Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
SWUTC/95/465040-1		

4. Title and Subtitle	5. Report Date
International Rail Freight Transportation in South Texas: Decreasing Fuel Consumption, Roadway Damage, and Hazardous Materials Movement on Texas Roadways	July 1995
	6. Performing Organization Code
7. Author(s) Stephen S. Roop and Richard W. Dickinson	8. Performing Organization Report No. Research Report 465040-1
9. Performing Organization Name and Address Texas Transportation Institute Texas A&M University System College Station, Texas 77843-3135	10. Work Unit No. (TRAIS) 11. Contract or Grant No. 0079
12. Sponsoring Agency Name and Address Southwest Region University Transportation Center Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135	13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

Supported by a grant from the Office of the Governor of the State of Texas, Energy Office

16. Abstract

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17. Key Words	18. Distribution Statement
Intermodal Freight Transportation, Modal Shift	No Restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	87	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

INTERNATIONAL RAIL FREIGHT TRANSPORTATION IN SOUTH TEXAS: DECREASING FUEL CONSUMPTION, ROADWAY DAMAGE, AND HAZARDOUS MATERIALS MOVEMENT ON TEXAS ROADWAYS

A Research Study

by

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July 1995

ACKNOWLEDGMENT

This publication was developed as part of the University Transportation Centers Program which is funded 50 percent in oil overcharge funds from the Stripper Well settlement as provided by the Texas State Energy Conservation Office and approved by the U.S. Department of Energy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

The objectives of this research were to examine impediments to the greater use of rail in the transport of freight, and to document projected reductions in congestion, roadway damage, hazards, and energy usage resulting from such a modal shift. In pursuing these objectives, an examination was made of the roles that are performed by decision-making agencies at the federal, state, and local levels. The findings of this examination are discussed in terms of how these roles interfere with the adoption of increased use of intermodal transportation. Additionally, the logistics associated with cross-border freight transportation are described, documenting the institutional and governmental inefficiencies hindering smooth flow of trade across the border. The balance of the research concerns itself with the potential of rail transportation to mitigate the negative impacts associated with truck transportation.

EXECUTIVE SUMMARY

The bulk of freight moving between the U.S. and Mexico travels primarily on the ground, the majority of it by truck. The result of this is increased levels of congestion, a greater number of accidents, and accelerated highway degradation. Facilitating a shift from truck to rail is of increasing importance. In recognition of this importance, research was sponsored to examine the economics, policy, and operational impediments to greater use of rail transport.

A fundamental impediment to increasing the intermodal share of transportation is the current organization of the U.S. Department of Transportation. According to the National Commission on Intermodal Transportation, only a more thorough reorganization away from modal lines will allow the vision of ISTEA to be realized. Such a reorganization will facilitate incorporation of all modes of transportation into an integrated intermodal transportation system. A potential benefit could be better cooperation and coordination between agencies involved in transportation, and greater flexibility in the way transportation policy is defined, decisions are made, and transportation projects are financed.

The rail industry has made great strides in the area of intermodal freight transportation. In order to continue the trend of increasing intermodal market share, the railroads must address the customer service issues of emerging market identification, sales process improvement, and the problem of long transit times and lack of flexibility. One technology proposed to accomplishing this is Interline Service Management (ISM). As defined by the Association of American Railroads (AAR), ISM is a set of management procedures and supporting information systems that will allow the rail industry to monitor service commitments to customers, facilitate post trip analysis, improve transit times, and allow customers information access.

The passage of NAFTA promises to streamline the process of transporting freight across the border between the U.S. and Mexico. Currently, though, traffic delays are the norm owing to the

multiplicity of government agencies operating on both sides of the border. Fortunately, both the U.S. and Mexico are working to address the problem of border delay. New initiatives, such as Despacho Previo, have been implemented to improve the cross-border process. Border patrol work schedules on both sides of the border are being coordinated, and increased operating times are being considered. Of particular importance to the movement of trade across the border is the recognition that FNM, the national railroad of Mexico, needs to improve productivity in its workforce and increase investment in information systems for cargo tracking and infrastructure management. Working toward this goad, FNM has increased its productivity by close to 50 percent in the last two years.

The expected growth in trade between the U.S. and Mexico is likely to significantly increase non-roadway and roadway impacts associated with highway congestion, pollution emissions, safety, and pavement degradation. For these reasons, increasing rail's share of freight transportation in this country is of increasing importance. Framers of policy involving truck and rail freight transportation need to take into consideration factors other than purely market forces, and begin to assess the costs that are extracted by truck transportation on the environment and infrastructure when evaluating the feasibility of increased use of rail.

The fact that the highway infrastructure in many areas of south Texas is reaching saturation has caused policy makers to take notice of the benefits of rail freight transportation. In terms of ton-miles per gallon, rail is four to eight times more efficient than trucks. Rail transportation produces 26 percent of the pollution produced by truck transportation, is almost five times safer in terms of hazardous materials movement than truck transportation, and is over 13 times safer than trucks when it comes to accidents involving a fatality.

Transportation planners, faced with ever increasing highway utilization in an era of fiscal constraint, are justifiably concerned with the ability of existing infrastructure to absorb current and projected transportation demand. Rail transportation, with its immense carrying capacity and fuel efficiency, offers one solution to the mitigation of negative impacts associated with truck transportation.

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CHAPTER 1. INTRODUCTION

There are many advantages to shipping commodities by rail. As an alternative to truck transportation, rail transportation offers the advantages of reduced road congestion, a better safety record, greater energy efficiency, and reduced air pollution. From this standpoint, the State of Texas would benefit from any significant shift from truck to rail transportation.

The bulk of freight moving between the U.S. and Mexico travels primarily on the ground, the majority of it by truck. This necessarily increases the level of congestion and hazard on Texas roadways. Transportation planners, faced with increasing traffic densities in several regions of south Texas, are concerned also with the degradation of the highway infrastructure as a result of an increasing number of heavier trucks.

Facilitating a shift from truck to rail is of increasing importance. In recognition of this importance, this research was sponsored to examine the economics, policy, and operational impediments to greater use of rail transport. In fulfilling this goal, the current research endeavored to satisfy the following two goals:

- Examine and document methods to facilitate increased use of rail transportation in south Texas, and
- Document the projected reductions in congestion, roadway damage, hazards, and energy usage resulting from increased use of rail transportation.

The goal of increased use of rail transportation could be accomplished through application of the concept of intermodalism. Intermodalism describes an approach to planning, building, and operating a transportation system that emphasizes the optimal utilization of transportation resources and connections between modes. There is much to recommend about intermodal transportation, including providing users with more choice, more efficient use of infrastructure, and energy savings. Intermodal transportation of freight is increasing. Nationally, intermodal growth for the year 1994 was over 14 percent, with many industry analysts projecting similar growth for 1995. For this trend to continue, impediments to intermodalism need to be examined.

The following chapters of this report address important issues concerning intermodal freight transportation and investigates rail's potential contribution to the benefits such transport offers. In accomplishing the goals of the study, this report will examine institutional barriers to intermodal transport, factors limiting international trade between the U.S. and Mexico, and will estimate reductions in non-roadway and roadway impacts that would accrue assuming a shift from truck transportation of freight to rail transportation.

Chapter 2 gives a brief description of the Texas rail system, highlighting the fact that it is the largest rail network in the nation and is fifth overall in the number of freight ton transported. Given Texas' proximity to Mexico, issues pertaining to U.S. - Mexico trade gain in importance, and are discussed throughout the report.

Chapter 3 describes the concept of intermodalism and the enormous potential it has for improving efficiency and reducing pressure on the nation's infrastructure. The major focus of the chapter is the need to reorganize Federal and State transportation agencies to reflect the intermodal vision expressed by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).

Chapter 4 discusses the needs of the rail industry in order that it may boost its share of the freight transportation market. Particular attention is paid to shipment tracking inefficiencies and the need of the industry to place more emphasis on the importance of sales and customer service.

U.S. - Mexico trade issues are examined in chapter 5, particularly as they relate to cross-border logistics and customs. The enormously involved clearance process for truck and rail crossings is discussed as well as some of the arbitrary and institutional practices that serve to hinder the efficient movement of freight.

Roadway and non-roadway impacts of freight transportation are addressed in chapters 6 and 7. A methodology for estimating roadway impacts of truck traffic is described and applied to the study objective of roadway degradation analysis. Rail and truck transportation are compared in terms of energy consumption, environmental impacts such as air pollution and hazardous materials, safety, congestion, and roadway degradation. In particular, the chapters document projected reductions in these areas following a percentage shift in truck transport to rail.

Chapter 8 describes a recent origin-destination survey that was performed of trucks traveling northbound across the border at Laredo, Texas. Over 1,200 truckers were interviewed as to the cargo they were carrying, its weight, and the final destination of their trip. The results of the survey are discussed in terms of the mitigating effects rail transportation might have had on roadway and non-roadway impacts had some of the cargo been shifted from trucks.

CHAPTER 2. THE RAIL SYSTEM OF TEXAS

INTRODUCTION

The State of Texas was introduced to rail in 1853 when the Buffalo Bayou, Brazos and Colorado Railroad linked the port of Harrisburg with Stafford's Point, 20 miles southwest. By then, almost 13,000 miles of track were in use in the rest of the U.S., and Chicago was already linked to the East Coast. Although rail was late coming to Texas, the post Civil War period saw dramatic growth in railroad construction. During the 1880s more miles of main line were built in Texas than in any decade before or since. Over 6,000 miles of new track were laid, tripling the state's rail mileage. By 1905, Texas had more miles of railroad than any other state; a distinction it still holds today. In the U.S., railroad construction had peaked by 1916, but continued in Texas until 1932, when the state had more than 17,000 miles of track. Since then, abandonments have exceeded new construction in every decade such that, by 1991, Texas had lost 28 percent of the rail network it had in 1932. The current Texas rail network, which constitutes approximately seven percent of the total national rail miles, can be seen in Figure 1.

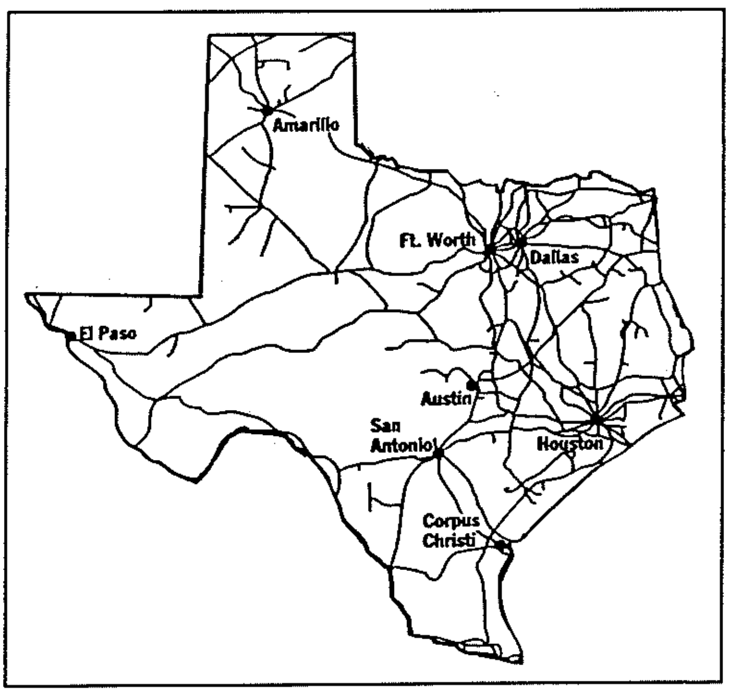

Figure 1. The Texas Rail Network

CHARACTERISTICS OF THE TEXAS RAIL SYSTEM

As the top ranking state in total rail miles and fifth in the nation in terms of freight tonnage hauled, the railroad industry in Texas continues to play a large role in the economy of the state. This consensus is amply demonstrated by the statistics presented in Table 1, which characterizes the rail system of Texas and its national ranking in selected categories. As can be seen in Table 1, Texas ranks no lower than fifth in any of the categories listed.

Table 1. Texas Railroad Industry Statistics - 1990

Category	Number	National Ranking
Total Rail Miles	11,370	1st
Rail Carloads Handled	4,133,145	3rd
Total Tons Transported	230,057,371	5th
Total Railroad Employment	16,028	2nd
Total Employee Wages	$679,716,000	2nd
Average Employee Wage	$42,408	--
Average Employee Benefit	$16,794	--
Retirement Beneficiaries	47,600	4th
Beneficiary Payments	$400,614,000	4th
Number of Railroads - All Classes	39	3rd

Source: (Texas Railroad Facts, 1990)

Referring to Table 1, Texas ranked first in the nation with 11,370 miles of rail, ranked third in the number of rail carloads handled, ranked fifth in the number of freight tons transported by rail, and was second in the nation in the number of rail employees.

The top five commodity groups originating and terminating by rail in Texas are depicted in Table 2 and Table 3. Chemical products are the major commodity shipped from Texas and account for 32 percent of all rail tonnage originating in the state. Twenty percent of the originating rail tonnage in the state is nonmetallic minerals. Farm products rank fifth in commodities originating in Texas, accounting for six percent of the tonnage.

Table 2. Top Five Commodity Groups Originating in Texas - 1990

Commodity Group	Tons Transported	Percent of Total
Chemical Products	27,558,824	32
Nonmetallic Minerals	17,473,657	20
Petroleum Products	6,112,348	7
Mixed Freight	6,062,817	7
Farm Products	5,047,166	6

Source: (Texas Railroad Facts, 1990)

As can be seen in Table 3, coal is currently the major commodity terminating in Texas, accounting for 28 percent of total rail terminations. The second largest group is nonmetallic minerals, followed closely by farm products.

