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# Suggested Research Agenda for the Railroad Industry

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## ABSTRACT

The railroad industry is experiencing a worldwide resurgence. International trade is booming as populations continue to grow and transportation infrastructures are nearing capacity. In the United States, the industry is being pressured to provide more services, while at the same time traffic levels are skyrocketing on a network that is much smaller than it was just fifty years ago. Additionally, security and safety issues are challenging the industry, as well as the regulatory agencies associated with railroading. To help with these problems, the industry is calling for more academic involvement through new degree programs and research initiatives. This paper reviews five major areas where academic research could assist the railroad industry in these challenges: capacity expansion, service standards, safety, security, and data management and analysis.

### RAILROADS: A CHANGING INDUSTRY

The reports of my death have been greatly exaggerated - Mark Twain.

The same can be said for the railroad industry in North America, and in fact, around the world. New rail lines to Tibet, privatization of government-owned systems in various countries, and unprecedented growth in freight and passenger volumes in North America all signal a renewed interest in rail transportation. According to Wick Moorman, President and CEO of Norfolk Southern Railway, "North American railroads are in the fortunate position of facing the challenges of a growth industry (Vantuono 2005, p.23)."

North American railroads are entering what many call a new age of railroading. Railroads are facing the problem of expanding volumes while meeting the needs of thousands of shippers with varying requirements. Many of the products handled are considered to be essential for everyday life in the United States. According to the U.S. Department of Homeland Security, railroads play a vital role, impacting almost all ways of life and business practices in the country (see Table 1). The Department further states that this importance makes it critical that railroads be protected from any outside interference.

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**TABLE 1  
RAILROAD IMPORTANCE  
TO THE U.S. ECONOMY**

Railroads transport

- 42% of intercity ton-miles
- 64% of coal for power plants
- 40% of the grain harvest
- 70% of US made automobiles
- 20% of chemicals

Source: "Cross Sector Interdependencies and Risk Assessment Guidance - Final Report and Recommendations by the Council" National Infrastructure Advisory Council, U.S. Department of Homeland Security, January 2004, p.24.

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Nevertheless, for most people, including academics, educators, and researchers, the railroad is simply something that they have to wait for at a railroad crossing or that they take to work in the morning. Very few degree programs in the United States include rail operations education and even fewer regularly research the subject. The issue has become such a concern to the railroad industry that the American Railway Engineering and Maintenance-of-Way Association (AREMA) has started a 10-10 program, aimed at having 10 U.S. universities with railroad programs by the year 2010.

In spite of this seeming lack of educational interest, railroading is a growth industry. Scan the covers of the industry trade magazines and two words keep appearing: growth and capacity. As a result of recent incidents in Europe, the word security has been added to the list. With these new pressures, the question arises: What is the suggested research agenda for the railroad industry?

In spite of a general lack of university interest in the field, a great deal of railroad research is conducted each year. For example, Google Scholar lists 251,000 papers related to the railroad field (compared to more than 500,000 related to highways alone). Much of the North American research was either conducted by the railroad industry, or funded by it through several university centers or through the industry's Pueblo, Colorado, test track. The federal government, through the Federal Railroad Administration and the Transportation Research Board, has also funded significant amounts of research. Additionally, international research is significant, and probably much more common with many countries having universities dedicated to the field.

The vast majority of the railroad research in the United States has traditionally been related to engineering. However, with the growth of rail freight and the ability to be more creative since the Staggers Rail Act of 1980, railroads and their customers have begun to focus much more effort on operational and capacity issues. For example, 39,200 of the 251,000 papers include the term capacity while 18,200 are operational in nature.

For railroads in the United States, the results of this research, and the change in the legal and business environments that encouraged it, have been very positive. As Table 2 demonstrates, the past 25 years have been good for railroad productivity and safety. However, the Association of American Railroads (AAR) states that, "because the most readily attainable productivity gains have already been made, future gains will require significant additional spending on infrastructure and equipment (including substantial new capacity) and new technologies (AAR, p.1).

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**TABLE 2**  
**CHANGES IN MAJOR U.S. RAILROAD**  
**MEASUREMENTS 1980-2005**

Rail Employee Productivity	+421%
Locomotive Productivity	+128%
Track Productivity	+171%
Fuel Efficiency	+76%
Train Accident Rate	-65%
Employee Casualty Rate	-79%

Source: AAR website: [www.aar.org](http://www.aar.org)

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### **SUGGESTED RAILROAD RESEARCH AGENDAS**

Based upon personal interviews and a literature review, the railroad industry has a large number of areas in which academic research would provide benefits. These areas include capacity problems, customer service issues, employee and public safety, security, and data management. However, AAR sources say that the previous improvements represent the easy gains and that most future gains will be evolutionary, not revolutionary. This suggests that researchers must understand current practices and sciences before exploring the future. However, this should not limit the topics of such research.

