The Newsletter of the
Railway Applications Section
Institute for Operations Research and the Management Sciences

From the Editor's Desk

Fall 2007

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It is that time of year again. The leaves are turning yellow, the air is crisp, and RAS members are finalizing plans for the annual INFORMS meeting. Yes, you read that correctly. RASIG has been officially renamed as the Railroad Applications Section (RAS). For those of us who have been in the group for a while, it will take some time to adjust to the new name, but it is a good change since we are not a Special Interest Group of INFORMS anymore, but have been elevated to a Section. And thanks to the tremendous efforts of our RAS officers and cluster chair, Mike Gorman, we have another great meeting planned this year. Details of each session are included in this newsletter.

Many articles in past newsletters have mentioned how Operations Research is gaining acceptances in the railroad industry. I agree with Carl Van Dyke when he said it seems like "Optimization is in the air". UP going from an OR group of zero to nine people is a testament to how railroads are looking to OR teams for greater productivity and improved profitability. Several factors, such as the unprecedented growth of traffic over the past two to three years, improvements in computer hardware and software that enable solving of challenging railroad problems, the looming retirement bubble, and the efforts of RAS members to increase OR awareness, have contributed to this movement. With success comes responsibility; I would like to stress three things that we need to remember to ensure OR's success.

First, I have seen firsthand how OR tools are sold as a nirvana. For most practical problems in the railroad, we cannot have final, packaged solutions coming out of a black box. Most problems are not that simple. In addition, not all factors used for decision-making are quantifiable. I am not talking about the hard-to-model constraints. I'm referring to the subjective factors that differ from one user to the next. Carl Van Dyke and Ravi Ahuja have both stated that we should not be creating black boxes, but instead creating decision support systems. I whole-heartedly agree with this observation. We need to create tools that not only recommend good solutions, but give the user the capability to understand the reasons for the solutions and the ability to alter that solution and solve around their changes. Tools often propose solutions that are not intuitive to the users. Providing users with the ability to understand how a tool's solution is reached is critical for building their acceptance of the tool.

Second, many of the tools we develop will require or result in business process change. We, as OR practitioners, need to be aware of this. We should work with our end-user teams to evaluate the current and future business processes. We need to understand the current business processes and provide a clear vision of the future.

Third, and most importantly, we need to remember that the tools we develop are for the end-users. Without their buy-in, the tools will not be utilized and the benefits will not be realized. We need to work with end-users during every step of the process – from requirements gathering to acceptance testing. Their involvement will promote ownership of the tool. We also need to help end-users understand "what is in it for them". Without an understanding of how they will benefit from the tool, gaining their acceptance will be a challenge. We, as OR practitioners, need to work closely with end-users and not limit our role to developing OR models, but instead, we need to see our role as successfully deploying OR models that will be used. This may require time spent doing data work or generating reports – simple things that help the end-users. This extra effort is not wasted. It may be the difference between success and failure.

We look forward to your future participation in RAS. See you in Seattle.

RAS Chairman's Message

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Fall Conference Around the Corner

First of all, I'd like to invite you to attend this year's annual INFORMS conference to be held in Seattle, November 4-7. We will have eight RAS-sponsored sessions and a business meeting. These sessions will include a Student Paper contest, a session on rail-related research being performed at universities, a session on fleet sizing, a session on freight demand forecasting, new OR models for rail planning, and European rail research. The Sunday afternoon's roundtable sessions will be focused on railway port interchange and intermodal transportation. A more detailed program listing of rail-related sessions is given on pages 10 and 11 of this newsletter. Last year, some RAS members suggested that we might have too many sessions during Sunday and Monday with very little time for networking and attending non-RAS sponsored sessions. We discussed this during our planning meetings earlier this year, and we've decided that if there is enough interest in presenting papers in various rail-related areas, we should accommodate them as much as possible. We leave it up to the individual members to decide whether to attend a particular session or not. We did have record turnouts in all sessions last year, and I'm confident that it will be the same this year as well.

I also invite all rail-interested conference participants to attend this year's RAS dinner on Sunday, November 4. The keynote speaker at the RAS dinner will be Pete Rickershauser, VP Network Planning, BNSF Railway. It will be a very interesting presentation since Pete was one of the key industry leaders involved in the AAR study that came out in September citing a need to invest $148 billion in rail infrastructure over the next 30 years. The restaurant location for the RAS dinner is given on page 12 of this newsletter.

Constitution Changes Official

RAS constitution changes proposed last year have been officially approved. We are officially now a Railway Applications Section! We now have over 200 memberships, and according to INFORMS guidelines we should be a "Section" instead of the "Special Interest Group." The following changes proposed related to the election process have also been officially approved.

- Change references from the "membership meeting" to the "business meeting."
- The Secretary and the Treasurer may serve a maximum of two consecutive terms, if they are reelected.
- The Vice Chair is responsible for conducting the elections.
- The timing of the elections was shortened to better reflect the actual practice.
- On the ballot, only one nominee is necessary for the office of Secretary and one nominee for the office of Treasurer.
- Electronic approval via secure e-mail or website login of amendments to the Constitution will be permitted instead of requiring a sealed envelop bearing the voter's name.

You will find the revised constitution on our website: www.RASIG.net, link Constitution.

Rail Renaissance is Here

Global Insight, Inc. predicts that the growth in freight demand will continue steadily over the next couple of decades. Major drivers for the increase in freight demand are population, economy and growth in foreign trade. Growth in truck volume is expected to outpace any other modes of transportation. Highways, particularly around many urban areas, are already heavily congested, and the government will not be able to continue building more highways and adding lanes to meet such demand. Some of this highway freight demand will shift over to rail, and consequently rail demand will continue growing at a much higher pace than normal. Since moving freight on rail is much more efficient economically and environmentally than on trucks, there has been a significant discussion around public-private partnerships lately.