Table 3. Top Five Commodity Groups Terminating in Texas - 1990

Commodity Group	Tons Transported	Percent of Total
Coal	39,997,651	28
Nonmetallic Minerals	19,579,387	14
Farm Products	19,373,633	14
Chemical Products	18,218,919	13
Food Products	9,782,907	7

Source: (Texas Railroad Facts, 1990)

Intermodal growth in Texas has been substantial. By 1994, Texas had 17 intermodal facilities with the newest being the Alliance terminal outside of the Dallas-Fort Worth area. Built through the cooperation of private and public sector organizations, the Alliance terminal features facilities for intermodal transfer of automobiles, airfreight, highway trailers, and international shipping containers. Table 4 displays the intermodal facilities in Texas, and details the number of containers each currently handles per year.

Table 4. Intermodal Facilities in Texas - 1994

City	Intermodal Facility	Containers/Year
Dallas-Fort Worth	Southern Pacific	220,000
Houston	Southern Pacific	216,000
Dallas-Fort Worth	Union Pacific	191,000
Dallas-Fort Worth	Santa Fe	189,000
Houston	Union Pacific	144,000
Laredo	Union Pacific	106,000
Dallas-Fort Worth	Kansas City Southern	72,000
Houston	Santa Fe	62,500
El Paso	Southern Pacific	60,000
San Antonio	Southern Pacific	60,000
Houston	Southern Pacific	50,000
El Paso	Santa Fe	45,600
San Antonio	Union Pacific	18,000
Marshall	Union Pacific	9,000
Amarillo	Santa Fe	8,800
Harlingen	Union Pacific	4,500
Lubbock	Santa Fe	4,000

CONCLUSION

Texas is in a unique position in regard to cross-border trade with Mexico. With 18 border crossings, nine of which are in south Texas alone, Texas has more ports of entry with Mexico than the rest of the border states combined.

The potential for increased rail freight traffic across the border is enormous. Because commercial development was not a high priority with FNM (Ferrocariles Nacionales de México, the national railroad of Mexico) in the past, rail access to industrial centers is limited, resulting in 80 to 90 percent of intercity freight traffic being moved by truck. This in itself has created problems with the Mexican highway infrastructure, which is in need of maintenance. As a consequence, rail-truck intermodal traffic is viewed by many as an area of great opportunity for cross-border operations. FNM is currently working on new and expanded intermodal facilities at Guadalajara, Pantaco (Mexico City), and Monterrey. Union Pacific, in particular, is investing in cross-border infrastructure, having expended over four million dollars in its Laredo facility, mainly for increasing the number of receiving and classification tracks in the yard, and is planning a new international bridge across the Rio Grande River at Laredo. Overall, a high level of confidence exists in the future of cross-border rail transport, and the State of Texas could well benefit from the expected increase in freight business.

CHAPTER 3. INTERMODAL TRANSPORTATION

INTRODUCTION

Intermodalism describes an approach to planning, building, and operating a transportation system that emphasizes the optimal utilization of transportation resources and connections between modes. Some of the many benefits of intermodalism are:

- Lowering transportation costs by allowing each mode to be used for the portion of the trip for which it is best suited,
- Reducing the burden on overstressed infrastructure,
- Generating higher returns from public and private infrastructure investments, and
- Reducing energy consumption and contributing to improved air quality and environmental conditions.

Significant intermodal freight transportation began in the mid-1980s, when ocean carriers and railroads cooperatively developed doublestack rail container service. Doublestack rail container service consists of stacking two shipping containers on specialized railcars for greater efficiency. Since this system was introduced, growth in intermodal transportation of freight has been explosive.

Confidence in the future potential of intermodal growth was demonstrated by the results obtained by Mercer Management Consulting in their 1993 survey of almost 600 U.S.-based transportation and distribution center managers. The survey focused on information related to full trailerload shipments traveling 500 miles or more by truck or intermodal services. As shown in Figure 2, the managers surveyed estimated that by 1996 over 20 percent of the over-500-mile market would be intermodal. A key finding of the survey was that almost 70 percent of the shippers expected their truckload carriers to provide an intermodal option within the next five years.

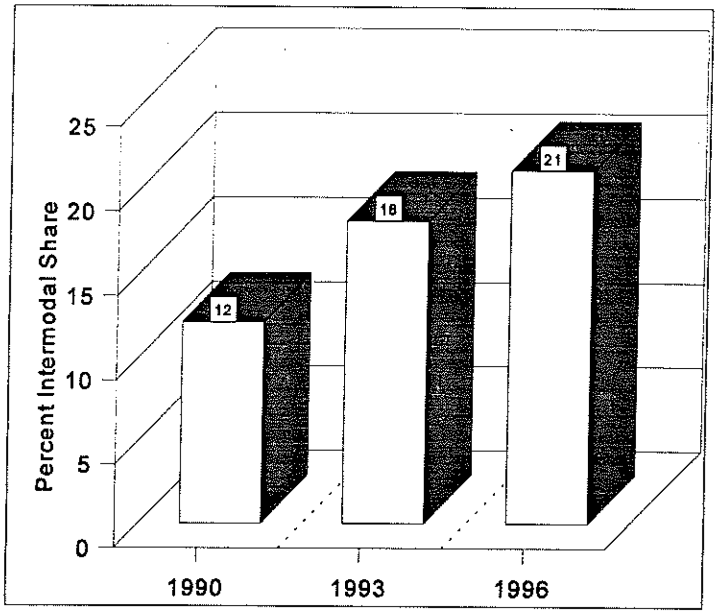

Figure 2. Estimated Intermodal Market Share

Even as the estimates of intermodal growth remain positive, there exists a growing awareness that fundamental change is required to ensure continued progress toward seamless transportation between modes. The discussion that follows will illustrate some of the barriers to increasing intermodal share of transport, and will address some of the proposed solutions for removing them.

DOT's MODAL ORGANIZATION

In its 1994 final report, *Toward a National Intermodal Transportation System*, the National Commission on Intermodal Transport stated:

> "The modal structure of the Federal Government is a fundamental barrier to intermodal transportation. DOT is organized along modal lines, maintaining the structures of the agencies that were brought together when DOT was formed in 1967."

While commending DOT for its initiatives aimed at satisfying the goals of ISTEA, the commission went on to state that a more complete reorganization of DOT would be required before the full potential of ISTEA could be realized. The current organization of the Department of Transportation can be seen in Figure 3.

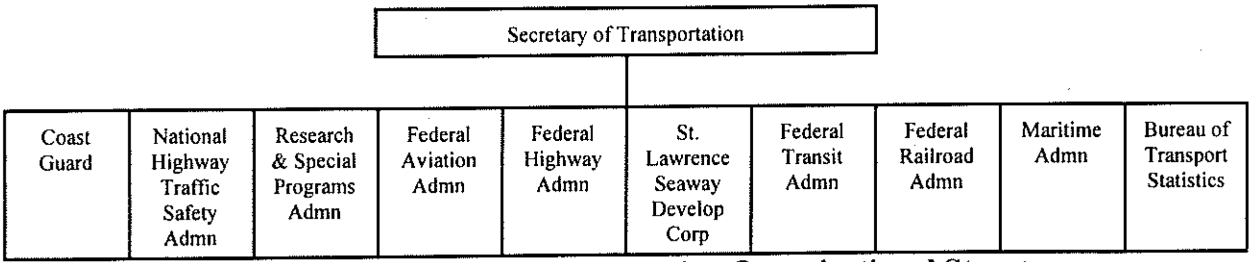

Figure 3. Department of Transportation Organizational Structure

DOT's modal organization fosters duplication of effort and sows confusion by disbursing policy making and funding decisions among agencies often having conflicting national goals. Unfortunately, this modal orientation finds itself replicated at many State DOTs. Compounding the problem is the fact that intermodal projects are often, by their very nature, more complicated than single-mode projects. Intermodal projects, because they involve different modes of transportation, tend to be governed by the regulations of more than one agency. All too often, the regulations are incompatible. Figure 4 Displays the many federal agencies having a say in transportation policy.

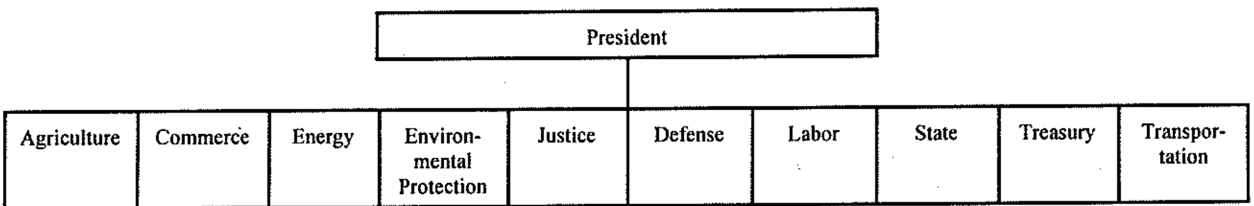

Figure 4. Federal Agencies Affecting Transportation Policy

RECOMMENDATIONS OF THE NATIONAL COMMISSION

Recognizing that seamless intermodal transportation is essential to the U.S. maintaining its competitive position in a global economy, the National Commission on Intermodal Transportation proposed a series of recommendations to help fulfill the basic vision and goals of ISTEA:

- Incorporate all modes of transport into a National Intermodal Transportation System,

- Foster development of the private sector freight intermodal system through a

Federal policy of eliminating barriers to freight movement at ports and borders,

- Fully fund transportation infrastructure programs at authorized levels,
- Encourage innovative public and private financing methods for transportation projects, and allow greater flexibility and eligibility in use of funds for intermodal projects,
- Expand research, education, and technology development in intermodal issues,
- Restructure the U.S. DOT to better support intermodal transportation,
- Streamline the transportation planning and project delivery process, and require DOT concurrence on other Federal agency actions that affect intermodal transportation, and
- Strengthen the MPO process to accomplish the goals of ISTEA.

In hearings before the National Commission, testimony was consistently heard about the need to fully fund ISTEA. In particular, statements were given about unfunded infrastructure needs and the importance of funding transportation projects at authorized levels, citing the $1.3 billion appropriations shortfall in 1994 surface transportation programs. A specific problem that was cited to the Commission was the constant drain on the transportation system of diversion of transportation trust funds to other uses, such as to offset the Federal deficit.

Given the current atmosphere of fiscal restraint, a major recommendation of the Commission was the need to encourage innovative public and private financing methods for transportation projects, and allow State and local officials greater flexibility in the way they spend transportation funds. Intermodal projects are placed at a disadvantage considering that funding too often comes from a modally oriented agency. Watson (1994) offers a solution to the lack of government funding of intermodal projects by suggesting that constraints on investment be removed to counteract the tendency of individual modal administrators to fund their own projects. One way to do this, he advises, is to create a transportation trust fund for all modes, reorganize congressional committees, and create an infrastructure to grant loans and favorable credit terms. The importance of innovative financing was underscored in President Clinton's Executive Order of January 28, 1994, *Principles for Federal Infrastructure Investment*, which directed all agencies to:

> "Seek private sector participation in infrastructure investment and management. Innovative public-private initiatives can bring about greater private sector participation in the ownership, financing, construction, and operation of [Federal] infrastructure programs... agencies should work with State and local entities to minimize legal and regulatory barriers to private sector participation."

CONCLUSION

Few could argue with the recommendations put forth by the National Commission on Intermodal Transportation. The private sector has spearheaded the move toward intermodal freight transportation, making the U.S. the world's leader in intermodal technology and innovation. For this status to be maintained, the public sector must become more involved. The lack of public and private decision-making systems and planning tools must be address in order to shrink the policy gaps that relate to intermodalism.

Freight transportation, because of its regional and national significance, has often been ignored by local jurisdictions and MPOs due to the narrow focus of their political mandates. ISTEA, in fact, specifically prohibits funding for most types of freight or intercity rail projects. These funding restrictions should be lessened to allow local agencies the opportunity to evaluate transportation decisions across modes, especially when they have to do with projects involving connective linkages between different modes of transport, and other joint use projects such as bridge clearances and grade crossings.

Transportation planning, in both the public and private sectors, is becoming increasingly intermodal. The recognition of the many benefits intermodalism has to offer, and the realization that the future competitiveness of the U.S. in the global economy is strongly linked to seamless transportation, has sounded the call for policy makers to coordinate resources in the local, State, Federal, and private sectors. Such coordination, as well as creativity and flexibility in approaching transportation challenges, will allow the vision of ISTEA to be fulfilled.

CHAPTER 4. RAIL INDUSTRY NEEDS

INTRODUCTION

Many of the advantages of rail transport are offset by long transit times and lack of flexibility. A common experience of rail customers is the need to deal with multiple rail carriers in moving their product from origin to destination. Shipment tracking inefficiencies as well as poor empty car management have interfered with the rail industry's ability to provide seamless transportation and reliable estimated times of arrival to its customers. In order to boost rail's market share of freight transportation, the industry must address these shipment issues as well as those of improving customer service and increasing sales efficiency.

In an effort to increase efficiency and boost sales as well as cut costs, the large railroads have been abandoning less profitable lines to improve asset utilization and concentrate their efforts on lines providing the best return on investment. Unfortunately, line abandonment is often a bridge burning activity that results in loss of valuable rights-of-way, that once gone, are gone forever. It is important that any line segment considered for abandonment be throughly evaluated as to its potential future role in the Texas transportation system. Maintaining industrial sidings is important from the standpoint of allowing continued long haul Class I service. Innovative alternatives to line abandonment will preserve rail market share and will, if service on the line is discontinued, at least keep the right-of-way in the public trust.

INTERLINE SERVICE MANAGEMENT

As defined by the Association of American Railroad's Interline Service Management Task Force, Interline Service Management (ISM) is a set of management procedures and supporting information systems that will allow the rail industry to monitor service commitments to customers, provide proactive problem resolution, facilitate post trip analysis, and allow customer information access. In scope, ISM is intended to encompass transit time commitment and delivery on all traffic, loaded or empty, moving via rail. The promise of ISM, in theory, is full control of each shipment from origin to destination, regardless of the number of carriers or mode involved.

A principal component of ISM is the lead carrier concept. The originating carrier assumes the lead role in bringing together the shipper, the consignee, and the carriers involved to develop mutually acceptable transit time and interchange commitments. Once customers and carriers have agreed to a service commitment, the lead carrier is responsible for recording and electronically transmitting to each party involved the commitment information for automatic updating of each party's computerized in-house commitment files.

