Rail Freight Solutions to Roadway Congestion
NCHRP Project 8-42

ASSESSING RAIL FREIGHT SOLUTIONS TO ROADWAY CONGESTION: FINAL REPORT

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PREFACE

This is one of two final documents produced in fulfillment of NCHRP Project 8-42: Assessing Rail Freight Solutions to Roadway Congestion.

- This ***Final Report*** document presents information collected and analyzed as part of the study process, including a literature review, analysis of case studies, analysis of issues in freight shipping and mode choices, analysis of trends affecting freight shipping patterns, and evaluation of data sources.

- A separate ***Guidebook*** document represents the final product. It presents tools and methods that transportation planners can use to examine the potential for rail freight as a way of help control the growth of roadway traffic congestion.

The last chapter of this Report describes the framework structure utilized in the Guidebook. It serves as a bridge to the Guide, an introduction to its content, and an overview of the analytical method planners can use to approach the problem of applying rail freight solutions to roadway congestion.

1 INTRODUCTION AND OVERVIEW

This chapter introduces the study motivation and goals, and describes the components of the research that are described in this report.

1.1 Objective

The National Cooperative Highway Research Program funded Project 8-42 to examine the potential for use of rail freight solutions as a way to relieve roadway traffic congestion by shifting some freight movement from trucks to railroads.

1.1.1 Background Motivation

Congestion in urban areas and intercity corridors is a growing concern. Truck traffic has become a significant contributor to road congestion. At the same time, some transportation planners have recognized rail as an underutilized mode for freight transport. They see the potential for increasing opportunities to move freight by rail as one way to help decrease deterioration of existing highways, while positively affecting congestion, safety, and pollution.

The interaction between rail and other modes of freight movement continues to be an issue for transportation planners. On the one hand, concerns about reliability, flexibility, and timeliness have contributed to a decline in market share for rail-freight movements. On the other hand, congestion, air quality, safety, and security concerns lead planners to consider rail options. These issues make it particularly important to develop methods that can be used to analyze the impacts and opportunities for public investment in rail-freight capacity as a way to help mitigate roadway congestion.

1.1.2 Report Goals

To address these concerns, this study was developed to accomplish two essential goals:

- to assemble a base of information on key factors, stakeholders, obstacles, strategies and constraints affecting the potential for rail freight solutions to roadway congestion, and

- to develop a guidebook for assessing the merits of public investment in rail-freight solutions to relieve roadway congestion, that lays out available tools and methods for evaluation along with guidelines for bringing these considerations into transportation planning and decision-making processes.

This final report presents findings from all phases of the study process, in fulfillment of the first goal. A separate Guidebook has been developed in fulfillment of the second goal. Together, these two documents represent the products of NCHRP Project 8-42.

1.2 Elements of the Study

1.2.1 Major Considerations

The study was organized into a series of tasks to cover major considerations affecting opportunities for diverting truck traffic to rail freight options. They can be grouped as follows:

(1) *Prior Research Findings* – relevant literature and ongoing research on rail-freight economics, rail and inter-modal planning, rail relocation, rail/road conflicts, benefit-cost analysis and modeling, and public/private partnerships. This topic is addressed in Chapter 2 of this Final Report.

(2) *Case Studies* – illustrative examples where rail-freight solutions have been applied in an attempt to reduce roadway congestion problems. These examples encompass congested ports and commercial centers, congested interstate corridors, congested terminal facilities, and rapidly growing cities. Together they provide insight into the potential for rail solutions to address these problems, and key factors affecting that potential. This topic is addressed in Chapter 3 of this Final Report.

(3) *Freight Mode Choice* – factors and constraints affecting the potential and likelihood of diverting various types of freight traffic from truck to rail. This includes economic, development, social, environmental, safety and security factors, as applied to private sector shippers and carriers as well as the public sector. This topic is addressed in Chapter 4 of this Final Report.

(4) *Freight Trends* – short-term and long-term trends in freight movements, business patterns and land use that affect congestion and freight flow patterns. Together, a multitude of such trends are changing the mix of situations and

solutions where there is potential to shift freight modes or otherwise mitigate congestion conflicts. This topic is addressed in Chapter 5 of this Final Report.

(5) *Data Sources* – currently available information on transportation and economic factors, as well as needs to span public and private sector sources, to evaluate opportunities for rail freight solutions to roadway congestion. This topic is addressed in Chapter 6 of this Final Report.

(6) *Analysis Framework* – a methodology for using available data to assess relative benefits, costs and feasibility of public investment in rail freight solutions to roadway congestion. This topic is introduced in Chapter 7 of this Final Report, and then discussed in greater detail in Chapter 3 of the separate Guidebook.

(7) *Public Policy* – processes, practices and barriers, at all levels of government, that can facilitate or inhibit public-sector investment in rail-freight. This includes legislative restrictions, planning processes and implementation procedures. This topic is introduced in Section 2.6 of this Final Report. Recommendations for effective public-private partnerships for both planning and funding are then presented in greater detail in Chapter 4 of the separate Guidebook.

(8) *Decision-making Considerations* – benefit- cost analysis procedures relevant for decision making on public investment in rail-freight transportation. This topic is introduced in Section 2.5 of this Final Report, and then discussed in greater detail in Chapter 5 of the separate Guidebook.

2 LITERATURE REVIEW

This literature review addresses four issues key to the subject of rail freight solutions to roadway congestion:

- Identification of the relevant transportation needs or problems (including congestion and other planning issues where rail freight can be part of the problem or solution)
- Identification of applicable assessment methods to evaluate the alternatives
- Identification of potentially applicable funding and implementation approaches
- Identification of potentially relevant approaches to developing guidebooks and tools

The review presents a discussion of major issues, and provides references for further reading. It is organized around six topic areas:

- Rail and General Freight Economics
- Intermodal Planning including Truck and/or Rail Freight
- Studies of Congestion Costs
- Rail Relocation and Road/Rail Conflict Issues
- Benefit-Cost Assessment and Modeling
- Public-Private Partnerships

These topic areas are each covered in more detail below. For each topic area, an introduction presents several key themes or issues that are relevant to this project.

2.1 Rail and General Freight Economics

2.1.1 Themes

There is a base of academic and operational literature documenting the institutional opportunities for enhanced reliance on rail freight as a transportation solution. There are a number of themes that are evident in this literature:

1. **Importance of logistics performance:** freight flows are determined largely by customers who are concerned with minimizing logistics costs, obtaining better materials, reaching broader markets, employing their logistics strategies

as competitive tolls, and, in general, improving their business results. The direct costs of a transportation option, and its consequential costs in terms of the type of distribution system it supports and the degree of management oversight it requires, shape the decisions of customers. They mainly do not take into account the effects of their decisions on highway congestion, air quality or other public concerns.

2. **There are many different segments to freight transportation**. In some of them, rail is dominant; in many of them truck is dominant; and in some of them rail and truck are competitive. Public action needs to address specific segments because of their discrete behavior, e.g. intermodal traffic originating or terminating within the region, automotive traffic, port traffic, bulk freight moving to local industry, or bulk freight moving through the region.

    - **Rail is not always cheaper and more fuel efficient than truck**: rail will not be cheaper for light density lines and rail will not be more fuel efficient for very short trains and cumbersome switching moves.

    - **Trucks provide a superior service for most movements:** truck service is usually more flexible, faster, and reliable than rail service; for many movements, truck is cheaper than rail, especially when the associated logistics costs are considered.

3. **Infrastructure costs are markedly different for railroads and for highway users:** Railroads for the most part own and maintain their infrastructure, while competing modes use infrastructure that is provided and maintained by the public. Railroads must pay for maintenance and rehabilitation as the work is done. Railroads themselves cause – and suffer from - the effects of railway congestion and track deterioration; they have an incentive as well as the responsibility to invest in track and equipment based upon the marginal effects on train speed, line capacity and life cycle costs of the track structure. Trucking companies use highways where the causes and costs of congestion are borne by all users; most of the major highways are toll free, and the public is generally against the use of congestion pricing to reduce highway traffic during peak periods; equipment design is based upon the structure of the user fees, taxes, and size/weight limits mandated by public agencies.

4. **There are still opportunities for rail network rationalization:** the rail infrastructure was largely designed and constructed prior to 1925. In many areas, the network is designed to serve customers who no longer exist or who no longer use rail; in other areas, the rail network does not well serve the traffic that does exist. The greatest problems are encountered in urban areas, where it is difficult to change terminal locations, add new routes, or even make substantial modifications to existing routes. Rationalization in this sense

does not mean merely reduction, it means alignment of the geography of the network with the geography of the modern market.

5. **Private decisions by railroads can have important public consequences:** the location of intermodal terminals affects the volume of shipments that will move by rail and the vehicle-miles traveled in urban areas by draymen moving trailers and containers to and from the terminals. Line characteristics and freight volumes determine the marginal cost of and capacity available for commuter operations. Train size and routing decisions affect delays to highway users at grade crossings.

2.1.2 Railroads and Economic Development

When first introduced, railroads transformed the world of business and changed the scale and dispersion of economic activity and the locus of population growth. Vance (1986) describes the evolution of the rail and highway systems of Europe and North America in terms of economic geography – new technologies provide better ways to overcome the geographic barriers to trade and development. Cronon (1991) provides an outstanding description of the way that rail technology and the benefits of rail networks allowed Chicago to become “Nature’s Metropolis”, the gateway to the American west. Trucks and the interstate highway system have long since reduced the role of rail in shaping economic geography, but Cronon’s history still is highly informative of the ways that details of transport cost and innovations in finance and marketing can lead to rapid growth in some locations while eliminating whole ranges of business activity in others.