As the rail volume increases, there will be increasing challenges for railroads to move freight more efficiently by better utilizing existing assets/resources. There will also be challenges in increasing resource capacities including locomotives, cars, crews, and track. Since railroad senior management has been more aware of OR capabilities, OR practitioners will be challenged to build/utilize systems and tools to help make more prudent decisions on these important issues on assets/resource utilization as well as capacity expansions. Many believe that the savings opportunities for railroads by better utilizing resources are in hundreds of millions of dollars.

Railroads have been reducing the size of their work forces continuously over many decades. More than 50% of the current work force is expected to retire over the next 5-10 years. With increasing demand for moving more freight, railroads will be looking for more and more skilled/technologically savvy work forces. Therefore, career opportunities with railroads are going to be growing at an unprecedented level. OR practitioners with strong analytical as well as computer and database skills are highly desirable not only in IT but also in various departments including Locomotive, Crew, Car, Service Design, Engineering and Finance. Because of all these exciting opportunities and challenges ahead of us, I believe that the Rail Renaissance is already here!

See you in Seattle!

The Sikkim Railroad

The Railroad Industry - 2027

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Economic Environment

Any forecast for the railroad industry twenty years hence will be critically dependent on key economic and regulatory assumptions, which in that time frame constitute predictions in themselves. Mine are as follows:

- Economic growth similar to the past ten years;
- Continued expansion of global trade flows;
- A political climate that favors free enterprise and market-based solutions;
- A stable financial environment with only modest inflation;
- Regulation of truck sizes and weights preserving the economic status quo.

Regulatory changes will likely limit pricing spreads between competitive and "captive" traffic but not eliminate differential pricing. Such changes will impact non-intermodal business and may include modification or partial repeal of the "bottleneck" decision. Dramatic changes, such as the separation of infrastructure and operations embraced by the European Union, will not find favor in the United States.

Railroad Traffic

In 2027, the rail industry will likely continue to be dominated by four segments as it is today:

- Utility Coal (especially from Wyoming's Powder River Basin)
- International Intermodal (primarily Asian imports)
- Agriculture (domestic feed market, export grains and ethanol)
- Industrial Products

The utility coal market is likely to grow steadily over the next decade. Despite inroads by alternative energy technologies, currently-planned coal plants will drive demand increases for the next ten years. The additional power needs of a growing population will trump environmental concerns and the abundant supply offered by the PRB will play well to energy security concerns.

While alternative technologies may challenge coal's supremacy beyond 2017, electric vehicles will increase overall power demand, preserving some coal growth. New technologies to counter global warming concerns will enhance coal's position in the fuel mix. Despite political pressure on the margins of the most profitable coal traffic, the segment will remain sufficiently attractive for continued investment.

International intermodal has driven railroad growth in the current decade. That growth will resume once the U.S. housing market returns to positive territory. Macroeconomic factors are likely to reduce the growth rate from the torrid pace of expansion experienced in 2002-2006, but China and other Asian export engines will drive continued import expansion.

A variety of factors will see diversification of origin shipping points, North American ports, and trade routes resulting in changes in flows on the U.S. rail system. Regional government rail shuttle moves between on-dock terminals and nearby inland intermodal hubs. Continued containerization of agricultural exports combined with currency revaluation will increase export intermodal traffic.

The Agriculture business is likely to be a steady, perhaps slightly declining, business for the rail carriers. Development of ethanol/bio-fuel facilities will change the market mix and likely reduce cyclicality. Continuing conversion of the whole grain and some grain product business to unit train operations has improved returns but has left rail unable to compete in some markets; that trend is likely to continue. Railroads will face significant political pressure to reduce rates in the most profitable segments and to provide more capacity than can be justified on the basis of sustained demand. Those issues are likely to persist into 2027.

The industrial products segment will witness declining market share but overall volumes will grow modestly. This is primarily a carload market with some unit train penetration. Short line railroads depend significantly on this traffic and their success will hinge on the rail industry's ability to contest these markets. Box cars face significant competition from dry van trucks and will continue to decline. Dry and liquid bulk products will be the source of most future growth. Increases in truck sizes and weights without offsetting user fees would lead to significant shift away from rail. On the other hand, should the rail industry overcome institutional barriers, short line and regional carriers could gain meaningful volumes of short haul traffic.

Industry Structure

By 2027 the continent will likely see two robustly profitable mega-railroads stretching from the Atlantic to the Pacific and from the Canadian heartland to central Mexico. Formation of such companies will allow the rail industry to compete more effectively for traffic in the "watershed" markets in the U.S. Midwest and the border regions of all three countries.

Consolidation will be accompanied by continued feeder line outsourcing fueling further short line growth. Capital investment will continue to challenge the industry and even the new mega-railroads will be unable to devote scarce resources to secondary lines.

Passenger transportation will be a greater component of the rail industry in 2027. New rail commuter systems will develop and intercity corridors on both coasts will continue to grow as well. Significant government expenditure will enable urban networks to handle the additional traffic.

Technology will be even more important in 2027 than today, helping to handle higher average-traffic density and improve operating precision. Some road trains, perhaps most will be operated with a single crewman and many engineering machines will operate in robotic fashion. Key corridors will operate at 39-ton axle loads to improve the productivity of unit trains, many of which will operate with computer-aided ECP brake systems.