Each participating carrier will utilize an on-line computer system that generates a trip plan for each loaded or empty car. These trip plans will serve as the basis for on-line computer support for day-to-day management of railroad train and yard operations. Each carrier involved would be responsible for monitoring actual reported car movement events on its lines. If an event differs from that called for in the original trip plan, the responsible carrier generates a revised trip plan which would then become part of the information mainstream.

Unfortunately, the Association of American Railroads (AAR) has placed a low priority on the development of functional requirements and specifications for systems supportive of ISM. These included the identification of appropriate models and software, contract support of systems development, and conduct of feasibility or needs studies for issues such as centralized shipment monitoring or interline logistics management. In addition, processes to achieve concurrence on customer commitments among interchange partners, performing impact analyses on hypothetical changes in railroad operating plans on service commitments, and booking freight reservations were deemed of marginal value. In general, the AAR's Customer Service Management Committee judged these conceptual aspects of ISM to be premature and recommended that any work in these areas be pursued, if at all, by the individual railroads.

Given that the ISM concepts deemed premature by the AAR are at the heart of ISM, it seems unlikely that significant progress will be in this area in the near future. This is particularly unfortunate considering the emphasis placed on customer service by transportation and distribution managers.

SALES AND CUSTOMER SERVICE

In the April, 1994 issue of Progressive Railroading, John H. Winner stated that sales people in the railroad industry typically spend only 10 to 20 percent of their time on face-to-face selling. This compares with 40 to 50 percent of the time spent by sales people in "best practices" industries. The time spent in face-to-face selling allows sales executives to develop insights into customer needs. The railroad industry could experience a significant increase in business simply by reengineering the sales process to more efficiently make use of time. This conclusion is reinforced by the finding of the 1993 Mercer Management Consulting survey that customers actually wanted *more* sales calls from intermodal providers.

One of the expected benefits of wide-spread adoption of ISM is improved customer service by allowing customers direct access to a central computer facility for real time tracing information. Customer feedback and post trip analysis would pinpoint causes of service unreliability, allowing carriers to address those causes through a continuous improvement process. Additionally, ISM would allow carriers to more effectively predict traffic demand fluctuations, yielding faster, more regular and reliable service.

The impact of faster transit times on modal share cannot be over-estimated. In the 1993 Mercer survey, improved transit time was overwhelmingly cited by transportation managers as the way to increase market share. As shown in Figure 5, improved transit time was emphasized by 55 percent of the transportation managers surveyed. This was over twice the 24 percent that emphasized lower rates. This finding is in keeping with the view that rates tend to become a factor after performance is satisfactory.

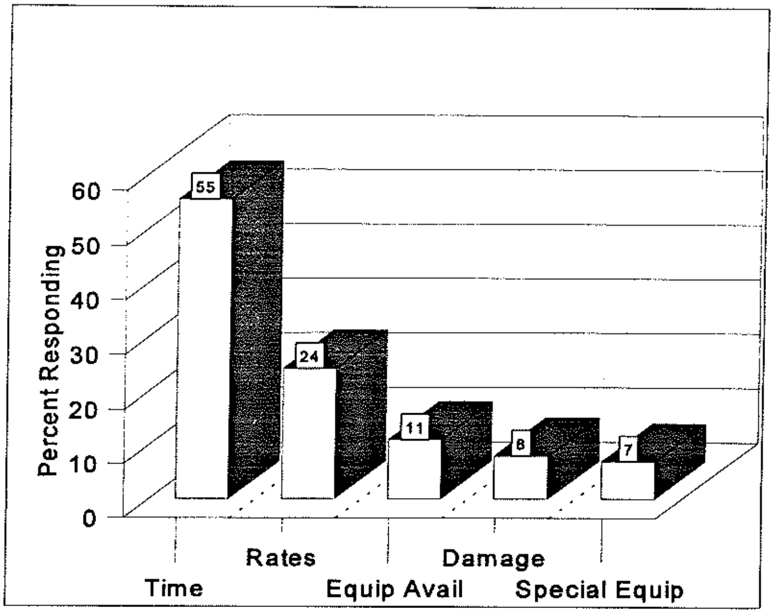

Figure 5. Factors Influencing Transport Mode Choice

THE ROLE OF THE SHORTLINE

In 1980, Congress passed the Staggers Act, ending decades of railroad regulation. The act eliminated state regulation of railroads except in matters of safety, and stripped the Interstate Commerce Commission (ICC) of most of its authority over railroads. By making mergers and abandonments easier, the Staggers Act cleared the way for a cycle, which continues today, of railroad consolidation. This consolidation often has meant abandoning the less-used, less-profitable branch lines. Abandoning track frees up cars and locomotives for use on the main lines, and allows train crews to spend more time operating trains and less time on layovers.

The 40 Class I railroads that existed in 1980 have been reduced through a series of merger, acquisitions, and bankruptcies, to only 12 today. Federal approval of the Burlington Northern acquisition of ATSF is expected, further reducing the number of Class I's to 11. These mergers, and the consolidation they represent, have, according to some experts, made an estimated 20,000 miles of branch line available for conversion to shortline service or, if no buyer is found, a candidate for abandonment.

Unfortunately, the action of abandoning a rail line segment, taking up track, removing bridges and structures, and salvaging crossties and roadbed materials is essentially a non-reversible decision. Where rail right-of-way is returned to abutting landowners through reversionary agreements, any future public use of the corridor is severely restricted. In addition, the loss of industrial sidings for business breaks the link to long haul rail service, forcing businesses to ship by truck with the adverse consequence of increased road damage and pollution or, if truck transport is impractical, to go out of business altogether. Therefore, it is essential that any rail line segment being considered for abandonment be subjected to a detailed evaluation as to its role in the current and future transportation system. State agency resources should be made available to help facilitate private ownership by a shortline railroad or, if the current rail service provided on the line is deemed not essential, then the rail corridor can be placed in interim public use until such time that a public need to restore rail service no longer exists.

Characteristics of the Shortline

A vigorous shortline rail industry is beneficial to the rail industry in general. Some estimates attribute as much a one-quarter of the nation's rail freight volume to feeder and shortlines. The larger railroads now recognize the benefits of selling to a shortline instead of simply abandoning track. More money is to be made by selling to a shortline than salvaging materials. More importantly, the large railroad preserves access to shippers and destinations along the line by negotiating track usage and car hauling agreements with the new operators.

Typically, shortlines are low-cost businesses, buying and operating older, used locomotives and cars. They tend to pay locally prevailing wages and are usually free from restrictive work rules allowing fewer workers to run the railroad. Shortlines cater to the needs of short haul customers with custom schedules, and are often highly specialized, carrying only one type of cargo such as agricultural products.

CONCLUSION

For a number of years now, the rail industry has experienced what is essentially flat revenue growth per ton-mile transported. Such a finding indicates a need for the industry to identify areas where productivity may be enhanced and available resources used more efficiently. Additionally, in order to increase modal share, the rail industry must place greater emphasis on sales and the identification of new markets, as well as provide better service to their customers.

Interline service management represents a technology that could significantly improve capacity utilization and customer service. Properly applied, the technology would reduce shipment tracking inefficiencies, simplify empty car management, and improve transit times through more effective prediction of traffic demand fluctuations.

Fostering the shortline rail industry is of value to the rail industry in general. By continuing service on lines deemed unprofitable by the large railroads, the shortlines preserve the right-of-way and provide a vital link between affected industries and long haul service. Without the shortline, the industries would have little choice but to transport by truck, or go out of business. Small railroad companies such a these represent efficient, low cost alternatives to line abandonment.

CHAPTER 5. U.S. - MEXICO TRADE

INTRODUCTION

Historically, Mexico has been a closed economy with high tariff barriers and little dependence on foreign trade. This was due in part to an abundance of oil which was exported to create the necessary foreign exchange and protect the Mexican economy. When the world price of oil dropped dramatically in 1981 and 1982, Mexico's oil could not be sold for enough dollars to buy the same amount of U.S. products that had been previously purchased. As a result of the oil crisis, Mexico was forced to devalue the currency (peso). During this time U.S. exports fell from $17.79 billion in 1981 to $9.08 in 1983 (see Table 5). A similar result could obtain from the peso devaluation that occurred in December of 1994.

Table 5. 1977 - 1994 U.S.-Mexico Trade and Average Yearly Export and Import Trade Growth (Billions of U.S. Dollars).

Year	U.S. Exports to Mexico	Export Growth	U.S. Imports from Mexico	Import Growth
1977	4.82		4.77	
1978	6.68	1.86	6.20	1.43
1979	9.86	3.18	9.0	2.80
1980	15.15	5.29	12.84	3.84
1981	17.79	2.64	14.01	1.18
1982	11.82	-5.97	15.77	1.76
1983	9.08	-2.74	17.02	1.25
1984	11.99	2.91	18.27	1.25
1985	13.64	1.64	19.39	1.13
1986	12.39	-1.24	17.56	-1.83
1987	14.58	2.19	20.52	2.96
1988	20.47	5.89	23.53	3.01
1989	24.97	4.50	27.59	4.06
1990	28.38	3.41	30.80	3.21
1991	33.28	4.90	31.89	1.09
1992	40.60	7.32	35.19	3.30
1993	41.58	0.98	39.92	4.73
1994	50.84	9.26	49.94	9.58
TOTAL	367.92	46.02	388.97	44.72
AVERAGE YEARLY GROWTH		2.71		2.63

After the oil crises in 1981 and 1982, Mexico changed its national policy to that of becoming an international competitive country. Actions were taken which stimulated the growth of U.S.-Mexico trade. In 1986 Mexico joined the General Agreement of Tariffs and Trade (GATT). Under the GATT, Mexico removed many of its required trade permits and reduced tariffs. This resulted in a substantial growth of U.S.-Mexico trade from $12.39 billion of U.S. exports and $17.56 billion of U.S. imports in 1986 to $33.28 billion of exports and $31.89 billion of imports in 1991. Trade growth has been further stimulated since 1991, first by the negotiations for the North American Free Trade Agreement (NAFTA), and then by its implementation, which further reduced tariffs and other trade restrictions when it was implemented on January 1, 1994.

CROSS BORDER ISSUES

Growth in trade necessarily leads to growth in traffic. Since most of the movement of goods across the border is accomplished by surface transportation (i.e., trucks and railroads), concern has been generated about transportation problems that could result from significant increases in trade between the U.S. and Mexico. This apprehension was expressed by government officials and private sector groups in a 1991 U.S. General Accounting Office study that identified the following major concerns:

- The existing U.S. border inspection facilities cannot adequately accommodate the current flow of commercial traffic. Additionally, current capital improvement programs did not anticipate increased traffic that could result from NAFTA, and no long-range planning process exists for designing, constructing, or renovating border inspection facilities.

- Traffic across the border remains congested, even after U.S. and Mexican Customs have introduced new automated and simplified procedures to speed the flow of commercial traffic.

- U.S. inspection agency staffing along the border has not kept pace with the increase in traffic. Staffing cannot adequately handle existing traffic.

- Adequate transportation infrastructure is required is required on both sides of the border in order to facilitate the flow of commerce between the countries.

- Most border cities were not designed to handle the existing and expected commercial traffic. The commercial traffic uses city streets that were never intended to handle such traffic, resulting in congestion, accidents, and accelerated pavement deterioration.

Getting rail traffic from one country to another has improved greatly since the passage of NAFTA. Despacho Previo, essentially a means of process improvement, was implemented first at Laredo and has since been put in place at a number of other crossings. Under the program, the U.S. railroad notifies the customshouse brokers in advance that a shipment is en route. The broker then has 72 hours to pre-file for customs clearance. The pre-filing includes payment of import duties, receipt of Mexican customs authority, and notice to Ferrocarriles Nacionales de México (the national railroad of Mexico, or FNM) of authority to cross. Union Pacific has seen a reduction of a full day on traffic moving south from Laredo from the time a car is received until the time it is delivered to the FNM.

Unfortunately, traffic delays are still a common experience owing to the multiplicity of government agencies operating on both sides of the border. Delay is exacerbated by shipments being physically unloaded and inspected as many as four times, paperwork duplication, inconsistent procedures among various ports of entry, and abrupt implementation of new rules.

An example of an abrupt implementation of a new rule was related by a U.S. customs official in Laredo about the administrator on the Mexican side of the border (the second one in a month, demonstrating another problem--high turnover of personnel) arbitrarily instituting a tier system for truck crossings. Designated trucks had to cross into Mexico at a specific time of day, or face a delay in being reassigned to another time window. The effect of this new rule has been heightened congestion due to truckers, fearful of missing their time window, lining up to cross hours earlier than necessary. The interviewed customs official could see no rationale for the implementation of the tier system.

The Devaluation of the Peso

Many economists are in agreement that the Mexican peso was overvalued during the last half of 1994. When the peso is overvalued, international investors sell pesos and buy dollars. The Mexican government must then enter the international money market and buy pesos, raise domestic interest rates, or devalue the peso and exchange more pesos for each dollar. Due to international money market pressure these actions all occurred in Mexico in December of 1994, quickly reducing the value of the peso, relative to the dollar, by 40 percent.

The effect this devaluation will have on U.S.-Mexico trade will be to decrease U.S. exports to Mexico while increasing U.S. imports from Mexico. Since the devaluation is much smaller than in 1981 and 1982, and since the Mexican economy is now in much better condition than in those years, it is reasonable to expect that the net effect of the current devaluation will be a net decrease in 1995 exports to Mexico, after which exports will again resume growing. Table 6 presents an estimate of trade volumes (in billions of dollars) for the year 2000.

Table 6. U.S.-Mexico Trade Estimates for the Year 2000

Trade Direction	1994	2000	Change
Southbound - U.S. Exports	50.84	71.74	41%
Northbound - U.S. Imports	49.94	73.37	48%

Mexico's economic crisis has had a severe impact on cross-border freight transportation. As reported by Perser (1995), southbound trucking is down by as much as 60 percent, while intermodal volumes moving by rail have dropped 35 to 45 percent. Particularly hard hit is rail freight involving autos and auto parts. Currently, autos are being deramped at the borders and being held for redistribution elsewhere in the United States.

