The Newsletter of the
RAILWAY APPLICATIONS SECTION

FALL 2010

From the Editor's Desk:

Pooja Dewan, BNSF Railway, Pooja.Dewan@BNSF.com

In last year's editorial, we discussed the unprecedented decline in railroad traffic volumes. Just one year later, traffic volumes are up 10%-15% over the previous year. What does this mean for OR practitioners? Increased volumes imply more assets taxed to capacity and more potential for us to make bottom line impacts. In my previous article, I urged railroad OR practitioners to consider the following three practices when working on any project:

1. Design Decision Support (DSS) tools not "black boxes."
2. Be cognizant of the business process changes.
3. Involve end-users early in the project to assure their buy-in.

I consider these essential ingredients for a successful implementation. In this article, I would like to share two additional insights to help us achieve successful implementations.

First, consider carefully how you decompose problems. Decomposition strategies are useful for finding solutions to big problems, but don't limit yourself to decomposition for computational purposes alone. Consider human-machine decomposition as well. How are users breaking up the problem and solving it? Is there a particular problem that users can solve as efficiently as computer models? If so, consider letting end-users solve problems they are good at and have models and analytics put around the other, harder-to-solve problems. Such a strategy will help with end -user buy in, ease computational complexity, and enable easier packaging in a DSS tool. Also, consider business processes and organizational structures when decomposing the problem. Is there an incentive to coordinate if the problem is decomposed among different departments? Are the objectives of different departments aligned? In technical terms, if individuals or groups are solving the sub-problems, is anyone solving the master problem? If decomposition is required for workload balancing, consider creating tools that either help with the coordination efforts or ease the workload to allow a single individual to solve the problem.

As another insight, I encourage you to immerse yourself in the business problem being solved. This can be done by job-sharing, job-shadowing, or just spending a lot of time with end-users; not just in formal meetings, but at their desks solving their problems with them. This will not only increase your understanding of the business, but will give you ideas for simple tools – tools that might not involve modeling at all, but will bring value to the bottom line and gain the confidence of end-users. Do not limit your ideas to OR models and heuristics! Consider what you would need to solve the problem and help create those simple reports, maps, and graphs. Create a tools strategy for the business problem that includes both simple technology enhancements and models.

May traffic volumes continue to grow as they have over the past year and may you continue to have success as you add value to your organization!

See you in Austin!

Inside:

Message from Rail Applications Section Chair

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

This year has been a recovery year for the railroads. Railroads are looking towards the future and it is a bright outlook for the industry. Let me explain why. First, internationalization continues its growth, despite last year's economic downturn, so more products will be moving longer distances. Second, fuel prices have remained high and a continually increasing emphasis has been placed on cost-efficient transportation technologies, favoring rail over truck. Third, public fiscal stimulation money has been earmarked for the expansion of both passenger and freight rail, because of its ecological advantage over road transport. Finally, advancing hardware technology such as positive train control gives hope to an expansion of rail network capacity with less intense capital investment required. On the whole – we expect a great year ahead for railroads. If you don't believe me, ask Warren Buffet, who just purchased the BNSF railway, what he thinks.

The theme for this year's INFORMS conference is "**Energizing the Future**," which is a powerful theme for RAS to leverage. With the current rail recovery comes a growing investment in new research and technology. This bodes well for OR in the rail industry. Thus, RAS has a full slate of 11 sessions planned for sharing ideas about what is currently in use at the railroads and what the next wave of rail research will include. See the summary of the upcoming RAS sessions in this newsletter for more details.

In particular, this year's RAS Roundtable discussion focuses on the current and future hot topics in rail research, and the ways that academics, practitioners and consultants can collaborate on mutually beneficial research topics. Read more about the Roundtable in Carl Van Dyke and Dave Hunt's summary of the session in this newsletter. Be sure to attend this session, which promises to be filled with inspiring research ideas and opportunities.

RAS's focus has been particularly forward looking this year. Thanks to $5,000 in prizes sponsored by the BNSF, CSX, NS and UP Railroads, RAS members Homarjun Agrahari (BNSF) and Shankara Kuppa (UP) have spearheaded an effort (aided by competition committee Mike Gorman, Vinay Mehendiratta, Juan Morales, Yanfeng Ouyang, Kamalesh Somani, Carl VanDyke, and Erick Wikum) to launch the First Annual "**RAS Problem Solving Competition"** to get new minds thinking about rail problems. Over 30 teams from all over the world entered solutions to the problem posted, and at least one team hopes to publish its solution to the problem. Read about the competition in this newsletter. The response to this competition was impressive, and we hope to continue it next year. See the finalists present and the winner will be chosen in Austin! We hope this is the first of many future rail problem competitions.

As I close my year's service as the Chair of the Rail Applications Section, I would like to thank my officers for their service: Vice Chair and Chair Elect - Kamalesh Somani, Secretary - Juan Morales, and Treasurer - Yanfeng Ouyang. I would also like to thank those running for service positions this year – good luck in your election efforts!

Finally, I would like to encourage our membership to become more involved in leadership positions for RAS. There are 229 members of RAS (up 7% since 2009) from 20 countries around the world who benefit from this group's conference attendance, full slate of engaging presentations, and networking opportunities. Such a vibrant, growing community benefits from new inputs and ideas from all of its members. There are many ways to help: running student paper competitions, judging the problem competition, chairing sessions, or coordinating the roundtable. We welcome and need your support and ideas so RAS can continue to grow and improve.

