Executive Summary

Although many IT and business managers today may be lured into business intelligence (BI) investments by the promise of predictive analytics and emerging BI trends, creating an enterprise-wide BI capability is a journey that takes time. This article describes Norfolk Southern Railway's BI journey, which began in the early 1990s with departmental reporting, evolved into data warehousing and analytic applications, and has resulted in a company that today uses BI to support corporate strategy. We describe how BI at Norfolk Southern evolved over several decades, with the company developing strong BI foundations and an effective enterprise-wide BI capability. We also identify the practices that kept the BI journey “on track.” These practices can be used by other IT and business leaders as they plan and develop BI capabilities in their own organizations.

THE IMPORTANCE OF BUSINESS INTELLIGENCE

There is considerable evidence of the importance of business intelligence (BI) for organizations. The origins of BI stem from decision support systems, which first emerged in the early 1970s when managers used computer applications to model business decisions. Over the years, other applications, such as executive information systems (EIS), online analytical processing (OLAP) and data mining/predictive analytics became important. Today, BI is a broad category of technologies, applications, and processes for gathering, storing, accessing, and analyzing data to help its users make better decisions.¹

BI has been at the top of CIOs’ strategic agendas for the past several years, according to Gartner research,² and Forrester expects the BI market to grow from $8.5 billion in 2008 to $12 billion in 2014. Consulting firms are launching new practices and analytics centers to address the increased demand for BI services, and books that illustrate the value of BI and analytics to organizations are best sellers.³ Fueling the growth in BI are exciting technology advances in the areas of social computing, unstructured data analytics, mobile delivery, and “big data”—datasets that grow so large that they become awkward to work with using conventional database management tools. However, building an enterprise BI capability does not occur overnight. Instead, it is a journey during which foundational competencies are developed over long periods of time.

¹ Jack Rockart is the accepting senior editor for this article.
² The authors gratefully acknowledge important contributions from Professor Jeff Hoffer of the University of Dayton; Linda Richardson, Senior Designer Information Systems, Norfolk Southern Corporation; and the many study participants who work at Norfolk Southern. The authors would like to thank Teradata for financially supporting this case study. We also are grateful for partial funding from the Von Thelan Fund at the University of Virginia’s McIntire School of Commerce.
⁵ For example, in 2010 Deloitte launched Deloitte Analytics; SAS, Teradata and Elder Research launched the Business Analytics Innovation Center; and Accenture opened an Analytics Innovation Center. Recent bestsellers include Davenport, T., Harris, J., and Morison, R. Analytics at Work: Smarter Decisions, Better Results, Harvard Business Press, 2010; and May, T. The New Know: Innovation Powered by Analytics, John Wiley and Sons, 2009.
In this article, we describe Norfolk Southern Railway’s BI journey. We interviewed 30 business and IT leaders from across Norfolk Southern and reviewed archival documents produced by the data warehouse team to understand how BI has evolved over the last two decades.

For most of its history, Norfolk Southern operated in a predictable, regulated environment, and the company’s business strategy focused on efficiently transporting freight from one point to another. With deregulation in the 1980s, railroads were free to compete in new ways. Deregulation also opened up the possibility of mergers and acquisitions. At the end of the twentieth century, Norfolk Southern acquired 58% of Conrail and developed into a service-oriented, scheduled railroad. The success of this strategy required significant investment in BI, including increased use of optimization algorithms, improved performance monitoring systems, and providing customers with access to up-to-date shipment data. Today, the railroad focuses on customer service, fuel efficiency, asset usage, and workforce productivity, and it leverages BI across the enterprise to help accomplish this.

The Norfolk Southern case provides an excellent example of how the BI journey occurred in one organization. From our analysis of Norfolk Southern’s experience, we provide an organizing framework for enterprise BI and the key practices that other organizations can use to help them “stay on track” during their own BI journeys.

NORFOLK SOUTHERN’S BI JOURNEY

Norfolk Southern Railway Company is one of the four largest Class I railroads in the U.S. The railway includes approximately 20,000 route miles in 22 eastern states and the District of Columbia, serves all major eastern ports, and connects with rail partners in the West and Canada, linking customers to markets around the world. Norfolk Southern provides comprehensive logistics services and offers the most extensive intermodal network in the East.