2.1.3 Declining Marginal Costs

Like many other transportation systems, railroads use a network to provide service to widely dispersed customers with many different service and handling requirements. In such systems, it is generally the case that marginal costs decline both as the network expands and as more traffic is added to the system. As the system grows, costs decline and, if there is competition, prices also decline. In fact, since competition tends to push prices toward marginal costs, systems with declining marginal costs have an inherent problem. Unless they can somehow keep prices at or above average costs or find a way to keep reducing costs, the companies eventually go bankrupt – and bankruptcy was a common occurrence in 19th century railroading, even with no competition from trucks. To deal with this problem, railroads try to charge higher rates where possible, which leads directly to inequities in pricing; some customers receive rates that reflect marginal costs, while others face monopolistic rates – “what the market will bear”.

Large-scale pricing inequities fuel political impetus for rate regulation. The US rail industry was highly regulated beginning in the late 1800s and continuing to the late

20th century. In the 1970s and 1980s, rail and truck transportation were “deregulated”, i.e. substantially less regulated. However, the history of rail expansion, of bankruptcies, and robber barons, and of regulation remains of great importance today to public agencies. Locklin (1966) provides a very detailed discussion of the logic for regulation and the history of the various public actions to regulate, assist, or restrict railroads in the United States.

2.1.4 Service Capabilities

The service and cost capabilities of various approaches to moving containerizable freight have been well-documented in prior studies, including Temple, Barker & Sloane (1986), Smith (1990), Norris and Haines (1996), and Muller (1999). Kwon et al. documented typical trip times and reliability for three types of rail service: general merchandise moving in boxcars, grain and other commodities moving in unit trains of covered hoppers, and intermodal. This study used a random sample of car movements for 1991 to calculate average trip times and various reliability measures. One conclusion of the study was that rail service in 1991 was very similar to what had been found in studies of rail service twenty years earlier. A typical boxcar trip took about 8 days, with considerable variation in trip times. A unit train typically made a trip in just a few days, although longer time is needed to assemble full train-loads of grain. Intermodal trains were faster and more reliable than the other train services, but not so fast or reliable as commonly achieved by truckload carriers.

Intermodal operations can provide fast, more reliable service than carload operations because motor carriers are much quicker in picking up and delivering trailers or containers to customers. Intermodal operations can be cheaper than truck operations because of the economies inherent in train operations. Under ideal conditions, where there are high volumes of traffic moving in a well-defined corridor with restricted highway capacity, intermodal can be competitive for relatively short trips. There is considerable interest in shuttle trains serving ports and inland terminals. Ports are typically located within highly congested urban areas, so the possibility of moving significantly more traffic by rail, if only for short distances, is very attractive. For example, Northwest Container Services moves 60,000 loaded and empty containers annually over the 170 miles between the Ports of Seattle, Tacoma, and Portland. In the Netherlands, the Betuwe Railfreight Line will run between the Port of Rotterdam and the border with Germany, connecting the port with the main freight lines of Europe. These cases are discussed in greater detail as part of Chapters 2 and 3.

Intermodal service features few intermediate handlings, and under favorable conditions can be fully the equivalent of over-the-road trucking. It mainly runs on schedules, some of them geared to the requirements and customer commitments of motor carriers. For many years, the huge trucking operation of United Parcel Service was the railroads' top intermodal client, and had substantial influence on train time commitments backed by guarantees. More recently, the railways have struggled to keep up with the efforts of UPS to tighten transit time standards as part of the company's product improvement (Wallace, 2006). While UPS and other major truck lines remain among the leading users of intermodal trains, rail intermodal capacity seems to have gravitated toward the international container market, where service demands generally are less stringent.

Rail carload service has always suffered from the difficulties of developing and implementing scheduled service. The typical move requires cars to be carried on 3-5 trains with classification at a similar number of freight yards. Given the inherent variability inherent in processing, the difficulties of operating in all terrain 24/7/365, and the lack of a reservation system, it is not surprising that rail service tends to be unreliable for general freight. The best service typically is offered when railroads are guided by an operating/service plan and provide the resources necessary to implement the plan, even when traffic volumes fluctuate day-to-day and month-to-month. The worst service occurs when weather problems cause prolonged disruptions in service or when management fails to provide sufficient resources to move the freight. High density shipping lanes even at short distances can support effective rail service, primarily when intermediate handlings can be avoided. Short line rail carriers particularly have become adept at local service for traffic within their networks, through a favorable cost structure that makes the business attractive and a sharp focus on customer service for shippers along their routes. The road congestion relief this can produce is of limited scope, but it can be quite material for specific roads in an urban or other circumscribed area.

The late 1990s were unfortunately a period of prolonged service disruptions for the major rail systems, as twin trends of rising traffic volumes and declining infrastructure finally led nearly to gridlock when the system was stressed by the implementing of various large-scale mergers, most notably the UP/SP merger. Service was so bad for so long that it led to feature articles in the popular press, before and long after the UP/SP merger (e.g. Machalaba, 1995; Whittaker, 1999). Substantial investments in equipment and in track allowed the railroads to recover to normal levels of reliability. The first part of the new century saw a widening movement to introduce scheduled carload operations as a way to elevate service. Some of the pioneering work on this in the US was undertaken by the Wisconsin Central, Ltd., and adopted on a larger scale by the Canadian National, who purchased the WCL; other large railroads followed suit. However, to get further improvements in service, McCarren (2000, then with the WCL) believes that the industry must adopt a reservation system that is linked to car scheduling and terminal management systems.

The Australian Department of Transportation, as part of a study to address the proper public role with respect to railroads, benchmarked performance of their railroads against railroads in other countries (Bureau of Industry Economics, 1995). Their report provides interesting contrasts concerning the types of traffic, levels of service, and costs of transportation for railroads around the world.

2.1.5 Truckload Competition

It is important to recognize that there are multiple market segments served by the trucking industry, not all of which are competitive with rail. Local and regional trucking accounts for the vast majority of truck movements in urban areas, and rail is competitive for almost none of this traffic (high volume moves of sand & gravel, road salt, coal, or oil products are the major exceptions). Rail and intermodal are options for intercity traffic that is traveling several hundred miles or more. This traffic includes small shipments that are commonly shipped in less-than-truckload (LTL) amounts as well as truckload (TL) shipments. Rail/truck intermodal is an option for both LTL and TL shipments if the service is reasonably fast, reliable and efficient compared to the trucking option. Rail carload must have rates that are low enough to offset the added logistics costs associated with the slower, less reliable service and the requirement for larger shipment size.

There is no hard-and-fast distance that demarcates rail and trucking zones. Trucks provide some transcontinental service, while rail provides some local and regional services. However, the average rail shipment is over 500 miles, whereas the average truck shipment is under 300 miles. The better the rail service in comparison to truck service, the shorter the distances for which rail is competitive – and vice versa.

Prior to the 1970s, trucking was highly regulated in terms of entry into particular markets and prices that could be charged. Most trucking firms were unionized and handled both TL and LTL freight. The average cost per ton-mile for all freight handled was much greater than the average cost of shipping by rail. Some people erroneously used average numbers to support an argument for much greater reliance upon rail. However, TL costs are much lower than LTL costs, and it is TL that is competitive with rail. TL costs of perhaps $0.05 per ton-mile for a full truckload shipment can be quite competitive with rail costs, assuming that TL services are offered at competitive rates by efficient carriers.

Three factors led to the development of highly efficient truckload operators. First, the construction of modern turnpikes and the Interstate Highway System allowed single drivers to travel 500 miles per day, at least doubling the reach of one-day service. Second, owner-operators and other non-union drivers were willing to drive 100,000 miles or more per year in truckload service. Third, the ICC allowed the so-called “Irregular Route Common Carriers” to offer highly specialized service, involving a few commodities moving over a few routes. These carriers obtained various operating authorities from the ICC, which allowed them to avoid empty backhauls and thereby achieve greater operating efficiencies. In the 1970s, at a time when much of the national rail system was experiencing severe financial problems, these irregular route carriers flourished.

Deregulation of truck service in 1980 accelerated the trend toward highly efficient truckload operators. By the mid-1980s, advanced truckload firms such as J.B. Hunt

Transport and Schneider National were strong competitors for long-distance intercity merchandise traffic because they were able to minimize operating costs, utilize wide-open networks, and provide excellent service (Corsi and Grimm, 1989). Each shipment was managed by the individual who booked it; each shipment was carried by an individual driver who normally had responsibility for it door to door; and each driver was monitored by a single dispatcher in communication with the booker. There were other advantages in addition to the tight, reliable performance this form of organization allows. These firms used non-union drivers; they minimized empty miles through careful load planning and direct marketing; and they used their size to reduce costs of truck acquisition, maintenance, and fuel. Contrary to the predictions of economists, there were economies of scale in trucking, and these large, low-cost firms kept pressure on rates for rail-competitive shipments of general merchandise. For most of the 1980s and 1990s, truckload rates remained at about $1 per mile for dry van, truckload movements of intercity freight (each year TTS published revenue per mile and other financial and operating statistics for trucking companies). Note that $1/mile, which was the prevailing rate for more than a decade after deregulation (Roth, 1995), is $0.05/ton-mile for a 20-ton shipment.