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

Quick Quotes

"The shortest distance between two points is always under construction."

- Noelie Alite

"The really happy man is one who can enjoy the scenery while taking a detour"

-Author Unknown

A Texan is bragging to an Englishman on a train journey through England. "In Texas, on a train, we ride all day long, and still be in Texas by nightfall."
"Yeah," replies the Englishman, "we have slow trains here too".

RAS Roundtable Session on Current and Future Trends in Rail Research

David Hunt, Oliver Wyman; David.Hunt@oliverwyman.com

Continuing a long tradition, the RAS Roundtable will be held during two Sunday afternoon sessions at the INFORMS meeting in Austin, TX. Including back-to-back sessions on a single topic, the roundtable provides a forum for delving more deeply into a current topic of interest to RAS members. This year, we are going to take a step back and invite experts to provide a broad overview of railroad research. The goal is to facilitate discussions on future research topics, opportunities for collaboration, funding sources, and other key topics.

The first session is titled "**Upcoming Topics in Railroad Operations Research**," and will be co-chaired by David Hunt and Carl Van Dyke of Oliver Wyman. Mike Gorman, University of Dayton, will represent the academic viewpoint by surveying recent trends in rail-related research and providing a projection of where those trends appear to be heading. Clark Cheng, Norfolk Southern, will provide the industry viewpoint by reviewing the implementation of recent Operations Research models and share his thoughts on upcoming industry needs. Rounding out the first session will be Carl Van Dyke, who will take an in-depth look at one topic that should generate many modeling challenges – positive train control.

The second session is co-chaired by Chris Barkan, University of Illinois, and Teodor Crainic, CIRRELT, and is titled "On the Collaborative Railroad Research." This session is comprised of a panel of experts from the industry, academia, and government, and will look at both impediments and opportunities for rail research. The panelists include: Pooja Dewan of BNSF; Dharma Acharya of CSX; John Gray of the AAR; Chris Barkan; and Teo Crainic. A primary focus for this session is the roles that RAS, INFORMS, and the government can play in promoting research collaboration and intellectual property rights sharing to accelerate the pace of breakthroughs in railroad research.

As an example, the newly created National Cooperative Rail Research Program provides funding for rail-related research in a broad array of topics. This program is modeled after other successful programs, such as the National Cooperative Highway Research Program and the National Cooperative Freight Research Program. The concept is that problem statements are submitted to the administering agency, which selects the best proposals for funding and then releases them for competitive bids. RAS can contribute in many ways, ranging from submitting problem statements for Operations Research related topics to encouraging our members to volunteer for panels to help guide the research, as well as encouraging members to form teams and bid on problem statements.

Length of High Speed Rails around the World

Country	In operation (km)	Under construction (km)	Total Country (km)
China	4,326	6,696	10,025
Spain	1,525	2,219	3,744
Japan	1,906	590	2,496
France	1,872	234	2,106
Germany	1,032	378	1,410
Italy	923	0	923
Turkey	235	510	745
South Korea	330	82	412
Taiwan	345	0	345
Belgium	209	0	209
The Netherlands	120	0	120
United Kingdom	113	0	113
Switzerland	35	72	107

RAS Problem Solving Competition 2010

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

The Genesis: It all started in 2005 with a presentation by Kevin Crook from BNSF Railway as part of the invited seminar series organized by the INFORMS Students Chapter of Texas A&M University, where I was then a graduate student. Kevin outlined several challenging and exciting Operations Research problems in the area of rail transportation that made me interested in railroads. I joined RAS and later accepted a position with BNSF Railway. As I attended RAS sessions at the annual INFORMS conferences, it struck me that other than in the student paper contest there were not many new faces at RAS each year. I shared this observation with RAS officers and members, and began considering how to reach the broader OR community and spread the word about the fascinating and challenging problems facing railroads. I began to contemplate the idea of a holding a problem solving competition. The initial concept was further refined through discussions with OR group members at BNSF and RAS officers. Finally, Shankara Kuppa (Union Pacific Railroad) and I proposed the RAS competition at the RAS Business Meeting in San Diego last year, and invited volunteers to help organize the 2010 RAS Problem Solving Competition. The proposal was well received and several RAS members offered to help.

Loony Laws

Alabama: Putting salt on a railroad track in Alabama may be punishable by death.

Wisconsin: It is illegal to kiss on a train.

South Carolina: Railroad companies may be held liable for scaring horses.

Texas: When two trains meet each other at a railroad crossing, each shall come to a full stop, and neither shall proceed until the other has gone.

Purpose of the Competition: The competition is designed to introduce Operations Research practitioners to challenging and interesting railroad problems and is open to anyone new to railroading, Operations Research, or both. The total prize money is $5,000, thanks to generous sponsorships from BNSF, CSX, UP and NS. First prize is $2,500, second prize $1,500, and third prize $1,000.