Competing in a Regulated Industry

Just a few decades ago, the U.S. railroad industry was highly regulated. Like most railroads, Norfolk Southern focused on moving shipments from point A to point B, and in doing so, the company provided a good cost advantage over other types of transportation, such as trucking. Consistent with this business approach, Norfolk Southern had implemented complex transaction-based information systems to support the movement of rail cars from point A to point B safely and efficiently. These systems were central to the operations of the railroad.

Unfortunately, these systems could not be used for any significant reporting purposes because processing queries might well degrade system performance. When employees needed a report, they had to submit a request to the IT organization; the resulting report would take time to produce and require considerable IT resources. Therefore, access to reporting facilities, particularly for specialized reports, was limited.

Post-deregulation, however, business functions at Norfolk Southern began thinking in new ways and had to make new kinds of decisions concerned with pricing and cost management. By 1995, employees within the Marketing and Cost Departments had developed enough reporting needs to justify investment in a dedicated reporting system. Together, these departments funded a one-terabyte data mart, which was updated each night with records of all the rail car movements from that day (e.g., arrivals, departures). This initial BI effort supported basic reporting about customer service and cost data to help the company understand “How was Norfolk Southern serving its customers?” and “What should Norfolk Southern charge its customers based on the cost of moving goods from one point to another?”

At first, Marketing Department employees with IT skills implemented and maintained the data mart, and a contractor developed the data models for the system. However, significant investment was required for the technology platform to support the data mart, and the skills of IT professionals were required to maintain it. Thus, when a member of the Marketing Department involved with the data mart transferred to the IT Department, the company moved the responsibility for the data mart to the IT Department.

At this point, the system still remained oriented toward the Marketing and Cost Departments, but the platform was housed and managed by corporate IT, and the data mart began to resemble an enterprise data warehouse. This was a critical step in the
evolution of BI at Norfolk Southern. This move not only positioned BI to become available across the enterprise but also allowed the IT Department to create proper controls and apply standard IT practices (e.g., data standards) to the warehouse so that it could become a sustainable technology platform. The original data modeling contractor continued working with the data warehouse after the move and helped the IT Department to effectively build on what had been achieved by the Marketing and Cost Departments.

**Becoming a Scheduled Railroad**

In 1999, senior management at Norfolk Southern invested in a growth strategy by acquiring 58% of Conrail. This move, known as the “Conrail Split,” increased Norfolk Southern’s size by 50% while providing direct track lines to the New York and Philadelphia markets and ownership of expanded intermodal capabilities. As CEO Wick Moorman explained, this acquisition prompted a two-fold effort:

“First, we needed to come up with a new operating plan. Second, we needed to put in place underlying systems and information tools to support the maintenance and the management of the plan.”

The result was an initiative in 2002 called the Thoroughbred Operating Plan, or TOP, to redesign Norfolk Southern’s operations. This was a fundamental change for the company. Prior to TOP, the primary operational objective was to maximize train size to minimize the number of train crews needed. Crews were the major variable, and the most visible cost to the railroad. As a consequence a car could stand idle for a day or so and in turn impact other trains to which it would be connected. Scheduled delivery dates sometimes varied within a window of up to three to five days. At the time, this is the way most railroads operated.

With TOP, management invested in new transaction-based information systems and processes that used operations research techniques to determine when and how rail cars should move throughout the Norfolk Southern transportation network. The new systems optimized inventory management and trip planning.

Once Norfolk Southern had implemented the systems to optimize the operating plan for its rail cars, employees throughout the organization needed measures, reports, and tools that would help them manage to the plan. Field managers needed to monitor performance and identify the root causes of going off-plan so that they could make adjustments.

The more field managers conformed to plan, the faster equipment would move through the system, arriving on time more often and spending less time in terminals. As a consequence, a TOP steering committee of senior-level managers funded a new BI data warehouse application that would provide managers with the information needed to manage to the TOP plan.

The TOP BI application analyzed trip plans (i.e., itineraries) for every shipment and determined which trains would handle the shipment and how, when, and where connections between the trains would be made. This application then provided field managers who were accountable for sticking to the TOP plan with graphical depictions of actual performance against the trip plan for both train performance and connection performance (see Figure 1 for a screenshot of the TOP BI application). This operational BI application is a performance dashboard, and its use is embedded within important operational processes at Norfolk Southern.