"quick quote"

The shortest distance between two points is always under construction.

-Noelie Alite

informs
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Approximate Dynamic Programming for Modeling Rail Operations

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Approximate dynamic programming has emerged as a powerful tool for handling the complexities of rail operations. So just what is approximate dynamic programming (ADP)? Actually, there are three ways to look at it: (i) A method for solving complex dynamic programming problems (at least, complicated enough so that you cannot use the methods you learned in school); (ii) a way of making simple simulation models more intelligent; and (iii) a technique for decomposing large-scale optimization models into sequences of smaller ones.

Our work in ADP has focused on the last two interpretations. We first started using ADP to solve very large-scale (deterministic) math programs (in particular, integer programs) that arose in freight transportation. Our first applications were managing drivers in LTL trucking and flatcars for intermodal rail freight. We did not care about uncertainty – we just wanted to solve optimization problems that were much too large for commercial solvers.

We have found that solving sequences of small problems is much easier than solving one large problem. Messy problems such as locomotives can be solved optimally (at a point in time) without sacrificing our ability to handle all the issues that arise in real applications. Instead of needing heuristics, we can solve these smaller problems using standard commercial packages such as CPLEX. The challenge is that we do not just want solutions that look good at a point in time – we want solutions that are good over time. This is where ADP comes in – we solve a problem at a point in time using an approximation of the value of locomotives (or cars, or crews) in the future. We do this using *value function approximations* to capture the value of assets in the future. Designing these approximations is the hard part, but we have found certain classes of approximations that work very well for the types of problems that arise in rail.

Later, we discovered that ADP handles uncertainty very easily. Perhaps you want to model uncertainty in transit times, equipment failures, or the demands of your customers. ADP works by stepping forward in time, just as you would in any simulation model. As you simulate forward, you perform coin-flipping on any random quantity (just as you would in a simulation model). The difference is that instead of running the simulation once, you run it repeatedly. Over the repetitions, you learn (using statistical methods) the impact of current decisions on the future. This means that we can run simulations to test the value of more reliable transit times, better equipment, or policies for encouraging customers to commit farther into the future.

ADP is starting to prove itself in the real-world of complex freight transportation problems. We have recently finished the development of a model that allows Schneider National to simulate its fleet, allowing them to ask questions about drivers and loads. The model was found to closely match historical metrics, showing that it can strike the right balance of simulating (that is, capturing all the business rules) and optimizing (which means matching a room full of very good dispatchers). Approximate dynamic programming allows the simulator to match the ability of human dispatchers to think about the impact of current decisions on the future (e.g., are we putting the driver on a load that will get him home?).

We used ADP in an operational planning model for managing freight cars and found that it was able to handle all the business rules required to produce good recommendations, both as a simulator and as an operational forecasting system (that is, one that would look several weeks into the future). We are currently working with Norfolk Southern to develop a model that helps with planning questions for locomotives. We expect the system will be used to help with fleet size and mix, measuring the value of improved transit time reliability, and a host of other policies and operating rules. The planning model is in its final stages of development. The next stage of the project will be an operational planning system that looks several days into the future to help identify trains that are at risk of not being covered and routing power to shop on time. The last stage of the project will be a system that helps the locomotive planners assign power to trains in real-time.

Speed Facts

- French TGV (*Train à Grande Vitesse*) is the fastest conventional train in the world, using powered metal wheels riding on metal rails. In April 2007, the TGV broke its own 1990 record with a new speed of 357.18 mph (574.8 km/h) under test conditions with a shortened train (two power cars and three passenger cars).
- The Japanese JR-Maglev is the fastest non-conventional train in the world, having achieved 361 mph (581 km/h) on a magnetic-levitation track.
- Unmanned rocket sleds that ride on rails have reached over 10,400 km/h (6,462 mph), equivalent to Mach 8.5.
- The fastest manned rail vehicle is a manned rocket sled, that traveled at 635 mph (1,017 km/h).

TGV, France

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The Ethanol Boom: Good or Bad for the Railroads?

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Overview

Ethanol is a growing rail market, based largely on mandates in the 2005 Energy Bill which requires 4.0 billion gallons of renewable fuel (mostly corn-based ethanol) be added to the gasoline supply in 2006. The requirement rises to 4.7 billion gallons for 2007 and 7.5 billion in 2012. Ethanol is produced primarily where corn is grown. The largest ethanol-producing states are Iowa, Nebraska, Illinois and Minnesota; taken together, they account for almost 60% of the national capacity. Transportation of ethanol has shifted from being shared almost equally between truck, rail and barge, to being dominated by rail with over 75% of ethanol now moved in tank cars. It is currently uneconomical to move ethanol in pipelines because it absorbs water and impurities normally found in pipelines and thus contaminates the fuel mixture it is eventually used in.

Consequently, over the last few years, railroads have transported a rapidly increasing volume of ethanol from plants in the mid-west to markets in California and New York. At the same time, shippers and leasing companies have invested heavily in new tank car purchases. Investors are very excited about the positive impact this new business is having on railroads and on railcar manufacturers. But, how much of the current railroad renaissance is due to ethanol? And how much more growth can we expect in the future? The impact of ethanol on grain markets and the demand for covered hopper cars is a matter of some debate. Our view is that while increased ethanol production will have a positive impact on tank car markets, the ethanol boom is having a negative impact on the rail grain markets.