Process: The organizing committee first met soon after the annual meeting in San Diego. We reached out to railroads and asked them to suggest problems for the competition. A subcommittee (Shankara Kuppa, Vinay Mehendiratta, Homarjun Agrahari, Juan Morales, and Kamalesh Somani) evaluated all of the proposed problems and narrowed the list down to three problems based on a moderate level of difficulty, the availability of data and relevant literature, etc. The fuel planning problem was finally selected as the 2010 competition problem. Juan Morales (BNSF) and Kamalesh Somani (CSX) worked hard to articulate the problem, showed a simple example covering all aspects, and provided data for a real life instance. Yanfeng Ouyang and Seyed Mohammad (UIUC) helped write a literature review for the problem. Kamalesh developed a model to solve the problem as a benchmark, provided problem data and solution templates, and developed routines to check the solution feasibility and accuracy. Krishna Jha (Innovative Scheduling) helped us to set up the competition website. Finally, the competition problem was successfully announced in April 2010. Erick Wikum (IBM) coordinated the effort to reach as many channels as possible to advertise the competition. Mike Gorman and Carl VanDyke were instrumental in guiding us through this process.

The Competition Problem: The participants were asked to solve the locomotive fuel planning problem. Here is a brief description of the problem (more details are available at the website: **http://informs-ras.org/problem.htm#competition**). A railroad needs to identify a fueling plan that minimizes total fuel-related expenses that include fueling truck operating costs, as well as fuel purchasing costs over a planning horizon. This plan must specify the number of trucks that should be contracted at each yard, and the quantity of fuel that must be dispensed into each locomotive at every yard for each train-start in the locomotive train assignment cycle.

The Response: The initial response exceeded our expectation by far. We received 89 team registrations from universities, companies, and consultants. Finally, 31 teams from 12 countries submitted entries making it a truly international competition. The solution techniques used by participants were varied; e.g., MIP, MIP with customized cuts, constraint programming, heuristic, and meta-heuristic methods. Several teams reported near-optimal solutions. The judging panel was chaired by Juan Morales and included Erick Wikum, Carl VanDyke, Mike Gorman, and Yanfeng Ouyang. The judging panel selected three finalists on the basis of solution quality, report and novelty and elegance of the formulation and solution approach. Team *EdRamsden* proposes a creative heuristics that provides near optimal solution within seconds. Team *HALOS* applies a series of valid inequalities and lagrangian relaxation approach that results in good performance. The team *TAU-IE* applies a series of insightful valid inequalities that enable them to solve MIP to near optimality within few seconds. The three finalists will compete at the RAS session on **Sunday Nov 07, 11:00 - 12:30** in Hilton, Salon F, 6th Floor. 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 **http://informs-ras.org**.

RAS and How You Can Help: We are encouraged by the broad 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 Austin!

RAS Student Paper Awards 2010

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

Rail Applications Section (RAS), a section of Institute for Operations Research and Management Science (INFORMS), sponsored a student research paper contest on Management Science in Railroad Applications. This contest offers the following awards:

- Cash Awards: $500 First Place, $250 Second Place
- Honorable Mention recognition for other top papers

Authors of the First Place and Second Place present their papers at the Student Paper Award Session of the INFORMS Annual Meeting. RAS covers the conference registration fees for all primary authors who are asked to present their papers.

To qualify, the paper must be written by a student or students enrolled in an academic institution during the 2009-2010 academic year. The paper must relate to the application of Management Science for the improvement or utilization of railroad transportation, and it must represent original research that has not been published elsewhere. More details on eligibility criteria, the application procedure, and deadlines for submission are available at RAS's website: http://informs-ras.org.

We expect that these award-winning papers will be presented in the Student Paper Contest session at the INFORMS 2010 Meeting in Austin We provide below the abstracts of these papers. 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. This year we had received submissions from around the world on a variety of topics.

First Prize:

Delay Management with Re-Routing of Passengers by Twan Dollevoet, Erasmus University, Rotterdam, Netherlands.
Coauthors: Dennis Huisman, Marie Schmidt, and Anita Schobel
Abstract: Delay management answers the question whether trains should wait for a delayed feeder train or should depart on time. We present a delay management model that allows passengers to adjust their route in case of delays and gives an integer programming formulation. Furthermore, we present a polynomial algorithm for the special case of one origin-destination pair, which can be applied to obtain lower bounds for the general problem. Computational experiments on real-world data of Netherlands Railways show that significant improvements can be obtained by considering re-routing explicitly.

Second Prize:

Robust Train Dispatching Model under a Dynamic and Stochastic Environment: A Scenario-Based Rolling Horizon Solution Approach by Lingyun Meng, University of Utah
Coauthors: Xuesong Zhou
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. **(contd.)**

Special Student Paper Presentation:

In this session, there will be another paper presented by the winner of the New Jersey Chapter of INFORMS Student Research Competition.

Flight Sequence Model for the Flight Conflict Resolution Problem by Zhe Liang, Rutgers University

Coauthors: W. Art Chaovalitwongse and Elsayed A. Elsayed.

Abstract: Every day the Anchorage, Oakland and Tokyo air-route traffic control centers (ARTCCs) receive requested flight plans detailing the level, track and entry time for flights that will enter the Pacific Oceanic airspace. Because each airline independently optimizes its own flight plans, it is common that the requested flight plans incur conflicts due to the Federal Aviation Administration's (FAA) safety standards, unbalanced level and track requests, and available level and track capacity. We develop a computational framework to resolve the flight conflicts by delaying one or more of the conflicting flights or changing one of the requested tracks or levels. The flight conflict resolution problem provides a flight schedule that minimizes the total penalty cost of delay, level change, and track change while maintaining the FAA separation standard.