Over time, Norfolk Southern has reinforced TOP through incentives; for example, a portion of corporate bonuses is tied to how well the railroad runs to plan. In the eight years since TOP was implemented in 2003, Norfolk Southern has reduced rail car cycle time by one day, which translates into millions of dollars of annual savings.

**Using accessNS to Compete on Service**

With TOP, service became predictable and Norfolk Southern strengthened its ability to compete on service. Becoming a service-oriented, scheduled railroad created huge opportunities. The Marketing Department initially provided visibility into the company’s extensive transportation network through its investments in BI reporting. Then, as Norfolk Southern became more “scheduled,” it expanded services to customers using a BI application called accessNS.

Customers want to know where their shipments are “right now”—and at times, they also want historical information: Where did my shipment come from? How long did it take to arrive? What were the problems along the route? Prior to the early 2000s, customers would call a Norfolk Southern customer service agent with questions and then wait for minutes, hours, or days for an answer. Behind the scenes, agents had to either ask the IT Department to provide the requested information or navigate legacy systems that were hard to use.
The accessNS application allows customers to access BI reports from the Internet and find answers to questions about service status and performance. This customer-facing BI application was the first of its kind in the industry and was immediately popular with customers. Over time, the user base grew to more than 11,000 in 8,000 customer organizations. Users log on to accessNS to access any of the 20 standard reports and retrieve information at any time. They can access current data, which is updated hourly, or they can look at three years of history. The application uses push technologies to provide alerts, text messages, and RSS feeds; 4,500 reports are now pushed to users daily.

The standard reports can meet a wide variety of user needs. Sometimes, though, customers have a one-off request, such as quickly needing a piece of information for a meeting, or they want information in a different format. For these cases, Norfolk Southern offers a Report Wizard that allows customers to manipulate over 125 data fields to modify existing reports or build new ones (see Figure 2 for Report Wizard screen shots). This capability makes it possible to access information without writing complex SQL queries. Users employ a drag and drop interface (e.g., for sorting fields, ordering columns, specifying limits) to build queries, and the Report Wizard automatically translates the queries into program code. In the words of Blair Hanna, Manager eCommerce:

“The users love it. It takes most business users only 5 to 10 minutes to customize their reports, and sometimes new users never need to contact us at all while creating their own reports.”

The success of accessNS had a positive effect on Norfolk Southern’s organizational capabilities. Deborah Butler, the company’s CIO, explained:

“The customer service center became a real customer center instead of a traditional call center. It became a lot smaller, with much more focus on finding areas where service was not meeting expectations—and finding them before our customers brought them to our attention.”

The BI team and business sponsors proactively worked to make internal and external users of accessNS and other BI applications self-sufficient and, in doing so, invested significant time and effort in interface design. Norfolk Southern developers built BI applications with point-and-click interfaces for querying and with dashboards for monitoring. They built custom wizards and web-based portals. They made screens graphically and visually straightforward. The intent was to create intuitive interfaces that users can understand immediately. One application developer explained:
“If I have to put together an expensive training program, then my tool isn’t simple enough to use. Our goal is for end users to click on a link or push a button.”

Additionally, Norfolk Southern has found that the needs of BI application users change over time. Initially, business users wanted applications that provided visibility into operations, and applications were created to do that. But, according to an application developer, that need has changed:
“Two to three years later, the business users said that they didn’t need to know if freight was moving according to plan—they just wanted to see exceptions. So we moved toward exception-based reporting where we clearly highlight problems.”

One new exception-based dashboard application is refreshed automatically every 15 minutes by using AJAX technologies.8

The external BI users at Norfolk Southern grew to include suppliers and partner organizations, including the U.S. Government. In fact, the Department of Defense and the Department of Homeland Security require transportation companies to provide quick responses to inquiries about high-threat commodities traveling in heavily populated areas. Through its existing BI applications, Norfolk Southern can track goods easily and quickly, enhancing the ability for emergency response.