Impact on Tank Cars

The most common tank cars are AAR types T104 through T108. These carbon steel cars holding 12,000 – 31,000 gallons comprise 70% of the tank car fleet. The T108 type is the most commonly produced new tank car design and the preferred style for ethanol transportation. Investors like the T108 because it is fungible and could be readily deployed to other commodity markets if the current ethanol boom were to end. We estimate about 22,100 tank cars were used in ethanol service in 2005.

Future ethanol growth is not a sure thing and investments in this market are at some risk. The US government currently protects domestic ethanol production with a 56-cent per gallon import tariff on ethanol. Some agricultural economists are worried that rising corn prices may impede ethanol expansion or even that there will be insufficient corn volumes to support new production capacity. And of course, in the event that oil prices fall, ethanol will no longer be an economical substitute even with existing subsidies. Assuming these risk factors are not manifested, a few simple calculations yield a very good estimate of the number of tank cars required to support the growing ethanol market.

7,500,000,000	Gallons per year in 2012 mandated by 2005 Energy Act
30,000	Gallons per tank car
58	Car days per car load (current T108 tank car utilization)
80%	% of Ethanol Moved by Rail
365	Days per year
31,781	**Cars required to transport ethanol in 2012**

Each new ethanol plant that comes on line will need a source of railcars to support it. A typical plant produces about 100 million gallons per year. So, using the same math, each new plant requires about 530 new tank cars to be added to the fleet.

Impact on Covered Hopper Cars

While corn plantings are up 19% in 2007 over 2006, export corn volumes, traditionally long haul rail traffic, are going down as farmers send more of their products to domestic ethanol plants. Since ethanol plants are located near fields, much of the inbound volume is trucked and not railed, shortening the average rail haul as compared to historical figures. Trucks used to move the grain from fields to elevators (say 50 to 150 miles away) where the grain was transferred to rail. Now, more and more trucks are moving grain from fields to ethanol plants (say 50 to 300 miles away) where the grain is processed and transferred into rail cars in the form of ethanol and the by-product Distillers' Dried Grains (DDGs). Each inbound bushel of corn produces 2.7 gallons of ethanol and creates almost 7 lbs of DDGs. An ethanol plant with 100 million gallons per year capacity, operating on a 24/7 basis, produces the equivalent of about nine rail cars of ethanol and an additional nine rail cars of DDGs per day. Thus, about a third of the volume of corn going into an ethanol plant comes back out as DDGs. Instead of moving 10 cars of grain as in the past, railroads will now only move 3 to 4 cars of DDGs. Therefore, we conclude that longer truck hauls at origin combined with the dramatic reduction in volume as the market goes from transporting unprocessed corn to processed DDGs will have a negative impact on covered hopper demand.

7,500,000,000	Gallons per year in 2012 mandated by 2005 Energy Act
7	Pounds of DDGs per gallon of ethanol
90	Tons of DDGs per rail car
36	Days per load (current covered hopper grain car utilization)
80%	% of DDGs moved by rail
365	Days per year
23,014	**= Cars required to transport DDGs in 2012**

But there will be an offset: a reduced need for covered hoppers to carry corn. If all corn going into ethanol plants is diverted from export or other long-haul markets, there will be a significant decrease in the need for covered hoppers.

7,500,000,000	Gallons per year in 2012 mandated by 2005 Energy Act
21.5	Pounds of corn per gallon of ethanol
100	Tons of corn per car
36	Days per load
100%	% of grain moved by rail
365	Days per year
79,521	**= Cars not required to move corn in 2012**

Thus, each new 100M gallon plant built will increase the tank car fleet by about 530 cars and generate 3,285 new tank car trips per year. But, the new plant will also decrease the required covered hopper demand by about 750 cars and reduce covered hopper car trips by a net 7,640 trips per year.

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The (In)Consistency of Strategic and Tactical Modeling of Seasonal Inventory Targets

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The rail industry is rife with seasonality of all sorts: weekly, monthly, quarterly. For purposes of this article, we will focus on daily patterns of demand for assets such as locomotives, railcars, rail controlled trailers and containers, and crews. To support this seasonal activity, railroads must position their assets appropriately. What are the best levels of asset inventory through time to support a highly fluctuating daily usage pattern?

Railroads measure and try to predict aggregate imbalances of supply and demand of assets. For example, supply and demand for locomotives may depend on the number of train terminations and originations; or, terminated loads and historical orders may establish supply and demand patterns for railcars, trailers or containers.

But, railroads have options such as asset repositioning, use of less desirable alternative assets, or service failures that are (perhaps undesirable) alternatives to balancing these assets. Beyond simple surplus and deficit situations, there are "preferred" and "less preferred" solutions that provide the railroad more options. For example, alternative box types or less efficient locomotives may suffice to meet some need.

In the name of optimal allocation of these resources, railroads can plan target inventories based on these cyclical patterns. Strategic models for setting target inventories are based on historical cyclical patterns in availability and uses of each resource. Typically, strategic models are formulated so that the ending period's ending stock variables must equal the beginning period's starting value, thus creating continuity and consistency in the strategic model. Just as a circle must tie back to itself, so does a cyclic model's starting and ending inventory. These targets might be used as a tool for management to evaluate how well these inventories are managed against strategically-set targets given some planned recurring steady-state patterns.

An alternative to strategic target setting is a more tactical orientation. Given the current situation and anticipated cyclic supply and demand, what is the best course of action for managing these critical assets? The same options exist in tactical modeling, but these models are tied to a starting condition: given the current situation (given all past patterns of supply and demand and management reactions to same), what is the best course of action for managing the railroad's assets? This approach may be closer to home, based on actual situations currently faced by the railroad (the problem du jour!), but they are reactionary in nature. Rather than establishing long-term targets that put a railroad in the best position for balancing asset needs, tactical models are more "recovery" or "disequilibrium" models that react to whatever situation is being faced, without a long-term, big picture ideal in mind.