Rail Research since Deregulation: Past Trends and Evolution

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

Since the deregulation of U.S. freight rail with the Staggers Act of 1980, rail has undergone a radical change and rebirth. Coupled with deregulation, computing technology has expanded dramatically over the last 30 years. These two stimuli have engendered great interest in rail-related OR. This article describes the evolution of rail research over the nearly 30 years from 1980 to 2009 and discerns its trends.

Searching Google Scholar using Harzing's "Publish or Perish" software, I found more than 14,000 referenced articles since 1980 that included the words "rail, railway, railroad or intermodal." This list may include some topics that are not rail centric (i.e., the Underground Railroad), and it also includes books, patents, dissertations, and some non-reviewed works. However, this list does not include thousands of other articles (especially older ones) that are not indexed by Google Scholar; the average published is more than 400 articles per year.

The most cited work I found was by economist H. Hotelling; it is a 1938 article on rail taxation and efficiency in *Econometrica* (639 citations). More recently, an article by Anas, Arnot and Small on passenger rail and urban development published in the *Journal of Economic Literature* was cited 632 times. The book most frequently cited is by Frank Dobbin, who wrote on historical rail regulation policy in 1997 (cited 453 times). In fact, rail articles cited most often are on economic topics.

Closer to the heart of INFORMS and RAS, the top 20 most cited OR-centric articles meeting the above search criteria are presented in Table 1. We see a mix of articles on topics about freight and passenger, train scheduling and blocking, empty car distribution, pricing, intermodal and survey.

Citations	Authors	Year	Journal	Title
126	AA Assad	1980	Transportation Research Part A:	Models for rail transportation
122	B Friedman, et al	1994	Transportation Research	Effect of neotraditional neighborhood design on travel characteristics
104	F Schulz, et al	2000	Journal of Exp Algorithmics	Dijkstra's algorithm on-line: ...public railroad transport
86	C Macharis, YM Bontekoning	2004	EJOR	Opportunities for OR in intermodal freight transport research: A review
85	WC Jordan, MA Turnquist	1983	Transportation Science	A stochastic, dynamic network model for railroad car distribution
85	A Caprara, P Toth, et al	1998	Operations Research	Modeling and solving the crew rostering problem
83	YM Bontekoning, et al	2004	Transportation Research Part A	Is a new applied ...emerging?--A review of intermodal transport literature
82	F Southworth, BE Peterson	2000	Transportation Research Part C	Intermodal and international freight network modeling* 1
72	S Melkote, MS Daskin	2001	Transportation Research Part A	An integrated model of facility location and transportation network design
69	R Steiner	1994	Transportation Research Record	Residential density and travel patterns: review of the literature
66	MR Bussieck, et al.	1997	EJOR	Optimal lines for railway systems
63	TG Crainic, KH Kim	2007	Transportation	Intermodal transportation
62	TG Crainic, M Florian, JE Leal	1990	Transportation Science	A model for the strategic planning of national freight transportation by rail
62	MA Al-Mosaind, et al.	1993	Transportation Research ...	Light-rail transit stations and property values: A hedonic price approach
60	ST Choong, et al	2002	Transportation Research Part E	Empty container management for intermodal transportation networks
54	TH Oum, WG Waters, C Yu	1999	Journal of Transport Econ/Policy	A survey of productivity and efficiency measurement in rail transport
53	AA Assad	1980	Transportation Research Part B	Modelling of rail networks: Toward a routing/makeup model
53	A Ciancimino, et al.	1999	Transportation	A mathematical programming ...railway yield management problem
51	LG Kroon, et al.	1997	EJOR	Routing trains through railway stations: complexity issues
49	M F Gorman	1998	Annals of Operations Research	An application of genetic and tabu searches ...operating plan problem

Table 1. Most Cited OR Articles in Rail Research

To achieve both a broader and more detailed perspective of rail research, I reviewed the abstracts of more than 550 articles published over the last 30 years in major theoretical and practical operations research journals using the above criteria in a search of EBSCO/Business Source Complete. I collected information from the following journals on transportation theory: *Transportation Science, Transportation Research A-F*; OR/MS theory: *Management Science, Operations Research, Annals of OR, European Journal of OR, Computers and OR*; Practice Journals: *Interfaces, Transportation Journal;* Engineering Journals*: Journal of Transportation Engineering;* and Economics Journals*: Journal of Transport Economics and Policy*.

As shown in Figure 1, the transportation journals were the most significant source of rail research. The *Journal of Transport Economics and Policy*, *Transportation Science* and *Transportation Research (A-E)* publications were the most prolific sources of theoretical rail research, with approximately 40 articles per journal encompassing rail (over 290 articles). *Transportation Journal* was by far the largest publisher of practitioner rail articles (over 120), although the rate of rail articles at that journal has dropped dramatically over the last two decades; *Interfaces* included 27 articles. The remaining OR/MS theory journals accounted for a total of 70 articles. There is a pronounced spike in rail research in the mid 1990s, though the spotty electronic database coverage in early years biases this slope upwards.