The net effect of the devaluation of the peso could eventually be that of a diversion of traffic from rail to truck. Mexican railyards are experiencing gridlock due to consignees being unable to liquidate letters of credit upon the acceptance of goods. This fact, along with that of a reduction of shipment sizes, could result in a shift of freight from truckload to less-than-truckload carriers.

The National Railroad of Mexico (FNM)

FNM's 12,706 route-miles reach Texas at El Paso, Presidio, Eagle Pass, and Brownsville. The busiest rail interchange is Laredo, Texas, where FNM connects with Union Pacific and TMM's Tex Mex. FNM's line south from Laredo, running through the industrial city of Monterrey on its way to Mexico City, accounts for as much as 70 percent of all its traffic.

Any discussion of increasing rail's share of the south Texas freight transportation market must include the current state of FNM's operations and infrastructure. Despite a modernization program that began in 1992, FNM remains a railroad in need of vast amounts of capital, requiring upgrades in power, track, and facilities. Operationally, FNM needs to improve its efficiency by responding to market needs, set rates that would allow it to compete with the trucking industry, and, in general, become more customer-oriented. In a survey of Mexican transportation service users (Rivera, 1992) in which respondents were asked to rate different transportation modes in five categories (transit time, capacity, equipment quality, cargo damage, and cargo control), rail ranked the lowest in user confidence in all categories. In all cases, fewer than five percent of the transportation service users sampled rated rail as adequate.

CROSS-BORDER LOGISTICS

Border activities involving truck and rail crossings are very complicated because of the policies and practices of both nations. Clearance processes involving U.S. and Mexican customs, customs inspections, U.S. and Mexican customs brokers, the declarations associated with commodity descriptions, import duty assessment, government tax identification, and a hoard of other special documentation all impede the smooth movement of freight transportation between the U.S. and Mexico.

Nevertheless, the number of freight crossings every year is staggering, and continues to grow. Figure 6 displays the number of southbound and northbound railcars that crossed the border from 1991 to 1994. The numbers represent Southern Pacific and Union Pacific railcars only (which constitute the vast majority of railcar crossings in Texas) and average double digit growth over the four years.

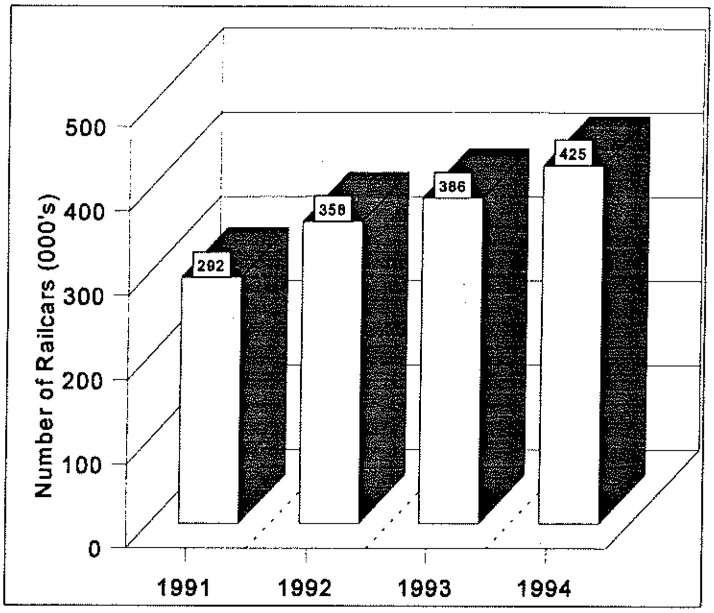

Figure 6. Railcars Conveyed To and From Mexico

The following discussion will detail the logistics process involved in northbound and southbound trade for both rail and truck transportation. The discussion of rail logistics in cross-border operations will be concentrated on the practices of the Southern Pacific railroad. The practices of the other rail players (primarily Union Pacific) involved in cross-border freight transportation are essentially the same.

Logistics Process for Southbound Mexico Shipments - Rail

The process of shipping a commodity to Mexico begins when the customer orders a rail car (or cars) from the originating railroad for loading. The customer then generates a Bill of Lading which consists of the following information:

- Origin and border destination, indicating "for export,"
- Mexico destination,
- Consignee name, address and phone number,
- Mexican broker,

- Quote or contract number,
- Weight of shipment, and
- Seal number(s).

At this point, the customer faxes a copy of the Bill of Lading to the originating railroad for waybill purposes (if the originating railroad is the Southern Pacific, the Bill of Lading is faxed to SP's Regional Business Center). Additionally, the customer faxes a copy of the Bill of Lading, the commercial invoice, packing list, and any other required certificates to a designated Mexican broker and to the affiliated U.S. freight forwarder or U.S. Customs to begin the clearance process. It is also customary for the customer to send all document originals via overnight express service to the U.S. freight forwarder or customs broker. Failure to supply all proper documents could result in border demurrage and late document charges.

All monies for FNM freight charges are rendered by the Mexican customs broker to FNM along with the Bill of Lading as well as shipping instructions. The Mexican customs broker then renders per diem charges to the U.S. railroad serving at the border point at the time the car is cleared. Per diem charges do not apply on private equipment or northbound shipments and are ordinarily paid by the Mexican consignee, depending on the agreement that was in effect at the time of sale. The origin railroad is responsible for giving a waybill to the Mexican broker to complete the documentation.

Southbound Documentation

The redtape associated with southbound freight transportation is, at best, complicated. The following discussion will enumerate the many transactions necessary to accomplish cross-border freight transport by rail.

U.S. Customs Broker (Freight Forwarder). The U.S. customs broker represents the exporter or importer, depending on the terms of sale. Exportation does not require a licensed U.S. customs broker. Typically, the U.S. customs broker:

- Prepares and files a "shipper's export declaration" (SED) which will accompany the crossing list given to the U.S. railroad,
- Receives authority (clearance) from U.S. Customs,
- Gathers the U.S. certificates required by the importer into a contract to be given to the Mexican customs broker for documentation purposes, and
- Gives the U.S. railroad a crossing list which is accompanied by the SED, a copy of the FNM waybill, and a copy of the paid per diem form. In-bond shipments do not require a shipper's export declaration.

Mexican Customs Broker. The Mexican customs broker represents the Mexican importer and is the only legal facilitator authorized. The Mexican customs broker is required by law. Mexican law holds the broker responsible for all declarations, including the description of the commodity, its value, import duty assessment, the commodity's government tax ID number, and special documentation required for certain commodities. Typically, the Mexican customs broker:

- Presents documentation (Pedimento) and duties to the Mexican Customs office,
- Prepares FNM shipping instructions and the Bill of Lading,
- Pays applicable per diem charges to the U.S. railroad making the interchange with FNM,
- Pays any accrued border demurrage on behalf of the shipper or consignee, depending on the terms of sale, and
- Gives a copy of the FNM waybill and certified paid per diem form to the U.S. customs broker (or freight forwarder), who will then attach it to the crossing list to be given to the U.S. railroad.

The Southbound Crossing. The U.S. railroad gives the list of proposed cars to interchange to FNM. FNM checks the list against the documentation list and accepts the interchange of cars if they are properly documented. Each car goes through a green light-red light process, and if red, must be inspected.

Logistics Process for Northbound Shipments - Rail

The process of shipping a commodity north of Mexico begins when the customer orders a rail car (or cars) from FMN for loading. The customer then generates a Bill of Lading which consists of the following information:

- Origin and border destination, indicating "for export,"
- U.S. destination,
- Consignee name, address and phone number,
- U.S. customs broker, name, phone, and fax number,
- Quote or contract number, and
- Seal number(s).

At this point, the customer faxes a copy of the Bill of Lading, commercial invoice, packing list, and any other required certificates to the Mexican broker and also to the U.S. customs broker to begin the clearance process. It is usually customary for the customer to send all originals via overnight service to the U.S. customs broker or freight forwarder. Failure to supply all proper documents could result in border demurrage and late document charges. The Mexican broker then forwards all documentation to the U.S. customs broker or freight forwarder for U.S. clearances.

Northbound Documentation

The following discussion will detail the many transactions required to accomplish northbound cross-border freight transport by rail.

Mexican Customs Broker. The Mexican customs broker represents the Mexican exporter and is the only legal facilitator authorized. The Mexican customs broker is required by Mexican law. Typically, the Mexican customs broker:

- Gathers Mexican certificates required by the U.S. importer and forwards them to the U.S. customs broker or freight forwarder,

- Prepares and submits an export declaration to Mexican Customs,
- Receives and acknowledges authorization to exit merchandise, and
- Notifies FNM of clearance.

U.S. Customs Broker. The U.S. customs broker represents the importer and, for northbound shipments, is the only legal facilitator authorized by law. The U.S. customs broker protects against U.S. Customs fines by arranging inspections of merchandise, preparing commercial invoices and packing lists, collecting duties from the importer and paying them to U.S. Customs, preparing all required forms, and gathering all required certifications. Typically, the U.S. customs broker:

- Presents documentation to U.S. Customs,
- Prepares the Bill of Lading and shipping instructions,
- Prepares the documentation for shipments entering "inbond" to the U.S., both for shipments that are destined to cross the U.S. for export or are moving to an interior port of entry,
- Prepares the crossing list of cleared rail cars, and
- Delivers U.S. Customs documentation signifying authority to cross to all interested participants.

The Northbound Crossing. FNM gives the list of proposed cars to interchange to the U.S. railroad. The U.S. railroad checks the list against the documentation list and accepts the interchange of cars if they are properly documented.

U.S. Customs selects approximately 15 percent of import shipments for inspection. Approximately one half of the 15 percent are inspected in order to insure the products comply with trademark, copyright, labeling, and commercial invoice description regulations. The other half of the 15 percent are inspected for enforcement of smuggling and other interdictive reasons. All shipments are subject to selection for U.S. Customs inspection. Some enforcement inspections require complete off-loading of lading. The cost of this is borne by the importer of record.

Cross-Border Truck Logistics

Years of increased trade with Mexico have brought a tremendous number of trucks to the border. In 1993, almost 1.7 million northbound and southbound trucks crossed the border between Texas and Mexico. In the first three quarters of 1994 commercial truck crossings in Laredo were up 40 percent. In 1993, the Laredo customs district, by itself, accounted for 54 percent (22.5 billion dollars) of all exports to Mexico from the United States.

The logistics associated with northbound and southbound truck traffic are, at least from the standpoint of customs and paperwork, essentially the same as that for rail. A major difference has to do simply with the number of entities involved. For rail, you are dealing primarily with Southern Pacific railroad, the Union Pacific railroad, and FNM. For trucks, you are dealing with hundreds of companies. The other major difference between the cross-border logistics associated with rail and truck has to do with the institutional practice of drayage.

Drayage

As described by Molina and Giermanski (1994) the drayage system as practiced in Laredo is as follows. A truck carrying freight destined for Mexico City drops off the trailer on the U.S. side of the border. After the cargo is cleared by customs, a U.S. drayage company picks up the trailer and transfers it to a designated location on the Mexican side of the border where a Mexican carrier takes the trailer on to its final destination in Mexico City. The U.S. drayage truck driver than returns to the U.S. without any cargo. The same drayage activity is practiced for northbound shipments coming from Mexico.

CONCLUSION

Streamlining and rationalizing border operations is one of the largest challenges to improving cross-border transit times. In the past few years formal mechanisms to simplify customs procedures have been put in place and require only that they be enforced. Current practices involving Mexican brokers are also being examined. Other relatively simple solutions to the border bottleneck are being considered such as increasing operating times at the border, coordinating border patrol work schedules in both countries, and shifting commercial traffic to non-peak times. Correcting cross-border inefficiencies could have enormous positive consequences for the Texas economy. Addressing this challenge should be of the highest priority.

Although much attention has been given to the idea of privatizing Mexico's national railroad (FNM), the consensus among many is that FNM will remain state-owned. In order for FNM to continue to function as a strategic transport system within the Mexican economy and be able to fill the role required as a valued partner in the North American freight transportation scheme, it will be necessary to make significant modifications in the way it does business. In recognition of this, FNM has embarked on a series of strategic plans to increase productivity, ease implementation of improved techniques, foster private company participation, and provide investment in information systems for cargo tracking and infrastructure management.

One area in particular that would realize relatively quick productivity returns would be for FNM to accelerate reduction of redundant personnel. The FNM has 2.38 employees per kilometer. This is over twice the average for the U.S. railroad industry of one worker per track kilometer. A step in the direction of employee reduction was a voluntary retirement program initiated by FNM in 1992. As a result of this action, the total number of field personnel related to engineering services was reduced from 17,500 to 11,000.

With total staff reduced by a third and traffic rising, FNM has increased its labor productivity by close to 50 percent in the last two years. Additionally, FNM has begun to move toward its goal of financial self-sufficiency, achieving a 1993 operating deficit almost 64 percent below that of 1992. Even with these improvements, FNM has much to do in order to provide the service necessary to support the expected increases in freight movement demand between the U.S. and Mexico.

CHAPTER 6. FREIGHT TRANSPORTATION - NON-ROADWAY IMPACTS

INTRODUCTION

Increasing rail's share of freight transportation in this country is of increasing importance. Most of the freight moving between Mexico and the U.S. travels on the ground, with the majority of that transported by truck. Trade between Mexico and the U.S. has been steadily increasing and the passage of NAFTA, according to many economists, will serve to fuel this growth at an ever increasing rate. This situation has raised concerns about the impact such growth in trade will have on fossil fuel emissions and the resultant degradation of air quality, vehicular traffic on already congested arterial highways, and the safety of those using the roadways.

The following discussion will compare and contrast truck and rail freight transportation in the areas of energy usage, environmental impacts, safety, and congestion. These areas will be analyzed in terms of the reductions to be expected from an increase in rail modal share.

