The Newsletter of the RAILWAY APPLICATIONS SECTION

From the Editors' Desk:

TransfORmation: What does this mean for us?

The focus of this year's INFORMS Annual meeting is "TransfORmation." In the spirit of this theme, we decided to focus this year's editorial on how can we as members of RAS transform for the better. There can be infinite Transformations. We would like to focus on just two different levels of transformation. First, our own mental models of what OR practitioners are supposed to work and not work on? Second, look for opportunities where railroads have not traditionally focused. We will be using the platform of the RAS roundtable this year to explore non-traditional applications of OR/Analytics in Railroads by creating a panel of railroad OR practitioners, consultants, and software vendors that force us to think out of the box and give us some ideas from experience with other industries. So we look forward to a healthy discussion at the roundtable on this topic!

Getting back to what is the role of OR practitioners? All along in school when you thought OR, you thought models, MIPS, Linear and Non-linear models, prove theorems and publish journal papers. You thought you will come to the industry and continue to do the same work; the only difference would be that you would be solving industry relevant business problems. You came to the industry and realized that only a small portion of your work involved building models. You had to deal with volumes of data and bad data. "Garbage in, garbage out"; so all of a sudden, the most intense part of your project was data cleansing. When you are dealing with huge datasets, you had to learn to use databases, write efficient queries, custom code for manipulating data even before implementing models. When you came to the industry, you realize your development skills are equally important as your OR skills. You are spending too much time in learning data structures and writing computer programs. So what happened? Are OR practitioners not doing OR? Was our initial mental model of what OR practitioners remiss?

To answer these questions, we need to remind ourselves of what is OR? There have been several definitions since the genesis of OR during World War II to deal with operational issues. Quoting from the INFORMS website:

"*In a nutshell, operations research (O.R.) is the science of decision-making by applying advanced analytical methods to help make better decisions. It is the science of doing better by using scientific research methods, analytical modeling, statistics, and algorithms to enable rational and meaningful management decisions. It's powerful, using advanced tools and technologies to provide analytical power that no ordinary software or spreadsheet can deliver out of the box. And it's tailored to you, because an O.R. professional offers you the ability to define your specific challenge in ways that make the most of your data and uncover your most beneficial options.*"

The answer to our questions was in the definition of OR itself. OR is beyond math models. It is about the science of better – creating efficiency, improving productivity, and creating return on investment or ROI as companies call it. We remember a plenary talk at INFORMS Practice Meeting a few years ago by Snyder's then CEO who held a Ph.D. from the Industrial & Systems Engineering Department at Georgia Tech. He said that whenever he receives a proposal, he takes out his calculator to estimate the cost of the project, its estimated return, its ROI, and then decides whether to fund it or not. Most corporations use this criterion to decide which project to fund.

Companies do not care whether a given solution is optimal or not, they care whether it is implementable and how much value it will create for them. We can create a lot of value through data visualizations and data analytics. Giving access to good quality data in user-friendly interfaces to decision makers empowers them to take better decisions. Want proof? Look at how smart phones and tablets have changed your lives. They do not optimize but provide right data in the right format at the right time so that you can take the right decisions. Indeed, more and more companies are realizing that optimization should follow the following step-wise process:

Visibility and Data Analytics: Analyze data and present results in a way that users can make better decisions. For example, if an airline flight leg is consistently delayed and this information is presented to a planner with some associated dataset for planner to do root cause analysis, the planner can find reasons for delays and make changes to reduce or eliminate delays.

Visit RAS on the Web!   http://www.informs.org/Community/RAS/

Interactive followed by Full Optimization: OR has traditionally focused on clean-slate or big-bang solutions but such solutions are hard to implement and are done rather infrequently. Mostly, changes are small and incremental in nature because businesses typically do not undergo dramatic changes quickly. We need to give a framework for making small incremental changes to solutions, evaluating them, and putting these into production. Through small successes created by incremental changes, we generate acceptance for models and make a business case for larger big-bang changes.

Thus, optimization should begin with data analytics and small changes leading the way for bigger changes. We are not suggesting we put aside all that you learnt in your classes but merely suggesting that we need to use all the skills in our tool bag including data analytics as the means to help us understand the real problem. So what do we mean by that? Our data analytics toolset can easily help us identify the areas of greatest inefficiencies and prioritize our tasks. Our modeling background can help us decompose a large decision problem into a series of smaller problems so that the decision maker can solve each smaller problem better through data analytics and visualization. Further, our initial solution should be focused on solving the problem that the human mind is solving to validate our optimization model. If the answer does not fit the mental model of the user and if the answer is not intuitive to the user, we will not get user buy-in. The tools that do not get buy-in do not get used. If the focus is on providing value to the business, then data analytics and incremental changes are as important as full-blown optimization techniques. We have observed that successful practitioners naturally understand this paradigm. Their focus is on providing value to the bottom line, understanding all the tools in the box and knowing when is the best time for each one of the tools to be used.

Universities have a big role in creating the mental image of practitioners. We think universities are doing a better job creating practitioners as compared to a decade ago and we salute their efforts! Development skills as well as data analytics are becoming part of the core curriculum rather than electives. Internships are becoming part of the graduate program. We as practitioners need to do our share of helping the universities. We need to enable creation of forums where it is mutually beneficial for universities and industry to partner and students to get experience of working on real problems.

We look forward to a healthy discussion in the roundtable, and hope you will actively participate in promoting the use of Operations Research within railroads to move railroads to greater levels of productivity and improved profitability.

Until next time …

Pooja Dewan, *BNSF Railway***; pooja.dewan@bnsf.com**

Ravindra Ahuja, *Innovative Scheduling*; **ravi@InnovativeScheduling.com**

RAILROAD FACTS

- The world's highest railway is in Peru. The central railway climbs to 15, 694 feet in Galera Tunnel, 108 miles from Lima.

- The longest railway in the world is Trans-Siberian Railway of Trans-Siberian Railroad, built 1891-1916. It is 5,787 miles long and spans eight time zones.

- Indian Railways is the largest employer in the world with a staff of 1.6 million people.

- In 1761, the first iron rails laid at Bath, England.

- The world's first passenger railway was Mumbles Railway in 1804 from Rutland Street Station to the Pier at Mumbles.

Annual Report by RAS Officers

Chair: **Kamalesh Somani**, *CSX Transportation*; Kamalesh_Somani@csx.com

Vice Chair: **Homarjun Agrahari**, *BNSF Railway*; Homarjun.Agrahari@bnsf.com

Treasurer: **Juan Morales**, *BNSF Railway*; Juan.Morales@bnsf.com

Secretary: **Yudi Pranoto**, *Norfolk Southern*; Yudi.Pranoto@nscorp.com

This year has been a very busy year for RAS. We worked hard towards our goal of "How to create more awareness about Operations Research in railroads." Here are highlights of this year.