2.1.6 Role of Technology

Technology has always been a hallmark of rail systems. Evolution in technology for equipment, track, and signals & communications has steadily increased capabilities and reduced costs for nearly 200 years. Furthermore, as the first type of organization to require communications and cooperation over a national scale, railroads pioneered many of the innovations necessary to manage the modern corporation (Chandler, 1962).

Track and Equipment. Technology has continued to be a key factor in improving railroad performance over the past 30 years. Two key areas where technology has been critical are heavy haul railroading and double stack container trains. Heavy haul railroading refers to the use of larger cars, more powerful locomotives, and longer trains operating over better track to sharply reduce the costs of hauling coal, ores, grain and other bulk commodities. Innovations in track have allowed the rail industry to increase the gross vehicle weight for bulk commodities from the 200,000 pounds that was standard in the 1960s to 286,000 pounds beginning in the early 1990s. Since the newer cars use aluminum bodies, the gain in payload has been even greater.

More than a decade of research and testing at the Transportation Technology Center in Pueblo has enabled the rail industry to improve track integrity through the use of better materials, better equipment designs, and advanced track components; with a stronger track structure, railroads have reduced the total costs of shipping bulk commodities on the order of 2-5% by allowing axle loads to be increased from 33- to 36-tons, i.e. to the so-called 286,000 pound car (gross vehicle weight). In fact, the advances in track technology have allowed railroads to reduce track maintenance costs, despite handling more freight using heavier cars (Chapman and Martland, 1997 and 1998). The annual benefits from using heavier axle loads have been estimated to exceed a half billion dollars per year (Martland, 2000; Kalay and Martland, 2001).

However, the AAR studies have all cautioned against using the heavier cars on poorly maintained lines. Heavy cars can cause rapid deterioration of weak track structure and necessitate expensive upgrades to bridges. The costs of infrastructure improvements may not justify the operating savings available for light density lines. Still, two other factors must be considered. To the extent that the 286,000 pound car is an industry standard, shortlines and their customers believe that they will be at a disadvantage if they are restricted to the use of smaller cars. They therefore have sought public funds to upgrade track to handle HAL (Heavy Axle Load) traffic. The costs to society of using trucks instead of rail on rural roads may justify public investment in upgrading short lines to carry heavier loads (TRF Agriculture paper)

Also, it is possible to redesign equipment to gain nearly all of the HAL advantages without increasing axle loads: shorter, higher cars can increase the loading density of the train while retaining 33-ton (or even lower) axle loads. Chapman, Robert, and Martland (1998) recommend that the interest in HAL loads be broadened into a discussion of equipment design, especially if there are to be significant public investments to enable light density lines to handle heavier loads. Investing in better-designed equipment might be a better option in some circumstances than investing in track and structures.

While heavy haul technology has provided savings in hauling coal, it has had fairly modest effects on mode choice. Rail has long been dominant in the bulk market, except for shipments where barge or coastwise transport is an option, and the same situation broadly prevails today as in 1980 or earlier.

In the intermodal arena, technological innovation caused dramatic changes in handling general intercity freight. Double stack trains cut the line-haul costs of rail intermodal services nearly in half, which made these services highly competitive with direct TL operations. Double stack services were promoted by ocean carriers serving the Pacific Rim, who sought a faster way to reach eastern US markets than by going through the Panama Canal. Once lightweight rail platform equipment was available, double stack services quickly linked the major West Coast ports (Los Angeles, Long Beach, Oakland, Portland, and Seattle) with major midwest and eastern destinations (e.g. Houston, St. Louis, Chicago, and New York). Seeking backhauls for their containers, the ocean carriers secured considerable domestic freight and soon a double stack network was in place linking the major metropolitan areas of the US. Coupled with the tremendous expansion of US-Asian trade, the international container business became the primary driver of rail intermodal growth, leading to the intermodal sector overtaking coal as the top revenue generator for Class I railroads.

Operating double stack trains requires clearances well beyond what was generally provided on rail lines. In the west, where double stack services began, bridges and other clearance restrictions were much less of a problem than in the older and more populated east. In some locations, notably New York and Pennsylvania, public assistance helped raise the clearances required to operate double stack.

Because of the history, public agencies may think of double stack trains as a matter of international trade and port access. However, outside of the major port cities, double stack trains are potentially much more important for domestic freight than for international trade, simply because there is so much more domestic traffic. Access to double stack terminals is therefore a concern for any metropolitan area, not just for ports.

These points notwithstanding, there is a second retardant to the domestic utilization of stack services that comes from the dimensions and practical advantages of truck trailers versus containers. Intermodal services by definition have an on-road component; a container requires a wheeled chassis to go on road, and the separate pools of chassis equipment have to be maintained and managed. Truck trailers carry their wheels with them, but they cannot be stacked. Moreover, the containers that are normally favored for steamship operations have smaller cubic capacity than the trailers typical of domestic service, rendering them an inferior good for the cube-limited shipments that make up the majority of domestic boxed freight. Domestic high-cube (53-foot) containers have taken hold in the industry to offset this disadvantage; however, they are operated mainly for the intermodal services and are not blended into the regular over-the-road (OTR) networks of motor carriers[1]. This sacrifices various fleet and balance benefits, and yet the intermodal spine cars that railroads use to carry trailers do not have nearly the cost efficiency of stack equipment. A newer technology that makes up some of the efficiency gap is the continuous moving platform successfully operated by CP Rail in Canada under the trade name Expressway, and known as the Iron Highway in earlier incarnations. Described in Chapter 3, Expressway has been able to attract short-distance highway business between Montreal and Toronto (337 miles), and between Toronto and Detroit (230 miles), carrying standard, non-reinforced highway trailers - including tank trailers, flatbeds, and units owned by private fleets. Equipment expense can be high, although CP has found ways to reduce it, and it is offset by lower terminal costs. (A U.S. application of Expressway technology was explored in the Virginia I-81 study, presented in the next chapter.)

Information Technology. Railroads have historically been heavy users of communications and information technology. Customer service, equipment management, traffic control, service design, and maintenance planning have all benefited from IT applications. Investment in IT has been justified by the ability to increase labor productivity (e.g. reduce clerks), to improve equipment utilization, or to reduce operating or maintenance costs.

However, it is not always easy for railways to justify the costs associated with new

IT, and the industry has generally been unwilling to adopt technology for technology's sake. The industry has been criticized by both IT experts and by public officials for moving too slowly to adopt new IT, especially in the area of train control. (Given the fate of the high tech companies over the past few years, the railroads should perhaps be congratulated for their prudence rather than chastised for their backwardness).

The train control issue deserves some elaboration, since this is a topic raised by public officials and the press whenever there is a serious train accident. Interest in communications-based train control began in the late 1970s, when an industry group began formulating standards for what was then called "Advanced Train Control Systems" (ATCS) (Moore-Ede, 1984). The basic ingredients of ATCS were a digital communications link between trains and headquarters, on-board computers linked to various sensors in the locomotive, and a positioning system. In principle, the train and headquarters could both know the location and speed of the train, so that it would be possible to slow or stop the train if it were in danger of going too fast or exceeding its operating authority. There are multiple approaches to advanced train control, and the digital communications link can serve many business purposes as well as potentially reducing accidents, e.g. reducing the load on dispatchers or making it feasible to transmit new switching assignments to local train crews. Advanced train control systems offer the potential for eliminating wayside signals, which can lower costs and in some circumstances improve capacity. For example, instead of the fixed blocks defined by signal locations, a communications-based train control system can maintain what are known as "moving blocks". Each train would have authority over a section of track that would continuously be updated as it progresses down the track. Minimum headways would therefore be determined not by the signal system, but by the terrain, train speed and braking characteristics. With moving blocks, trains can generally follow more closely, which will increase line capacity; while the same effect can be achieved by using short signal blocks, the communications-based approach would be much cheaper. It is unclear how much benefit can actually be achieved from rolling blocks (or shorter signal blocks). Route capacity is more often limited by terminal capacity or meet/pass requirements than by headways, so that the benefits of shorter headways may be most useful in special circumstances, e.g. recovery from disruptions in service related to accidents or track maintenance.

In the late 1980s, the Burlington Northern Railway elected not to implement an advanced, communications-based control system, despite the potential for achieving some improvements in service. An extensive analysis of the costs and benefits was undertaken, which indicated that marketing and business benefits could justify the investment expense. However, the marketing benefits were perceived as too "soft" to justify the $1 billion investment. A good summary of the issues is available as a case from the Harvard Business School (Hertenstein and Kaplan, 1990), while more detailed papers describe the manner in which better communications and dispatching enable faster and more reliable trains (Smith, 1990), which translates into more reliable terminal performance (Smith & Martland, 1990). Public interest in advanced train control systems persists because of the potential for safety improvements, since these systems can prevent certain kinds of collisions and overspeed derailments. The costs of the systems have proved to be a stumbling block. For example, a congressionally-mandated study of train control's potential for improving safety concluded that the safety benefits alone could not justify the multi-billion dollar investment that would be required (Office of Safety, 1994); this same report includes an excellent introduction to signaling and communications for railroads.