**Track 2012: A Strategy for the New Decade**

In recent years, Norfolk Southern has developed a strategy called Track 2012, described by CEO Wick Moorman as follows:

“The first goal of Track 2012 is service. At the end of the day, we are a service business ... and our company will rise and fall depending on the level of transportation service we offer. Second, we need to manage our cost structure, which determines the value we can provide and the margins we can earn. We focus on three big drivers. The first is fuel use. We burn 500 million gallons of diesel fuel a year; how do we reduce fuel consumption? The second is asset turns, or productivity. We are an extraordinarily asset-intensive business. How do we make our locomotives and rail cars more productive? The last driver is workforce productivity. Running to schedule and eliminating variations has a helpful impact in improving labor productivity.”

The four Track 2012 goals—providing superb customer service, managing fuel use, managing asset turns, and improving workforce productivity—are enabled by the variety of BI tools used by departments across Norfolk Southern, ranging from Accounting and Human Resources to Operations and Fleet Management to Strategic Planning. The BI tools range from queries to reports and applications. Table 1 shows examples of how BI tools are tied into Track 2012 goals.

**Norfolk Southern’s Governance Structure for BI**

By August 2007, the large number of BI business sponsors located throughout Norfolk Southern prompted the IT Department to institute a formal BI governance structure. This structure brings together 26 business managers and three representatives from the IT Department who meet for two hours every month. Originally, the IT representatives spearheaded the governance body to promote more effective use of technical resources. However, the group quickly morphed into a customer-focused body motivated to promote BI as an enterprise resource at Norfolk Southern.

The group is chaired by a business manager, and every business function represented in the group has one vote. The group has a set of founding principles and a website, and annual updates are provided to the company directors who have members involved in the group. At times, special interest groups (SIGs) are formed to investigate special issues. For example, the governance body has created SIGs to investigate and drive metadata efforts, data quality issues, and the selection of a next-generation BI tool for the company.

Members of the governance group have expanded their understanding of BI through information shared by their peers in the business. At each meeting, a subject matter expert makes a presentation on existing data or an application. One governance group member from the Tax Department explained:

“This has been an eye opener. I’ve seen data that I was not aware of and capabilities that I can bring back to my own department.”

This Tax Department manager learned how to use e-mail alerts in tax processing when he saw a demonstration of BI alerts used by another department.

Many of the business managers who sit on the BI governance board are business-IT “hybrids”—employees with an impressive mix of business and IT knowledge. In general, employees at Norfolk Southern have long tenures and often move between departments. Over time, the company has developed hybrid employees as people moved from IT into the business, and vice versa, as people were specifically...
hired because they possessed a unique combination of both technical and business skills and as people worked in specialty BI reporting groups within business units. As a result, Norfolk Southern currently has a large base of workers who are well equipped to translate business requirements into actions enabled by BI. A text box below provides examples of these four different ways in which Norfolk Southern has built business-IT hybrids.

**AN ORGANIZING FRAMEWORK FOR BI AND ENABLING PRACTICES**

At Norfolk Southern, BI began with a data mart reporting solution for the Marketing and Cost Departments. Today, it directly supports corporate strategy and is used pervasively across the enterprise, as evidenced by the following three quotes:

> “Everybody across Norfolk Southern is viewing the same set of facts. It is very hard to put a numerical value on that. Having an enterprise view of data is hugely important and probably one of the most important benefits that has come from our BI program.”
> (Deborah Butler, CIO)

> “When someone walks down the hall or our executive department at Norfolk [has] a question about something, within minutes, we can be looking at data and analyzing whatever the situation is. We have all kinds of data now that is out there—projections, runs, timed queries that tell us the status of the railroad at the push of a button—all because of this data.”
> (Andy Fitzgerald, Manager Car Service)

> “There will always be questions that we weren’t expecting at the time we were putting together the data warehouse. With an enterprise view, you certainly have all the information that you need. You don’t want to put stuff in the data warehouse just for the sake of it but it certainly makes doing analysis a whole lot easier. One of the things that I was asked by our Vice Chairman this morning was: ‘What’s been the impact of the floods in the Midwest on our operation?’ Having an enterprise view with that breadth of information makes it possible for me to say, ‘Yes, we can get that information without any problem.’”
> (Fred Ehlers, VP Customer Service)

It took years for Norfolk Southern to build its BI capability, and Table 2 describes the highlights of the

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**Table 1: Track 2012 Goals and BI Applications**