New Website and Logo

We have transitioned from a privately hosted/maintained website to a new website hosted on the IN-FORMS server (visit http://www.informs.org/Community/RAS/). Most of the material from the previous website has been moved to this new website. The new website benefits from INFORMS branding and ease of maintenance. Please take a few minutes to browse through the new website. We also would like to thank Innovative Scheduling for hosting and maintaining the RAS website for the past several years.

Also, RAS has a new logo. Thanks to Krishna Jha and Saumya Ahuja from Innovative Scheduling for the design. The logo is used on our website, LinkedIn group and other places where RAS is present in print or electronically.

LinkedIn and Email list

RAS has a LinkedIn group (visit http://www.linkedin.com/groups?gid=2399643) or simply search the *Rail Applications Section of INFORMS*). LinkedIn provides us a forum where people can post and discuss topics. We have 181 members and are growing. Join the group if you are not already a member. LinkedIn has apps for iPhone as well as Android, so it is easy to stay connected!

We also have a mailing list of all RAS members (past and present). The mailing list allows us to communicate with RAS members. You can post job opportunities or reach out to other members for a specific question or discussion item. This year we updated the RAS and LinkedIn members regularly on what's going on with RAS.

Joint Rail Conference (Session Chair: Kamalesh Somani, *CSX Transportation*)

Joint Rail Conference (JRC) is a major, multidisciplinary North American railroad conference that encompasses all aspects of rail transportation and engineering research. In our effort to connect and identify opportunities for collaboration with non-OR professionals in rail industry, RAS participated and sponsored JRC for the first time this year in Pueblo, Colorado.

RAS hosted 5 presentations and a plenary session at the JRC 2011. We had participation from BNSF Railway Company, CSX Transportation, Norfolk Southern, Union Pacific Railroad and the University of Illinois at Urbana-Champaign (UIUC). It was a great success.

We are participating and sponsoring JRC in 2012 as well. It will be held April 17-19, 2012 in Philadelphia, Pennsylvania. The conference theme is '*Technology to Advance the Future of Rail Transport'* and will cover freight and passenger rail, encompassing commuter, regional and intercity systems. Please contact Clark Cheng, Norfolk Southern (clark.cheng@nscorp.com) if you would like to be a part of JRC 2012.

Student Paper Contest (Chair: Juan Morales, *BNSF Railway*)

RAS sponsors an annual student research paper contest focused on rail applications to promote awareness of rail topics, encourage new rail research, and develop a pool of world class intellectual talent that is interested in rail applications. In the Student Paper Contest, contestants submit a paper of their previously chosen and independently generated research.

Read more about the *Student Paper Contest* in *Juan Morales's* article in this newsletter.

Problem Solving Competition (Chair: Homarjun Agrahari, *BNSF Railway*)

Starting last year, RAS began a new competition – Problem Solving Competition – to further promote awareness of and interest in intriguing rail problems. The problem solving competition is different from the student paper contest in that all contestants will work on the same problem defined by a group of rail professionals, rather than submit a paper of their previously chosen and independently generated research.
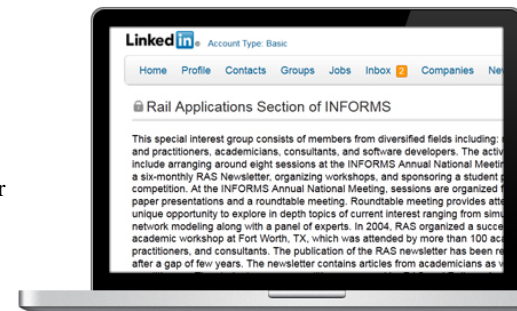
While the problem will be based on rail, it will be specified in a way that allows non-rail experts to apply talents from other disciplines and industries. RAS hopes that by doing this, more outside talent will be attracted to the rail problem solving domain.

The Problem Solving Competition created a buzz for railroad-related work in the areas of Operations Research and analytical problem solving. To keep the enthusiasm going, we had a RAS Rail Problem Solving Competition for 2011. The problem chosen for this year was *"Train Design Optimization"*.

Read more about the *Problem Solving Competition* in *Homarjun Agrahari's* article in this newsletter.

Sponsorship

We needed financial support to continue prizes at previous levels (total $5,000) for the problem solving competition and to revise them for student research competition (increased to total $2,500). We have been able to raise $7,500 with the generous support from our sponsors BNSF Railway Company, CSX Transportation, GUROBI, Norfolk Southern and Union Pacific Railroad.
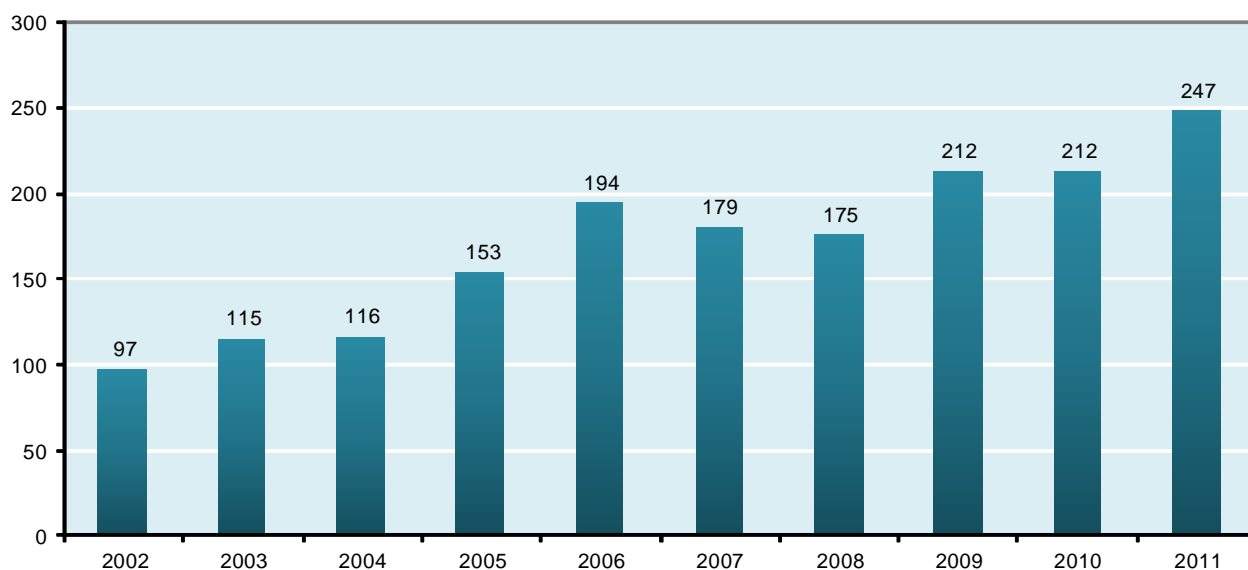
In addition, we will be hosting the RAS dinner on Sunday as we do every year. The dinner is sponsored in part by Innovative Scheduling and Oliver Wyman. Innovative Scheduling is also sponsoring this newsletter.

Membership

We have seen significant growth in RAS membership over the past several years. We currently have 247 members from 26 countries. This gives us the tremendous advantage of sharing knowledge and best practices from all around the world.

Year	Members
2002	97
2003	115
2004	116
2005	153
2006	194
2007	179
2008	175
2009	212
2010	212
2011	247

New ideas to be Discussed at Annual Meeting in Charlotte

Vice President - Public Relations: Change is the only constant in nature, and RAS must transform itself to meet the needs of its members in the changing environment. We all have witnessed a huge change in the ways in which organizations like ours can reach out to prospective members, communicate with current members, recruit new members, and connect, socialize and network with OR professionals around the world. This

change demands that RAS transforms itself in order to more effectively manage its public relations.

The current bylaws allow RAS to have four officer positions: Secretary, Treasurer, Vice-Chair and Chair. Given the increased workload to manage PR, we are proposing a new elected position - Vice President - Public Relations. This position will be responsible for maintaining our website, managing distribution list, taking care of RAS communications with the membership and helping RAS reach out to the OR community outside of RAS. This position will be discussed at the RAS business meeting in Charlotte. We propose that the position be filled by nomination in the first year, and filled by regular elections from next year. We invite your participation and look forward to this discussion in Charlotte.

Problem Repository: The idea of an open and publicly available RAS problem repository was presented at last year's RAS business meeting. The objective is to facilitate a platform where:

1. Companies may make problem descriptions, dataset(s) and solutions publicly available for anyone to research, develop and test solution approaches.

2. Researchers may showcase their results, engage in questions, answers and discussions and measure the performance of their solution approach against those of other researchers.

All information will be available on the RAS website. Neither RAS, nor the company may claim intellectual property rights on the outcome of the research. Companies should not think of this initiative as a way to access free research. This effort is targeted at increasing awareness about difficult problems for the OR community, so that railroad can benefit from increased research activity. Complete details of the repository, processes and first problem will be presented at the RAS meeting.

Friend of RAS Appreciation Award: RAS, like its parent organization INFORMS, is able to serve our profession through the contributions of volunteers. Although contributions from everyone are appreciated, some volunteers' contributions have far reaching impact. Their impact has given RAS a new direction and continues to inspire others to follow their footsteps. With this new "Friend of RAS Appreciation Award," we want to recognize such individuals.

We propose the following: The RAS executive committee will establish an award committee that will be chaired by the RAS president or a designated person. It may include current/past RAS officers and previous award winners. The committee will set up the nomination process and eligibility. This award will be given out during the annual INFORMS conference. The details of this award and various criteria about Nomination, Selection, Decision and Prize will be a discussion topic at the business meeting in this year's annual conference. The RAS executive committee seeks your active participation in helping to shape this award.

Annual Meeting (Cluster Chair: Jagadish Jampani, *CSX Transportation*)

We have 13 sessions lined up with diverse topics such as Safety, Capacity, Revenue Management, First Mile Last Mile, Disruption Management, Resource Planning, Time-tabling, Passenger and High Speed Rail. This year's round table aligns with the conference theme of TransfORmation. A panel of experts from academia, practitioners (railroads and consultants) and analytics software vendors will discuss what transformation means to the railroad industry in the near- and long-term futures.

Finally, we would like to encourage RAS members to become more involved in RAS activities. There are many ways to help: volunteering for committee members for Problem Solving Competition and Student Paper Contest, chairing sessions, website maintenance, newsletter editing etc. We welcome and need your support and ideas so that RAS can continue to grow and improve.

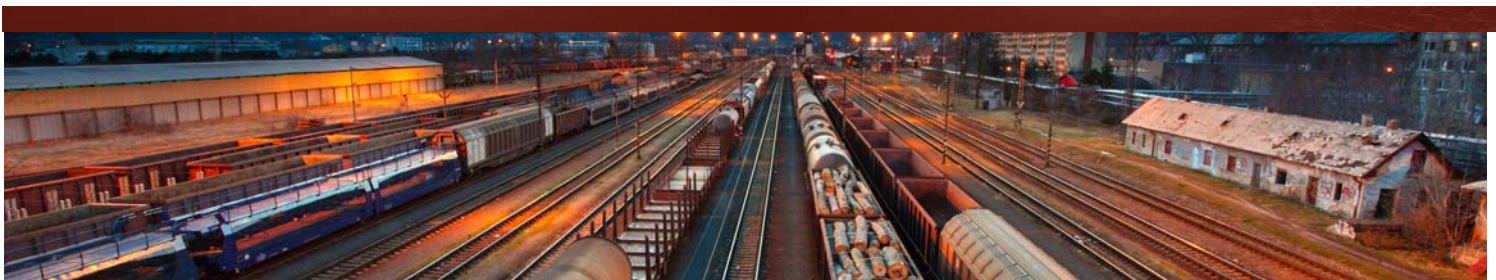Thanks for a great year, and see you in Charlotte!

> ## Quick Quotes
>
> "Children and dogs are as necessary to the welfare of the country as Wall Street and the railroads."
>
> - Harry S. Truman
>
> "A railroad is like a lie you have to keep building to make it stand"
>
> -Mark Twain

RAS Student Paper Awards 2011

Juan C. Morales, *BNSF Railway*; *Juan.Morales@bnsf.com*

Rail Applications Section (RAS), a section of the Institute for Operations Research and Management Science (INFORMS), sponsored a student research paper contest on analytics and fact-base decision making in railway applications. This year we increased the contest's total cash award from $750 to $2,500:

Cash Awards: $1,250 for First Place, $750 for Second Place, $500 for Third Place

To qualify, the paper must have been written by a student or students enrolled in an academic institution during the 2010-2011 academic year. The paper must advance the application or theory of OR/MS for improvement of freight or passenger railway transportation, and it must represent original research that has not been published elsewhere by the time it is submitted. More details on eligibility criteria, the application procedure, and deadlines for submission are available at RAS's website: *http://www.informs.org/Community/RAS/Student-Paper-Award*.

Ten students from around the world with a wide variety of topics registered for the competition. The quality of the submitted papers was in general quite outstanding. Aside from the three finalists, the Reviewing Panel decided to recognize one of the papers with an Honorable Mention. Authors of the First, Second and Third Place will present their papers at the Student Paper Award Session of the INFORMS Annual Meeting in Charlotte, NC. We encourage all RAS members to attend this session and motivate our young researchers to continue to make great strides in building new models for railroad planning and scheduling problems. We provide below the abstracts of these papers. Extended abstracts of the awarded papers are available in the RAS website.

First Prize:

Time and Capacity Constrained Routing Problem in Railroad Planning. by Yazhe Feng, Virginia Tech;

Coauthors: Kimberly P. Ellis, Krishna C. Jha and Yasemin Merzifonluoglu

Abstract: In the railroad industry, shipments are often grouped in blocks to minimize the impact of reclassification at train yards. This paper considers the time and capacity constrained routing (TCCR) problem, which assigns shipments to blocks and train-runs to minimize overall transportation costs, while satisfying the train capacity and shipment due dates. Two optimization models are developed based on a customized network, and two heuristic algorithms are proposed to solve the complex problem efficiently.

Second Prize:

Strategic Gang Scheduling for Railroad Maintenance. by Conrado Borraz-Sánchez, Northwestern University;

Coauthors: Dengfeng Yang and Diego Klabjan

Abstract: We address the railway track maintenance scheduling problem. The problem stems from the significant percentage of the annual budget invested by the railway industry for maintaining its railway tracks. The process requires consideration of human resource allocations (gangs), as well as effective logistics for equipment movement and routing around the rail network under time window constraints. We propose an efficient solution approach to minimize total costs incurred by the maintenance projects or jobs within a given planning horizon. This is accomplished by designing a job-time network model to capture feasible schedules under the constraints of job precedence and developing a mathematical programming heuristic to solve the underlying model. The key ingredient is an iterative process that extracts and then re-inserts jobs based on an integer programming model. Computational experiments show the capability of the proposed heuristic to schedule more than 1,000 jobs and more than 30 gangs.

Third Prize:

Periodical Rail Inspection Scheduling in Railroad Networks. by Fan Peng, University of Illinois at Urbana-Champaign;

Coauthors: Yanfeng Ouyang and Kamalesh Somani

Abstract: Railroads use a set of rail inspection teams to periodically examine the status of rail tracks across the railroad network. The rail inspection scheduling problem (RISP) is a large-scale routing and scheduling problem where thousands of inspection tasks are to be scheduled subject to many complex side constraints. This paper proposes a vehicle routing problem formulation for RISP and a customized heuristic solution algorithm. Real-world case studies show that the proposed approach significantly outperforms the state-of-the-art manual solution approach.

Honorable Mention:

Service Oriented Line Planning and Timetabling for Passenger Trains by Mor Kaspi, Tel Aviv University, Israel;

Coauthors: Tal Raviv

Abstract: This paper aims to solve the robust train dispatching problem under a major disruption with dynamic and stochastic information. Based on a stochastic programming with recourse framework, the proposed model periodically optimizes schedules for a relatively long rolling horizon, while selecting and disseminating a robust meet-pass plan for every roll period. A multi-layer branching solution procedure is developed to systematically generate and select meet-pass plans under different stochastic scenarios. Illustrative examples and numerical experiments are used to demonstrate the importance of robust disruption handling under a dynamic and stochastic environment.

RAS Problem Solving Competition 2011

Homarjun Agrahari, *BNSF Railway; Homarjun.Agrahari@bnsf.com*

Debut and Success

2010 was the debut year of the problem solving competition. The objective of the competition is to introduce Operations Research practitioners to challenging and interesting railroad problems. It is open to anyone new to railroading, Operations Research, or both. Thanks to generous support from our sponsors, we were able to offer a total prize money of $5,000 (first prize is $2,500, second prize $1,500, and third prize $1,000). In its debut year, the competition turned out to be very well received as we had 89 team registrations from universities, companies, and consultants from 12 countries around the world. A total of 31 teams submitted their entries with high quality work. The three winning teams were given prizes and one team received Honorable Mention to recognize its high quality work. The awards were given in Austin during RAS' business meeting. The winning teams were interviewed where they talked about the satisfaction derived while solving this problem. Some of the teams were so interested that they requested access to larger datasets to test their solution approaches. Some of the teams have plans to publish their work in international journals. A team has informed us that it intends to include the competition problem in a book chapter as well. It may not be an exaggeration to say that the competition has been successful in meeting its objective of creating awareness about operations research problems in railroad.

What Changed in 2011?

The key to the success of the competition was an enthusiastic organizing team [1], generous prize money (thanks to the sponsors [1]) and flawless execution from conceptualization to delivery (i.e., a well-written problem description document, a well-designed process of answering clarification questions, a carefully crafted example problem and data for competition and, last but not least, a systematic, rigorous and fair judging process.) Read more about it in our article in last year's newsletter [2]. In the second year of the competition, we have kept what is working and made changes to make the competition even better. The majority of the 2010 organizing team comprises the team for 2011, all sponsors have pledged the same or more amount of money in 2011. We added GUROBI as a new sponsor this year. We have kept the prize at the same level. We have also kept the high quality of problem description document and example. The main differences in 2011 are: (1) this year's problems are more difficult – they cannot be solved by simply submitting the MIP to commercial solver; and (2) we have provided two datasets, both small and large in order to differentiate solution approaches based on scalability.

The 2011 Competition Problem

This year the participants were asked to solve the train design optimization problem - a fundamental aspect of efficient railroad operations. In railroad operations, different freight railcars are aggregated based on different attributes in order to create blocks and, subsequently, these blocks are assigned to trains. A good train design will dictate route and schedule trains that carry blocks from their origin to destination while satisfying several capacity and operational constraints. Given the large scale of railroad operations, even a small percentage improvement in efficiency translates into substantial cost savings. Full description of the competition problem is available at RAS website: http://www.informs.org/Community/RAS/).

The Response

Again, the competition problem was well-received internationally. We had more than 35 registrations from teams around the world. Finally, 12 teams submitted their solutions and reports from the US, China, Taiwan, Singapore, Switzerland, Italy, Colombia and Mexico. Since the problem introduced teams to railroad specific concepts such as blocks, car trip etc., we observed the increased volume of questions. Thanks to our problem owner Jagadish Jampani (CSX Transportation) who responded to those questions in a timely manner. Teams have explored innovative decomposition and heuristics-based solution approaches to solve the problem.

Finalists

In general, the competition saw a very high quality of work this year - both in terms of the quality of reports and the maturity of solution approaches. The judging panel went through a rigorous process to objectively rank and select the following three teams as finalists (Listed in alphabetical order).

- **Koppa** - Leonardo Lozano, Jaime E. Gonzalez And Andres L. Medaglia Universidad de Los Andes, Bogota, Colombia

- **NCKU** - I-Lin Wang, Hung-Yi Lee, and Yu-Ting Liang, National Cheng Kung University, Taiwan

- **OR@UNIMI** - Fabio Colombo, Roberto Cordone, Marco Trubian, Universita degli Studi di Milano, Italia

These three finalists will compete at the RAS session on Sunday Nov 13, 11:00 - 12:30 at the Convention Center, Room 209A. The winners will be announced the same evening at the RAS business meeting at 6:15 PM. The three finalist team reports will be made available on our website (www.informs.org/Community/RAS/) soon after. We invite you to come and support these bright minds.

Honorable Mention

The judging panel also decided to recognize the high quality of work by the team RAIL-OPT (members Jian Gang Jin from National University of Singapore and Jun Zhao from Southwest Jiaotong University, Chengdu , China).

Recognition

We thank the sponsors, the problem owner Jagadish Jampani and the judging panel chair Juan Morales. We also thank the organizing committee members Carl VanDyke, Kamalesh Somani, Eric Wikum, Yanfeng Ouyang, Shankara Kuppa, and Yudi Pranoto for their guidance and suggestions.

RAS and How You Can Help

We are encouraged by the wide support received from the OR community around the world. We thank you for contributing to the success of our first competition. If you are a professor, we invite you to use this problem as a course project and challenge your students to match or beat the winning entry. If you are a consultant seeking to engage railroads, we invite you to showcase your organization by competing next year. If you are a railroad leader, we invite you to consider competition participants as potential employees or research and consulting collaborators. If you are a practitioner and have a problem for next year's competition, please contact us. If you have suggestions to improve the RAS Competition, please send them to Homarjun.Agrahari@BNSF.com.

RAS is what we members make it. There are several ways to help with next year's RAS competition: sponsor the competition to show your support and spread your brand, offer to help organize the competition; compete to get recognized, and volunteer to be part of the organizing committee. As RAS members, we should make it a point to attend all of the RAS sessions and contribute. See you soon in Charlotte!

[1] http://www.informs.org/Community/RAS/Problem-Solving-Competition/2010-RAS-Competition

[2] http://www.informs.org/content/download/188995/1888605/file/RAS-2010-Newsletter.pdf

RAS Sessions 2011

SA16 - Sunday Nov 13

8:00 – 9:30

RAS Student Paper Research Contest, Room 209A-CC
Chair: Juan Morales, BNSF Railway

1. Time and Capacity Constrained Routing Problem in Railroad Planning (Yazhe Feng)
2. Strategic Gang Scheduling for Railroad Maintenance (Conrado Borraz-Sánchez)
3. Periodical Rail Inspection Scheduling in Railroad Networks (Fan Peng)

11:00 – 12:30

RAS Problem Solving Competition, Room 209A-CC
Chair: Homarjun Agrahari, BNSF Railway

1. **A Network-Oriented Formulation and Decomposition Approach to Solve the 2011 RAS Problem**

   Team: Koppa - Leonardo Lozano, Jaime E. González, Advisor: Andrés L. Medaglia

   Departamento de Ingeniera Industrial, Universidad de Los Andes, Bogota, Colombia
2. **Train Design Optimization**

   Team: NCKU – I-Lin Wang, Hung-Yi Lee, and Yu-Ting Liang

   Department of Industrial & Information Management, National Cheng Kung University, Taiwan
3. **A Column-Row Generation Heuristic for the Train Design Optimization Problem**

   Team: OR@UNIMI - Fabio Colombo, Roberto Cordone, Marco Trubian

   Dipartimento di Scienze dell'Informazione (DSI), Universit`a degli Studi di Milano, Milano MI, Italia

13:30 – 15:00

Panel Discussion I: Analytics Applications in Railroads I, Room 209A-CC
Chair: Pooja Dewan, BNSF Railway

Panelists: Dharma Acharya, CSX Transportation; **Ravindra K. Ahuja,** Innovative Scheduling; **Jeff Day,** SAS Institute; **Michael Gorman,** University of Dayton; **David Hunt,** Oliver Wyman; **Erick Wikum,** IBM.

This year's round table goes well with the conference theme of TransfORmation. As you know our profession is trying to move itself to Analytics, in the hope of becoming more appealing to a general audience, especially industry. We have put together a panel of experts from academia, practitioners (railroads and consultants) and analytics software vendors. There will be two sessions in which we expect to hear their opinions on what this transformation means to the railroad industry in the near- and long-term futures.

16:30 – 18:00

Panel Discussion Cotinued: Analytics Applications in Railroads II, Room 217BC-CC
Chair: Pooja Dewan, BNSF Railway

Panelists: Dharma Acharya, CSX Transportation; **Ravindra K. Ahuja,** Innovative Scheduling; **Jeff Day,** SAS Institute; **Michael Gorman,** University of Dayton; **David Hunt,** Oliver Wyman; **Erick Wikum,** IBM.

18:00 – 19:00

RAS Business Meeting, Room 217 BC-CC

19:30

RAS Dinner sponsored by Oliver Wyman and Innovative Scheduling
Please see details on the last page of the Newsletter.

MA32 - Monday Nov 14

8:00 – 9:30

Railway Safety and Capacity Research, Room 217BC-CC
Chair: Rapik Saat, University of Illinois at Urbana-Champaign

1. Integrated Railroad Hazardous Materials Transportation Safety Risk Management Framework (Rapik Saat)
2. A Multivariate Analysis of Railroad Toxic-Inhalation-Hazard (TIH) Transportation Release Rate (Xiang Liu)
3. Effects of Highway-Rail Grade Crossings on Hazardous Materials Release Rates (Samantha Chadwick)
4. Measuring the Capacity Impact of Higher Speed Passenger Trains (Samuel Sogin)

11:00 – 12:30

Recent Advances in Transportation, Room 217BC-CC
Chair: Ravindra Ahuja, President, Innovative Scheduling

1. A Hump Yard Planning System and Its Application for Yard Capacity Expansion Studies (Krishna Jha)
2. Real-time Inter-modal Strategies for Airline Schedule Perturbation Recovery & Congestion Mitigation (Yu Zhang)
3. Solving Linehaul Planning Problems for Less-Than-Truckload Carriers (Ravindra Ahuja)

13:30 – 15:00

Modeling Opportunities in Improving Pickup/Delivery Freight Operation, Room 217BC-CC
Chris Dharma Acharya, CSX Transportation

1. Review of Delivery/Pickup Service Modeling Practices (Dharma Acharya)
2. Journey to a Customer-Focused Culture (Jan Hobbs)
3. Improving Local Service at BNSF Railway (John Orrison)
4. Small Yards: Increased Network Flexibility at Low Incremental Cost (David Lehlbach)

16:30 – 18:00

Revenue Management with Flexible Capacity, Room 217BC-CC
Aihong Wen, CSX Transportation

1. An Application of Revenue Management at Con-way Freight (Charlie Rosa)
2. Yield Management – The Next Advance in Railroad Profitability (Jason Kuehn)
3. Revenue Management Approaches for Intermodal Freight (Bruce Patty)
4. Hybrid Forecast and Leg Optimization in Passenger Rail System (Victoria Huynh)

INFORMS 2011 ANNUAL MEETING
CHAROLETTE, NORTH CAROLINA

WE CAN'T WAIT TO SEE YOU!

TA32 - Tuesday Nov 15

8:00 – 9:30

Railroad Disruption Management, Room 217BC-CC
Chair: Clark Cheng, Norfolk Southern Corporation

1. Railroad Disruption Management and Opportunities for Modeling (Cary Helton)
2. Simulation of Disruptions in a Class I Railroad (Yudi Pranoto)
3. Criticality Evaluation of Railway Infrastructure based on Freight Flow Network Optimization (Mingzhou Jin)
4. Overview of Methodologies to Estimate the Economic Impacts of Disruptions to Freight Movements (Michael Meyer)

11:00 – 12:30

Advances in OR/MS for Passenger Railways, Room 217B-CC
Chair: David Hunt, Oliver Wyman

1. An Exploratory Study of a Revenue Management System (RMS) for a Railway in South East Asia (Goutam Dutta)
2. Software Tools to Optimize Crew Schedules for The New Hours of Service Rules (John Dezio)
3. Capacity Planning for Shared Use Corridors (Chip Kraft)
4. An Equipment Optimization Model for SEPTA (Marc Meketon)

13:30 – 15:00

Resource Planning, Room 217B-CC
Chair: April Kuo, BNSF Railway

1. Locomotive Assignment with Train Delay Options (Sebastian Souyris)
2. General Model of Railway Transportation Capacity (Hans Boysen)
3. Assigning Train Crews in Double-ended Districts (Xiaoyan Si)
4. A Time-Space Network Flow Model for Coal/Bulk Reservations Optimization (Ilksen Icyuz)

16:30 – 18:00

Transportation System Timetabling and Scheduling , Room 217B-CC
Chair: Xuesong Zhou, University of Utah

1. Generating and Optimizing Cyclic Timetables using Relational Algebra (Shiwei He)
2. Reduce Number of Constraints in Train Scheduling Problem: A Hypergraph-based Formulation (Xuesong Zhou)
3. A Parallel Heuristic for Fast Train Dispatching During Railway Traffic Disturbance Early Results (Muhammad Zeeshan Iqbal)
4. Concepts from Public Transit Service Planning (Mark Hickman)

WB32 - Wednesday Nov 16

11:00 – 12:30

High-Speed Rail: International Experience and Research Needs in US , Room 217BC-CC
Chair: Xuesong Zhou, University of Utah

1. Analyzing the Influence of Train Operation Plan on Passenger Demands of High Speed Railway (Shiwei He)
2. High Speed Rail Requirements in North America (Steven Harrod)
3. High-Speed Railway in Korea: Past, Present and Future (Jun Oh)
4. An Integrated Optimization Model and Algorithm for Rail Train Operating Plan and Locomotive (Baohua Wang)

Big Data and Railroad Analytics

David Hunt and Jason Kuehn, *Oliver Wyman*; David.Hunt@oliverwyman.com and Jason.Kuehn@oliverwyman.com
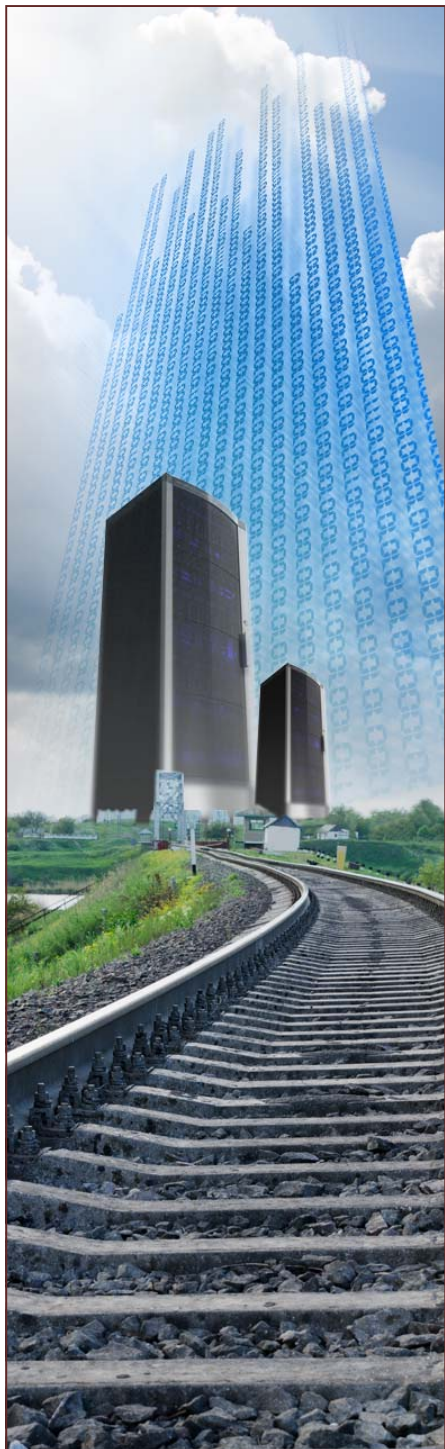
The new movie "Moneyball," starring Brad Pitt, tells the story of how a low-budget baseball team was able to effectively compete with the wealthiest teams through better analytics. By focusing on metrics that lead to victories, the Oakland Athletics avoided high-priced players and signed undervalued players whose statistics translated into more wins.

Railroads may well rival baseball in terms of the amount of data collected and the number of statistics published. The earliest railroads collected financial and operating data to facilitate improvements. As easily as you can learn that outfielder Hugh Duffy had a .440 batting average for the Boston Beaneaters in 1894, you can also discover that there were 9,021 miles of track in the US in 1850, or that the Pacific Railroad carried an estimated value of $50 million in freight over the Great Plains in 1880.

With the widespread use of computers in the latter part of the 20th century, railroad analytics rapidly expanded from producing tables of facts to performing in-depth analysis that helped drive decisions. It also led to exponential growth in the amount of data that could be collected and stored. It was now possible to analyze millions of waybill records to build a better operating plan, or plow through mountains of financial data to improve the bottom line. National data sources included reliable time-series economic data from the Surface Transportation Board/Interstate Commerce Commission, accident and incident data from the Federal Railroad Administration, and numerous statistics from the Association of American Railroads, including the "Green Book" which became the bible of railroad statistics.