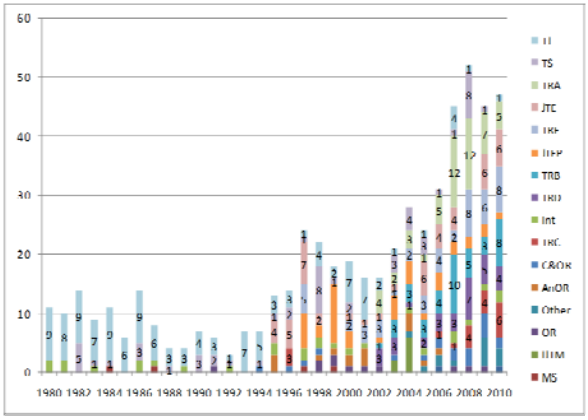


Figure 1. Rail Centric Publications by Major Journals 1980-2010.

Optimization and economic modeling techniques were the most common, comprising 35% and 30% of the methods employed, respectively. Statistical methods were third, accounting for approximately 20%. Cases, surveys, and historical accounts were 12%, and the remaining articles were a random assortment of commercial topics, tutorials and the like (primarily in *Transportation Journal*). Figure 2 shows a reduction in practitioner-focused research in these journals (commercial, case, historical accounts, etc.). Economic modeling, though growing, has shown a slight decline in the percentage of total rail research, while statistical and optimization modeling have increased in the last two decades.

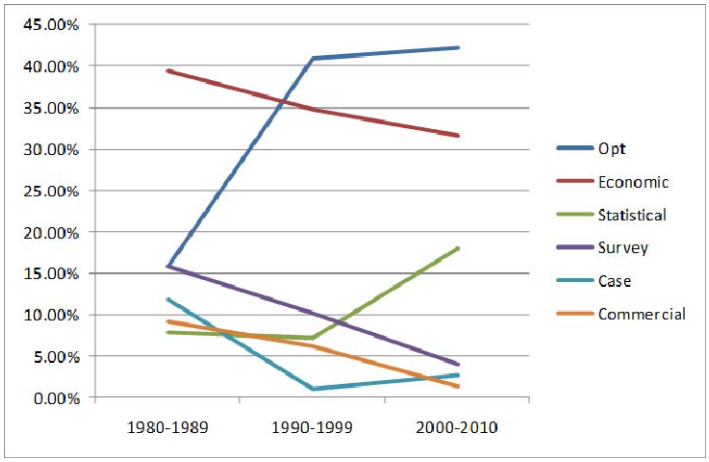


Figure 2. Research by General Research Technique as a Percent of Total by Decade

I judged the broad research area, topic and methodology employed to determine which topics were most often researched. Freight research comprises over 50% of these articles; passenger research comprises approximately 30% and intermodal research 10%, while 10% is applicable to both. Research on train scheduling was most common across all methodological boundaries (19%), followed by mode choice (11%), railcar research (7%), industrial organization (7%), network design (6%), service quality (5%), track (4%), cost measurement (3%), yard (2%), shortline (2%), infrastructure (2%), locomotive (2%), crew scheduling (2%), pricing and yield management (2%), followed by a host of others (station, supply chain, recovery, fleet, safety, maintenance, etc.).

Among optimization methods, MIP, network flow models and heuristics were the most common methodologies. By far the most common subject in optimization problems was train scheduling and track capacity (either train throughput or schedule robustness and adherence), which accounts for nearly 40% of the optimization -based research. Railcar related optimization followed at approximately 15%, with locomotives, crews, yards and network design behind that at about 5% a piece.

Additional and more in-depth insights from data spelunking might be possible, but we will save that for the Roundtable Session "**Current and Future Trends in Rail Research**" in Austin.

Train Scheduling for High-Speed Passenger Rail in China

Shiwei He, Beijing Jiaotong University, China; shwhe@bjtu.edu.cn
Xuesong Zhou, University of Utah, USA; zhou@eng.utah.edu

China is developing an extensive high-speed rail network to improve the Level of Service (LOS) for inter-city and inter-region passenger transportation. With about 4,300 miles of high-speed rail currently in service, by 2020 China plans to operate 10,000 miles of high-speed rail lines that include both upgraded conventional lines and newly-built passenger dedicated lines (PDL). Aiming to optimize the LOS of passenger rail through better line planning and schedule generation, this article briefly presents two related studies we have conducted for High-Speed Passenger Rail in China.

Impact of LOS on PDL mode split

Developing high-speed rail lines involves high infrastructure and operating costs, so the cost-effectiveness of PDL greatly depends on achieving a sufficiently high ridership level. As a result, accurately estimating the mode share under different LOS plans (in terms of frequency, travel time and station waiting time) is extremely important when projecting the resulting service revenue and ensuring system profitability.

Using a revealed preference survey data set involving 1,500 travelers on the 665-mile Wuhan-Guangzhou PDL in China, we developed a comprehensive mode choice utility function to incorporate different LOS attributes for travelers, such as train travel time and passenger waiting time at stations. A nested logit model, shown in Figure 1, is further used to estimate the ridership under different operations settings. A sample sensitivity result is shown in Figure 2. The above discrete choice model provides an important foundation for systematically evaluating how train frequency and stop schedules of trains can be adjusted to improve the PDL mode share, with respect to other competing modes such as airline, conventional train, bus, and passenger car.