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<thead>
<tr>
<th>Track 2012 Goal</th>
<th>Department</th>
<th>BI Tools</th>
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<tbody>
<tr>
<td>Providing Superb Customer Service</td>
<td>eCommerce</td>
<td>accessNS</td>
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<tr>
<td></td>
<td>Intermodal</td>
<td>Intermodal Operational Dashboard: A real-time (updated every 15 minutes) exception-based dashboard that communicates operational information about intermodal services.</td>
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<tr>
<td>Managing Fuel Use</td>
<td>Industrial Engineering</td>
<td>An ad hoc application was developed after Hurricane Katrina to ensure that fuel was delivered to the right places at the right times in an emergency situation.</td>
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<tr>
<td>Managing Asset Turns</td>
<td>Modalgistics</td>
<td>The Multi-level application optimizes the movement of special multi-level cars.</td>
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<td></td>
<td>Rail Car Distribution</td>
<td>The Empty application reduces the number of empty rail cars that travel on the track network.</td>
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<tr>
<td>Improving Workforce Productivity</td>
<td>Crew Call</td>
<td>The Crew Call application optimizes crew scheduling to ensure crews are at the right train at the right time. It has resulted in $2.8 million annual savings by reducing the cost of trains held for crews.</td>
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<td></td>
<td>Human Resources</td>
<td>The Workforce Planning application predicts future staffing needs. HR planning personnel proactively examine departmental staffing and explore historical trends for retirement ages and years of service. Armed with this data, they forecast retirement attrition for the next 5 to 10 years and help put strategies in place to meet hiring needs.</td>
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company’s journey from the perspectives of business strategy, data, and BI tools.

Norfolk Southern’s journey as described in Table 2 has resulted in a BI capability that can be represented by the organizing framework depicted in Figure 3. First, the company created the critical data foundations required for BI—high-quality, integrated enterprise data that is usable by business users. Second, Norfolk Southern’s business functions identified and communicated important strategic business requirements to the IT Department, enabled primarily by the company’s business-IT hybrid employees and a strong governance structure. Third, Norfolk Southern has a variety of BI tools, ranging from queries to reports to applications that exploit the data foundations to enable business strategies from across the organization. Finally, the BI capability produces business value that varies from bottom-line cost savings and revenue generation to improved business processes and better decision making.

Keeping the components of this framework aligned over time is easier said than done. We have identified six practices applied by Norfolk Southern that have helped the company keep its BI initiatives “on track.”

**Practice 1: Create a Business-run BI Governance Structure that is Meaningful to the Business**

BI governance should include a group of engaged and committed business sponsors from across the company. The governance structure at Norfolk Southern enables business functions to share information and spread BI practices. It also allows the business groups to voice opinions about BI, alter BI priorities, and provide input into BI decisions. The challenge, however, is to keep the attention of a large
Table 2: Norfolk Southern’s Journey in Building its BI Capability

<table>
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<tr>
<th>Strategic Journey</th>
<th>Data Journey</th>
<th>BI Tools</th>
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<tbody>
<tr>
<td>New kinds of decisions on pricing and cost had to be made after the industry was deregulated.</td>
<td>Marketing and Cost Departments funded a one-terabyte data mart to house rail car data, which was loaded nightly.</td>
<td>Marketing and Cost employees used basic reporting and ad hoc query tools.</td>
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<tr>
<td>Acquisition of a majority share in Conrail prompted investments in new operating systems that optimized rail car movement.</td>
<td>Responsibility for the data mart was moved to the IT Department and became a data warehouse that supported functions across the company; enterprise data models, data standards, and controls were developed.</td>
<td>Performance management dashboard applications were built to support decision making in the field; intuitive user interfaces were created.</td>
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<td>Norfolk Southern strategically differentiated itself from competitors through its service.</td>
<td>More subject areas of data were included in the data warehouse and update frequency was increased from nightly to hourly to better support customer queries.</td>
<td>A customer-facing web portal BI application was built for customers to provide pre-formatted reports and ad hoc query capabilities; reporting became more exception-based, using push technologies, such as alerts and RSS feeds; focus was on creating decision support applications with short learning curves.</td>
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<tr>
<td>Top management created a new corporate strategy that focused the organization on service, fuel use, asset turns, and workforce productivity.</td>
<td>More subject areas of data were added along with new data types, such as geospatial data; an enterprise governance board initiated efforts to ramp up the areas of data quality and metadata.</td>
<td>A diverse portfolio of BI tools and applications now exists across the enterprise, leveraged by both internal and external users; the user base has grown to include a large number of business-IT hybrid employees.</td>
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Figure 3: BI Capability Framework
number of sponsors and to leverage their support in productive ways. Attendance at governance meetings is treated very seriously at Norfolk Southern. In fact, members of the group are not allowed to delegate their seats to anyone else. All of this has helped deepen BI sponsorship, creating a strong foundation for enterprise commitment.

