Netherlands Railways:

Growing ridership with minimum congestion and maximum efficiency

Overview

The Need … Netherlands Railways—the nation's largest and Europe's busiest—needed the ability to manage more trains and passengers within its existing infrastructure footprint.

The Solution … Netherlands Railways used IBM ILOG® CPLEX® to develop powerful algorithms that can adapt scheduling and rolling stock allocations to short-term fluctuations in ridership.

What Makes it Smarter … Netherlands Railways is able to create an optimized operating plan that maximizes service quality, minimizes costs and provides guidance for future infrastructure investments.

The Result … "We've been able to improve our utilization and save €20 million annually, all while improving our on-time performance."

—Wim Fabries, head of logistics, Netherlands Railways

The Netherlands is Europe's most densely populated country. Its citizens, having reclaimed much of the country's land area from the North Sea and protected it with a network of dikes and canals, don't take their real estate for granted. Having conquered the threat of flooding once and for all with a massive dam project that took nearly 50 years to complete, the Netherlands now faces the more insidious threat posed by transportation congestion.

Over the last 20 years, as the Dutch grew in both mobility and population, relatively few new roadways were built. On top of this, the layout and capacity of the Netherlands's existing road network made it predisposed to bottlenecks. Not surprisingly, road congestion in the Netherlands has intensified considerably, especially on the roads connecting the country's four largest cities—Amsterdam, Rotterdam, The Hague, and Utrecht.

As their roadways grew more congested, the Dutch increasingly took to train transport, resulting in a near doubling of passenger railway volume (to 16.2 billion passenger kilometers) by 2008. Netherlands Railways—by far the country's largest passenger train operator with over a million passengers transported each day—was a major beneficiary of the rail surge. While the growth in rail volume helped relieve road congestion, it eventually began to put its own set of pressures on the Netherlands Railways infrastructure. Lacking the large tracts of land necessary to expand the rail network, Netherlands Railways was compelled to use its existing railway network more and more intensively. In the process, Netherlands Railways became the busiest national railway network in Europe.

IBM

Business Benefits

- €20 million (US$27.1 million) in annual cost reduction through the optimization of rolling stock allocation
- Incremental revenue gain of €40 million (US$54.2 million) through new approach to timetabling
- Two percent increase in on-time performance
- Shorter lead time for the development of new rolling stock allocation plans
- Ability to accommodate additional ridership growth with minimal new infrastructure investments

Adding trains threatens congestion

For a time, Netherlands Railways kept up with growing passenger volume by scheduling more and larger trains, including the use of double-decker cars. Inevitably, however, traffic density on Netherlands Railways reached a point where the trade-off between train volume and on-time performance—and thus customer satisfaction—became more pronounced. The company's first step was to fundamentally realign its timetable structure with its current operational capacity, with IBM ILOG CPLEX used to perform multivariable calculations. The benefits were immediate, with on-time performance increasing by more than two percent—to 87 percent of arrivals—and customer satisfaction and ridership growing commensurately.

But that was only half of a very complex equation. In addition to timetable optimization, Netherlands Railways also needed to ensure that the right level of seating capacity was available where it was needed in the rail network. Excess capacity on a given line raises the company's overhead costs, while too little runs the risk of seating shortages and customer dissatisfaction. To achieve the right balance, Netherlands Railways—with assistance from IBM Software Consulting Services—used IBM ILOG OPL-CPLEX to build a comprehensive resource planning tool called ROSA (rolling stock allocation) that incorporates 56,000 variables and 32,000 constraints to create an optimized operating plan, one that minimizes costs and maximizes its service quality.

Under the previous manual process, the complexity of the model limited the number of plans that could be developed to perhaps one or two per year. Conceptually, the process by which the resource plan is compiled has much in common with a manufacturer's production plan.

Smarter Rail: Adapting faster to changing ridership patterns

Instrumented

Changes in ridership patterns and rolling stock location and availability are captured by monitoring systems.

Interconnected

The timetable and rolling stock allocation (ROSA) solutions incorporate information from 2,800 km of rail network and 280 stations.