It is notable that the federal government has invested heavily in research concerning "Intelligent Transportation Systems", most of which relates to highway technologies. The range of applications includes traffic control, use of transponders to allow vehicles to avoid lines at toll booths, weigh-in-motion scales, predicting traffic conditions, and facilitating emergency response. It is now feasible to collect tolls without requiring traffic to stop. In Toronto, cameras capture the license plate, character recognition software reads the license, the license is linked to the owner, and the owner of the car receives a bill as part of their phone bill. The technology for much more extensive use of tolls and congestion pricing is available, although little has yet been implemented.

Fuel Efficiency. Railroads on the whole are more fuel efficient than trucks because of the inherent efficiency of the steel wheel on the steel rail and the use of gentle grades on rail routes. However, fuel usage varies greatly with the commodity and the car type, and public agencies need to be able to go well beyond "average gallons per ton-mile for rail vs. truck". Heavy trucks operating on good roads may in fact be more fuel efficient than very short trains operating on poorly maintained, circuitous routes. Detailed assessments of energy and environmental factors are available for freight (e.g. Abacus Technology, 1991), with a major EPA study examines fuel efficiency in great detail, especially for trucks (ICF Consulting, 2001).

2.2 Intermodal Planning including Truck and/or Rail Freight

Conferences over the last decade have provided a wealth of material on intermodal capabilities and intermodal partnerships, including the National Conference on Intermodalism (1994), the Intermodal Freight Terminal of the Future (1996), and the Partnership to Promote Enhanced Freight Movement at Ports and Intermodal Terminals (2000).

There is a base of planning reports at state, metropolitan and local levels that show how truck and rail freight alternatives and solutions can be, and in fact have been, successfully included in transportation planning, evaluation and implementation practice.

The major themes include the following:

1. Intermodal transportation at its best combines the efficiency of rail with service levels normally associated with trucks.
2. There are many intermodal options for moving freight, including bulk and breakbulk transfers, as well as the transloading of trailers and containers. There are many supply chain options for the size and location of warehouses, the source of supplies, and the nature of markets that are served. Changes in supply chains made by remote companies can have significant effects on local freight flows.
3. Intermodal transportation is rapidly growing, but there are potential problems in providing sufficient capacity.
4. Even if intermodal transportation doubled, there would be only a minor reduction in truck traffic.
5. Location of intermodal terminals is critical: terminal location is a major consideration in customer's use of this mode as well as a major determinant in the nature of drayage flows within a region. Terminal location therefore affects the extent to which intermodal transportation affects air quality, energy consumption and congestion.
6. There are several types of intermodal terminals, including major facilities serving local pickup and delivery, interchange terminals, port support terminals, and terminals where trailers and containers are transferred from one train to another. Larger terminals often serve multiple functions, and there is considerable flexibility concerning the way that traffic is, or could be routed between terminals. While railroads have traditionally tried to provide direct, single train service, there are also possibilities for creating more of a hub-and-spoke network. The nature and location of hubs could be much different than for other kinds of intermodal terminals.
7. Public support could conceivably lead to intermodal shuttle systems aimed specifically at alleviating congested portions of the highway network.

2.2.1 Intermodal Planning Techniques

There are various simple models that can be used to estimate the costs and service levels associated with intermodal transportation. Simple analytic models can be employed to provide quick estimates of cost (e.g. Martland and Marcus, 1987); such models have been used to estimate the effects of providing double stack service to the

Port of Boston and options for relocation of intermodal terminals within eastern Massachusetts.

New planning techniques are being developed that make extensive use of traffic flow data and graphical analysis for intermodal freight planning. These techniques have been applied, for example, in Pennsylvania (Gannett Fleming, 1999), New York State (Erlbaum, 2001) and Ohio (Gad, 2001).

New technology, especially information technology can be very useful in coordinating intermodal operations. A study conducted for the National Commission on Intermodal Transportation summarized the technological opportunities for improving rail/truck coordination (A&L Associates, 1994).

Research sponsored by the AAR identified ways that information technology can be used to increase the capacity and reduce the cost of terminal operations (Zhu and Martland, 2002). This study found that investment in IT on the order of $1 million could increase capacity by 5-10% while providing net operating benefits on the order of $3-7 million. The study called for greater cooperation among terminal operators, carriers, customers, and public agencies in using IT to coordinate movement of trains and trucks to and from intermodal terminals. The information requirements for economic analysis were addressed during a TRB conference (TRB, 2000).

2.3 Studies of Congestion Cost

The central purpose of this report is the potential for moving more freight by rail in order to reduce truck traffic on congested roads, especially in urban areas. Most of the literature on congestion, and most of the measures for dealing with congestion, deal with peak period auto traffic generated by commuters, which does address the costs of congestion. However, it is otherwise of limited use for examining the ways that truck traffic contributes to and suffers from highway congestion. Also warranting consideration is the fact that rail freight can contribute to congestion in any location where trains use routes with grade crossings.

Some major themes can be identified with respect to congestion cost:

- Congestion costs are typically calculated using the value of time for the people caught in traffic, including commuters, other automobile users, bus riders, business travelers, local truck drivers, and intercity truck drivers.
- Consequential costs can extend well beyond time value. A truck that misses a fifteen-minute delivery window can a) disrupt the production or merchandising of goods by the recipient; b) interfere with other trucks maneuvering into tight spaces and scheduled door capacity at customer docks; c) be held outside or turned away – and in the latter case, the VMT of local

delivery is tripled, as the truck departs for a holding point and returns later. Chronic and variable delay makes modern logistics strategies less effective.

- Congestion is a phenomenon where marginal costs can be much greater than average costs: a user encounters average delays that depend upon the time-of-day, but causes incremental delays to other users that in the aggregate can be many times greater.

Congestion tolls can reduce peak use of facilities by encouraging some users to make fewer trips or to shift trips to other modes, other time periods or to other destinations. Despite the effectiveness of congestion tolls, they have rarely been implemented because of lack of public acceptance of the concept, although recent years have seen the level of interest rising. For commercial traffic, there is also a question as to how directly the incentive bears on the point of decision. While freight recipients normally set the delivery schedule, responsibility for paying the bill usually rests with the shipper. Thus if a truck line wishes to recover the cost of tolls, the charge goes to the shipper, and not to the party who controls timing.

- Adding highway capacity to handle peak loads is very expensive, because the incremental capacity is needed only for a small fraction of the typical week.
- Urban freight is adversely affected by congestion, because it takes longer to reach customers and drivers are able to make fewer pickups or deliveries per day. The costs of congestion for trucks will, for high valued freight, include the time value of the freight.
- Truck movements do not follow the same patterns as other traffic; trucking companies and their customers have some flexibility in when they use congested facilities, and truck fleets actively make an effort to operate off-peak. As a rule, a commercial vehicle traveling at peak hour is obligated to be there by its customer and schedule.
- The composition of truck traffic exposed to delay varies by time of day, because of the diurnal shipping cycle. Morning peak will have a relatively large number of vehicles at the end of their runs and making deliveries – with looming appointments and no cushion left in their schedules. The quantity of vehicles traveling empty may be relatively high mid-day, as trucks move from delivery point to the next point of pick-up.
- Restrictions on truck movements have been implemented in some cities and discussed in others. Such restrictions do not necessarily affect congestion, as more people may drive, but they certainly will increase costs of moving freight within the city. Studies generally show that the costs to truckers and their customers outweigh the benefits to commuters.

2.3.1 Congestion Costs

Congestion increases both the average time and the variability of time required for trips. As traffic flows approach capacity, congestion rapidly increases and accidents or bad weather can lead to gridlock. In congested conditions, the marginal delays can be many times higher than the average delay. Each additional vehicle not only suffers from slower speeds and long delays at intersections, it increases the delays to subsequent vehicles. Likewise, diverting a vehicle from a congested route will have benefits much greater than the average travel time along that route.

Large trucks have a much bigger effect on congestion than automobiles because they are longer, less maneuverable, and underpowered compared to typical automobiles. They accelerate more slowly, need larger gaps, more lane width and more time to make turns, and may slow down on long grades. Thus a single truck is equivalent to several cars in terms of capacity.

Methods for estimating the effects of trucks on highway operations are given in the Highway Capacity Manual published periodically by TRB. The larger the truck, the greater the effects, assuming similar equipment design and operations; a special TRB report investigated the ways in which larger combination vehicles affect highway and intersection capacity (TRB, 1989). On a level, multi-lane highway, a large truck is equivalent to 1.7 passenger cars, i.e. it equals 1.7 “passenger car equivalents (PCEs)”. If there are steep grades or sustained grades, the trucks will slow down and represent 8 PCEs on freeways or even more on 2-lane highways where passing opportunities are limited. At intersections, a large truck can represent 3-4 PCEs. Increasing the percentage of trucks in the general mix of traffic therefore can cause a marked reduction in capacity. For example, if 10% of the vehicles are heavy trucks on a route with signaled intersections, capacity will drop 20-25%. To look at this another way, if this route is operating close to capacity at rush hour, diverting the trucks would allow approximately 50% more automobiles on the road.

An NCHRP study of congestion costs (Weisbrod and Vary, 2001) focused a major element of its analytic work on urban freight deliveries. This study included case studies of Chicago and Philadelphia that provide useful insights.