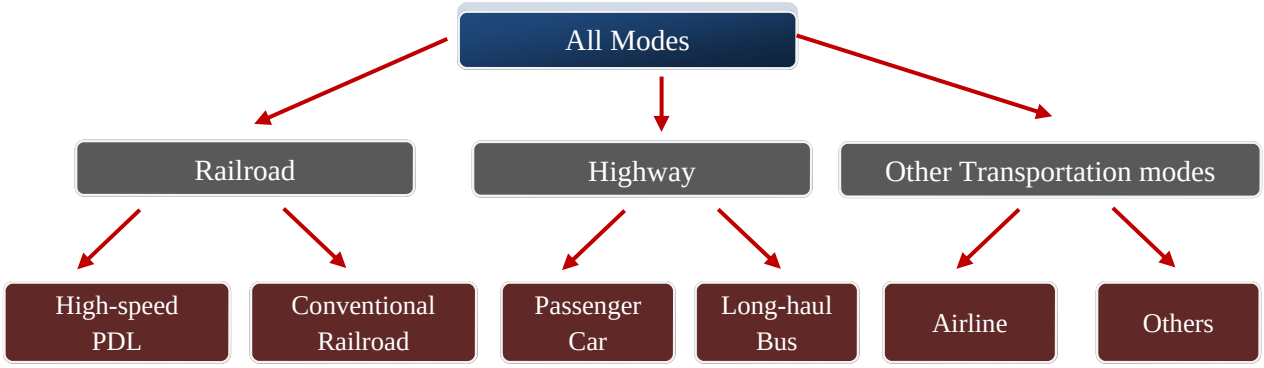


Figure 1. Structure of the nested logit model.

Balancing levels of service on upgraded conventional lines

Operating high-speed passenger trains on existing rail lines is considered an economically viable option for many countries trying to initiate and accelerate their high-speed rail services. In this case, two types of trains, high-speed and medium-speed trains, are designed to operate in the same track system. The high-speed train service is typically expected to provide a "perfect" schedule with high frequency and even departure time intervals. Medium-speed trains, on the other hand, need to run on both high-speed lines and adjacent conventional rail lines to reduce connecting delay for interline travelers. However, as high-speed trains typically always hold higher priority, medium-speed trains might have an extremely long total yield time.

Our research employs utility function-based heuristic rules to generate a representative set of non-dominated solutions. The efficient frontier of solutions is approximated to further balance service quality for both types of trains. A branch-and-bound schedule generation scheme is used to explicitly consider acceleration and deceleration time loss of trains. By considering two LOS-related objectives, namely expected passenger waiting time on stations for high-speed trains and total delays of medium-speed trains, rail planners can systematically assess the trade-offs for different train timetable settings.

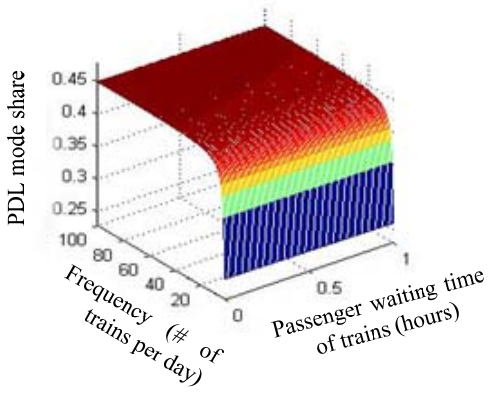
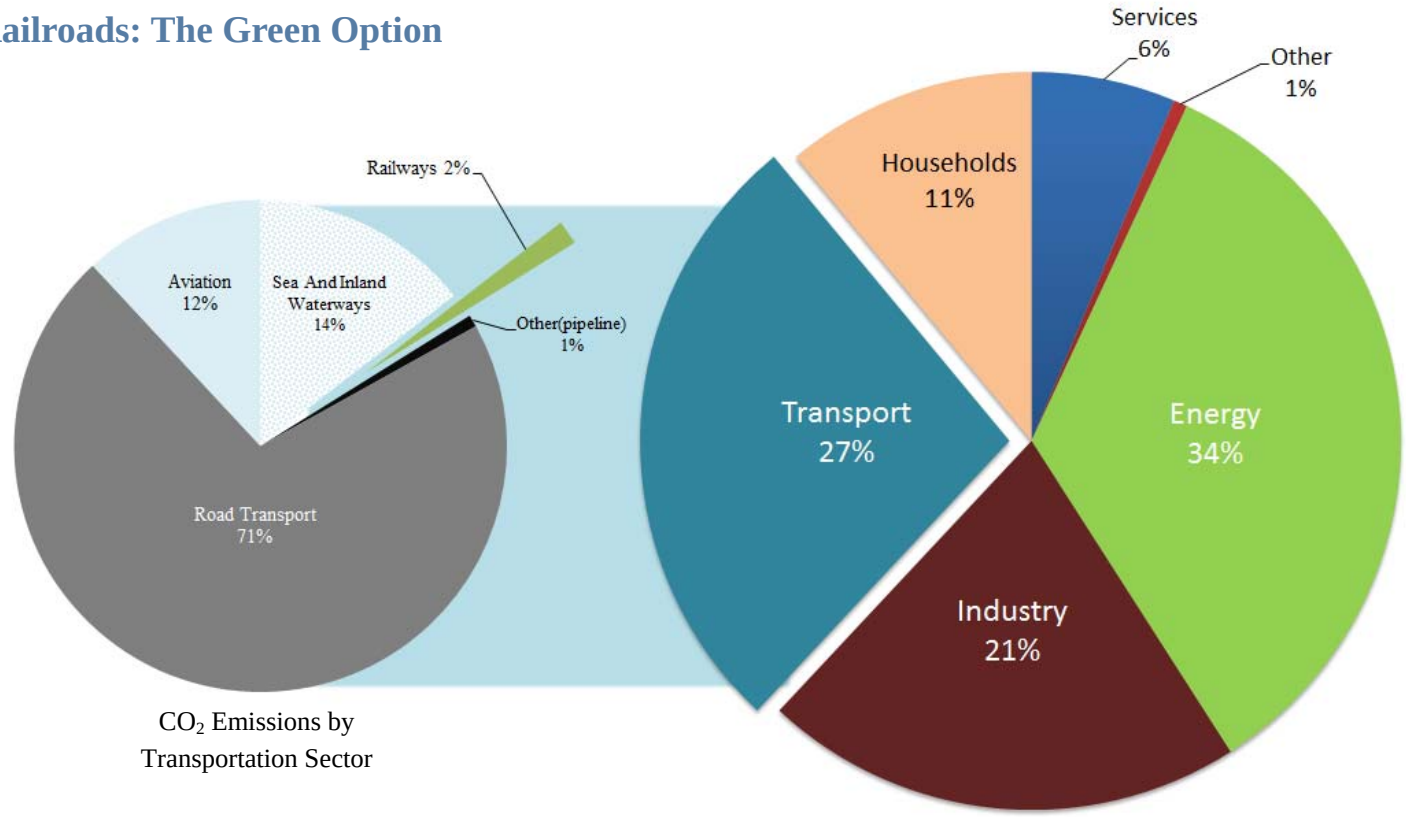