Service and capacity are obvious areas for railroad research. The railroad industry knows that there are improvements to be made. Jack Koraleski, Union Pacific EVP of Sales and Marketing, has stated that, "we know we're not where customers want us to be (Stagl 2006, p.20)." The Policy and Economic Department of the AAR has written that, "there are many opportunities for railroads to achieve further evolutionary gains, including improved track and signaling to allow faster speeds and better track utilization; improved information technology systems to monitor system performance, allow more efficient train operations, and to provide more and better shipment information to customers; more powerful and reliable

locomotives; larger freight cars; improved access to ports; enhanced doublestack capability; more efficient yards and switching for interchange and routing; and continued redesign of operations to remove capacity constraints and increase asset utilization (AAR, p.2)."

Safety is an area of major success for the railroad industry. Past and current research has resulted in a number of safety improvements in many areas. For example, Operation Lifesaver states that grade crossing research has resulted in a significant decrease in annual collisions (9295 to 3010), injuries (3293 to 970), and fatalities (728 to 355) between 1981 and 2005. As already mentioned, accident rates for the industry are also down. Much of these improvements are due to better equipment design and practices, generally the result of industry and supplier research.

Security is certainly a research area receiving increased attention. In the first four years after 9/11, rail transit systems in the United States spent more than \$2 billion on security. Metro North President Peter Cannito, head of one of two major commuter rail systems serving New York City, stated that security has, "become part of our everyday business (Luczak 2005, p.37)."

A final area of research that appears to interest the railroad industry is better data management. At the September 2006 American Railway Engineering and Maintenance-of-Way Association Annual Conference, there were a number of presentations on improved data collection, but with a number calling for better management of this data. The general concern is that rail management is being overwhelmed with the large amount of data being collected and being made available for decision making.

### **CAPACITY EXPANSION**

Railroads used to brag about their ability to handle more freight. However, the economic deregulation of the 1970's-1980's allowed the railroads to attract new freight movements while eliminating duplicate or unnecessary routes and

employees, as shown in Table 3. The result more than twenty years later is an actual shortage of rail capacity on many major routes. This shortage has resulted in railroads turning away business and service issues for those that are accepted.

In response to this capacity issue, railroads have begun to apply many different strategies. Three basic areas of research being used to address the railroad's growth are operational management, engineering, and capacity expansion.

### Operational Management

"Today, the demand for rail transportation is growing in almost all sectors of our business. This increased demand for rail transportation is being driven by a convergence of conditions that reflect a fundamentally changed environment in the freight transportation industry (Vantuono 2006, p. 26)." This statement by Norfolk Southern Vice Chairman and CEO Henry C. Wolf clearly shows the need for a new understanding of rail operational issues and the capacity solutions that they can deliver.

Operations represent the largest expenses within a railroad company, and also provides the service

that customers seek. Therefore, it is a logical place to make improvements to create additional capacity. Within the last few years, Union Pacific has begun using a number of supply chain management and Six Sigma strategies. For example, UP has essentially added 50 additional locomotives to their fleet through a program to speed up locomotive repairs as opposed to spending \$2 million a piece to buy more locomotives (Stagl 2006, p. 23). Matt Rose, President and CEO of BNSF, also points out that service and capacity are related issues that need more research when he states "improving service through better equipment velocity is one key to our ability to continue to handle volume growth (Vantuono 2005, p.26)."

One of the largest operational management debates in the railroad industry deals with the issue of scheduled railroads. Railroads such as Canadian National claim that scheduling most of their train movements allows them to find capacity and provide better customer service. Others claim that scheduling removes the flexibility needed to respond to changing customer and capacity needs. Research in this area could provide significant benefit to the industry.

**TABLE 3**  
**RAILROAD FREIGHT TON-MILE INCREASES VERSUS RAILROAD NETWORK SIZE AND EMPLOYMENT**

Year	Ton-miles (BIL)	Miles Operated	Employment
1940	375	364,174	987,943
1960	575	340,000*	850,000*
1980	932	270,623	480,410
2004	1,720	170,071	176,899

\*(est.)

Sources: "U.S. Freight Railroad Statistics" by Association of American Railroads—Policy & Economics Department, various editions; and U.S. Railroad Retirement Board.

## Engineering

Another way railroads are adding capacity is to increase the hauling capacity of rail cars and the track and bridge structure. The North American railroad industry is in the process of increasing loaded car weights from 263,000 to 286,000 pounds, and in some cases, on to 315,000 pounds. While the larger railroads have generally been able to afford the change, many of the smaller and poorer railroads have failed to make the change due to available funding.

To assist in making the entire rail system compatible, a great deal of research has been conducted since the late 1990's by such organizations as the AAR, AREMA, and the American Shortline & Regional Railroad Association (ASLRRRA). While the design issues are generally understood, more research is still required, especially to help find ways for smaller and less well funded railroads to reach the higher weight capacities. In a number of cases, the improvements are funded through various state and federal grant programs, requiring research into various alternative plans.

## New Capacity

Often the easiest way to acquire more system capacity is to simply build more infrastructure capacity by adding second and third tracks and new sidings on existing right-of-ways. For example, *Railway Track & Structures* magazine states that railroads are using capital to buy increased capacity in 2006, such as BNSF adding 18.8 miles of triple track in Wyoming and 40 miles of double track between Chicago and Los Angeles (Railroads loosening purse strings for m/w," 2006, p.18).