2.4 Rail Relocation and Road/Rail Conflict

Both the rail and the highway networks evolve in response to changes in economic geography, transportation needs, and competitive capabilities of the various modes. As traffic volumes grow, as traffic shifts to new routes, and as new customers ship more freight, there are bound to be increasing pressures for network improvements. Where traffic is declining, there is pressure to reduce maintenance or abandon certain line segments. Where traffic is growing, there is pressure to add line or terminal capacity. Where traffic is shifting to new locations, there is pressure to add new routes or new terminals. Wherever there are grade crossings, growth in either highway or rail traffic leads to greater highway congestion and pressure for restricting rail operations, grade separation, or closing the crossings. Thus, there are a number of standard planning issues related to the structure of the rail network:

Standard Planning Issues for Rail Network Structure

Planning Issue	Factors
Rationalization of center city rail network	Port access
	Commuter rail
	Redevelopment potential
	Access to rail/truck intermodal terminals ▪ Rail clearances (vertical) ▪ Highway clearances (lane width, corners, intersections) ▪ Highway connections to service area
	Facilities suitable for through as well as local traffic ▪ Rail clearances ▪ Line capacity
Conflicts among traffic flows	Rail freight and rail passenger ▪ Capacity and schedule effects ▪ Commuter rail effect on highway congestion
	Rail and highways ▪ Improved protection ▪ Enforcement ▪ Rail operations during rush hour ▪ Grade separation and closing of grade crossings
	Intermodal, merchandise, and bulk trains on high density rail lines
Intermodal issues	Terminals ▪ Capacity for growth ▪ Centralized versus dispersed facilities ▪ In-town versus perimeter facilities ▪ Location and highway access
	Equipment ▪ Containers vs. trailers ▪ Potential for non-standard technologies
Grade crossings	Closure of crossings with low highway traffic
	Protection for crossings with high road traffic volume
	Effects of rail routing changes on roadway congestion
Service to industry	Rail service to industrial parks and large potential customers
	Provision of sidings and support yards for potential customers
	Rail inclusion in economic development planning
Heavy haul railroads	Axle load limits for track structure
	Weight limits for bridges
	Assistance to short line and regional railroads ▪ Upgrade tracks and bridges for common Class I trains

2.4.1 Rationalization of Rail Facilities

Rationalization involves restructuring the network so as to reduce costs, reduce conflicts between rail and highway traffic, improve service to rail customers, and to free up land for redevelopment. In the 1970s, following the collapse of the Penn Central, extensive public debate focused on two major types of rationalization: abandonment of light density lines and railroad mergers. At that time, both processes were under the jurisdiction of the Interstate Commerce Commission. Rail abandonments were highly contentious, as the railroads emphasized their financial losses, while customers and local governments emphasized the impacts on local communities. In general, the ICC approved most merger and abandonment applications, but the railroads felt that the proceedings dragged on too long [Sloss]. As they pushed for more rapid abandonment, the public resisted. Eventually, as part of the legislation creating Conrail, abandonment was put on a more rational footing. Railroads were allowed to abandon lines unless customers, local or state agencies, or someone else covered the railroad’s operating losses; federal funds were allowed for states to use to keep light density lines in operation.

Gradually, the emphasis shifted from abandonment to the transfer of light density lines from the large railroads to short-line and regional railroads, some of which were owned or supported by the states. [Levine]. The impetus for divesting light density lines was that the smaller railroad would not be bound by the same labor contracts and would have closer contact with customers, thereby eliciting more freight.

The results not unexpectedly have been mixed. Where lines had a reasonable traffic base and some prospect for growth, without major capital requirements for continuing operations or heavy debt service, then lower costs and better marketing have helped the short-lines to succeed. Where the traffic base was declining, because firms were moving or mines were closing or markets were changing, the added benefits of short line operation could not postpone the inevitable decline. An example of the latter case is the Lamoille Valley Railroad, which was upgraded with approximately $20 million in support in the l980s from the state of Vermont, but which had no traffic at all by the end of the 1990s. A study commissioned by the Northeastern Vermont Development Association (Martland and Wong, 1997) concluded that the best use of the railway would be as a recreational trail, which would allow 4-season use of the route while preserving the right-of-way for possible future resurrection. A lesson from this experience, and indeed from the entire experience with state support of light density lines, is that investing substantial public money in rail facilities does not necessarily create a competitive advantage for rail, nor does it mean that the rail system will be used.

2.4.2 Redevelopment of Urban Rail Facilities

The rail system was largely constructed in the 19th century, long before trucks offered competition to rail or suburbs offered competition to city centers. The rail network was necessarily dense, as it served numerous industrial sidings and port facilities. Since many railroads served each major city, a vast complex of classification yards, interchange yards, and Industrial support yards developed in all the major cities of the east and the Midwest.

As trucks became available, of course, the scale and density of the urban rail networks were clearly inconsistent with the demand for rail. Trucks could handle most port and regional traffic quicker and more efficiently than rail, so many of the urban facilities were underutilized. Railroads responded in part by consolidating yards, freeing up valuable urban space for redevelopment. Many notable buildings, centers, and parks are built upon former rail freight or passenger terminals, including the Prudential Center in Boston, the Crystal City development opposite Washington National Airport, and various waterfront developments in New York and New Jersey. After the Penn Central Railroad went into bankruptcy in 1970, the Penn Central company survived in part because of the value of its extensive holdings of obsolete rail facilities.

Today, there is still a common interest among railroads, public agencies, and railroads in restructuring the urban rail system so as to improve land use. Railroads no longer need the extensive inner city terminals, but may have difficulty in assembling land in the suburbs for facilities closer to their current customers. Public agencies have difficulty in determining whether or not a particular terminal is well-sited for rail, or whether better opportunities exist where real estate is cheaper.

Beacon Park Yard in Boston is an example of current discussion about land use. The site, which is under long-term lease to CSX, is adjacent to the Massachusetts Turnpike and is conveniently located with respect to the urban road network. It is also located strategically between Boston College and Harvard University and a new biotechnical industrial center. In the early 1990s, the site was owned by the Massachusetts Turnpike Authority, which was very interested in moving the intermodal operations to another site in order to allow redevelopment of the real estate. MassPike commissioned a study of possible alternative locations, but, because of the local geography and development patterns, was unable to find a large enough site that had good highway and rail access, that was relatively close to Boston, and that did not have unique environmental features. MassPike did not pursue the matter, and the site was sold by the Turnpike Authority to Harvard University. CSX retained its lease, yet a new study was launched subsequently by the Massachusetts Executive Office of Transportation and Construction, now considering how to balance railroad requirements and regional transportation objectives with Harvard's need for educational facilities expansion.

2.4.3 Location of Intermodal Terminals

The location of intermodal terminals is a key factor in the effectiveness of intermodal operations in reducing local truck traffic. A study of intermodal terminal movements in the Los Angeles basin found that having multiple terminals throughout the region allows significant reduction in truck-miles traveled on local streets (Frazer et al., 1996). Conversely, centralization of intermodal operations in a single terminal would likely increase truck-miles traveled, even if the terminal were centrally located. Locating terminals at the periphery of the region would certainly increase truck-miles moving containers and trailers to and from the facility. Shuttle systems that move containers between major hubs and downtown terminals can reduce drayage, but may increase operating costs for the railroads. It is possible that minor subsidies would enable shuttle systems to be operated, thereby retaining the air quality and congestion benefits of rail for central business districts. Moving intermodal operations to remote hubs would also reduce the land required for terminals in expensive urban areas.

There is a trend toward locating new intermodal terminals away from the central cities, which will affect both highway traffic and future development. Norfolk Southern located a new facility outside Atlanta in Austell, Georgia (Norfolk Southern, 2001); UP decided to add capacity outside of Chicago in Rochelle, Illinois (Union Pacific, 2001).

Ideally, truck transload facilities will be located close to the rail intermodal terminal. UPS has constructed major sorting centers in Jacksonville and in Chicago in locations that are adjacent to the rail facility, thereby minimizing drayage costs and highway impacts.

2.4.4 Grade Crossings and Grade Separation

Grade separation will eliminate highway delays at rail crossings and reduce the risk of crossing accidents. Closing crossings where there are low volumes of highway traffic is an alternative way to reduce the risk of accidents, although there may be increased travel times for some highway users.

A study conducted by Florida DOT estimated the potential to eliminate as many as 19 rail-highway at-grade crossings in the Sarasota-Bradenton, Florida Urbanized Area. The eliminations would require consolidation of trackage operated by the Seminole Gulf Railway (SGLR), lessee of CSX Transportation branch lines in the area. Consolidation of operations of CSXT predecessors Atlantic Coast Line and Seaboard Air Line after their merger resulted in two separate but parallel tracks serving the immediate study area with a connection in downtown Sarasota. One track had few rail users, the vast majority of the railroad's freight traffic in the area being generated on the second line.

Two means of consolidating the trackage were considered and designed. The preferred alternative involved a new connection, which required a grade separation of very heavily traveled U.S. 301. Rail traffic and operating data were obtained from the railroad and highway data from the FDOT national railroad-highway grade crossing inventory for the existing crossings. Highway traffic counts were obtained from FDOT for the proposed grade-separated crossing and existing rail users located on the line segment to be eliminated were interviewed.

Construction estimates were prepared and a benefit-cost analysis performed. Benefits consisted of:

- Highway user vehicle operating and maintenance costs avoided;
- Vehicle occupant time delays avoided;
- Grade crossing crashes avoided;
- Railway operating savings;
- Railway and crossing maintenance savings; and
- Track material and right-of-way salvage value.

