academia.



Although the railroad transportation industry is rich with planning and scheduling problems that can be modeled and solved through operations research techniques, these techniques are not widely utilized throughout the rail industry. Currently, most railroad personnel rely on manual decision-making processes for the majority of their planning and scheduling needs. The complexity of railroad scheduling problems and the absence of IT infrastructure to capture real-time data impedes the feasibility of these techniques. RASIG's upcoming collaborative workshop will bring together leading researchers and practitioners from the field of operations research as well as senior and mid-level railroad managers to encourage an exchange of ideas about these issues.

WORKSHOP GOALS:

The goals of this workshop are to:

- identify the railroad industry's significant problems on which academicians can do research and develop model-based decision support systems;
- develop an awareness of operations research techniques among the senior railroad executives; and
- learn from senior railroad management about the current challenges faced in railroad scheduling as well as future opportunities for research and development.

WORKSHOP ORGANIZERS:

Dr. Ravindra K. Ahuja (Vice-Chair, RASIG), University of Florida & Innovative Scheduling, Gainesville, FL;
Dr. Clark Cheng (Treasurer, RASIG), Norfolk Southern Corporation, Atlanta, GA;
Dr. Pooja Dewan (Chair, RASIG), Burlington Northern Santa Fe (BNSF) Railway, Fort Worth, TX;
Mr. Kevin Foy, Multimodal Applied Systems, Princeton, NJ;
Dr. Liu Jian (Secretary, RASIG), Innovative Scheduling, Gainesville, FL.

QUICK QUOTE

"Children and dogs are as necessary to the welfare of the country as Wall Street and the railroads."

- Harry S. Truman

WORKSHOP PROGRAM:

The workshop program will consist of: (i) invited lectures by academicians and practitioners who have been involved in the applications of operations research which resulted in substantial savings; (ii) invited lectures by senior management executives on the state-of-the-art of railroad scheduling, the tools currently used by them, their shortcomings, and their views on the next generation decision support systems based on operations research techniques; and (iii) panel discussions between academicians, practitioners and railroad executives to identify research problems and possible research directions. Preliminary program of the workshop is given on the next page. A detailed program will become available soon and will be emailed to the RASIG members. The workshop website will also be ready soon and we will email you its address.

CORPORATE SPONSORSHIP

We invite railroad companies as well as software development and consulting companies to be corporate sponsors for the workshop. The corporate sponsorship fee is \$2,500 and includes free registrations for five participants from the sponsoring organization.

December 5, 2004 (Sunday)	
6:00 PM — 9:00 PM	Registration, Welcome Session and Banquet Dinner
December 6, 2004 (Monday)	
8:00 AM — 8:30 AM	Breakfast (provided)
8:30 AM — 12:00 PM	<i>Invited Lectures: Success Stories of Operations Research in Logistics</i>
12:00 PM — 1:00 PM	Lunch (Provided)
1:00 PM—3:00 PM	<i>Invited Lectures: Challenges faced by Railroads</i>
3:30 PM—5:00 PM	<i>Panel Discussion: Opportunities in Developing Next Generation Decision Support Systems for Railroads</i>
6:00 PM– 9:00 PM	Banquet Dinner (Provided)
December 7, 2004: (Tuesday)	
8:00 AM—8:30 AM	Breakfast (Provided)
8:30 AM — 12:00 PM	<i>Invited Lectures: Operations Research Models in Railroads, Software Products Available and the Need for New Software Tools</i>
12:00 PM– 1:00 PM	Lunch (Provided)
1:00 PM– 3:00 PM	<i>Panel Discussions: Developing an Action Plan for the Integration of OR Methodologies in Railroad Planning and Scheduling</i>
3:00 PM— 4:00 PM	BNSF Tour

REGISTRATION:

The registration fee for the conference is \$300 and includes all meals. All attendees, including speakers, must register and pay the registration fee. One-day registration fees and discounted registration fees are not available. Register early on the web and save time! Cancellations must be received in writing (email or fax) no later than October 8, 2004 for a refund minus a \$50 processing fee. The URL of the workshop website will be emailed to all RASIG members soon.

CONTACT PERSON:

The workshop will be held on the Fort Worth campus of BNSF Railway. BNSF Railway is located at 2600 Lou Menk Drive, Fort Worth, TX 76131. Rooms for registered participants are available at the special rate of \$75 per night at the Doral Tesoro Hotel and Golf Club. The hotel is located at 3300 Championship Parkway, Fort Worth, TX 76177. Reservations can be made by calling (817) 497-3011. Transportation between the hotel and the BNSF Railway campus will be provided on both days of the workshop. For any questions relating to the scope and content of the workshop, please contact Pooja Dewan at (817) 352-2257 or Pooja.Dewan@bnsf.com. For logistics and all other issues, please contact Ann Klein at (817) 352-0323.