**Practice 2: Develop Business-IT Hybrids Who Understand Real Business Needs**

BI delivers value when reporting and analysis capabilities are highly aligned with business requirements. In many organizations, however, there is a chasm between IT people who build applications and the people who use them. Differences in the domain knowledge and application development skills of these two groups can result in lengthy application development cycles and applications that don’t meet user needs. Norfolk Southern bridges this chasm through hybrid employees who have both domain knowledge and the technical skills to develop applications. Organizations should encourage rotational practices, hiring practices, and BI competency groups that align BI reporting and analysis with user requirements. Ultimately, as BI reporting and analysis grows in relevance and importance, so does enterprise usage of BI.

**Practice 3: Choose Your BI Applications Wisely**

Although Norfolk Southern has a large portfolio of BI applications, it is notable that just two are clearly at the top of the company’s priority list. The first is an operational dashboard application (the TOP BI application) that is embedded in the fabric of the company’s operations. The second is its customer-facing application (accessNS), which plays a core role in the company’s customer service strategy. The widespread use and obvious importance to the business of both applications reinforces the funding and momentum for BI in general.

**Practice 4: Create Usable, Graphical Applications that Require Little Support**

Ideally, the scope of BI should grow to include all parts of the organization and all potential users, including customers and suppliers. However, as BI scope increases, companies risk becoming overwhelmed by having to support and meet the needs of a large user community. By focusing on creating self-sufficient users through providing easy-to-learn graphical interfaces (dashboards) and through push technologies (e.g., alerts, RSS feeds), Norfolk Southern has reduced support and training costs, while meeting user needs more effectively. This encourages more and more users to embrace BI because the learning curve is not intimidating.

**Practice 5: Don’t Ignore the Basics of Data Management**

Norfolk Southern has learned that you cannot ignore the basics of the data that support BI—data quality, standards, and metadata. In some respects, the company was fortunate to have a single contractor who has modeled the BI data since the inception of the warehouse and has created standards and maintained consistency as new data types were added.

**Practice 6: Treat Data as an Enterprise Asset**

Even with quality data, standards, and metadata, companies need to have a culture that supports an enterprise view of data. The governance group at Norfolk Southern reinforces data as an enterprise asset and spearheads special data initiatives, such as metadata and data quality projects, when gaps are identified. Additionally, the company has an open data philosophy whereby user groups are encouraged to share data. This leads to new and interesting uses of data, an example of which is described in the text box below.

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**Example of the Benefits of Sharing Data Across Departments**

Employees in Norfolk Southern’s Human Resource Planning group engaging in strategic planning efforts needed to determine where to locate service offices in the field that best meet the needs of the company’s employees. This is not an easy task: Norfolk Southern employs over 30,000 people across 22 states. Using BI, the HR Planning group combined employee demographic data (e.g., zip codes) with geospatial data used traditionally by the Engineering Department and was able to visually map out the employee population density, making it much easier to optimize service office locations.

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**CONCLUDING COMMENTS**

There is now a bewildering array of emerging BI trends—big data, mobile delivery, unstructured data mining, social analytics, collaborative BI, and many others. The danger is that companies might be
tempted to jump on board the latest bandwagon in
the belief that it will provide instant solutions to all
their BI requirements. However, a BI capability—on
an enterprise scale—cannot be created overnight:
most companies with a true enterprise BI capability
have taken years to acquire their BI staff, build
a comprehensive data infrastructure, select and
implement BI software, develop applications, train
users, and more. Norfolk Southern is an example
of a company whose BI journey has remained “on
track.” We believe the practices that helped Norfolk
Southern accomplish this provide guidelines for other
organizations as they progress in their BI journeys.

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