These benefits were reduced by the cost of relocation of one rail user who would have to be relocated. The results of the study were presented to the Sarasota/Manatee MPO in September 1993. The MPO accepted the report, but recommended that FDOT not pursue any improvements at that time because the MPO did not believe that the proposed project would "necessarily represent a great benefit to the community at large."

Elimination of grade crossing delays has been a major motivation for some notable examples of public investment in rail facilities, including the Alameda Corridor in Los Angeles/Long Beach and the Sheffield Flyover in Kansas City, two projects that are examined among the case illustrations in Chapter 2.

2.5 Benefit-Cost Assessment and Modeling

State and local transport planners may be called upon to consider a variety of issues related to changes in rail systems and the resulting impacts on such public concerns as highway congestion and land use. A number of themes run through these considerations:

- Public agencies must demonstrate that total benefits of a project are sufficient to justify the costs of the project, taking into account the time value of money in order to compare current and future costs and benefits.
- Both costs and benefits may include much more than financial matters, and there are many ways that have been used to quantify non-monetary factors.
- There are various methodologies for assessing projects with multiple categories of costs and benefits. Many types of weighting schemes have been used or proposed, but weighting schemes still require political input in establishing the weights.
- Public agencies also are concerned with equity – how are costs and benefits distributed? Major public projects must ultimately be approved by a political process.
- Public policies are often subjected to vigorous debate concerning what types of projects should be considered, how projects should be structured and

whether regulations or other public actions may be able to reduce the need for public investment.

MPOs or other public agencies may be asked to carry out a study involving several distinct steps:

1. Identify the effects of proposed investments in rail facilities or changes in rail operations on rail cost and performance;
2. Predict the effects of the anticipated changes in rail performance on highway traffic flows;
3. Estimate the effects of the predicted changes in traffic flows on congestion and air quality;
4. Predict the effects of the proposed rail investments on land use, employment, economic growth and economic justice;
5. Evaluate the effectiveness of proposed rail investments relative to:
    a. Other investments in the rail system,
    b. Other investments in the transportation system,
    c. Other approaches to reducing congestion and improving air quality.

The first two steps are likely to cause problems for public officials, as they are not generally familiar with the details of rail systems or the mechanisms of freight competition. They will also need help with the last step, which requires an understanding of the options for freight investments.

Railroads contemplating major investments in a metropolitan area will - in theory – go through similar steps, especially if they are seeking cooperation from local governments. Like the state agencies, they will be able to deal well with some steps, but need help with the other. Railroads will be able to predict the effects of investments on their performance and their competitive position, and they will be able to consider alternative rail investments. They would ordinarily be interested in their own costs and benefits rather than the public issues address in the 3rd and 4th steps. However, if they are seeking to cooperate with public agencies, then they will be interested in using public benefits to justify improvements in the rail system. Both railroads and public agencies will need help in finding alternatives to any proposed investment.

2.5.1 Examples of Intermodal Freight Planning Studies

I-35 Trade Corridor Study: Recommended Corridor Investment Strategies. The FHWA and the state departments of transportation in Texas, Oklahoma, Kansas, Missouri, Iowa and Minnesota combined their efforts to conduct a study of Interstate Highway 35 (I-35) from Laredo, Texas to Duluth, Minnesota (HNTB & WSA, 1999). The study assessed the need for improved local, intrastate, interstate, and international transportation services in the 1-35 corridor and defined a general strategy to address those needs. The base case was a “Do Little Scenario” that included maintenance of pavement and bridges, committed highway and transit improvements, demand management, ITS, and growth management. The three best of five initial alternatives to the base case were studied in greater detail:

- Highway Upgrade with a Partial NAFTA Truckway
- Highway Upgrade within Existing ROW
- Highway Upgrade with Rail Implementation

Based upon a full analysis, the "Highway Upgrade with a Partial NAFTA Truckway" strategy was recommended because it provided the best overall movement of traffic in the corridor and the highest benefits, taking into account travel times, accident costs, environmental impacts, and benefit-to-cost ratios. This alternative included special provisions (a separate truckway facility or a truckway within the existing I-35 right-of way) to accommodate the high-volume truck traffic between the Dallas-Fort Worth area and Laredo. In contrast, the "Highway Upgrade with Rail Implementation" strategy promoted cooperative rail services between Kansas City and Laredo in order to decrease freight traffic on I-35. The study did not find this to be a promising strategy:

> "A limitation on the Highway Upgrade with Rail Implementation strategy relates to the reliance upon shifting significant freight to rail service. Even with a high proportion of shifted freight, there is a rather small change in the requirements for I-35 improvements, and the capability of rail companies to accommodate those increased volumes on rail is uncertain."

National I-10 Freight Corridor Feasibility Study. This study addressed the issue of increased truck traffic and intermodal freight along an existing interstate corridor of international, national, regional, state and local significance. I-10 stretches from California to Florida, passing through eight states and 17 major urban areas. It is connected to key international ports including the nation's largest container and bulk ports and all US/Mexican border gateways. The Texas Department of Transportation served as the contracting agency for the I-10 Corridor Coalition (CA, AZ, NM, TX, LA, MS, AL, FL).

A comprehensive evaluation of the overall transportation system was researched in order to assess the need for, and the feasibility of, developing a broad range of alternatives to facilitate the movement of goods along the I-10 Corridor. Among the scenarios to be evaluated was the use of rail as a means for alleviating congestion. The study examined freight traffic growth along the corridor and identified traffic streams that can be served by rail. The study measured the impacts of rail service on the I-10 facility (capacity, operations, etc) and determined that conventional approaches to rail service would not significantly delay construction, or reduce delay on a corridor basis.

The National I-10 Freight Corridor Study was divided into three time frames: short-range, 2008; mid-range, 2013; and long-range, 2025. Short-term solutions were project specific and the majority of those solutions identified were state specific consisting of physical components in urban areas, including additional lane miles as well as operational (ITS/CVO) measures. Mid-range and long- term solutions were for the corridor as a whole and focused on innovative technological and operational solutions, including the feasibility of dedicated truck lanes in certain segments of the corridor.

The Potential for Shifting Virginia's Highway Traffic to Railroads. Virginia DOT was directed by the Commonwealth's legislature to examine the potential for diverting traffic from highways to rail. Interstate 81 was cited as an "acute example" as its current traffic is made up of as much as 40 percent trucks although it was designed to carry no more than 15 percent. The purpose of the study was to determine a) if the potential existed to divert enough highway traffic from I-81 to rail transport to significantly impact the need for planned improvements, and b) if the impacts over time would justify public expenditures for rail improvements.

A number of analyses were performed in conduct of the study. First the various truck traffic flows contained in the various databases were examined and assigned to the highway system. The trucks that would use I-81, all or part of the length in Virginia, were identified by route segment. (VDOT, 2001; WSA et al, 2001). A diversion potential of around 10 percent of trucks with dry van semi-trailers moving in excess of 500 miles was used as a reasonable expectation. Trucks with those characteristics comprised approximately 70 percent of all trucks on the corridor.

Highway impacts were estimated using the Highway Economic Requirements System (HERS). HERS is a comprehensive highway performance model used to prepare the U.S. Department of Transportation's biennial report to Congress on the "Status of the Nation's Surface Transportation System." The study found that the planned improvements to I-81 would have to proceed, and, in fact additional capacity improvements should be considered. Even with additional capacity improvements, the removal of trucks (diverted to rail) impacts the amount and timing of those improvements. An analysis of the present value of the benefits that would be attributable to the diversion of trucks over the 22-year study period was conducted. The results revealed that at a 10 percent diversion level, almost $400 million worth of benefits were generated

The study concluded that public investment in rail improvements in the I-81 Corridor should be considered based on the potential to accrue public benefits. Its recommendations led to a subsequent market assessment project that surveyed customer requirements, evaluated the appeal of conventional and unconventional rail products, and reviewed the related public investment proposals of railroads in the region. Results of the market assessment are presented among the case illustrations in Chapter 2.

Wilmington-Harrisburg Freight Study. This study investigated strategies for more efficient and safe movement of freight along the Wilmington-Harrisburg Corridor.

Originally conceived as an analysis of strategies to divert Port of Wilmington traffic traversing the Corridor to other routes and modes, it was expanded after discovering that the Port generates less than ten percent of the Corridor truck volumes. The vast majority of the freight traffic was either originating or terminating (and often both) in the counties along the Corridor (New Castle, Chester, Lancaster, and Dauphin). Two scenarios address the potential for diverting long haul, through traffic either to railroads or to the Pennsylvania Turnpike. Two other scenarios focused on enhancing the efficiency of freight flows that are necessary to support local businesses.

The rail scenario included improvements to the Norfolk Southern route into Delaware, construction of a Triple Crown terminal in New Castle County, better utilization of the Brandywine Valley Railroad, and the impacts of the Shellpot Bridge repair. The conclusion was that investments in the rail system offered some potential to divert existing truck freight to rail.

The shipper scenario discussed different operating strategies that can be employed to reduce congestion. These included off-peak pick-ups/deliveries, increased use of warehouses and distribution centers, and alternate routes and modes. It also presented the results of a shipper questionnaire. The primary concern of the shippers was roadway congestion between Lancaster and Wilmington. Many of the shippers supported construction of a bypass. The study therefore examined proposed enhancements to the Corridor, specifically Route 41 and U.S. 30 bypasses and managing the flow of freight through truck bans, traffic calming, and enhanced enforcement initiatives on Route 41. A U.S. 30 bypass would have a significant positive impact on freight flows by providing an appropriate route for trucks passing through the region. By working with area shippers, it may be possible to shift some local freight activities to the U.S. 30 bypass by constructing warehouses or distribution centers. A Route 41 truck ban and traffic calming would have very negative impacts on businesses in Chester, Lancaster, Dauphin, and York counties. A truck ban on through traffic where “through” is defined to be west of Harrisburg/Carlisle would not impact local businesses as much and was deemed worth further exploration.