CALL FOR ARTICLES

With this issue, RASIG Newsletter is staging a comeback. As of now, the RASIG Newsletter will be published regularly and will become an important medium for the exchange of ideas between the academicians, practitioners, and consultants who comprise RASIG's members. We invite all RASIG members to contribute articles to the newsletter and share their experiences and insights with others. You may contribute your article on any aspect of railroad OR, be it theory, modeling, algorithm and/or practice. The main criterion for acceptance of your submission will be its readability, relevance, and usefulness to RASIG's members. Please limit your articles to 1,000 words (two pages) and send them to:

Krishna C. Jha
krishna@InnovativeScheduling.com

NEW FRONTIERS IN RAILROAD OPERATIONS RESEARCH

The past few decades have seen numerous applications of operations research (OR) techniques in logistics, and these applications have resulted in substantial cost savings. Consider, for example, the airline industry. Operations research techniques are routinely used by most major airline carriers in their planning and scheduling decisions: airline schedule generators models generate effective flight legs; flight assignment models assign plane types to flight legs; aircraft rotation models produce itineraries for each aircraft; and crew scheduling models assign crew to planes. Yield management models allow airlines to determine overbooking levels and price itineraries, and recovery models assist airlines in quickly recovering from disturbances in operations due to bad weather.

Railroads, however, have not benefited from the advances in the field of OR, and most of the planning and scheduling processes do not use modeling and optimization. The main factors responsible for this phenomenon are: (i) the highly stochastic decision problems; (ii) their mathematical complexity; and (iii) the unreliable data due to poor information technology infrastructure. But the situation is now changing: railroads are demonstrating better on-time performance; the newer IT and GPS system are providing trustworthy data; and newer operations research techniques are able to solve larger and more complex problems. Railroad management is also realizing the inherent inefficiencies of the present-day manual decision-making process, as well as the need for intelligent decision support systems.

I believe that the time is now ripe to introduce the railroad industry to OR models and to produce major success stories of this decade. OR models are needed for the following railroad operational decision problems:

Blocking Plan: A blocking plan specifies the classification policies (that is, what blocks to make) at all yards to minimize the average car miles and car handlings. The blocking plan also routes shipments over the blocks made and specifies the routing of shipments (or waybills) over the blocks made. These blocks then travel over the train network.

Train Scheduling: A train schedule provides the number of trains formed, the origin, the destination, the route of each train, the arrival and departure times of each train at each station it visits, and the days of operation of each train. A subproblem of train scheduling is to determine the assignment of blocks to trains.

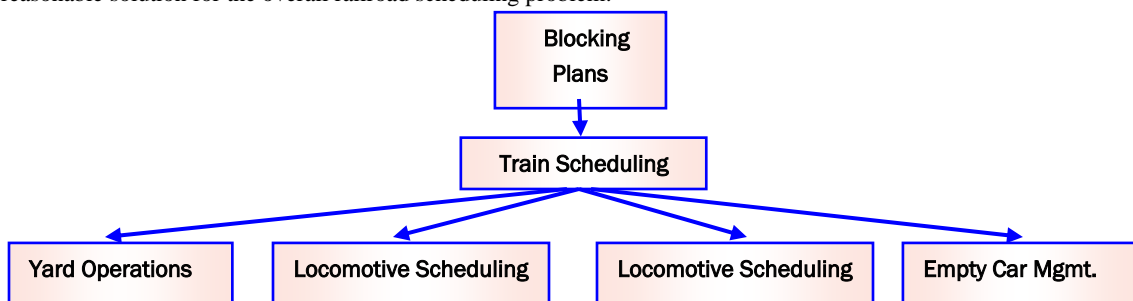
Yard Operations: Yards are the nerve centers of the railroad network. Yards receive blocks from inbound trains, reclassify them on classification tracks to create new blocks, and merge several new blocks to create new outbound trains. Decision problems faced at a yard are the order in which incoming trains should be reclassified at tracks to maximize the throughput of the yard.

Locomotive Scheduling: Locomotive scheduling consists of assigning different types of locomotives to trains so they receive the desired pulling power while satisfying a variety of constraints, including fleet size constraints on different locomotive types and fueling and maintenance constraints.

Crew Scheduling: Crew scheduling comprises of assigning crews to trains for each crew district, consistent with the union rules, so that the crew costs are minimum and, at the same time, train delays due to crew unavailability are minimized.

Empty Car Management: Every loaded movement on a rail network leads to a supply of empty cars at their destinations. The empty car management consists of dynamically distributing empty cars in the network to improve the railroad's ability to promptly answer requests for empty cars, while minimizing the costs associated with their movement.