Simply, tactical models react to past events; strategic models plan for them by viewing yesterday's events as next week's future events. Perhaps most importantly, tactical models do not indicate a path back to any sort of strategic steady state. As has been said, if you don't know where you are going, you probably won't get there. Tactical models are necessary for handling where you are; strategic models are necessary for knowing "where you want to be". The question is how to align these models.

Ostensibly, the goal is to manage to the "strategic target" level of inventory. Given that in the tactical setting we are often off the strategic target, we might strive to return to the optimal strategic levels. However, how close to strategic targets is "close enough?" What is the cost of deviating from this target? Is it better to be over or under target? What is the cost of adjustment? How fast should we adjust? How much weight should be given to strategic and tactical considerations?

To answer these questions, we created optimal strategic models for asset management in a cyclical environment. Then, through simulation of various starting conditions in a tactical modeling environment, we evaluated the cost of deviation from these targets as estimated by the change in objective function value. We found that the costs of deviation from strategic targets are asymmetric relative to the target inventory; the cost of being over can be very different from the cost of being under. Further, the cost of deviation can be shown to be convex; larger deviations have increasing costs per unit.

Most importantly, as it turns out, in many cases the strategic model ideal in fact *does not* indicate the optimal inventory level for given situations leading up to some tactical disequilibrium; the strategic optimum may not be desirable in some situations and pursuing them can be counterproductive. The optimal solution is not optimal!

This unintuitive result comes from the patterns of supply and demand and the series of events that led to the disequilibrium. Because of the fewer constraints afforded strategic models, the potential solutions are typically of better value than those of the tactical models. Thus, we strive to achieve our strategic targets. But, a level of inventory that is in fact not achievable (but still desirable) in a strategic setting may be experienced due to a myriad of influences that led up to that point in the tactical world. We may in fact be glad to be over strategic targets, making tactical solution results preferable to strategic model solutions. Thus, being off target can be an advantage over the strategic optimum.

Simply, we are faced with a paradox that strategic and tactical model recommendations do not necessarily match. The implications for asset management are palpable. While having an idea of "where you want to be" is important, managing too strictly to these targets can be shown to be suboptimal. Thus, a coordinated blend of the two approaches is required. Our experiments describe the appropriate mix of the two model regimes: strategic models to set policy, tactical models to set optimal behavior given current conditions and the long run strategic targets.

"quick quote"

Silver is a market that sort of acts like a freight train. It's really slow-moving, and once it gets started in a direction, you cannot stand in front of it.

- Frank McGhee

RAS Student Paper Awards

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RAS (Rail Applications Section), a section of INFORMS (Institute for Operations Research and Management Science), 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 First Place and Second Place are asked to present the papers at the INFORMS Annual Meeting November 4-7, 2007, in Seattle, WA. RAS covers the conference registration fees for all primary authors who are asked to present their papers. Railway Age will publish summaries of the First Place and Second Place entries.

To qualify, the paper must be written by a student or students enrolled in an academic institution during the 2006-2007 academic year. The paper must relate to the application of Management Science for the improvement or utilization of railroad transportation, and must represent original research that has not been published elsewhere. More details on eligibility criterion, the application procedure, and deadlines for submission are available at RAS's website www.rasig.net.

We expect that these award-winning papers will be presented in Student Paper Contest session at the INFORMS 2007 Meeting in Seattle. We give 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.

First Prize:

- **A Tabu Search Algorithm for Rerouting Trains During Rail Operations.** Andrea D'Ariano, Faculty of Civil Engineering and Geosciences, Department of Transport and Planning, Delft University of Technology, Stevinweg Delft, The Netherlands; a.dariano@tudelft.nl

  Abstract: This paper addresses the problem of train conflict detection and resolution, which is dealt every day by traffic controllers to adapt the timetable to real-time unpredictable events. We take advantage from existing reliable rescheduling algorithms to incorporate them in a rerouting tabu search scheme, and investigate the effectiveness of different neighbourhood structures. Extensive computational experiments show the high potential of advanced reordering and rerouting algorithms to reduce delays and to improve the use of infrastructure capacity.

Second Prize:

- **Load Planning Problem at an Intermodal Railroad Terminal**. Ashish Kumar Nemani, Industrial and Systems Engineering, University of Florida, Gainesville, FL; aknemani@ufl.edu

  Abstract: In this paper, we study the load planning problem (LPP) arising at an intermodal railroad terminal. The LPP is to assign the containers and trailers on the given set of railcars to maximize train utilization and aerodynamic efficiency. A solution of this problem must also satisfy several operational and regulatory requirements. We formulate the LPP as an integer program on an underlying network and solve it to optimality using CPLEX. The run-time of the CPLEX optimizer increases exponentially with the network size, and it fails to solve modest size problems in reasonable time. To efficiently solve these real-life instances, we propose two multi-exchange neighborhood search algorithms. Our empirical studies demonstrate that these algorithms are able to solve the problems of modest size in reasonable time. The additional advantage of our approach is the flexibility to incorporate any new business requirement easily.

Fairy Queen: World's Oldest Working Locomotive (1855, India)

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Remarks on 130 Years of Port Rail Service in the Pacific Northwest

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"A waterfront is merely a more or less ornamental property unless it is connected with the inland territory by the steel highway," Robert Bridges, President, Seattle Port Commission, October 1915

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Our meeting this November will feature a roundtable session entitled "Rails to the Sea" in honor of our host city, Seattle, as well as the neighboring ports of Tacoma and Vancouver. These northwestern ports continue to ride the record-breaking surge in marine traffic, and are fundamental to the North American economy. Over half of the tonnage handled is container traffic, and approximately half of this container traffic moves by rail. We have arranged an excellent selection of speakers for this year's roundtable, representing the Port of Tacoma, CSX, DMJM Harris, and the Trade and Transportation Practice of Global Insight. Seattle and Tacoma especially have an interesting historic relationship, one worth retelling before our journey to the Northwest.

Unlike other port cities, such as New York, New Orleans, or San Francisico, whose maritime significance predates the arrival of railroads, Seattle and Tacoma's ports are creatures of the connecting railroads. Prior to the arrival of the railroads, Seattle was a frontier town and Tacoma was an undeveloped outpost. The Northern Pacific was the first railroad projected into the region, but its finances were motivated primarily by government land grants and speculation. So, rather than terminate in the established commercial center of Seattle, on July 14, 1873 the Northern Pacific announced its intent to terminate in Tacoma.

Furious and proud, the citizens of Seattle initiated construction of their own railroad on May 1, 1874. The first few months of construction were in fact a volunteer effort, conducted with a series of picnics and civic exhortations. After transition to a more conventional workforce, a 15-mile line connecting the waterfront with regional coal mines opened in March of 1876. Meanwhile, the Northern Pacific struggled with difficult terrain and shaky finances and did not complete its transcontinental link until September 8, 1883.

Seattle's relationship with the Northern Pacific was bitter, and only became worse upon the opening of through service. Seattle referred to the Northern Pacific as the "Steel Noose" and was desperate to break this monopoly. Once again, local financiers initiated a railway, the Seattle, Lake Shore and Eastern, to connect Seattle with Vancouver to the north and to the eastern United States via the Canadian Pacific. The Northern Pacific of course recognized this line as a threat and went to great lengths to block its completion, leading to a legendary maneuver known as the "Battle of Snohomish Bridge."

The Seattle, Lake Shore & Eastern laid track north from Seattle along the western bank of Lake Washington, through Winsor, and had reached the bank of the Snohomish River by June of 1888. The Northern Pacific had allied itself with a paper corporation and local landowner to obtain an injunction against the construction of a bridge for the Seattle, Lake Shore & Eastern. A prominent Seattle judge and Seattle, Lake Shore & Eastern proponent, Thomas Burke, got wind of this injunction, and managed to reach the train station before the northbound passenger train carrying the process server had departed. Judge Burke convinced the train engineer to uncouple his engine from the train and run light to Snohomish with the Judge riding in the cab, leaving the passenger train, and the injunction, stranded in the station. On arrival in Snohomish, Judge Burke convinced the local authorities to make themselves unavailable, and motivated work crews to accelerate construction of the bridge. Thus by the time the process server arrived in Snohomish and found the Sheriff, the bridge was finished!

Ultimately, the connection to the Canadian Pacific was not a satisfactory competitor to the Northern Pacific. Seattle had to wait until January 7, 1892 for the completion of the Great Northern to obtain a competitive rail link to the eastern United States. But a rail link alone was mere hardware, and it was the economic development leadership of James J. Hill that allowed Seattle and Washington State to flourish. Hill aggressively cut rates on lumber and commodities traveling eastbound from Seattle, and followed the lead of the Canadian Pacific by establishing a competing line of steamships from Seattle to the Orient, culminating in the 28,000-ton steamers Minnesota (1903) and Dakota (1904). Seattle and Great Northern's link to the Orient was typified by the "silk trains", fast, priority freight trains moving raw silk in passenger baggage cars from the Seattle dockside to the eastern apparel markets. The record time for such a run was set in 1911, 45 hours and 16 minutes from Seattle to St. Paul, where the traffic was handed off to connecting lines such as the Chicago, Burlington, and Quincy or the Chicago, Milwaukee, St. Paul, and Pacific.

The silk trains have long since been replaced by jet planes, and the Great Northern and Northern Pacific are no longer competitors, but are components of BNSF. Yet Seattle and Tacoma remain competing, and growing, ports with comparable traffic in ship calls and container tonnage, as demonstrated in Figures 1 and 2. We hope this introduction has whet your appetite, and we encourage you to join us next month at Rails to the Sea and learn what is projected for the future of not only the ports of Seattle and Tacoma, but railway-port relations in general. **>> Continued on Page 9**

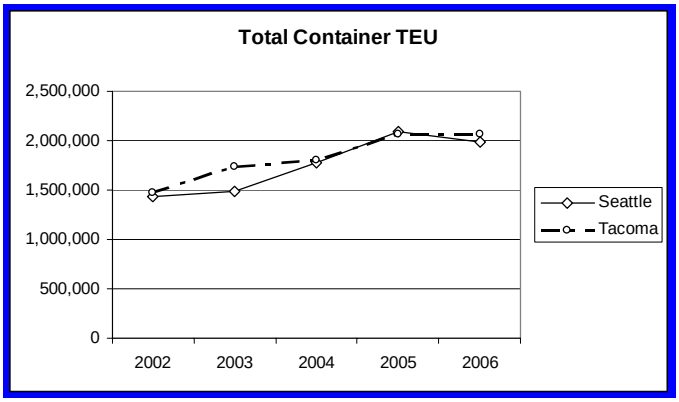

Figure 1: Container TEU, 2002-2006

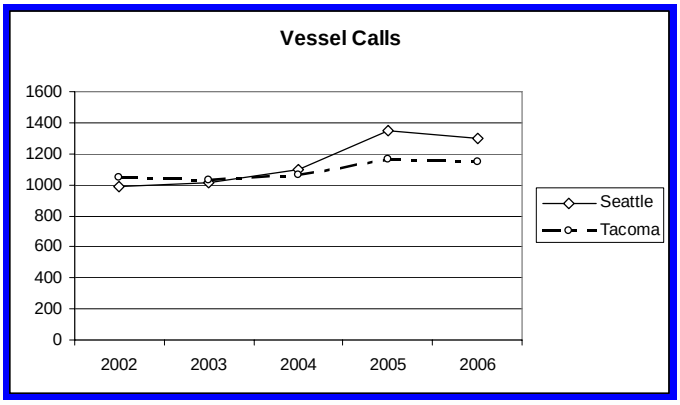

Figure 2: Ship Landings, 2002-2006

Jeppesen Implements Lifestyle Rostering for French National Railways

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Lifestyle Rostering is a crew-scheduling concept in which worker preferences for the days they work and the types of shifts they work are blended into the traditional shift-creation and shift-assignment process. With Lifestyle Rostering, workers gain greater control over their work/life balance. This produces benefits to the railway such as less absenteeism, less use of reserve workers, and better employee morale. Less absenteeism is the result of workers having a direct method to request days off when they need them (rather than calling in sick). With more visibility for days off requests, the railway can schedule regular workers to cover the duties of absent workers and make less use of reserve workers on a short-term/emergency basis. Better employee morale is the result of more employees working the types of shifts they prefer. In combination, these features help the railway become a more attractive employer to younger workers. In turn, this improves employee recruiting and retention.

The process of building shift assignments for individual workers also allows the railway to tailor those assignments to the specific workload of the roster period. If a roster period contains both a special event (increased load) and a public holiday (decreased load), then it may be possible to optimize the roster for that period rather than making override adjustments to a roster constructed for "normal" periods. Alternatively, it may make sense to grant (slightly) more leave in weeks with lower load (e.g., public holidays) and (slightly) less leave in weeks with higher load (e.g., many special events).

For the French National Railways (SNCF), Jeppesen has extended its crew-scheduling software to support the Lifestyle Rostering concept for scheduling train guards (equivalent to conductors on North American passenger trains). SNCF has deployed the software in four regions covering about 1,500 guards. After full roll-out, the software will be deployed in 24 regions covering about 9,000 guards.

SNCF constructs two types of shifts for their crews. *Simple* shifts start and end at the same depot within a standard maximum duration (say, 9 hours). *Rest* shifts are typically composed of up to 8 hours of work, a break of 8 to 12 hours at a location that is not the home depot, and then another block of up to 8 hours of work, returning to the home depot. Rest shifts are often used on longer distance passenger services.

At SNCF, the basic roster period is one month. Two months prior to a new roster period, crew bid for the type of work they wish to do. They can bid to start late (and finish late) or start early (and finish early). They can also bid to do more, fewer or specific rest shifts. Individual assignments for crew are posted 45 days in advance of the roster period.

To date, SNCF has achieved two key benefits:

- A high rate of preference satisfaction, which is only reduced when there is contention for scarce resources (e.g., additional high value shifts);
- Reduced "reserve" pools. The number of crew who are given their work with short notice or are used to cover annual leave has been reduced. Most, but not all, of this number is being absorbed into the main part of the roster.

Remarks on 130 years (contd.)

References:

Armbruster, Kurt E. "Orphan Road, The Railroad Comes to Seattle, 1853-1911." Pullman: Washington State University Press, 1999.

Hidy, Ralph W., Muriel E. Hidy, Roy V. Scott, and Don L. Hofsommer. "The Great Northern Railway, A History." Minneapolis: University of Minnesota Press, 1988.

Binns, Archie. "Northwest Gateway, The Story of the Port of Seattle." Garden City: Doubleday & Company, 1946.

Bridges, Robert. "Public Ownership and Operation of Water and Rail Terminal Facilities Produce the Greatest Dispatch and Economy." Sixth Annual Convention League of Washington Municipalities, North Yakima, October 6-7-8, 1915.

"quick quote"

Sir, Sunday morning, although recurring at regular and well foreseen intervals, always seems to take this railway by surprise.

-William S. Gilbert

The Ethanol Boom: (contd.)

This short exercise demonstrates that even with very rudimentary calculations and simple data, one can provide meaningful insights into some very complicated questions. Operations Research and Management Science does not always have to be based on sophisticated network models, but should always be rooted in analysis, logic, and structured thinking.

Innovative Scheduling has worked for rail car manufacturers, leasing companies, railroads and investors to analyze, model, and forecast rail car supply and demand. We have a sophisticated rail car supply–demand forecasting model that takes into account freight volumes, fleet demographics, projected retirements, improved rail velocity, and shifts in geographic and commodity markets. Our framework enables clients to test assumptions, quantify the risk and sensitivity of the forecast to various future scenarios, and gain valuable insights on the cause-and-effect relationships between freight flows, network performance, and rail car supply and demand.