The study also explored strategies to move trucks off of the Corridor and onto the PA Turnpike. A value pricing study determined that about 30 trucks per day would divert to the Turnpike if toll discounts were offered between Exit 23 (Downingtown) and Exit 19 (Harrisburg). Allowing longer combination vehicles (LCVs) on the Turnpike and connecting roads had the potential to divert a significant number of trucks from the Corridor. This proposal faced numerous obstacles, including strong opposition from the Pennsylvania Turnpike Commission.

A Multimodal Transportation Plan for Wisconsin. Wisconsin DOT developed a multimodal transportation plan for Wisconsin called “Translinks 21” (WSA and Reebie Associates, 1996). The intercity freight planning effort began with the development of a county-level commodity flow data set for all modes. The databases are comprised of information obtained from state, federal, and private industry sources. Trend commodity forecasts were developed for truck, rail, waterborne and air shipments using employment and productivity factors through the Year 2020. A number of future scenarios were developed for each mode. A Freight Expert Panel made up of Wisconsin industry and transportation leaders and a set of subcommittees representing individual modes reviewed the scenarios, databases, and traffic forecasts used in the study. A truck-rail transportation scenario was identified as the most promising freight alternative.

Translinks 21 called for making improvements to the state's rail system to be funded through the creation of a revolving low-interest loan program supported by state bonds with debt service to be paid from the State Transportation Fund. The following types of improvement projects were identified.

- Primary corridor tracks that need to be upgraded so that entire segments operate at the same speed – a key for efficient service.
- Secondary tracks that need to be upgraded in areas that demonstrate a need for improved service levels.
- Track improvements needed to allow for higher speeds within urban areas. This could include consolidating of some lines or closing some rail-highway crossings.
- Operating signal improvements needed to increase rail efficiency.
- Track and bridge upgrades needed to increase the weight capacity of rail corridors that may be required to accommodate heavier car loadings.
- Two active program activities – the preservation of low-volume rail lines and upgrades on rail lines preserved by public ownership – that would continue.

In order to improve intermodal shipments using rail, the following types of improvements were also cited:

- Needed intermodal facility improvements, including terminals, intermodal yards and storage facilities, pulp loading sites and bulk transfer facilities.
- Track improvements needed to accommodate higher-speed intermodal movements.
- Clearance improvements necessary to accommodate doublestack movements.

2.5.2 Performance Models for Specific Types of Services

It is important that public policy be based upon costs and performance for particular locations and types of operations, not upon averages. Simple models of rail costs for intermodal, general merchandise, and bulk service can be used to frame many policy questions; more sophisticated models can be used as necessary. Spreadsheet models can differentiate performance for the major classes of rail service (unit train, general freight, automobiles, chemicals, and intermodal) and of truck operations (truckload, less-than-truckload, drayage, long-haul vs. short-haul, etc.) They can also reflect economies of scale, productivity (of equipment, facilities, and labor), unit costs, and service levels.

The decision-making process is ultimately political, in the best sense of that word. Decisions will require some weighting of financial, environmental, land use, and equity factors. Weighting schemes, which may be helpful in some cases, cannot replace the need for a political decision, since it is seldom possible to agree upon an objective basis for any weighting scheme. The process therefore can build upon two principles: a) assess the entire range of relevant costs and benefits and b) require comparisons to other ways of achieving the same benefits.

A previous section outlined the many types of investments that could be considered as a way to reduce rail/road conflicts, including the following:

- Improved access to intermodal terminals
- Development of new terminals
- Grade separation
- Adding tracks to mainlines
- Adding customer sidings
- Building transfer facilities.

The relevant rail and freight options can be identified for various minor, medium, and major projects. The intent is to give public agencies, carriers, industries, and others a better understanding of what is likely to be important in each type of improvement.

It is important to distinguish among projects that are of purely local significance and those of regional or national significance. Providing sufficient capacity for growth in intermodal traffic is essential for a region – but not for any point within that region. Adding a siding for a customer or eliminating a grade crossing will have local effects; creating a multi-track grade-separated corridor for rail movement through a major rail hub may have national significance.

The guidebook accompanying this report supplies a framework for evaluating rail initiatives, from a scoping analysis to a comprehensive assessment, and for small and large projects. Presented below is a range of other resources that can be used to supplement, or in conjunction with it.

2.5.3 Guidebooks

Overview. There is a plethora of “guides” and “tools” which address various aspects of multi-modal project evaluation, impact analysis and benefit-cost analysis. Some of them provide insight and applications that are potentially applicable for parts of this study, though they are presented in forms that specialize in other types of applications. Some of the guides and tools focus on transit vs. highway planning for passenger travel, without consideration of the special issues associated with rail freight. Others provide sophisticated analytic models that require data not commonly available for rail freight applications.

A useful general reference that specifically treats the interrelation of the freight rail and highway systems is the AASHTO Freight Rail Bottom Line Report, released in 2003. Although designed as a policy document, the report also affords a survey of the function and state of the rail industry, and is rich in graphical illustrations. The policy challenges and choices it poses are helpful as well for framing the issues of public rail investment in a strategic context. A synopsis of the table of contents from the Report, presented below, offers a good overview of its subject matter.

AASHTO Freight-Rail Bottom Line Report
I. Rail's Role in the Intermodal System
The Evolution of the Nation's Freight System
Goods Movement Today
Freight-Rail Services Today
Freight-Rail Benefits Today
The Freight-Rail Business Today
II. Alternative Futures for the Freight-Rail System
Economic and Logistic Drivers of Freight Demand
Freight Forecasts and Transportation System Impacts
Alternative Freight-Rail Growth Scenarios
Assessment of Freight Corridors
III. Creating the 21st Century Freight-Rail System
Choices and Vision
Public-Private Partnership Opportunity
The Bottom Line
IV. Appendices
Private Sector Rail Issues and Challenges
Public Sector Rail Programs
Public-Private Rail Financing Strategies

Among the many other prior studies and reports are these:

- NCHRP 2-23: Update to the AASHTO Redbook
- NCHRP 2-18(4): StratBENCOST
- NCHRP 7-12: Microcomputer Evaluation of Highway User Benefits
- NCHRP 20-29(2): Computer Model for Multimodal, Multicriteria Transportation Investment Analysis
- NCHRP 25-10: “Estimating the Indirect Effects of Proposed Transportation Projects”
- NCHRP 25-19 Guide for Addressing Social and Economic Factors.
- NCHRP Synthesis 302: “Mitigation of Ecological Impacts”
- NCHRP Report 462: “Quantifying Air-Quality and Other Benefits and Costs of Transportation Control Measures”.

Several of these are discussed in the following sub-section to illustrate how guidebooks may differ in terms of the breadth of their concerns and the depth of their coverage.

Examples NCHRP Guidebooks and References. NCHRP Project 25-10 and its continuation 25-10(2) addressed "Estimating the Indirect Effects of Proposed Transportation Projects" and resulted in NCHRP Reports 403 and 466 (The Louis Berger Group, 2002). NCHRP 466, which is called a "desk reference", is structured to serve as training materials for practitioners who must complete environmental impact statements for transportation projects. The 99-page report is divided into 10 course modules, each of which has an overview, a discussion of relevant considerations or methods, a summary, and references:

1. Introduction to Indirect Effects Analysis
2. Review of Case Law on Indirect Effects Evaluation
3. Step 1 – Initial Scoping for Indirect Effects Analysis
4. Step 2 – Identify Study Area Directions and Goals
5. Step 3 – Inventory Notable Features
6. Step 4 – Identify Impact-Causing Activities of the Proposed Action and Alternatives
7. Step 5 – Identify Potentially Significant Indirect Effects for Analysis
8. Step 6 – Analyze Indirect Effects
9. Step 7 – Evaluate Analysis Results
10. Step 8 – Assess the Consequences and Develop Appropriate Mitigation and Enhancement Strategies

A set of slides is published in PDF format as an NCHRP Web Document 43 (available at www4.trb.org/trb/crp.nsf).

The report builds upon surveys of more than 350 government agencies, university researchers, and other groups; it synthesizes regulatory framework, case law, published literature, contents of environmental impact statements; and it provides a typology of indirect effects of transportation projects. The first chapter includes a succinct 5-page literature review; additional references are included at the end of each module. This report offers a concise introduction to an important aspect of transportation planning where three decades of experience offer many potential examples and methodologies. The report benefits form several brief case studies of state programs, thorough categorization of possible effects, listing of data sources, and a well-structured review of planning questions and analytic methods.

NCHRP Synthesis 302 is a more narrowly focused study, as it is concerned with "Mitigation of Ecological Impacts" of transportation projects. The body of the report is only 30 pages, including a chapter on the regulatory framework, ecological impact assessment, and ecological mitigation assessment. There are seven case studies illustrating best practices, e.g. a public-private approach to banking wetlands in North

Carolina and NYDOT's pro-active approach to improving the environment as a normal part of transport projects; 56 pages of documents provide the details on these program. The bibliography includes more than 50 references, including a mix of journal articles and agency reports.