These are some of the railroad industry's major scheduling problems that need to be addressed by the OR community. Ideally, we would like to develop a single integrated model that includes each of the above problems as a subproblem and whose solution provides an optimal solution of each of the problems. However, such a task is impossible using the state-of-the-art OR techniques and problem decomposition is necessary to solve these problems to a satisfactory extent. I provide below a possible decomposition of railroad problems whose sequential solution may provide a reasonable solution for the overall railroad scheduling problem.



In other words, railroads may first determine optimal blocking plans that then becomes an input for the train scheduling problem. Once the train schedule is known, yard operations can be optimized, locomotive and crew scheduling can be determined, and empty car management can be done. There is a clear interdependence among the five problems, but the above decomposition offers a practical approach to solve railroad scheduling problems. Additionally, these problems arise at two levels: *planning level* and *real-time scheduling level*. For example, at the planning level, there may be a scheduled train from station A to station B, but if there is an insufficient car load on a particular day, then the scheduled train can be canceled. (continued on next page)

NEW FRONTIERS IN RAILROAD OPERATIONS RESEARCH (CONT'D.)

At this time, most railroads do not have optimization-based approaches to solve any of these problems, either at the planning or the real-time scheduling level. Railroads rely on a manual decision-making process based on the experience and insight of the railroad personnel, which is a very time-intensive process and leaves room for inaccuracies and inefficiencies. I invite operations researchers to adopt a fresh perspective of these problems so that we may develop practical solutions approaches that railroads can put to use. These approaches should have the following features:

Implementability: They must satisfy various constraints needed in practice. Implementability of solutions is more important than their optimality.

Interactability: Railroads do not need a magical optimization method to solve a decision problem; rather, they require an optimization-based decision support system, an interactive system that assists a human in decision making.

Scalability: Railroad problems are very large-scale optimization problems. Therefore, the running time of a solution approach should not increase exponentially with the increase in problem size.

Incremental Optimization: The solution of an optimization problem can be vastly different from the solution currently achieved by railroads. Such a solution may require changing a railroad's operations substantially and so may be risky to implement. The solution approach should be able to use a railroad's current solution and change it incrementally so that changes are kept to a minimum and to those which produce the largest improvement in the objective function.

I believe that operations research techniques have now evolved to a degree at which railroad problems can be satisfactorily solved. Needless to say, this process will require a unique combination of modeling, algorithmic development, and implementation skills, as well as an active participation of railroad personnel. RASIG can play an important role in this task by connecting academicians with railroad personnel and disseminating exciting developments. I am optimistic that in the upcoming years, operations research techniques will find widespread use in railroad scheduling processes and increase railroads' profitability. Let us all work together toward this worthwhile endeavor.

Ravi Ahuja
University of Florida & Innovative Scheduling

RAILROAD TRIVIA

Q: What was the first railroad in the United States?

A: Granite Railway Company, Inc. in Massachusetts in 1826.

Q: How did railroad engines get the name "locomotives"?

A: When the steam engine was put on wheels and made to run on rails (1804 - 1825), it was called a "locomotive engine" - that is, a traveling engine - because it could move from place to place under its own power (locomotion). Later, it became simply a "locomotive" or an "engine," and both terms have been in common use since.

Q: How many freight railroads are there in the United States?

A: In 2002, there were 8 Class I freight railroads, 34 regional, and 529 local. All together, that makes 571 freight railroads in the United States.

Q: How many freight cars are there in service in the United States?

A: In 2001, there were 1,314,136 freight cars in service in the USA.

Q: What are the total miles operated (total active train track miles) for all freight railroads in North America?

A: 143,361 miles.

Q: What state had the most freight rail route-miles in operation in 2002?

A: Texas, with 10,473 miles, followed by Illinois (7,197), California (6,052), and Ohio (5,484).

Krishna C. Jha
Innovative Scheduling

RASIG SESSIONS AT INFORMS ANNUAL MEETING

RASIG has organized several interesting sessions at the forthcoming INFORMS National Meeting in Denver, Colorado, from October 24-27, 2004 (www.informs.org/Conf/Denver2004/). The titles and the authors of these talks are provided below. We hope that RASIG members will attend and benefit from these sessions. - **Jian Liu, Innovative Scheduling**

Session 1: **Yard Simulation and Optimization**, October 24 (Sunday), 10:00-11:30 am

Chair: Krishna Jha, Innovative Scheduling

- ✦ Guvenc Sahin, University of Florida, *Optimization Models for Yard Operations*
- ✦ Chip Craft, *Classification of Yard Simulation*
- ✦ Michael Gorman, Univ. of Dayton, *DEA of Railyard Efficiency*