Figure 2. Relationship of PDL mode share, train frequency and passenger waiting time.

Conclusions

While many existing studies concentrate on the optimization aspects of line planning and schedule generation, how to incorporate different LOS-oriented considerations into these two stages has not received adequate attention, especially for high-speed rail passenger services. In order to improve high-speed rail market share and cost-effectiveness, railway industries and public-sector planning agencies should shift their focus from traditional operation-constrained decision making to market-driven decision making, which highlights the seamless integration of demand management and schedule optimization.

Railroads: The Green Option



CO_2 emissions 2005 in EU27 by sector and Transport mode.
Source: EC2007 and UIC Energy /CO_2 database

RAS Sessions 2010

Location: Hilton—Salon F, 6th Floor. Chair: Homarjun Agrahari, BNSF Railway

SA69 - Sunday Nov 07

8:00 – 9:30

Student Rail Research Competition - FINALIST Presentations

Chair: Michael Gorman, University of Dayton

1. Robust Train Dispatching Model Under a Dynamic and Stochastic Environment: A Scenario-based Rolling Horizon Solution Approach (Xuesong Zhou)
2. Delay Management with Re-Routing of Passengers (Twan Dollevoet)
3. Flight Sequence Model for Flight Conflict Resolving Problem (Zhe Liang)

11:00 – 12:30

RAS Problem Solving Competition - 2010

Chair: Shankara Kuppa, Union Pacific Railroad, Co-Chair: Homarjun Agrahari, BNSF Railway

The three finalists will present their solution approach and results.

1. EDRAMSDEN, Members - Ed Ramsden, Lattice Semiconductor Corp., USA
2. HALOS, Members - Virot Chiraphadhanakul, Cristian Figueroa, MIT, USA
3. TAU-IE, Members - Mor Kaspi & Tal Raviv, Tel Aviv University, Israel

Winners will be announced at RAS meeting at RAS Business Meeting at 06:15 PM.

1:30 – 3:00

Roundtable I - Upcoming Topics in Railroad OR

Chair: David Hunt, Co-Chair: Carl Van Dyke

1. Current Trends and Future Topics Rail Research: A Survey and Forecast (Michael Gorman)
2. Use Operations Research Models to Improve Railroad Operations (Clark Cheng)
3. The Impacts of Positive Train Control (PTC) and Implications for Further Research (Carl VanDyke)

4:30 – 6:00

Roundtable II - Panel Discussion On the Collaborative Railroad Research

Chair: Chris Barkan, UIUC, Co-Chair: Teodor Gabriel Crainic, CIRRELT, Montreal

Panelists: Chris Barkan, Theodor Crainic, Pooja Dewan, John Gary, Dharma Acharya

6:15 – 7:15

RAS Business Meeting

1. **RAS Business (Includes naming new RAS officers)**
2. **Award Presentation - Problem Solving Competition**
3. **Award Presentation – Student Paper Competition**

MA69 - Monday Nov 08

8:00 – 9:30

Current O.R. Based Planning Tools Used by US Railroads, and Opportunities for Further Application of O.R.