Despite this long history of railroad analytics, we are really just on the precipice of what can be done. Today, railroads collect enormous quantities of data through GPS, AEI readers, electronic data interchange, video inspections, handheld field tablets, and many other sources. The data are growing not only in quantity, but also in quality as they are more frequent and more precise. The problem is that the tools to extract information from these data are not keeping pace with the data explosion. We are quickly exceeding the limits of spreadsheet analysis.

An example of a tool specifically designed to handle massive railroad databases is the Traffic Flow Analyzer (TFA); built for CSX by Oliver Wyman. The TFA archives three years of car and train movement records in a custom designed data warehouse. The TFA provides data extraction and mapping tools that can be used to generate traffic density maps, geographic pie maps of yard activity, and detailed reports. What is really unique about the TFA is that it does not model rail routes, but it stores the actual route taken by each railcar and each train on every trip. This provides tremendous value for rigorous engineering studies of loads on bridges and line segments, precise financial calculations involving ton-mile and car-mile statistics, federal compliance when reporting exact hazardous material routings, and many other uses throughout the company.

Analyzing big data is not just about databases growing bigger, it can also be about merging databases to extract even more useful intelligence. Imagine detailed network mappings of track layouts merged with inspection data on rail, tie, and ballast conditions also merged with traffic density and tonnage data. This data cocktail would be very powerful in defining capital budgets and prioritizing work programs. Another example would be the merging of financial and operational data to allow managing revenues (as opposed to trains) through network bottlenecks. By managing revenues, it becomes easier to identify the hurdle points that trigger capital investments for capacity expansion, or to build an operating plan that considers revenue maximization.

Tomorrow, the quantity and the quality of railroad data will be even greater than today, and the demand for timely information from these data will also increase. Just like in "Moneyball," the railroads that are best able to use analytics to improve decision making will be the ones that end up victorious. It is up to the OR community to deliver the right tool sets to make this possible.

Railroad Analytics: Where are We?

Michael F. Gorman, *University of Dayton*; Michael.Gorman@udayton.edu

"Analytics" is quite the buzz. It has been touted as a key competitive advantage of analytically advanced companies and as a new wave in business, enabled by advanced analytical techniques, and volumes of accurate and timely data. As many INFORMS members have commented – "Analytics is what we have always been doing!" – I couldn't agree more. Analytics is clearly in the INFORMS sweet spot; Analytics might be viewed as a rebranding (or perhaps an extension) of OR/MS. It is what INFORMS has been promoting as an opportunity for business improvement for a long time, as can be observed in its "The Science of Better" campaign. As RAS members, we might ask, how have the railroads been affected by the analytics "movement", and how might it affect them going forward? To begin to address this question, I conducted a recent survey of major U.S. railroad OR leaders to assess what they see as recent, current and future trends.

How is OR doing in the rail industry?

It is worth observing that railroad OR groups have been generally growing over the last decade. Much of the growth has been in the "intern" area, where railroads seem to be leveraging young talent. Some railroads report the on-going and growing "budget" of IT resources to support large-scale production decision support projects as well. Of course, we can't say that the growth is due to "analytics", but it is welcome news nonetheless.

Organizationally, where is the OR group in the railroad?

OR groups have landed in a number of areas. BNSF for example, has had OR in Finance, IT, and now in Service Design and Capacity Planning. UP's group is in IT, CSX's group is in Service Design, and NS's group is in Process Engineering. In all cases, the vast majority, if not all major OR activity, is housed within the OR group; little OR modeling goes on in other parts of the organization.

What do OR resources do?

As we might expect, OR resources do more than "OR"; OR modeling can't operate in a vacuum. OR Resources spend only between 25% and 50% of their time doing model development, with other tasks in the analytics process such as data development, user meetings and results analysis and interpretation.

What tools are OR resources most commonly using?

Optimization remains the bedrock tool of OR groups. Traditional discrete event simulation has had some reduction in use in many railroads, being replaced by rules-based artificial intelligence, customer decision analysis simulation and car routing simulations/network visualizations. Statistical tools are used by these groups, but in general only for data development and management to support modeling efforts.

In what areas of the railroads are OR tools used most?

The traditional areas of focus continue to dominate. As no surprise, equipment, locomotive, crew and service design are the areas that consume most OR resources.

Any new areas for analytics in the railroads?

Coal and unit trains, yard and terminal modeling (particularly as it relates to design and expansion). More integrated tools are on the horizon, combining the major train planning and asset planning tools into a single hierarchical view of rail operations and asset management.

Are OR resources expanding their "bag of tricks"?

Not really. Although extensive "descriptive" and "predictive" analytics takes place in the railroads, it is largely outside of the OR group activities. For example, railroads have invested in business intelligence tools and dashboards, they continue to leverage forecasts for planning, and of course, have many, many resources dedicated to historical reporting. However, for the most part, OR groups have not been active in these areas of analytics. (contd..)

Two drunks were walking down a New York City street when one fell down the subway steps. When he got back up top he told his drinking partner, "...boy you got to see that guy's train set in the basement!"

What is the outlook for OR and analytics?

OR groups are benefiting from the increased awareness and use of analytics in railroads. Analytics has caught on at the C-level, with big proponents for data-based decision making at high levels of the organization (e.g., COO, CIO, etc.). OR is increasingly being included in long-range, visionary rail planning exercises. OR groups are looking for qualified new analytical hires, and are planning for increased IT resources to enable production level OR tools.

What are the organizational challenges and enablers for OR and Analytics?

OR leaders in railroads have identified a great deal of momentum for OR and data-based decision making techniques. OR groups are focused on delivering immediate value and high ROI, and build credibility to continue to build that momentum. The focus is on building models that match the decision making process and horizon, and including users in the evaluation and evolution of OR models. However, longer term OR projects that are game changers continue to be an important component in the OR groups' role as "thought leaders" in their organizations. One OR leader noted that as an industry, a major opportunity and challenge for OR groups is to be able to come together and leverage and share data, tools, and philosophies that help the industry as a whole provide more efficient and effective service.

Coming up….

At the RAS Roundtable in Charlotte, we will delve into this subject more deeply – for railroad OR groups, is it more of the same, with a higher level of attention, or is there something fundamentally different going on in the Analytics movement? I look forward to seeing you there.

A Simulation Model for Planning Hump Yard Capacity and Service

Jeremiah Dirnberger, *CSX Transportation;* Jeremiah_Dirnberger@csx.com

Krishna Jha, *Innovative Scheduling;* krishna@InnovativeScheduling.com

Yards serve many vital roles in the rail transportation system. For shipments moving in a carload (merchandise) network, local serving yards gather and distribute railcars for customers. A local train then takes the railcars to a classification yard whose primary function is to receive inbound trains and sort (classify) the cars into outgoing trains for various destinations. A shipment in the carload network will move through a series of classification yards on its journey from origin to destination. There are two kinds of classification yards: flat and hump yards. In a flat yard, locomotive power is used to switch (or sort) cars into classification tracks. In a hump yard, gravity is used to move cars during the sorting process. Cars are pushed over the top of the hump and released to roll down at a controlled speed onto the proper track corresponding to its destination. This article presents a case study of a simulation system for hump yards at CSX Transportation, one of the nation's leading transportation companies.