Session 2: **RASIG Roundtable Discussion: Joint Service Design**,

October 24 (Sunday), 1:30 - 5:00 pm

Chair: Jian Liu, Innovative Scheduling

- ✦ Ravindra Ahuja, University of Florida, *Optimization Model for Interchange Gateway Analysis*
- ✦ Carl Van Dyke, Multimodal, *The Interline Service Design Problem: Definition, Objectives, Constraints, and Current Practice*
- ✦ Ron Griffith, BNSF Railway, *Designing the Joint Service Product*
- ✦ Natasha Zuraikat, CSX Transportation, *Class One Alliances as an Immediate Alternative to Merger*



Business Meeting, October 24 (Sunday), 5:15-6:15 pm

Session 3: **OR Applied to Railroads I**, October 25 (Monday), 8:00-9:30 am

Chair: Chip Craft

- ✦ Warren Powell, Princeton University, *A Rail Car Distribution Model with Multiple Information Streams*
- ✦ Dharma Acharya, CSX Transportation, *Utilizing Operations Research Tools at CSX*
- ✦ Jian Liu, Innovative Scheduling, *NeO: An Executive Decision Support System for Yard Closure Analysis*

Session 4: **OR Applied to Railroads II**, October 25 (Monday), 10:00-11:30 am

Chair: Michael Gorman, University of Dayton

- ✦ Michael Gorman, University of Dayton, *Maintenance Gang Scheduling*
- ✦ Krishna Jha, Innovative Scheduling, *A Decomposition Approach to Solve Train Schedule Design Problems*
- ✦ Chip Craft, *Railroad Line Capacity Simulation Modeling*

Session 5: **New Advances in Railroad OR**, October 25 (Monday), 1:00-2:30 pm

Chair: David Hunt, Cambridge Systematics

- ✦ Ravindra Ahuja, University of Florida, *New Advances in Solving Large-Scale Railroad Optimization Problems*
- ✦ Carl Van Dyke, Multimodal Applied Systems, *Current Directions in Model-Driven Freight Railway Service Design*

Session 6: **RASIG Student Paper Contest**, October 25 (Monday), 3:00-4:30 pm

QUICK QUOTE

"Almost anything is possible in a train..."

- Paul Theroux

RESULTS OF 2003 RASIG STUDENT PAPER COMPETITION

Following are the titles of the award-winning papers of the Student Paper Competition, which were presented at the 2003 INFORMS Annual Meeting held in Atlanta, GA.

First Place: *New Approaches for Solving the Block-to-Train Assignment Problem*, by Krishna C. Jha, University of Florida, Gainesville.

Second Place: *Bicriteria Train Scheduling for Intercity Passenger Railroad Planning*, by Xuesong Zhou and Ming Zhong, University of Maryland, College Park, MD.

Honorable Mentions: (i) *Solving Real-Life Railroad Blocking Problems*, by Jian Liu, University of Florida, Gainesville, FL; and (ii) *Timetable Buffer Magnitude and Allocation: An Analysis Using Simulation*, by Steven Harrod, University of Cincinnati, Cincinnati.

RASIG OFFICERS

Pooja Dewan (Chair)
BNSF Railway
Pooja.Dewan@bnsf.com

Ravindra K. Ahuja (Vice-Chair)
University of Florida &
Innovative Scheduling
ravi@InnovativeScheduling.com

Jian Liu (Secretary)
Innovative Scheduling
liujian@InnovativeScheduling.com

Clark Cheng (Treasurer)
Norfolk Southern Corporation
Clark.Cheng@nscorp.com

NEWSLETTER STAFF

Ravindra K. Ahuja (Editor)

Krishna C. Jha (Editorial Assistant)

Saumya Ahuja (Layout Designer)



This issue of the RASIG Newsletter is sponsored by:

INNOVATIVE SCHEDULING

Innovative Scheduling is engaged in developing optimization-based software products for very large-scale decision problems arising in railroads. We believe that there are significant opportunities for decision support systems utilizing cutting-edge optimization techniques that can provide significant cost savings to railroads.

Innovating Scheduling is now developing software for:

- **Railroad Blocking**
- **Train Schedule Design**
- **Yard Closure Analysis**
- **Yard Operating Plans**
- **Locomotive Scheduling**
- **Crew Scheduling**

We are a highly qualified team of professionals with strong operations research, computer science, and information systems development skills. To find out how Innovative Scheduling can develop decision support systems for your company, feel free to contact us.

Ravindra K. Ahuja
President & CEO
(352) 870-8401

www.InnovativeScheduling.com

Ravindra K. Ahuja
Innovative Scheduling
GTEC, 2153 Hawthorne Rd., Suite 128,
Gainesville, FL 32641

ADDRESS CORRECTION REQUESTED

PLACE
STAMP
HERE

TO: