



Roundtable profile: BNSF Railway

Railway's operations research team helps lay tracks for the future

By Amy Casas

When people think of railroads, what often comes to mind are thoughts of the American West with steaming locomotives chugging along endless miles of track interrupted only by the occasional train station. While railroads are not settling the Wild West anymore, they are continuing to break into new frontiers of trade, efficiency and innovation that find them pioneering and on the cutting edge of research and technology. Such is the case for today's BNSF Railway, which is the product of nearly 400 different railroad lines that merged or were acquired during more than 160 years.

The Fort Worth, Texas-based BNSF has more than 47,000 employees spread across its 32,500 miles of rail network operating in 28 states and three Canadian provinces. As one of the largest freight railroads in North America, BNSF serves more than 10,000 customers by transporting goods and commodities that make people's lives better. The coal hauled by BNSF powers one out of every 10 homes in the nation. BNSF also transports enough grain to supply 900 million people with a year's supply of bread, enough asphalt in a year to lay a single lane road four times around the equator, and last year it moved more than 5 million containers of con-

All About the Roundtable

sumer products that were sold by big box retailers and specialty shops alike all across America.

According to the most recent Commodity Flow Survey, railroads carry more than 40 percent of freight volume in the United States – more than any other mode of transportation – and provide the most fuel- and cost-efficient means for moving freight over land. In fact, BNSF is able to move a ton of freight almost 500 miles on a single gallon of diesel fuel thanks to the technological advancements achieved in operating today's locomotives.

Unlike other forms of freight transportation, BNSF trains operate on an infrastructure built and financed mostly by the railroad. BNSF has created one of the most advanced rail networks in the world by better utilizing existing rail capacity and making record investments in new infrastructure and equipment directly connected to its operations. Since 2000 BNSF will have reinvested more than \$50 billion by the end of this year to improve the safety and reliability of its rail network and accommodate expected growth.

Driving Solutions with O.R. & Analytics

Behind the scenes helping equip BNSF leaders with the research necessary to make decisions on everything from capital investments to improving train efficiency is the company's Operations Research and Advanced Analytics team. The team is led by Pooja Dewan, BNSF's general director of decision support systems, who provides analytical consulting and decision support throughout the company. Dewan has led the team for the past 12 years and has been with BNSF for 17 years.

Through the years the team has grown to include more than 20 full-time team members with advanced degrees in a variety of fields including operations research, industrial engineering and applied math and statistics.

"We use advanced analytics to help drive and enhance the decisions made by BNSF's leaders," Dewan says. "With a network of thousands of miles of tracks and tens of thousands of train movements to move millions of containers and railcars, we have vast amounts of data. Our team works to make sense of all that data. That analysis then gives business leaders insight into how we can increase efficiency and grow our business."

Every day Dewan and the Operations Research and Advanced Analytics team help the company bridge the gap between practice and academia. Over the years the team has grown to play an integral part of the decision-making process at BNSF in projects such as creating the most efficient and safest train routes, the availability of train crews, building trains at rail terminals, equipment ordering, train dispatching, fueling and inspecting trains, and so much more.

The Roundtable consists of the institutional members of INFORMS with member company representatives typically the overall leader of O.R. activity. The Roundtable is composed of about 50 organizations that have demonstrated leadership in the application of O.R. and advanced analytics. The Roundtable culture is peer-to-peer, encouraging networking and sharing lessons learned among members.

The Roundtable meets three times a year. Roundtable goals are to improve member organizations' OR/MS practice, help Roundtable representatives grow professionally and help the OR/MS profession to thrive. Further information is available at <http://roundtable.informs.org>.

The Roundtable also has an advisory responsibility to INFORMS. According to its bylaws, "The Roundtable shall regularly share with INFORMS leadership and advise the INFORMS Board on its views, its suggested initiatives and its implementation plans on the important problems and opportunities facing operations research and the management sciences as a profession and on the ways in which INFORMS can deal proactively with those problems and opportunities." The Roundtable meets with the INFORMS president-elect each spring to discuss practice-related topics of interest to him or her, and with the entire INFORMS Board each fall to discuss topics of mutual concern.

This series of articles aims to share with the INFORMS membership at large some information and insights into how O.R. is carried on in practice today.

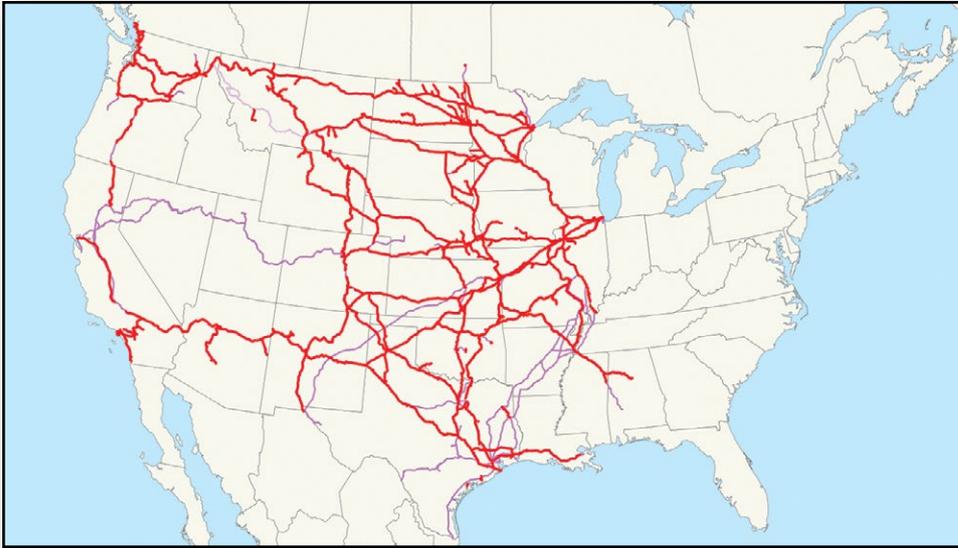


INFORMS member Pooja Dewan (sitting, third from left) leads BNSF's Operations Research and Advanced Analytics team.

"Considering the complexity of railroad operations and the speed with which business, technology and government regulations can change, it is important for us to be able to use scientific thinking to help us solve problems," says Rollin Bredenberg, BNSF's vice president for capacity planning and operations research.

The team always looks to spend quality time with its internal clients and whenever possible even shadow them so they can gain additional insights that help them frame and solve problems. They often put together cross-functional teams to develop solutions that their internal clients can understand and find useful. When certain tools aren't being used, they reach out to their stakeholders to learn why. This helps ensure that the tools are still relevant and when necessary improve upon the models and insights.

"I believe our recipe for success has been our ability to hire technically strong team members, who help



One of the largest freight railroads in North America, BNSF's 32,500-mile rail network spans 28 states and three Canadian provinces.

Planning
train crew
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complex
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large
number of
factors
in a
very limited
amount of
time.

us deliver quality solutions that solve the right problem,” Dewan says. “To be effective we have to take these technically strong individuals and educate them about the railroad industry and help each person cultivate strong relationships within the organization.”

Designing a Train Transportation Plan

In 2014, BNSF handled more than 10 million shipments. Roughly 19 percent of those shipments were moved in what are known as “merchandise” trains. Those are trains made up of rail cars that contain a variety of mixed freight. They include lumber, paper, machinery and various industrial parts, as well as tank cars containing various types of chemicals used in manufacturing.

The merchandise train business is complex. Those rail shipments move between 2,300 railway stations and consist of small groups of railcars ranging from 1 to 40 railcars, which are added together to make full-length trains. To facilitate efficient movement of these shipments, railcars with similar destinations are grouped at freight yards for movement on trains. Each group of railcars, known in the rail industry as a block, moves together from one rail yard to the next, where the cars are re-sorted into new groups with railcars more closely matching their destination. The objective of grouping together railcars with similar destinations is to minimize the miles and amount of sorting that has to happen before the shipment reaches its final destination, all while taking into consideration each rail yard’s capacity.

Working closely with their BNSF colleagues, the Operations Research and Advanced Analytics team developed a series of tools to help improve the flow of merchandise trains across BNSF’s network by assigning the right railcar groups to the right trains. Those tools allow service design planners to

determine the most efficient frequency and timing of trains, which has reduced the amount of time it takes for each railcar to reach its final destination. The team’s efforts to develop these tools have been recognized with the Daniel H. Wagner Prize for Excellence in Operations Research Practice and being named a semi-finalist for the Franz Edelman Award from INFORMS.

Crew Planning & Time Prediction Tools

In the railroad industry, like many industries with large workforces, labor costs are the businesses’ biggest expense. For decades, experienced crew planners have, for the most part, manually assigned train crews. Planning train crew assignments is a complex process that involves the con-

sideration of a large number of factors in a very limited amount of time. The train crew planner is tasked with assigning crews located across a vast geography in the most efficient and cost-effective manner possible so trains are not delayed or canceled. The task is made more complicated by the large number of rules the crew planners must observe to maintain safe rail operations.

Partnering with operations leaders, the BNSF’s Operations Research and Advanced Analytics team developed an application to assist in the crew planning process. Launched in 2013, the Crew Decision Assist (CDA) application uses a formal optimization algorithm that suggests, in real time, effective crew plans to dispatchers. The implementation of this application has helped reduce the overall cost of positioning crews to operate trains within a territory. The CDA application is currently being used in approximately 60 percent of BNSF’s train crew districts with plans to expand it even more.

Timing is everything, especially when customers are relying on the railroad to get their shipments where they need to be on time. It is especially critical for BNSF’s intermodal business, which moves containers and trailers carrying the consumer products people use every day. Working with BNSF’s intermodal group, the Operations Research and Advanced Analytics team is developing a model that more accurately predicts train arrival times.

The Train Travel Time Prediction tool will help BNSF further enhance the information that it provides its customers. The development of this tool will enable BNSF to provide customers with information that more accurately tracks their shipments in real time. There are also plans to expand the use of this tool to other parts of the business to assist with

planning for train crew operations and inspections, as well as equipment and track maintenance.

Projects Currently Underway

In today's data rich environment everything creates an electronic trail, and the Operations Research and Advanced Analytics team can use that information to generate better inputs for the models they develop. Whether it's GPS tools that help track the exact location of BNSF's assets or sensors and gauges that monitor and assist in determining when would be the best time to schedule railcars and locomotives for inspections and maintenance, these tools analyze data that enable the team to delve deeper and create effective solutions.

With thousands of sensors across its network, BNSF produces large amounts of data daily. These data sets are so large and complex that traditional data processing applications are inadequate. The Operations Research and Advanced Analytics team is currently looking into how to best process and synthesize all that information more effectively for use throughout the organization.

Another tool currently on the horizon is Movement Planner. When complete this tool will improve the movement of trains across BNSF's entire network instead of just certain segments. Having this

tool will enable BNSF to better dispatch trains and improve the utilization of its tracks.

What the Future Holds

Over the years the Operations Research and Advanced Analytics team has helped BNSF save millions of dollars with their work. As computing powers continue to advance and the data that is generated and gathered increases exponentially, the team will continue to play an increasingly valuable role in developing decision tools that help BNSF leaders manage and operate trains in the most effective and efficient way possible.

"To continuously improve the way your rail operations work, you have to evolve the way you make operational decisions," says David Freeman, BNSF's senior vice president for transportation. "The recommendations and programs that our Operations Research and Advanced Analytics team has developed have resulted in solutions that have positively impacted our bottom line and the way we run trains today and into the future." **ORMS**

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**thousands
of sensors**
across its network,
**BNSF
produces**
large amounts
of
data daily.

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