Chair: Ron Griffith, BNSF Railway

1. MIP Based Approach to Solve Train Routing Problem (Ravindra Ahuja)
2. PHMSA Route Analyzer: An Algorithm Based Routing Tool for TIH/PIH Traffic (Viraj Karnik)
3. Application of OR Models in Service Design (Dharma Acharya)

11:00 – 12:30

Operations Research Application in Railroad Engineering
Chair: Jagadish Jampani, CSX Transportation

1. Rail Test Scheduling at CSX (Kamalesh Somani)
2. Scheduling Rail Grinding Operations (Kurshad Derinkuyu)
3. Routing and Scheduling Preventive Railway Maintenance with Predetermined Desired Reliability (Anand Retharekar)

1:30 – 3:00

Fleet Management Models in Rail Transportation
Chair: Brian Lunday, United States Military Academy

1. Estimating Order Flow Times in Freight Rail Networks (Ram Gopalan)
2. An Approximate Dynamic Programming Model for Locomotive Optimization (Belgacem Bouzaiene-Ayari)
3. Probabilistic and Possibilistic Optimal Wagon Management Models for Stochastic Railways Networks (Loukas Dimitriou)
4. Equitable Apportionment of Railcars within a Pooling Agreement for Shipping Automobiles (Brian Lunday)

4:30 – 6:00

Railroad OR Models
Chair: Clark Cheng, Norfolk Southern Corp

1. Simplified and Integrated Decision Support System for Real-time Train Traffic Management (Michael Swindler)
2. Algorithms for Scheduling Freight Trains Over a Complex Rail Network (Pavan Murali)
3. A Heuristic Approach to a Classification Yard's Scheduling Problem (Shuangjun Xia)

TA69 - Tuesday Nov 09

8:00 – 9:30

Joint Sessions - RAS/TSL: Recent Advances in Transportation Planning Systems
Chair: Ravindra Ahuja, University of Florida & Innovative Scheduling

1. A New Solution for Rail Service Network Design Problem (Endong Zhu)
2. An Algorithmic Approach to Design an Optimal Truckload Plan for Less-Than-Truckload (LTL) Carriers (Artyom Nahapetyan)
3. Computational Results of Solving Large-Scale Network Design and Routing Problems (Ravindra Ahuja)

11:00 – 12:30

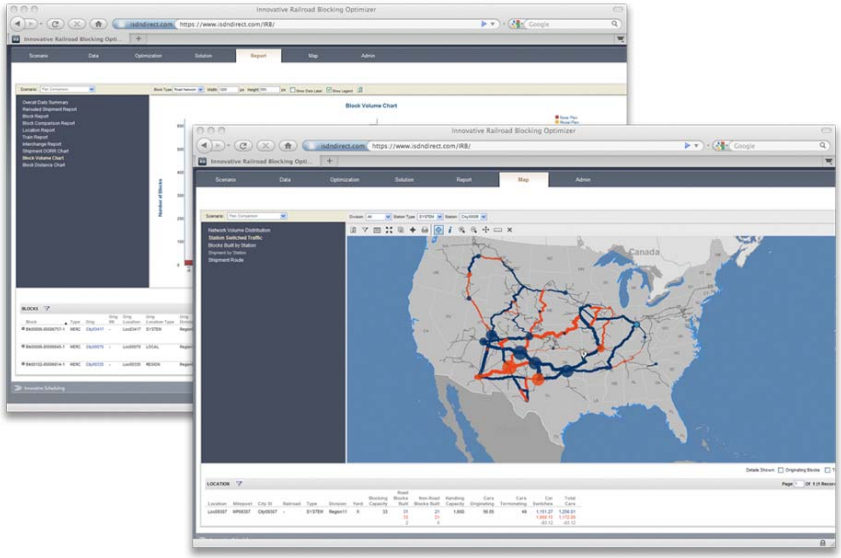
Train Timetabling
Chair: Xuesong Zhou, University of Utah

1. Optimizing Train Priorities to Support Regulation of Train Services with Economic Constraints (Christian Sakowitz)
2. Comparison of Planning a Tonnage Based Railway Versus a Scheduled Based Railway (Marc Meketon)
3. Deterministic Scheduling Formulations for Train Pathing and Timetabling (Steven Harrod)
4. High-speed Passenger Trains on Freight Tracks: Modeling Issues on Train Timetabling and Dispatching (Xuesong Zhou)

1:30 – 3:00

Hot Topics in Railroad Operations Research
Chris Barkan, Professor, University of Illinois at Urbana-Champaign

1. Determining the Causes of Train Delay (Mark Dingler)
2. Risk Analysis of Multiple-Car Releases in Railroad Hazardous Materials Transportation (Xiang Liu)
3. Efficient Automation: Applying Lean Manufacturing to Freight Car Inspection and Maintenance (Bryan Schlake)



Innovative Scheduling licenses software products, builds custom software applications in a rapid development mode, and provides management consulting related to railroad planning, scheduling, and real-time operations. Our domain of expertise includes:

- Train Scheduling
- Locomotive Planning
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RAS Dinner at INFORMS

We would like to invite all RAS members for a dinner on Sunday (November 7) 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 401 Congress Avenue, Houston, TX 78701, at the intersection of 4th Street and Congress Avenue; Telephone: (512) 236-9600. The restaurant is within a walking distance of the Convention Center and hotels. The dinner is sponsored by Innovative Scheduling and Oliver Wyman. Please RSVP to ann@InnovativeScheduling.com by November 2. We will try to accommodate you even if you have not RSVP, however we may not be able to guarantee it.

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