ENERGY CONSUMPTION

Of the 4,457.1 trillion BTU of petroleum consumed by the State of Texas each year, the transportation sector is responsible for 2.044.6 trillion BTU (45.9 percent). Specifically, highway transportation uses 1,242.3 trillion BTU per year, accounting for approximately 60.8 percent of the transportation use, while rail transportation consumes 52.1 trillion BTU per year, or just 2.5 percent of the transportation use (TTI, 1991).

Comparisons between the efficiency of truck and rail transportation usually take the form fuel consumption rates relative to the amount of goods transported, or ton-miles per gallon. Ton-miles per gallon is described as the number of tons that can be transported one mile on a gallon of fuel. This unit of measure is preferred for comparative purposes because it not only provides a means of evaluating vehicle fuel efficiency, but also the factor of quantity moved.

Fuel consumption rates for both rail and trucks vary greatly as a function of the type of cargo being transported. Product density relative to the type of container used for transport becomes an important factor in measuring fuel efficiency ratings. Low density cargo (such as automobiles) requires a larger number of transport vehicles to ship an equivalent amount of weight than does a high density cargo (such as chemical products). Table 7 shows the impact of various product densities on rail and truck fuel efficiencies. Other factors, such as frequency of speed changes,

Table 7. Impact of Cargo Density on Fuel Efficiency

Commodity Type	Rail (Ton-mi/gallon)	Truck (Ton-mi/gallon)	Rail/Truck Fuel Efficiency Ratio
Corn	616	148	4.2
Grain	752	139	5.4
Misc. Food	1,019	131	7.8
Chem. Prod.	1,104	131	8.4

Source: (Abacus Technology Corporation, 1991)

locomotive horsepower, trailing weight, and average locomotive speed also affect fuel consumption. Using the efficiency ratios displayed in Table 7 in a real world situation of transporting 4,500 tons of corn a distance of 54 miles, rail transport would consume approximately 395 gallons of fuel, while truck transport would consume 1,645 gallons of fuel. These figures make it very apparent that even a small increase in rail modal share could translate into large savings in fuel consumption.

ENVIRONMENTAL IMPACTS

Air Pollution

Both the truck and rail modes emit harmful exhaust gases. The primary constituents of exhaust contaminants are carbon monoxide, hydrocarbons, oxides of nitrogen, and particulate matter. Locomotives emit air pollution at a rate of 0.69 lbs/gallon of fuel burned during transport, while trucks maintain an emissions rate of 0.31 lbs/gallon (Newstrand, 1991). Although trucks emit less pollution per unit gallon of fuel burned, the greater carrying capacity of rail is easily able to compensate for its deficiency with a lower overall emissions level. For extremely high density products, such as chemicals, rail transport produces emissions only 26 percent that of truck transport.

Air pollution from truck emissions is a serious concern at border ports of entry in Texas. Three factors affect pollution from truck exhaust emissions: the number of trucks, the quality of fuel, and the maintenance of engines. In a 1993 accounting of truck border crossings, it was found that almost 1.7 million trucks traversed the border at only 9 Texas ports of entry (Border Business Indicators, January 1993). Compounding the problem is the low quality of Mexican fuel. A 1990 Texas A&M International University study entitled *U.S. Trucking in Mexico: A Free Trade Issue* revealed that Mexican diesel had three times the maximum allowable sulfur content permitted by U.S. Law, and it exceeded Mexico's own national limit by 50 percent. Little improvement was found in a 1992 follow-up laboratory examination, leaving Mexico with extraordinarily poor diesel fuel quality when compared to that of U.S. diesel fuel. After they cross into the U.S., Mexican trucks burning Mexican diesel will be allowed to violate U.S. emissions laws concerning sulfur content. Only after the Mexican trucker runs out of fuel will the requirement of using cleaner burning U.S. diesel be imposed. Given that diesel fuel in Mexico is significantly cheaper than U.S. diesel, economic incentives will likely compel Mexican drivers to fill-up on lower quality Mexican diesel prior to crossing the border. The situation is further exacerbated by the fact that practically no emission standards are enforced for Mexican trucks, reducing the motivation to perform regular maintenance and further contributing to the emissions problem.

Hazardous Material Spills

In the past, studies performing safety comparisons of rail and truck carrying hazardous materials (hazmat) have often been criticized on the grounds that rail and truck compete in different markets. For instance, a large number of truck hazmat shipments are local gasoline deliveries, a market for which no competitive railroad equal exists. However, through a process of excluding all short-haul and local delivery traffic and focusing analysis on the comparison of shipments for which there is plausible direct rail and truck competition, the Association of American Railroads (AAR) issued a *Competitive Policy Report* (CPR) on December 8, 1993, regarded by many as the first truly accurate hazmat analysis. In this CPR, which analyzed only shipments traveling more than two hundred miles, the AAR reported that trucks had almost five accidents per billion ton-miles for every one railroad accident or derailment while carrying hazardous materials. Railroads cataloged approximately 65.9 billion hazardous cargo ton-miles on movements greater than two hundred miles in 1991. Within this mileage, only 65 accidents or derailments involving a release of hazmat occurred, translating into one accident or derailment per billion ton-miles. In contrast, trucks produced 18.7 billion hazardous cargo ton-miles on movements over two hundred miles, experiencing 89 reported accidents in which an unintentional release of hazmat occurred. This converts into 4.8 hazmat releasing accidents per billion ton-miles (AAR, 1993).

Although 4.8 truck related hazmat accidents per billion ton-miles may seen relatively insignificant, the extreme toxicity of some of the cargo transported could have detrimental effects on all forms of life were it to contaminate the food or water supply following a spill. Given the potential for a worst-case truck hazmat accident, the five-fold improvement in hazmat transportation safety offered by rail is a powerful inducement for increasing rail's share of the transport market.

Tire Disposal

Old and obsolete tires are rapidly becoming a waste disposal problem, so much so that a recent federal highway bill contained a provision that at least 10 percent of the composition of federally funded pavement must contain recycled tires (Newstrand, 1991). Although the intent of this provision is an environmental one, the requirement will increase the cost of building highways and add economic value to transportation by rail.

A recent study of the environmental effects of vehicular tire disposal demonstrates that in over-the-road traffic, truck tires have an average life expectancy of 100,000 miles, a recap rate of 80 percent, and a second recapping rate of 40 percent. Using this data, the average truck tire life is a predicted to be approximately 212,000 miles. In the real-world example of transporting 4,500 tons of corn 54 miles, the wear on the tires of an 18-wheel truck would be approximately 70 percent. Needless to say, worn tire disposal is not a concern with rail transportation.

SAFETY

One quantifies rail and truck safety statistics in terms of accident rates or incidents. An environmental impact study performed by the Minnesota Department of Transportation reports truck and rail accident rates as follows:

Table 8. Rail and Truck Safety Rate Comparisons

	Rail	Truck	Rail/Truck Ratio
Ton-miles/accident	1.80×10^9	2.35×10^8	7.7
Ton-miles/fatality	3.12×10^8	2.32×10^7	13.4

Source: (Newstrand, 1991)

As illustrated by Table 8, rail can transport 7.7 times more ton-miles than truck before an accident occurs, and 13.4 times more ton-miles than truck before a fatality occurs.

For purposes of this study, the rate at which accidents occur on the highways is based on the number of vehicle miles traveled. The standard trucking accident rate is approximately 76.6 accidents per 100 million miles traveled. This rate, when applied to each truck shipment shifted to rail, will readily project the decrease in accidents resulting from such a shift. The calculation follows:

Accident decrease = (76.6 accidents / 100,000,000 truck miles)
* (Number of miles) * (Number of shifted trucks)

The nature of this accident analysis precludes the accidents which may be caused by passenger vehicles, and is justified by the constant number of vehicles and miles traveled by passenger cars unaffected by a shift from truck to rail. New accident rates can be determined through a simple subtraction of present accident rates and the number of accidents prevented by shifting shipments to rail transportation.

HIGHWAY CONGESTION

The capacity of a multilane highway is defined as the maximum sustained hourly flow rate at which vehicles can travel over a section of roadway. The flow of traffic tends toward this capacity when the traffic free-flow speed is compromised. Free-flow speed is the theoretical speed of traffic as density approaches zero (i.e. average desired speed of all drivers). The speed of traffic is insensitive to traffic volume to the point where the volume to capacity ratio approaches 1.00.

The congestion factor, measured in units of passenger cars per hour per lane (pcphpl), varies as a function of average traffic volume and the number of accessible highway lanes. For the categories of roadways most likely impacted by an increase in rail freight modal share (due to freight being shifted from trucks to rail), the following congestion factor capacities have been set to that displayed in Table 9.

Table 9. Congestion Factor Capacities

Roadway Class	Pcphpl
State Highways	1,400
FM Roadways	1,400
U.S. Highways	2,200
Interstates	2,200

The congestion factor for any given section of road can easily be calculated by using the relationship:

C.F. = (0.75)(pc-total)/(# hrs analysis)(# lanes)

where:

pc-total = the total number of passenger cars

In qualifying this relationship, certain traffic analysis assumptions were made. A peak-hour traffic factor compensated for the temporal variation in traffic flow within a given 24-hour time frame. The analysis period spanned from 6:00 am to 6:00 pm and accounted for 75 percent of the average daily traffic. Furthermore, all traffic was normalized to a measure of passenger car equivalents. Thus, truck traffic was converted to passenger car equivalents using a factor of 2.0 provided by a TTI congestion expert. Each truck adds two passenger car equivalents to the ADT. A new congestion factor, computed from the difference of present traffic and estimated rail modal share increase, can be compared to the previously determined roadway capacities to identify roadway relief in terms of highway congestion.

CONCLUSION

Comparisons between truck and rail transportation in the non-roadway impact areas of energy consumption, pollution, accidents involving a hazardous material spill, and accidents involving fatalities all demonstrate rail's superiority over trucks. Additionally, rail's potential for reducing congestion on our roadways further highlights the many beneficial returns that could be expected were rail's modal share of transportation to increase.

Depending on the type of cargo being transported (i.e., whether the cargo is low or high density), rail can be anywhere from 4 to 8 times more energy efficient than trucks. This observation is directly related to the fact that rail transportation is inherently less polluting than truck transportation. Although locomotives emit over twice the air pollution of trucks for every gallon of fuel burned in transport, the greater carrying capacity of rail easily compensates for this with a lower overall emissions level that is 26 percent that of trucks. Rail's favorable standing in regard to pollutant emission is almost certain to improve with the introduction of more efficient AC traction locomotives and the potential large-scale introduction of locomotives powered by natural gas.

In terms of hazardous materials transportation, railroads are five times safer than truck transport. Railroads are over 13 times safer than trucks in regard to accidents resulting in a fatality. Were it not for the fatalities associated with grade crossing encroachment and trespassing, rail and truck safety comparisons would demonstrate an even greater disproportion in favor of the railroads.

In 1993, an average of 67 cars comprised each train consist. The average car load transported weighed approximately 65 tons (Railroad Facts, 1994). Assuming the cargo in each rail car could be carried by two trucks, then the average train consist would represent over 130 trucks not impacting the roadways.

Many experts have stated that the passage of NAFTA portends dramatic increase in the number of trucks on U.S. roadways. This increase in truck traffic will necessarily result in a concomitant expansion in energy consumption, pollutant emissions, the number of accidents, and congestion. The previous discussion clearly demonstrates rail's potential for mitigating the detrimental impacts truck transportation has on non-roadway factors associated with freight transport.

CHAPTER 7. FREIGHT TRANSPORTATION - ROADWAY IMPACTS

INTRODUCTION

There is little argument as to the negative impact truck traffic has on roads and highways. Trucks cause accelerated pavement deterioration resulting in constant repair of highways, closed lanes, and the presence of maintenance and repair crews on already congested highways. As with the apprehensions associated with non-roadway impacts, the expectations of increased trade with Mexico have raised concerns among transportation planners about the ability of the current and planned highway infrastructure to absorb the resulting expansion in freight traffic.

The following discussion will focus on highway infrastructure issues as they pertain to truck freight transport. An examination will be made of the problems associated with overweight truck shipments, and a methodology for estimating roadway impacts of truck traffic will be described. Using this analysis, the estimated reduction in roadway degradation and transportation costs that will result from a shift from truck to rail transport will be documented.

OVERWEIGHT INTERNATIONAL SHIPMENTS

In the May 1992 General Accounting Office (GAO) report, *U.S.-Mexico Trade: Concerns About the Adequacy of Border Infrastructure*, officials of border cities, private citizens, and even the truckers themselves expressed concerns about overweight shipments and their impact on roads and highways. The overweight problem is so acute that the American Trucking Association (ATA) believes that only special legislation can solve the problem. According to Strefflre (1990), the ATA has recommended the following:

- Require all persons tendering shipments to motor carriers to verify in writing the weight of the shipment,
- Provide that anyone submitting a false or erroneous weight verification to a motor carrier shall bear the full civil and criminal responsibility,
- Create a lien on the goods being transported in the amount of the fines, penalties or other liabilities arising from the incorrect verification,

- In the event that a carrier accepts a shipment without verification, both the carrier and the party tendering the load should be subject to fine or punishment,

- Provide protection for the motor carrier from economic retaliation by shippers and others, should a carrier refuse to transport an overweight shipment or otherwise violate highway safety laws, and

- Correct an oversight in the employee protection provisions of 49 USC 2305 to provide for protection for employees of shippers who are disciplined or punished by their employer for refusing to violate the safety laws.

What the ATA has been lobbying for has recently been achieved in the October 1992 Public Law 102-548, *Intermodal Safe Container Transportation Act of 1992.* Because of this new federal law, the border states now have the mechanism to address the overweight problem. The law allows major political subdivisions of Texas having a population of 100,000 or more to enforce the Federal Motor Carrier Safety and Hazardous Materials Regulation, once certified to do so by the Department of Public Safety. In other words, major border cities could enforce the new safe container act.