Intelligent

ROSA algorithms balance 56,000 variables and 32,000 constraints to create an optimized operating plan—governing the number, location and scheduling of passenger cars and crews—to maximize service quality and minimize costs.

Solution Components:

Software

- IBM ILOG® CPLEX®
- IBM ILOG OPL Development Studio

Services

- IBM Software Consulting Services

"ILOG's optimization technology helped us to achieve our primary goal of improving service but has also had a significant impact on our bottom line in terms of operational cost savings."

—Wim Fabries

In the simple view of the process, planners begin with a forecast of seating demand (based on projected ridership), factor in their existing "inventory" seating capacity, and from that, calculate the plan's main output—the number of passenger seats to be deployed and where they need to be positioned. As with any complex system, getting to this goal requires planners to take into account a vast number of operational parameters, many of which have to do with the properties of its 2,800 km rail network (e.g., whether a segment is electric or diesel) and its hundreds of cars (e.g., whether single or double-decker).

In addition to the attributes of its fixed infrastructure, Netherlands Railways' planners also need to factor in a multitude of operational rules and constraints that relate to the critical—yet often invisible—details involved in orchestrating the on-time movement of trains. One set of rules calls for minimizing the rearrangement, or shunting, of train cars on sidetracks, a process that introduces complexity and cost into day-to-day rail operations. Another establishes guidelines and work rules for the various crews required to operate, clean and otherwise maintain the trains. Still another requires cars of certain types to be kept together or limited to certain stretches of track. These examples merely scratch the surface of the complex trade-offs the company's planners need to take into account.

Changing the planning process

Revisiting the inventory analogy, imagine if a manufacturer was forced to come up with a single production plan based on a yearly forecast and adhere to it regardless of the ups and downs of end-user demand. Clearly not a recipe for precision, this scenario approximates the way Netherlands Railways' planners formulated their rolling stock plan. Given the complexity and time involved, the company was compelled to develop plans far in advance. Moreover, because planners justifiably placed a high priority on avoiding seat shortages—and the customer dissatisfaction likely to result—the plan typically reflected the high side of ridership projections. The general result was a tendency to overprovision rolling stock, resulting in higher costs.

With its new ROSA planning tool, Netherlands Railways can now develop a fresh plan in a number of hours, thus enabling the company to generate a weekly schedule. By cutting the lead-time required to formulate a new schedule and allocation plan, Netherlands Railways has far more flexibility to refine them in the face of seasonal or unexpected variations in ridership. In the event of a short-term up-tick in ridership, Netherlands Railways has the means to add the right level of capacity, such that revenue is maximized without over- or undershooting the mark. Likewise, if ridership is projected to subside,the company can scale capacity down to the right level, thus enabling the company to minimize overhead costs without impacting service quality. In the year after its implementation, the ROSA planning tool reduced Netherlands Railways' annual operations costs by €20 million (US$27.1 million) by giving the company the means to optimize the allocation of its rolling stock. By the same token, the company's new approach to timetabling—also developed and run using IBM ILOG CPLEX—enabled Netherlands Railways to capture an additional €40 million (US$54.2 million) in fare revenue.

Keeping congestion at bay

Netherlands Railways is committed to remaining one of Europe's best-run rail networks. By maximizing its efficiency, the company's new planning tools enable it to accommodate increasing Dutch ridership within its existing infrastructure footprint. When and if new infrastructure is required, the solution's cost and revenue optimization capabilities strengthen the ability of Netherlands Railways to make these investments and—in the process—do its part to minimize transportation congestion in a country that's prone to it. Wim Fabries, Head of Logistics for Netherlands Railways, sees the company's use of IBM ILOG CPLEX as an important tool in meeting the challenges of efficient growth as well as high customer satisfaction. "We've been able to improve our utilization and save €20 million annually, all while improving our on-time performance," says Fabries. "ILOG's optimization technology helped us to achieve our primary goal of improving service but has also had a significant impact on our bottom line in terms of operational cost savings."

For more information

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Produced in the United States of America
March 2010

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