The negative of this issue is that railroads have traditionally found it difficult to fund such construction from external sources, and internal sources are generally dedicated to maintenance and repair needs. While Wall Street seems to currently support much of this growth, research into creative financing opportunities, public-private funding programs, and methods to

decrease construction costs is important. Also important in this process are more accurate methods to simulate alternatives for planning purposes on a national scale. Large capital programs in rail congested cities such as Chicago and Kansas City have significant local support, but the problem is often demonstrating the benefits to the country as a whole.

## SERVICE

The railroads have only one thing to sell: transportation service. Their problem is that many trains may carry the cargo of hundreds of shippers, each with a different service goal and requirement. Additionally, their tracks are being used by all types of trains, from high speed intermodal trains hauling consumer goods to slow coal trains. Many routes must also deal with on-line customers that require trains to stop and pick up or deliver cars. Railroads work to develop service plans that will allow them to serve the many different needs found among their customers while maintaining a fluid transportation system. Research into this problem, associated with the issue of operational management, has the potential for great returns.

## SAFETY

The railroad industry's overall safety record has improved over the last decade and most safety trends are moving in the right direction. However, significant train accidents continue to occur, and the train accident rate has not shown substantive improvement in recent years. Moreover, recent train accidents have highlighted specific issues that need prompt government and industry attention, and the strong growth of rail and highway traffic continue to drive up exposure at highway-rail grade crossings (FRA 2005, p.1).

This is how the Federal Railroad Administration's 2005 accident action plan describes the current safety status of the U.S. railroad industry.

Safety has been a traditional area of research for the railroad industry. During recent years, studies in this area have heavily focused on railroad-highway grade crossing and trespasser safety. Much of this is due to the joint interest by both the Federal Railroad and the Federal Highway Administrations. However, the FRA's 2005 action plan is based upon a statistical analysis of recent safety issues. From this study, the FRA has produced a list of six areas in which safety research initiatives are needed. These areas are:

- (1) Human factor-caused train accidents,
- (2) Railroad employee fatigue,
- (3) Track maintenance,
- (4) Hazardous material safety and emergency preparedness,
- (5) Better utilization of FRA inspection and enforcement practices, and
- (6) Highway-railroad grade crossing issues (FRA 2005, p.2).

Based upon this report, the FRA has accelerated its funded research in these areas, opening up a number of opportunities for academic research in the railroad field.

While the FRA has traditionally focused on its primary responsibilities involving safety, rail transit has not had the same treatment until recently. Within the Department of Transportation, the Federal Transit Administration has had more of a promotional role. However, this is changing. In response to Congressional concern regarding the potential for accidents and incidents on rail transit systems, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) added Section 28 to the Federal Transit Act (codified at 49 U.S.C. Section 5330). This section requires the Federal Transit Administration to issue a regulation creating the first state-managed oversight program for rail transit safety, something finalized in 2005. The requirement that transit systems research and respond to safety concerns on their systems has

created the need for a great deal of research in the area.

## **SECURITY**

Railroad security has taken on even more importance since the London and Madrid bombings. However, much of the security plans are internal, relying upon existing railroad security systems and the observation ability of the industry's 180,000 employees, as well as general law enforcement, many of whom have only a minimum understanding of the industry.

Unlike the air industry, railroads operate out in the open, exposed to the general public along their 220,000 miles of track. Because of this, some rail transit systems, as well as Amtrak, have programs that encourage their riders to report suspicious activities. However, on the freight side, only BNSF and the Alaska Railroad have programs to include the general public in some form of community watch effort to protect their rail systems. Additionally, the public is not included in the Railway Alert Network (RAN), the major security planning tool created with the Department of Homeland Security.

But many believe that the nation has too many tracks, bridges, and railroad yards scattered across the country to be patrolled and observed only by railroad workers and law enforcement personnel. Research is needed to provide railroads with additional security strategies and plans that would produce a more secure transportation system.

## **DATA MANAGEMENT AND ANALYSIS**

As the railroad industry works to improve its safety record, new techniques and devices are providing railroad engineering personnel with far more data than in the past. New automated geometry cars, track and ground imaging

devices, automated tie inspection systems, and vehicle-track interaction systems all call for better management of the data to establish forecasts and priorities in the field. Additionally, operating pressures are also placing more emphasis on evaluating various operating practices such as train schedules, crew and equipment availability, loading forecasts, and many other factors related to customer service. According to many industry sources, the data is more available but is harder to manage on a daily basis (Clause 2006, Eby 2006, Judge 2006). Based upon these comments, techniques to better manage and analyze the data would be most welcome to the industry.

## CONCLUSION

The railroad industry is a growing, vibrant industry, often constrained by its past practices and designs. This growth provides ample research opportunities in almost every field from engineering to finance to data management. The key to any of this research is an understanding of the field, a field that is currently open to ideas that will assist it in serving the needs of the shipping industry.

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