Research has discovered that it is common for Mexican carriers to carry twice the usual U.S. carrier weight. Information from the Mexican trucking industry has revealed that Mexico no longer maintains truck scales along commercial and other routes, thus allowing for overloaded vehicles by not enforcing weight limit laws. Thirty ton, 40 ton, and even heavier loads are common in Mexico and, consequently, they are common in the U.S. commercial zones (Molina and Giermanski, 1994). Strefflre (1990) clearly and succinctly emphasizes the need to solve this problem, especially in light of a free-trade environment.

> "Overloading degrades vehicle performance by significantly decreasing braking capacity and power to accelerate, by over-stressing tires, and by causing mechanical failures. Moreover, if heavy cargo is improperly packed in the container, it may create a dangerously high center of gravity. All of this impairs a driver's control of the truck and may put him in jeopardy, to say nothing of the motoring public."

In addition, by sharply increasing pavement and bridge damage, overweight containers directly affect federal and state highway budgets and therefore taxpayers in general. Pavement research has found that relatively small increases in axle loads or load repetitions can produce profound increases in pavement wear. Repeated applications of heavy axle loads can accelerate the need for pavement resurfacing or reconstruction, for strengthening or replacing bridge structures, for increasing levels of maintenance, and (consequently) for increased financial commitment of public funds.

ASSESSING ROADWAY IMPACTS

A 1993 TTI study, *Closure of the GIWW and Its Impact on the Texas Highway Transportation System*, addressed the adverse impacts of a GIWW (Gulf Intracoastal Waterway) closure on Texas highways through a modal shift process of freight from barges to trucks. The development of a Pavement and Traffic Analysis System (PTAS) model resulted, assessing pavement types and characteristics, roadway serviceability and damage, and effective roadway lifespan. With proper adjustments, the roadway degradation model can be adapted for the purposes of this study and used to estimate the projected reductions in roadway damage resulting from increased use of rail transportation (TTI, 1993).

The roadway impact analysis was directed at a wide array of state and federally funded roads including Interstates, U.S. Highways, State Highways, and Farm-to-Market roads. Roadway structures vary due to ranging construction techniques, the materials used, the environment, and the sub-soils upon which they are built. The factors contributing to the diversity found in roadway structure and durability include pavement type (rigid or flexible), thickness, supporting foundation, and climate.

Roadway surfaces may be categorized as either *rigid* or *flexible*. Rigid pavements are those constructed with concrete and contain steel reinforcing material. These surfaces are extremely durable, and offer a high quality ride, but have high initial costs. Flexible pavements are those constructed over a crushed rock base. They are most frequently constructed of asphalt or some other similar petroleum product and have bases of varying thickness. The flexible roadway is an integrated system composed of soil, base material, and surfacing material. The construction results in a system that flexes as loaded vehicles pass. The greater the loading, the more flexing that may be observed in the roadway surface.

Loading (weight of vehicles and cargo) plays a primary role in roadway degradation. The weight of the vehicle and its cargo relative to the number of axles and the specific physical configuration of the vehicle determine the amount of loading. To systematically and uniformly evaluate loads, a convention for measurement has been established. This widely used standard is referred to as the 18 Kip Equivalent Single Axle Loading (18 K-ESAL). The unit of measure relates to the effects of an 18,000 pound load on one axle.

Two other factors relate to roadway performance and the speed to which they degrade under conditions of accelerated load. These are the supporting foundation upon which the roadway is built and the general climate within which the structure resides. The *supporting foundation* relates to the amount of support given by soil type, i.e., clay, sand, etc., which can vary greatly. Each soil foundation is represented by an index relating to its support strength. Climate interacts with soil and helps determine the life-span or speed of deterioration of a roadway. For example, roads located in the dry regions of West Texas can be built with a thinner sub-base than the roads paved in the humidity of Southeast Texas. This factor is accounted for by a regional index which generalizes the amount of rainfall and average temperature in each given district of study. In order to accurately assess the behavior of a roadway, these factors, in addition to pavement type and thickness, must be measured and weighed accordingly

PTAS MODEL COMPONENTS

The analysis of pavement behavior performed as a part of roadway impact sub-model development resulted in the finding that rigid pavements need not be included. Rigid pavement is not susceptible to degradation or destruction as a result of the kind and amount of extra loading projected to result from a traffic shift. Therefore, prior to analysis, roadways were divided into flexible and rigid pavement types with all rigid sections in the impact zones omitted from the degradation analysis.

Flexible Pavements

Flexible pavements are generally constructed with a flexible base ranging in thickness from 6 to 16 inches (15 to 41 cm). This base is overlaid with an asphalt-type surface ranging in thickness from 1.5 to 6 inches (3.8 to 15 cm). The behavior of flexible pavements is governed by the following logarithmic function:

$$\log W_{t18} = 9.36\log(SN+1)-0.20+\log[(Pi-Pt)/(4.2-1.5)] / \{0.40+[1094/(SN+1)_{5.19}]\}+\log(1/R)+0.372(Si-3.0)$$

This expression relates the number of 18 Kip Equivalent Single Axle Loadings (W_{t18}) required to degrade the roadway to a predetermined terminal serviceability index (Pt) for a given structural number (SN), initial serviceability index (Pi), climatic condition (R), and support value (Si). The 18 Kip Equivalent Single Axle Loading (ESAL) is an industry standard by which different axle loadings (single, tandem, tridem, etc.) are normalized to the same scale to allow comparative measures. The output of this function results in a basis to which comparison of new roadway conditions can later be made (Yoder, 1975).

Serviceability Index

The serviceability factor is an index compiled from various pavement distress factors and surface riding indices. In effect, this serviceability index is the score by which the condition of the roadway will be rated. Ideally, a newly constructed road should be rated at a serviceability index of 5.0. Realistically, however, ideal conditions cannot be achieved and a maximum rating of 4.2 is assigned. The low end of the roadway operating range falls between 2.0 and 2.5 (AASHTO, 1986).

The exact serviceability index is a function of the average volume of the roadway and the thickness of the pavement. The terminal serviceability (Pt) for any given roadway is reached whenever the road is no longer able to operate at the service level for which it was designed. For the roadways to be impacted in this study the critical Pt were set at 2.0, 2.3, and 2.5, depending on the level of thickness of the flexible pavement. The initial serviceability index (Pi) indicates the present condition of the road at the time of testing. For the purpose of this analysis the most up-to-date PSI readings were taken from a 1991 Pavement Evaluation System (PEST) run provided by TxDOT. Visual inspection should be performed when this sub-model is used to update the serviceability condition of the pavement.

Pavement Types

The types of pavements found in Texas can be divided into ten categories. The categories are defined as:

1. Construction Reinforced Concrete Pavement
2. Jointed Concrete Reinforced Pavement
3. Jointed Concrete Unreinforced Pavement
4. Asphaltic Thick Hot Mix > 5" (12.7 cm)
5. Asphaltic Intermediate Hot Mix < 2.5" - 5.5" (6.35 - 14.0 cm)
6. Asphaltic Thin Hot Mix < 2.5" (6.35 cm)
7. Unwidened Asphalt Over Concrete
8. Widened Asphalt Over Concrete
9. Overlay, Asphalt on Asphalt
10. Surface Treated < 0.5" (1.3 cm)

Note that pavement types 1-3 are rigid pavements, while the remaining pavements are flexible. Any PEST (Pavement Evaluation System) run provided by TxDOT specifies the classification of these roadway types.

Structural Numbers

For flexible pavements, the variable that distinguishes one pavement structure from another is the structure number. Analytically, the structure number is given by:

$$SN = a_1D_1 + a_2D_2 + a_3D_3$$

where: D_i values are respective layer thicknesses, and
a_i values are layer coefficients

This empirical relationship between SN for a pavement structure and layer thickness expresses the relative ability of a material to function as a structural component of the pavement. The layer coefficient relates to the material typing for the surface, base, and sub-base of the roadway. Layer coefficients may be attained from the AASHTO Road Test using crushed stone, gravel, cement-treated gravel, and bituminous-treated gravel. Table 10 shows the results of the AASHTO Road Test.

Table 10. Layer Coefficients

Course Type	Course Component	Coefficient
Surface course	Roadmix (low stability) Plantmix (high stability) Sand Asphalt	0.20 0.44 0.40
Base course	Sandy Gravel Crushed Cement	0.07 0.14
Cement-treated (no soil-cement) Compressive strength @ 7 days	650 psi (45.8 Kg/cm^2) or more 400 psi to 650 psi (28.2 - 45.8 Kg/cm^2) 400 psi (28.2 Kg/cm^2) or less	0.23 0.20 0.15
Bituminous-treated	Coarse-graded Sand asphalt Lime treated	0.34 0.30 0.15-0.30
Subbase course	Sandy gravel Sand or sandy clay	0.11 0.05-0.10

Source: (Yoder, 1975).

With these layer coefficients and pavement surface thicknesses, the following structural numbers were estimated:

$$SN = (6.0*0.42) + (16.0*0.14) = 4.76$$

$$SN = (5.0*0.42) + (6.0*0.17) + (7.0*0.095) = 3.785$$

$$SN = (5.0*0.42) + (4.0*0.25) + (7.5*0.095) = 3.8125$$

$$SN = (0.5*0.40) + (5.0*0.42) + (4.0*0.25) + (7.5*0.095) = 4.0125$$

Regional Factor (Environmental Conditions)

The regional factor (R) is an index between 0.5 and 4.0 used to compensate for the effects of climatic conditions on existing roadways. Specifically, average temperature and the amount of rainfall can have adverse expansion and moisture seepage effects on highway durability.

Soil Support

The amount of structural support provided for roadways by soil is referred to as the soil support value (S_i). The soil support value can be somewhat arbitrary because many methods of soil support testing exist. Therefore, a correlation between soil tests and soil support values must be established (Yoder, 1975).

Rigid Pavements

Rigid pavements are a concrete structure built to withstand very large loads. Due to their rigidity and high modulus of elasticity, concrete pavements tend to distribute the load over a large area so that minor variations in subgrade and base strength types have little impact on the structural capacity of the pavement. From structure mechanics:

$$\text{Modulus of Elasticity} = \text{Stress/Strain}$$

where:

$$\text{Strain} = \text{Change in Length/Original Length}$$

A high modulus results from a low strain factor which yields a small change in pavement size. In effect, the degradation of a rigid pavement then becomes only a function of the volume and the number of repetitions of load (AASHTO, 1986). The serviceability concept for rigid pavements parallels that applied to flexible pavements.

The critical serviceability index for rigid pavements is generally set at 2.0. To simplify the degradation analysis, a linear slope (B=1) has been assumed for the degradation slope. The following functions govern the condition of a concrete pavement as the number of axles traversing the roadway increases (Yoder, 1975):

$$PSI = B(N) + c_o$$

where:

PSI	= the present serviceability index
N	= the repetitions of load
c_o	= the initial serviceability index (y-intercept)

and:

$$Pt = 2.0 = B(P) + 4.2$$

where:

P	= the critical number of 18 Kip Equivalent Single Axle Loadings necessary to reach a terminal serviceability of 2.0.

18 Kip Equivalent Single Axle Loading (18 K-ESAL)

In order to effectively compare relative loadings caused by various types of vehicles such as passenger cars, empty 18 wheelers, and trucks filled to their carrying capacities, all weights must be scaled to an equivalent single axle loading measure. Regardless of the axle type (single, tandem, tridem, etc.), all axle types can be converted through the use of a Load Equivalence Factor (LEF).

Defined in the *AASHTO Guide for Design of Pavement Structures*, "LEFs represent the ratio of the number of repetitions of any axle load and axle configuration necessary to cause the same reduction in PSI as one application of an 18-Kip Single Axle Load." Through years of field testing, load equivalence factors have been generated for flexible and rigid pavements, varying axle configurations, and varying terminal serviceabilities.

The LEFs for flexible pavements have been measured as functions of structural numbers and axle loads, whereas rigid pavement LEFs are functions of pavement thickness and axle loads. The SNs calculated to represent the pavements under analysis for this study do not readily match the SNs in the tables. Furthermore, the critical serviceability of 2.3 for certain impacted roadways is not displayed. Therefore, mathematical interpolation was used to fill in load equivalence factors corresponding to the selected structural numbers.

However, the LEF variance is not linear so that third order polynomials were generated to model the LEF trends. Empirically, the generation of 18-K ESALs follows from the product of the axle load equivalent factor and the number of vehicles (AASHTO, 1986):

$$18\text{-K ESAL} = (\text{LEF}) \times (\text{ADT}).$$

Table 11 displays the LEFs generated for the affected critical serviceabilities of 2.0, 2.3, and 2.5.

Table 11. Load Equivalency Factors

Pt = 2.0						
		Single	Single	Tandem	Tandem	Tandem
		1.625K	12K	5K	19.5K	34K
PType 4	SN=4.76	0	0.1763	0	0.0935	1.08
PType 5,6,7,8	SN=3.785	0	0.1840	0	0.1020	1.08
PType 9	SN=3.9125	0	0.1842	0	0.1015	1.08
PType 10	SN=4.0125	0	0.1830	0	0.1000	1.08
Pt = 2.3						
PType 4	SN=4.76	0	0.1875	0	0.1034	1.0902
PType 5,6,7,8	SN=3.785	0	0.2041	0.0008	0.1200	1.0994
PType 9	SN=3.9125	0	0.2039	0.0006	0.1186	1.0992
PType 10	SN=4.0125	0	0.2007	0.0004	0.1164	1.0980
Pt = 2.5						
PType 4	SN=4.76	0	0.1950	0	0.1100	1.0970
PType 5,6,7,8	SN=3.785	0	0.2175	0.0013	0.1320	1.1123
PType 9	SN=3.9125	0	0.2170	0.0010	0.1300	1.1120
PType 10	SN=4.0125	0	0.2125	0.0007	0.1273	1.1100

Source: (Yoder, 1975)

Vehicle Types

For the purposes of the present study, traffic on Texas highways was represented by the Average Daily Traffic (ADT) measure. To facilitate data processing, traffic may be distributed into passenger cars with only single axles averaging 1.625 kips each and 5 axle trucks may be subdivided into full, half-full, and empty trucks. Each truck is equipped with a single cab axle and two tandem axles. The distribution is allocated according to percentage truck figures obtained from traffic analysis data (RI2T) provided by TxDOT. Cargo weight comparisons between rail and truck may be made by distributing among full and empty five axle trucks with a carrying capacity of 58,000 lbs (26,332 Kg). The axle configurations employed for analysis are as follows:

(Note: **O** denotes single axle and **OO** denotes tandem axle)

Empty Truck:	**O**		**OO**		**OO**	
	12K	5K		5K		
Half Full:	**O**		**OO**		**OO**	
	12K	19.5K		19.5K		
Full Truck:		**O**		**OO**		**OO**
	12K	34K		34K		
Automobile:		**O**		**O**		
	1.625K	1.625K				

This analysis will produce an estimation of the number of vehicles necessary to deliver/receive tonnages transferred between rail and highway transport. These new traffic levels, in conjunction with the LEFs, can be used to translate the tonnages into additional 18-K ESALs. The projected number of vehicles and additional ESALs are then compared to the number of critical 18-K ESALs that a roadway is designed to withstand. The results can then yield an updated life expectancy of each highway impacted.

ANALYSIS

Roadway damage from truck transportation is a serious problem that costs hundreds of millions of dollars a year in infrastructure maintenance. A significant shift of cargo from truck to rail transportation could have a dramatic effect on mitigating roadway damage and extending the life of the highway infrastructure. To illustrate this, the PTAS model was applied to a section of U.S. 77 in order to demonstrate the magnitude of damage reduction that could be avoided given a modal shift of cargo from truck to rail transportation.

Section 372-03 of U.S. 77 is located in the Corpus Christi district. In 1992, this section of highway was experiencing an AADT of 7,933 and was calculated to have, assuming the AADT level remained constant, approximately 15 more years of serviceable life before requiring extensive maintenance. For purposes of this analysis, assume that this section of highway begins to experience 1.6 million additional tons of cargo a year from truck transportation. This translates into approximately 50,000 additional trucks a year traversing this section of highway. Applying the PTAS model, this increase in truck traffic would reduce the serviceable life of this section of roadway from 15 years to 8 years, and would result in a 48 percent increase in maintenance costs. Rail transportation's immense cargo carrying capacity could absorb this hypothetical increase in cargo weight through the annual operation of just *one train a day*.

CONCLUSION

The analysis section of this chapter provided an example of rail transportation's potential for elevating roadway damage resulting from truck traffic. Although it is unrealistic to assume that all freight currently transported by truck could be shifted to trains, even a relatively small modal shift could have dramatic consequences in terms of cost savings associated with reduced infrastructure maintenance.

In light of the free trade environment that will evolve from the passage of NAFTA, and the estimated increase in truck traffic that will result from the trade agreement, the state of Texas urgently needs to begin addressing the problem of future infrastructure degradation. Heavy truck containers directly affect federal and state highway budgets and therefore taxpayers in general. Given this fact, it should be a matter of public policy to encourage intermodal freight transportation. Additionally, the true costs associated with truck transportation need to be quantified so as to levy from the trucking industry their fair share of the cost of maintaining our roadway system. Such action would help level the playing field and allow rail transportation to more effectively compete with truck transportation.

CHAPTER 8. LAREDO TRUCK SURVEY

INTRODUCTION

The Laredo truck survey was initiated in order to establish and characterize the present movement of truck transportation north from Laredo. To accomplish this, researchers at Texas A&M International University in conjunction with less than trailer load (LTL) and trailer load (TL) motor carriers, the Texas Transportation Institute, and the United States Border Patrol designed a questionnaire that would acquire from truckers information regarding their destination, the cargo they were carrying, and their bill weight. The questionnaire was designed to be as simple as possible in order to minimize the time a trucker would have to stop to answer the questions. Through the efforts of the U.S. Border Patrol, all loaded commercial vehicles leaving Laredo heading north on I-35 were stopped at the border patrol checkpoint to allow the driver to be interviewed.

The information gathered from the survey was analyzed in terms of weight of cargo and distance traveled, allowing for direct computation of impacts resulting from the transportation of cargo by truck. The following discussion will discuss the findings of the survey, and will examine the mitigating effects rail transportation might have had on roadway and non-roadway impacts had the cargo been shifted from trucks to rail.

SURVEY METHODOLOGY

The truck survey was performed from Monday December 5, 1994 through Friday December 9, 1994. Truck drivers were interviewed in four shifts of two hours each from 12:00 noon until 8:00 pm. Inclement weather forced cancellation of the 6:00 pm to 8:00 pm shift on Friday and severely limited the number of surveys completed in the previous shift (4:00 pm to 6:00 pm).

The border patrol checkpoint north of Laredo accommodates three lanes of traffic (one lane for cars and small vehicles, and two lanes for larger commercial trucks). The third lane is often closed to traffic to allow room for inspection of suspicious cargo. Immediately north of the inspection station, before you merge back onto I35, is a shoulder approximately 200 ft in length that served as the truck interview site. Loaded commercial vehicles were directed by the border patrol to pullover to the interview site where the survey team was waiting. No more than two trucks could be surveyed at one time.

Each survey took approximately one to two minutes. Factors that contributed to longer survey times were trucks blocking access to the interview site, inquisitive truckers asking questions about the purpose of the survey, language difficulties, and the high volume of sound overwhelming the interview. At any sign that trucks were beginning to backup, the border patrol would waive trucks through the inspection station without directing them to the interview site.

The five survey days resulted in 1,222 usable interviews being conducted. Table 12 displays the number of surveys conducted by day and shift.

Table 12. Number of Surveys Conducted

Shift	Day of The Week					
	Mon	Tue	Wed	Thr	Fri	Total
12:00-2:00	59	73	73	63	65	333
2:00-4:00	86	51	83	77	63	360
4:00-6:00	84	73	47	67	27*	298
6:00-8:00	59	63	49	60	0*	231
Total	288	260	252	267	155	1,222

* Note: Numbers negatively impacted by inclement weather

SHIPMENT DESTINATION

The total weight of shipments of the surveyed trucks was in excess of 19,000 tons. Of this weight, over 65 percent was destined for locations outside the state of Texas. Included in this percentage are over 495 tons of shipments to Canada (representing 2.57 percent of the total). Table 13 provides a breakdown of general shipment destination, the number of trucks surveyed, the average shipment weight, and the total weight of shipments. As can be seen in Table 13, over 6,600 tons of commodities (34.35 percent of the total) were being shipped to locations inside the state of Texas.

Table 13. Truck Numbers, Weight, and Destination

Shipment Destination	Trucks Surveyed	Average Weight*	Weight of Shipments*
Canada	34	14.58	495.80
Texas	421	15.72	6,619.04
USA	767	15.85	12,153.62
TOTAL	1,222	15.77	19,268.46

* Note: Weight is expressed in tons

Table 14 displays truck shipments in terms of destination distance category. An examination of the table indicates that almost half (49 percent) of the trucks surveyed were transporting commodities over 830 miles. Note that in Table 14, the number of trucks surveyed does not equal 1,222. This is due to an inability to determine the destination of 15 of the surveyed trucks, thus precluding their inclusion into a distance category.

Table 14. Shipment Destination by Distance Category

Distance Category	Trucks Surveyed	Miles Traveled	Weight of Shipments*
1-280	159	25,150	2,423
281-540	295	116,654	4,637
541-830	160	114,188	2,498
831-1,130	174	169,274	2,908
> 1,130	419	538,277	6,542
TOTAL	1,207	963,543	19,008

* Note: Weight is expressed in tons

Shipment Destinations Within Texas

Forty counties within the state acted as the final destination for the shipments. Figure 7 displays the distribution of shipment destinations within Texas. Examination of the shipment distribution indicates that Bexar, Harris, and Dallas counties receive the greatest weight of truck shipments, accounting for almost 72 percent of the total (4,748.97 tons).

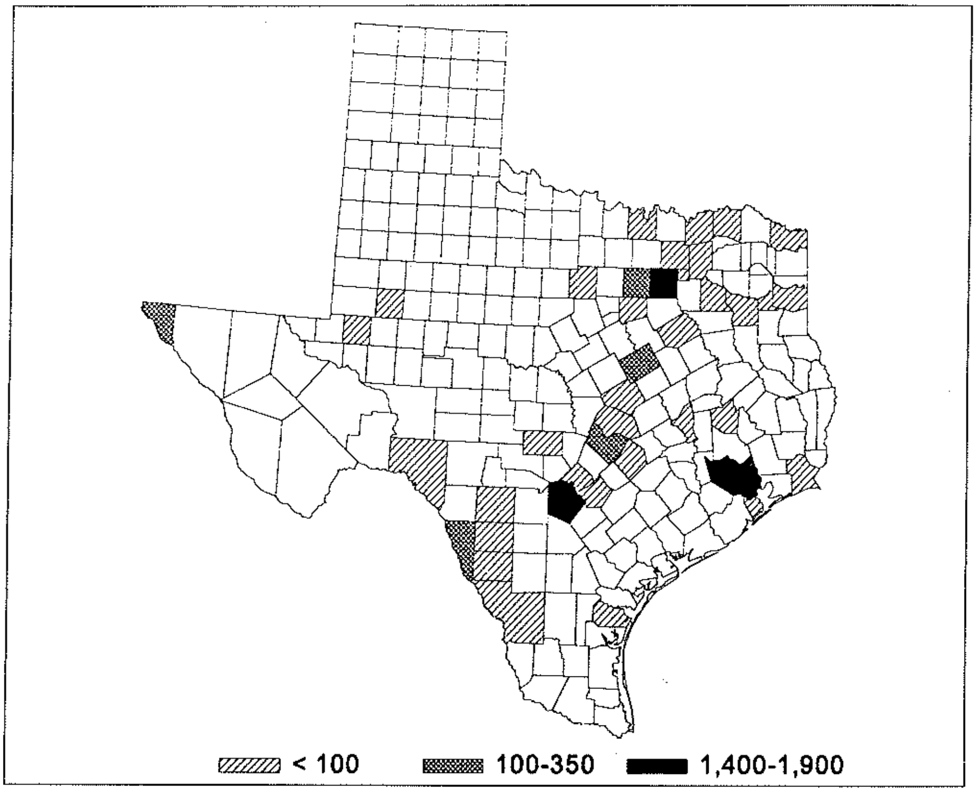

Figure 7. Final Destination Weight Distribution For Texas (Tons)

Closer examination of the counties roughly distributed along the I35 corridor between San Antonio and Dallas (Bexar, Comal, Guadalupe, Travis, Williamson, Bell, Mc Lennan, Johnson, Tarrant, and Dallas) leads to the finding that of the 40 counties serving as the final destination for shipments originating at Laredo, these 10 counties account for over 62 percent of the weight of commodities shipped (4,113.12 tons) and almost 65 percent of the trucks making the shipments (272). Table 15 lists (in descending shipment weight order) the 40 Texas counties that were the terminus of truck shipments from Laredo.

Table 15. Texas Shipment Destination and Tons Transported

County	Trucks	Tonnage	County	Trucks	Tonnage
Bexar	123	1,878.14	Galveston	1	22.50
Harris	83	1,465.63	Nueces	1	22.50
Dallas	97	1,405.20	Hunt	1	22.00
Tarrant	24	312.47	Bowie	1	20.95
Mc Lennan	7	159.26	Harrison	1	20.90
El Paso	10	123.27	Martin	1	20.50
Maverick	6	110.50	Walker	1	20.00
Travis	7	110.49	Williamson	1	18.37
Rockwall	3	83.96	Cooke	1	18.24
Collin	5	77.66	Brazos	1	12.40
Val Verde	7	72.44	Jefferson	1	11.00
Bell	3	60.95	Webb	1	9.55
Johnson	3	60.79	Palo Pinto	1	9.49
Guadalupe	2	59.72	Ector	1	8.20
Comal	5	47.72	Gillespie	1	4.20
Smith	2	44.50	Zavala	1	3.78
Lamar	2	43.80	Bastrop	1	3.50
Uvalde	2	43.00	Navarro	1	3.16
Dimmit	1	39.50	Fannin	1	2.00
Gregg	2	33.45	Van Zandt	1	0.83

As can be seen in Table 15, Bexar county leads all other counties in cargo weight received, serving as the destination for over 1,878 tons of cargo in 123 truck shipments. This finding run counter to what many transportation experts would expect, the common expectation being that Dallas and Harris counties would rank higher. The finding that Bexar county ranked first in shipment destination could simply be an artifact of the time of year the survey was performed. These same 40 counties are listed in alphabetical order in Table 16.

Table 16. Shipment Destination and Tons Transported in Texas Texas Counties Listed Alphabetically

County	Trucks	Tonnage			
Bastrop	1	3.50	Jefferson	1	11.00
Bell	3	60.95	Johnson	3	60.79
Bexar	123	1,878.14	Lamar	2	43.80
Bowie	1	20.95	Martin	1	20.50
Brazos	1	12.40	Maverick	6	110.50
Collin	5	77.66	Mc Lennan	7	159.26
Comal	5	47.72	Navarro	1	3.16
Cooke	1	18.24	Nueces	1	22.50
Dallas	97	1,405.20	Palo Pinto	1	9.49
Dimmit	1	39.50	Rockwall	3	83.97
Ector	1	8.20	Smith	2	44.50
El Paso	10	123.27	Tarrant	24	312.48
Fannin	1	2.00	Travis	7	110.49
Galveston	1	22.50	Uvalde	2	43.00
Gillespie	1	4.20	Val Verde	7	72.44
Gregg	2	33.45	Van Zandt	1	0.83
Guadalupe	2	59.72	Walker	1	20.00
Harris	83	1,465.63	Webb	1	9.55
Harrison	1	20.90	Williamson	1	18.37
Hunt	1	22.00	Zavala	1	3.78

Shipment Destinations Nationwide

Forty states were indicated as a final destination in the truck interviews. These forty states were organized into six regional areas: Midwest, North East, North West, South East, South West, and Texas. Figure 8 displays shipment destination tonnages for the six regional areas of the United States. The region receiving the greatest weight of shipments (besides the Texas region) was the

South East region, closely followed by the North East region. These regions received 4,277 and 4,212 tons of shipments (22 percent of the total), respectively.

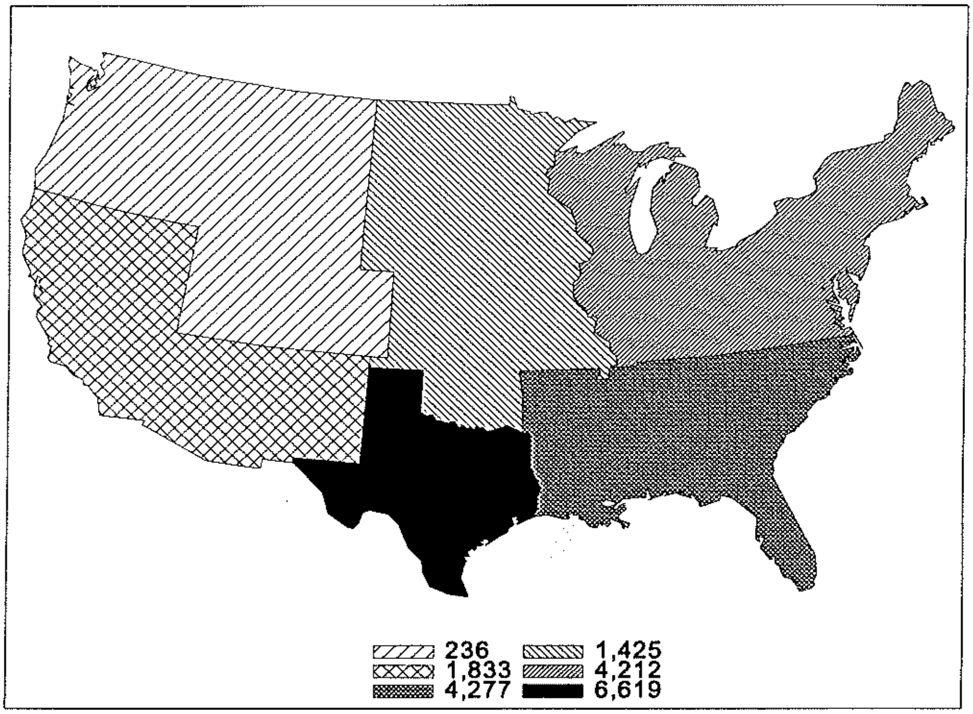

Figure 8. Regional Distribution of Shipment Weight

Table 17 displays the same information as Figure 8, but additionally provides the number of shipments terminating in each region.

Table 17. Regional Shipment Destination

Region	Trucks	Weight
North West	14	236
Midwest	90	1,425
South West	102	1,833
North East	299	4,212
South East	252	4,277
Texas	421	6,619
TOTAL	1,178	18,602

Figure 9 presents a more detailed view of national shipment destination distribution, displaying total shipment weight by each individual state.

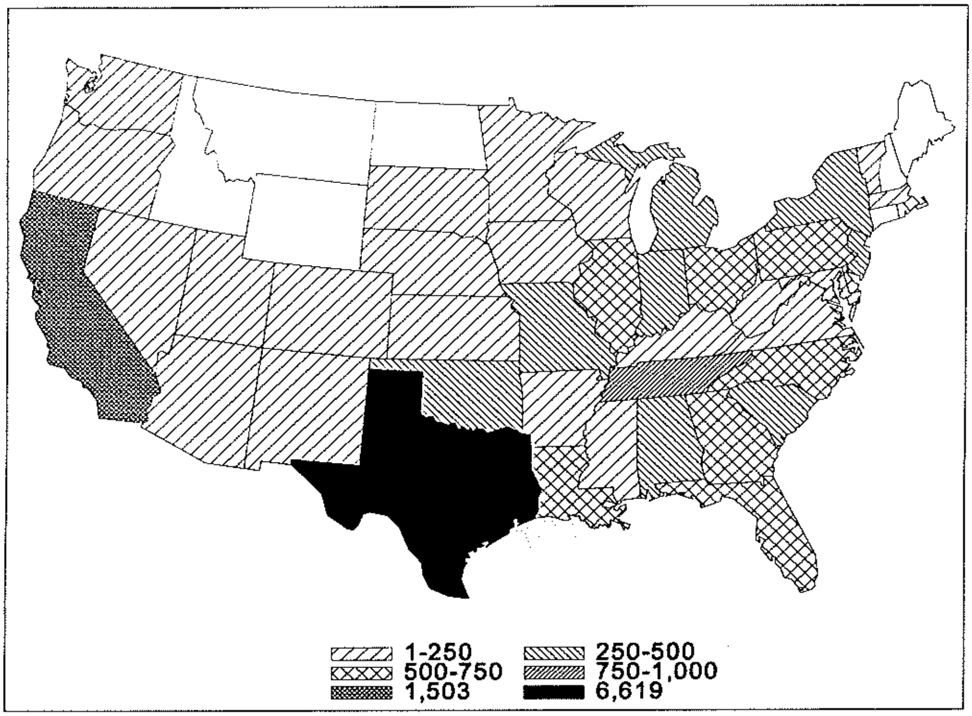

Figure 9. Nationwide Shipment Weight Distribution

As can be seen in Figure 9, Texas and California receive the greatest weight of truck shipments from Laredo. These two states together account for over 42 percent of the total weight shipped (8,122 tons). Table 18 displays, in descending shipment weight order, the 40 states that served as the final terminus for truck traffic from north from Laredo. As can be seen in the table, excepting Tennessee, the decline in shipment weight is relatively constant, slowly shrinking until only a single shipment of 14.18 tons terminates in Vermont.

Table 18. Shipment Destination and Tons Transported

State	Trucks	Tonnage	State	Trucks	Tonnage
Texas	421	6,619.04	Kansas	12	214.37
California	81	1,502.99	Mississippi	11	162.32
Tennessee	55	836.32	Massachusetts	8	148.59
Georgia	36	681.03	Iowa	9	143.46
Ohio	67	640.83	Minnesota	9	128.11
Louisiana	41	629.08	Kentucky	9	103.03
Illinois	42	620.37	Colorado	7	101.42
Florida	40	618.89	Arkansas	7	99.92
North Carolina	29	617.19	Maryland	6	89.87
Pennsylvania	31	546.52	Washington	4	77.38
New York	28	478.31	New Mexico	5	57.32
New Jersey	26	445.20	West Virginia	4	53.50
Oklahoma	27	436.54	South Dakota	2	43.14
Indiana	29	424.95	Oregon	2	43.11
Missouri	28	419.44	Nebraska	3	39.61
Alabama	20	364.77	Nevada	2	35.59
Michigan	30	339.75	Virginia	3	32.66
South Carolina	13	267.75	Delaware	3	28.30
Wisconsin	12	245.64	Utah	1	14.22
Arizona	14	237.02	Vermont	1	14.18

These same states are listed alphabetically in Table 19.

Table 19. Shipment Destination and Tons Transported
States Listed Alphabetically

State	Trucks	Tonnage	State	Trucks	Tonnage
Alabama	20	364.77	Nebraska	3	39.61
Arizona	14	237.02	Nevada	2	35.59
Arkansas	7	99.92	New Jersey	26	445.20
California	81	1,502.99	New Mexico	5	57.32
Colorado	7	101.42	New York	28	478.31
Delaware	3	28.30	North Carolina	29	617.19
Florida	40	618.89	Ohio	67	640.83
Georgia	36	681.03	Oklahoma	27	436.54
Illinois	42	620.37	Oregon	2	43.10
Indiana	29	424.95	Pennsylvania	31	546.52
Iowa	9	143.46	South Carolina	13	267.75
Kansas	12	214.37	South Dakota	2	43.14
Kentucky	9	103.03	Tennessee	55	836.32
Louisiana	41	629.08	Texas	421	6,619.04
Maryland	6	89.87	Utah	1	14.22
Massachusetts	8	148.59	Vermont	1	14.18
Michigan	30	339.75	Virginia	3	32.66
Minnesota	9	128.11	Washington	4	77.38
Mississippi	11	162.32	West Virginia	4	53.50
Missouri	28	419.44	Wisconsin	12	245.64

ANALYSIS AND CONCLUSION

During the week long Laredo truck survey, 1,222 truckers were surveyed. The total weight of the cargo they were transporting was over 19,268 tons. The shipment destinations blanketed the U.S. and Canada, with distances traveled ranging from as little as two miles to distances of over 1,500 miles. Although the magnitude of these numbers may seem large, they are quite small in relation to the overall truck traffic on the roadways. This number of trucks and the weight they were carrying have a negligible impact in terms of roadway degradation. Given this fact, the following discussion will concentrate on non-roadway impacts such as fuel consumption and cost, and pollution emissions.

Depending on the cargo being transported, rail transportation can be as much as four to eight times more efficient than truck transportation. For purposes of this analysis, it was assumed that rail transportation was 5.4 times more efficient than truck transportation. This translates into a ton-miles per gallon figure of 752 for rail and 139 for truck. The basis for cost of fuel comparisons was provided by a specialist with the CONOCO Tax Group, in which the price of a gallon of diesel for trucks was $1.00, and $0.65 a gallon for rail.

Table 20 displays the estimated fuel consumption, fuel cost, and pollution emissions of the trucks that were surveyed at the Laredo Border Patrol checkpoint, and compares these figures against those that would be generated had all cargo being transported by truck been transported instead by rail.

Table 20. Comparison of Truck and Rail - Laredo Survey

Transportation Mode	Fuel Consumed (Gallons)	Fuel Cost ($)	Emissions (Pounds)
Truck	1,432,487	1,432,487	444,071
Rail	264,782	172,108	182,699

An examination of Table 20 reveals that had the cargo shipped by truck in the Laredo survey instead been shipped by rail, the net savings in fuel consumed is estimated to be 1,167,705 gallons of diesel fuel, would have resulted in a net savings of $1,260,379, and reduced pollution emissions by 261,372 pounds. Clearly, the case for rail transportation having a significant potential to mitigate the negative impacts of truck transportation is a strong one. The point is further emphasized when it is realized that the entire cargo being carried by the 1,222 trucks that were surveyed could have been transported by fewer than five trains.

CHAPTER 9. CONCLUSION

The purpose of this research was to examine and document methods to facilitate increased use of rail transportation in south Texas. Additionally, the research was intended to document the projected reductions in congestion, roadway damage, hazards, and energy usage resulting from increased use of rail transportation. In doing so, this research investigated the challenges associated with increasing intermodal transportation of freight, the needs of the rail industry, barriers to more efficient U.S.-Mexico trade, non-roadway and roadway impacts of truck transportation, and examined and analyzed a real-world situation involving over a thousand trucks transporting freight northbound from Laredo, Texas.

According to the National Commission on Intermodal Transportation, a fundamental impediment to increasing the intermodal share of transportation is the current organization of the U.S. Department of Transportation. Only a more thorough reorganization away from modal lines will allow the vision of ISTEA to be realized. Such a reorganization will facilitate incorporation of all modes of transportation into an integrated intermodal transportation system. A potential benefit could be better cooperation and coordination between agencies involved in transportation, and greater flexibility in the way transportation policy is defined, decisions are made, and transportation projects are financed.

The rail industry has made great strides in the area of intermodal freight transportation. In order to continue the trend of increasing intermodal market share, the railroads must address the customer service issues of emerging market identification, sales process improvement, and the problem of long transit times and lack of flexibility. One technology proposed to accomplishing this is Interline Service Management (ISM). As defined by the Association of American Railroads (AAR), ISM is a set of management procedures and supporting information systems that will allow the rail industry to monitor service commitments to customers, facilitate post trip analysis, improve transit times, and allow customers information access. In light of the fact that quicker transit time was deemed of paramount importance by distribution managers, the AAR's decision to place a low priority on ISM development could be construed as short-sighted.

The passage of NAFTA promises to streamline the process of transporting freight across the border between the U.S. and Mexico. Currently, though, traffic delays are the norm owing to the multiplicity of government agencies operating on both sides of the border. Fortunately, both the U.S. and Mexico are working to address the problem of border delay. New initiatives, such as Despacho Previo, have been implemented to improve the cross-border process. Border patrol work schedules on both sides of the border are being coordinated, and increased operating times are being considered. Of particular importance to the movement of trade across the border is the recognition that FNM, the national railroad of Mexico, needs to improve productivity in its workforce and increase investment in information systems for cargo tracking and infrastructure management. Working toward this goad, FNM has increased its productivity by close to 50 percent in the last two years.

The expected growth in trade between the U.S. and Mexico is likely to significantly increase non-roadway and roadway impacts associated with highway congestion, pollution emissions, safety, and pavement degradation. For these reasons, increasing rail's share of freight transportation in this country is of increasing importance. Framers of policy involving truck and rail freight transportation need to take into consideration factors other than purely market forces, and begin to assess the costs that are extracted by truck transportation on the environment and infrastructure when evaluating the feasibility of increased use of rail.

The fact that the highway infrastructure in many areas of south Texas is reaching saturation has caused policy makers to take notice of the benefits of rail freight transportation. In terms of ton-miles per gallon, rail is four to eight times more efficient than trucks. Rail transportation produces 26 percent of the pollution produced by truck transportation, is almost five times safer in terms of hazardous materials movement than truck transportation, and is over 13 times safer than trucks when it comes to accidents involving a fatality. When evaluating rail transportation's potential for mitigating congestion and roadway degradation, it is useful to keep in mind that a single average train consist is equivalent to 130 trucks.

Transportation planners, faced with ever increasing highway utilization in an era of fiscal constraint, are justifiably concerned with the ability of existing infrastructure to absorb current and projected transportation demand. Rail transportation, with its immense carrying capacity and fuel efficiency, offers one solution to the mitigation of negative impacts associated with truck transportation.

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