RAS Sessions at 2007 INFORMS Annual Meeting, Seattle

Sunday (November 4): Cluster 52	
8:00 – 9:30 AM	**SA52: RAS Student Paper Session** Chair: Pooja Dewan, BNSF Railway • A Tabu Search Algorithm for Rerouting Trains During Rail Operations (Andrea D'Ariano) • Load Planning Problem at an Intermodal Railroad Terminal (Ashish Kumar Nemani)
10:00 – 11:30 AM	**SB52: Academic Contributions to Railroad Operations Research** Chair: Christopher Barkan, University of Illinois at Urbana-Champaign • Estimating Congestion Impacts on Rail Lines via Statistical Methods (Michael Gorman) • Trolley Assignment Model for a Container Terminal with a Low Viaduct Horizontal Rail System (Anne Goodchild, Karthik Mohan) • Capacity Management for Heterogenous Traffic on Double Track Railroads (Steven Harrod) • A Decision Support Framework for Railway Capacity Expansion (Yung Cheng Lai, Christopher Barkan)
1:30 – 3:00 PM	**SC52: RASIG Roundtable: Rails to the Sea: Current Issues in Railway-port Interchange - Part I** Chair: Steven Harrod, University of Dayton • Matching and Forecasting US Inland Trade (Bengt Muten) • Advances and Operating Strategies for "Green" Intermodal Container Terminals (Vaibhav Govil) • How Ports and Railroads Must Work Together to Support Projected Traffic Growth (Larry St. Clair) • Driving the Renaissance of Rail Transportation with Marine Container Growth (Cary Helton)
3:00 – 3:15 PM	**Refreshments (Courtesy of RAS)**
4:30 – 6:00 PM	**SD52: Roundtable: Rail to the Sea: Current Issue in Railway-Port Interchange - Part II** Chair: Steven Harrod, University of Dayton • Continued from the previous session.
6:15 – 7:15 PM	**Refreshments, Railroad Applications Annual Meeting & Election of Officers** **Location: Sheraton Hotel, Room: LESCHI, Level 3**
7:30 PM - 9:30 PM	**Railroad Applications Annual Dinner (Sponsored by Innovative Scheduling, Jeppesen Rail, Logistics & Terminals, and Oliver Wyman)** **Location**: Rosebud Restaurant, 719 East Pike St.; 0.5 mile walk from Sheraton Hotel; Phone: 206-323-6636; www.rosebud-restaurant.com; Emergency contact: Dharma Acharya (904) 607-7211. **Dinner Speaker**: Pete Rickershauser, VP Network Development, BNSF Railway

Monday (November 5): Cluster 52	
8:00 – 9:30 AM	**MA52: New Operations Research Models for Railroad Planning** Chair: Ravindra Ahuja, University of Florida • LocoSim: A Simulation/Optimization Framework for Locomotive Planning (Kamalesh Somani, Artyom Nahapetyan, Ravindra Ahuja, Zeynep Sargut, Andy John) • Optimization-Based Railroad Blocking Case Studies at BNSF (Xiaoyun Ji , Pooja Dewan) • Optimizing Train Plans: Case Studies from the Field (Arvind Kumar, Ravindra Ahuja, Krishna Jha, Larry Shughart)
10:00 – 11:30 AM	**MB52: European Rail Research** Chair: Michael Gorman, University of Dayton • Deadhead Selection for Railway Crew Scheduling Applications (Marc Albers, Ulrich Thonemann) • A Mathematical Model for Optimizing the Management of Empty Railcars (David De Almeida, Christian Weber, Romain Wlodarczyk) • Solving Rolling Stock Scheduling Problems at SNCF (Nicolas Marcos, Guillaume Bourez, David De Almeida, Christian Weber) • A New Railway Rolling Stock Planning System (Jesper Hanson, Mattias Grönkvist, Erik Hasselberg, Jens Kjerrström, Tomas Lidén)
1:30 – 3:00 PM	**MC52: Fleet Sizing** Chair: Moncef Sellami, TTX Company • Reconciling Strategic and Tactical Fleet Inventory Targets with Cyclical Demand (Michael Gorman) • Locomotive and Freight Car Planning: Predicting the Future (Evan Bell) • Intermodal Fleet Sizing (Maia Pykina) • Introduction to the Reload Fleet Size Model (Moncef Sellami) • Strategic Railcar Fleet Planning at Norfolk Southern (Stephanie Jernigan, Clark Cheng)
4:30 – 6:00 PM	**MD52: Rail Demand Forecasting** Chair: Clark Cheng, Norfolk Southern Corporation • Forecasting Demand at Union Pacific Railroad (Mark Czerwinski) • Demand Forecasting and Resource Planning Utilizing the Operating Plan Tool Set at CSX (Gabe Farra, Dharma Acharya) • Intermodal Demand Forecasting (Maia Pykina) • Use Demand Forecast for Operations and Asset Planning at Norfolk Southern (Clark Cheng, Viraj Karnik, Ilya Lavrik, Kitty Vollbrecht)

Railroad OR Library

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

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Innovative Scheduling is developing software products to solve several planning and scheduling problems arising in railroads. The company is developing optimization and simulation engines using cutting-edge operations research techniques and packaging them in interactive, web-based decision support systems using latest information technology tools. Our products include:

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- **Innovative Locomotive Simulation Optimizer**
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Free RAS Dinner at INFORMS

We would like to invite all RAS members for a dinner on Sunday (November 4) 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 their spouses. The dinner will take place at 7:30 PM at the Rosebud Restaurant, 719 East Pike St.; www.rosebud-restaurant.com; a few blocks walk from the Sheraton Hotel; Phone: 206-323-6636. Another special attraction of the dinner will be a featured lecture by Pete Rickershauser, VP - Network Development, BNSF Railway. This dinner is sponsored by: Innovative Scheduling, Jeppesen Rail, Logistics, & Terminals, and Oliver Wynman. If you have any last-minute questions or problems, feel free to call Dharma Acharya on his cell phone: (904) 607-7211.

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