Yards and yard resources (crews, different types of tracks, locomotive, switches, etc.) play a crucial role in minimizing operating cost and travel time from origin to destination for a railcar. On average, a typical car spends 60% - 65% of its trip cycle in a yard. Consequently, improving the efficiency of yard operations will contribute to achieving the goals of improved service reliability and increased profitability.

In the aftermath of the 2008 economic crisis, traffic levels on all North American railroads fell significantly. In order to cope with this loss of revenue, the railroads, including CSX, became more efficient by adopting a series of technological, productivity and operational improvements. The result for CSX was a reduction of the operating ratio from 74.9% in 2009 to 71.1% in 2010. CSX has now set a goal of reaching a 65% operating ratio no later than 2015. While the company is continuing to implement efficiency and pricing improvements, growing the coal, intermodal and carload business is the cornerstone of the "Grow to 65" initiative.

The Network Planning group at CSX, under the direction of Evan Bell, has been tasked with using simulation models to provide scientific analysis for many groups within Operations. This includes analysis of the impact to capacity and service that proposed improvements have at both the line-of-road and terminal levels. Because of the well-documented link between service reliability and terminal performance (Dirnberger & Barkan 2007, Martland et al 1992), the group needed a more detailed hump yard simulation model. To fill that need, CSX
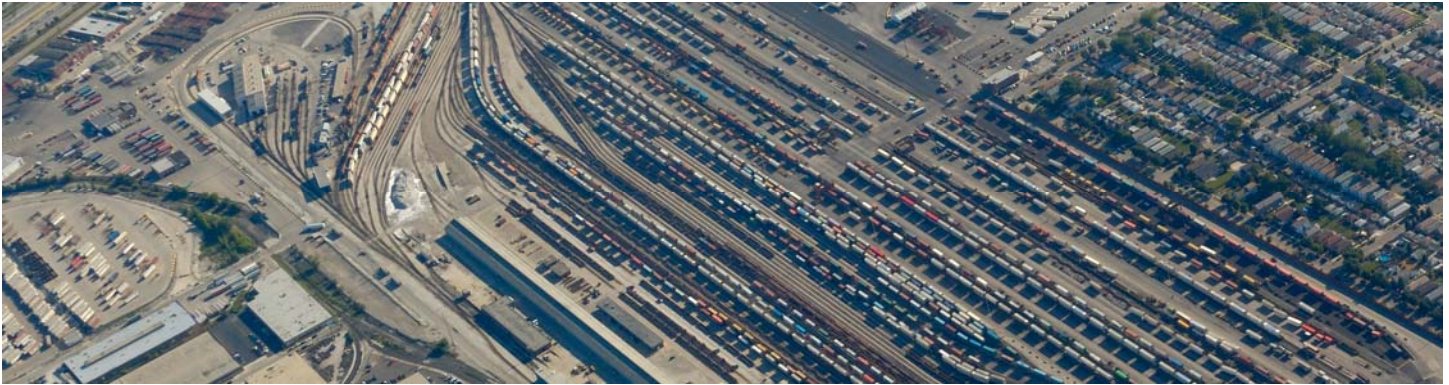
partnered with Innovative Scheduling to develop a prototype web-based simulation system of its Hamlet, NC terminal, one of twelve hump yards at CSX (Figure 1). Hamlet Yard was chosen as the pilot for this project because of its geographical importance. Hamlet anchors a large portion of the network and alternatives for traffic connecting through it are limited. Also, from a modeling standpoint, it is "simpler" to model because it is separated from the mainline, has minimal local industries and supports very few non-merchandise trains. This would enable the next "more complex" yard modeled to be built on a solid foundation.

A valid model, which would be accepted at all levels of the company, could not be built without direct involvement of the front-line managers who operate the yard. In order to understand the complex interactions in a hump yard, the CSX and Innovative Scheduling team spent several weeks at Hamlet Yard prior to modeling the yard. Time was spent directly observing the processes and conducting question and answer sessions with yardmasters, trainmasters and the superintendent. The result of these efforts was 28 process maps that were used to code the decision modules for the simulation model. An iterative process led to the right balance of details and complexity to be captured in the model. Users of the model have 73 different operational parameters (e.g. time to secure a train on a clear track, percentage of mis-routed cars to be switched, etc.) that can be changed to simulate different scenarios. The values for these parameters were gathered from existing CSX data systems when possible; however, many could only be gathered through time-study observation. Also included in the system are 12 cost parameters that enable financial performance to be generated simultaneously with the operational metrics.

This is a web-based simulation system designed and developed considering the ease of inputting data (yard layout, operational data, parameters, resources by shift), realistic animation, and various output reports. For example, a user can easily modify the yard layout by adding or removing tracks and analyze the impact all at one place. A robust simulation model was adopted to ensure the portability of the model from one yard to another. The routing engine facilitating movements of locomotives and cars is independent of specific yard layout. Output reports are designed to provide easy visibility to core performance indicators as well as detailed performance reports by car, train, or specific resource. A key requirement was to validate system output to above 95% of actual for major performance indicators. Once the model was validated to within 5% of actual performance for two periods of historical data, CSX began using the model to understand the relationship between service and throughput at future volume levels with a variety of operational, technological and infrastructure changes. As a completely new tool to CSX, Network Planning is working with the Terminal Improvement Team, Service Design, Front-line Managers, Finance and others to integrate the model into various planning processes that involve hump yards. While this integration is still under development, the Hamlet model has already added value by providing guidance about potential service impacts of proposed changes during the 2012 Capital Planning process.

The authors will be presenting on the development and use of the simulation model during the 2012 INFORMS Annual Meeting in Charlotte, NC. The presentation is scheduled for Monday, November 14, from 11:00am to 12:30pm.

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RAS Dinner at INFORMS

We would like to invite all RAS members for a dinner on Sunday (November 13) at the INFORMS Meeting. Please show your commitment to RAS by joining us at the dinner. This dinner will be free for all RAS members and spouses are welcome too. The dinner will take place at 7:30 PM at the **McCormicks and Schmicks (Steak and Seafood)** located at 200 South Tryon Street #130, Charlotte, NC 28202; Telephone: (704) 377-0201. The restaurant is within walking distance of the Convention Center and hotels. The dinner is sponsored by Innovative Scheduling and Oliver Wyman. Please RSVP by November 10 (Thursday) 5 PM Eastern time to suzanne@InnovativeScheduling.com.

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