NCHRP Report 462 is concerned with analytical issues related to "Quantifying Air-Quality and Other Benefits and Costs of Transportation Control Measures". Only the body of the study is published in the 61-page report; three appendices, 5 interim reports and three NCHRP Research Results Digests are made available in a CD enclosed with the report. Since this report discusses technical issues related to estimating the effects of TCM on air quality, most of the material relates to modeling approaches and calibration issues. It includes good summary charts showing the range of effects to be considered and the types of TCM strategies that are possible. This report represents an incremental step toward improving analytical techniques within a mature transportation planning environment.

Other Resources. Relevant reports of other agencies include the following:

- Guide to Economic Impact Assessment (TRB Circular 477)
- Handbook for Planners to Maximize Economic Benefits of Highways (Appalachian Regional Commission)
- Guide to Measurement of Highway Impacts (FHWA)
- Guide to Measuring Economic Impacts of Public Transit (APTA)
- Major Corridor Investment-Benefit Analysis System (IN DOT) and others.

The American Railway Engineering and Maintenance-of-way Association publishes an engineering manual that is updated annually. The AREMA manual, in addition to highly technical information, includes some discussion of the types of costs and benefits that should be considered when evaluating various restructuring decisions. Hay (1982) presents the technical information in a far more readable format. Although his text book is now 20 years out-of-date with respect to the details of track and vehicle technology, it still provides a useful introduction to railway engineering concepts.

There are many texts and examples of project evaluation in a transportation systems context. Roberts & Kresge were among the first to show how to use models of cost and service to evaluate multi-modal transportation options. Their study of freight options for Columbia is well-documented, thorough, and accessible. Mannheim (1972) was the first to publish a text for transportation systems planning. Like Roberts & Kresge, he emphasized the use of planning models and the consideration of different perspectives – carrier, public agency, abutters, and the general public. Wilson's text (1980) describes the economic issues associated with freight. A more recent text (Sussman, 2000) provides a contemporary view of transportation systems issues, with chapters that provide general background on rail operations and logistics costs.

Economists and public agencies often use sophisticated econometric analysis in support of public policy decisions. Railroads and consultants are much more apt to use engineering economic models. The econometric approaches are best suited to situations where there is good system-level data for a variety of operations with different characteristics and traffic volumes. Econometric analysis is particularly useful at demonstrating such things as economies of scale, economies of density, elasticities of demand, and other issues that could affect public policy. The engineering economic approach is used when detailed analysis of options for a particular site or a particular movement are being investigated. Braeutigam (1999) reviews various approaches to costing for transportation systems. Button (1985) reviews approaches to costing for railways.

As computers and data sources improve, researchers are trying to link transportation and economic development within a common modeling framework. The basic notion is that economic activity and population will shift in response to changes in the transportation system: producers will seek locations where their costs are lower and people will seek locations where wages are higher. Hence, building a major bridge or upgrading a highway to superhighway status should lead both to lower transport costs and to measurable shifts in economic activity. The theory was summarized by Bröcker (2000) at a conference on ITEM – “integrated transportation and economic modeling”.

2.6 Public-Private Partnerships

Major transportation initiatives almost always involve some kind of public/private initiative. As a minimum, public action is needed to assemble land for rights-of-way and terminals and to authorize the construction of new facilities. Public action may also be needed to specify who will build or operate particular facilities, under what conditions (safety and environmental regulation), at what prices (economic regulation). Public powers of eminent domain and land use control have been necessary to construct both the highway and railway networks, as well as the major airports and seaports. Even when the operations are fully private, there is a legacy of public action that created the infrastructure that the carriers use and a remnant of law and regulation that affects costs, prices, and competition.

Likewise, there is almost always some private involvement in any major transportation endeavor, even if it is just the construction of infrastructure or operating a terminal under a short-term lease or other arrangement. Following are several of the themes affecting these relationships:

1. **Public costs could be an important consideration in freight investments:** railroads and trucking companies ordinarily will invest in equipment and facilities based upon a financial analysis that includes costs and benefits to carriers and their customers. They do not ordinarily consider the effects (good

or bad) of their decisions on congestion, the environment, communities, or regional economic development. Adding in these public benefits could result in different size and location of terminals, different routings of through traffic across cities, higher capacity mainlines, and further rationalization of the rail network in metropolitan areas.

2. **Public investments must be justified in the context of the specific situation:** increases in capacity, changes in network structure, additions of terminals and any other investments must clearly lead to changes in traffic flows or reductions in conflicts. It is possible to spend a small amount of money and achieve significant benefits, just as it is possible to spend a large amount of money without achieving any benefits at all. Also, because railroading is a service, investments in plant have to be protected with competitive operations that are sustained through time.

3. **Criteria for success:** public/private initiatives can be judged to have been successful when a) the public investment or support is sufficient for the private carriers and customers to justify greater use of rail and less use of highway transport, b) the public benefits are sufficient to justify the public portion of the investment, and c) there were no clearly superior means of achieving similar results.

2.6.1 Brief History of Public/Private Relationships with Rail Industry

Land Grants & the Transcontinental Railroads. There are many examples in the US of public-private partnerships for the construction and operation of railroads. The construction of the transcontinental railways are well-known examples, as land grants, loans, and loan guarantees allowed private companies to build networks across the west. Ambrose (2000) has written an enjoyable history of the creation of the first transcontinental railroad from Omaha to Sacramento via Ogden, Utah. Several interesting approaches were used to finance this ambitious project. The railway was authorized to issue bonds with interest payments guaranteed by the federal government in order to raise funds required for construction. As construction proceeded, more bonds could be issued. Land grants were also important to the private companies, as they received what amounted to half of a 20-mile-wide strip along the route of the track (the government owned all of the land in the west and retained ownership of alternate sections of land on either side of the railroad).

It is important to separate the mythology from the history of this project. The railroad companies were caught up in some major financial shenanigans known as the “Credit Mobilier Scandal”, while the land grants are periodically cited by anti-railroad writers as evidence that the railroads have long enjoyed federal subsidies. Even Ambrose is swept up in the wonder of the construction, and devotes very little text to the importance of and ultimate impact of the project. The interest in the building process, the allure of the financing scandals, and the debate over the vast “gifts” to the railroads can overshadow the fundamental fact that an innovative public/private partnership successfully completed a 2000-mile construction project over difficult, largely uncharted terrain within a few years.

Land grants were used extensively during the 19th century to encourage the rapid construction of railroads to enable development of the west. Railroads were given a total of more than 130 million acres, while the government received the right to reduced rates for its freight. Rates charged the government were generally half the rates charged the private sector, a benefit that was used until 1940 for general government traffic and until 1946 for military traffic. Locklin (1966) compared the benefits to the railroads from the land grants and the benefits to the government from reduced rates. Both sets of benefits were large, but Locklin concluded that the value of reduced rates was much greater than the value of the land grants. The government did not “give away” the land, but in fact structured a successful financial incentive for the railroads to construct new lines very rapidly, providing enormous development potential, while delivering as well a fair long term financial benefit to the public.

Other railroads were constructed with public assistance, and the railroads were not shy in the 19th century about in effect blackmailing towns into supporting the construction costs to avoid having the railroad routed through another town. The fact that the funds were provided was indicative of the tremendous development value of having a railroad for transportation as opposed to a horse and buggy. Public involvement was common because the public benefits were so obvious.

Rationalizing, Rehabilitating & Reviving the Railroads in the Late 20th Century. With the invention of the truck and the paving of the highways, railroads lost their dominant position. As described above, the rail industry spent the last three-quarters of the 20th century downsizing and adjusting their network in recognition of the reality of highway and later air competition. The collapse of the Penn Central in 1970 ushered in a new type of public/private cooperation. In its bankruptcy proceedings, PC identified 4 strategic problems that led to its bankruptcy:

- The high costs of light density line operations, the need to sharply reduce the size of the network, and the delays in acquiring permission from the ICC to abandon lines;
- The high costs of labor, based upon both pay scales and restrictive work rules;
- The mounting deficits of passenger operation;
- The sluggish response of the ICC in allowing rate increases to keep up with inflation.

Following extensive studies and public debate, congress structured the process that led to the creation of Conrail as a publicly controlled company. The federal government acquired portions of the bankrupt railroads (several smaller railroads in addition to PC), invested billions in upgrading the equipment and track structure, and covered much of the cost of labor protection, allowing Conrail to reduce its labor force dramatically. During the late 1970s and early 1980s, Conrail made rapid improvements in productivity and eventually achieved profitability. In 1999 it was sold to Norfolk Southern and CSX for a total of $10 billion.

The high costs of saving Conrail led in part to the deregulation of the rail and trucking industries. The notion was that deregulation would allow the railroads greater freedom in rationalizing their networks, more pricing flexibility, and room for marketing and operating initiatives. The federal government did not step in to save the Rock Island, which was dismembered with the best lines sold to other railroads, nor did it create a "Farm Rail" involving the Chicago & Northwestern, the Milwaukee Road, or other troubled lines in the Midwest. Instead, the Staggers Act allowed and encouraged further rail mergers that ultimately produced 4 major systems by the beginning of the 21st century.

Deregulation may not seem like a public/private partnership, but in a certain sense it was. The government changed the rules of the game and the private sector responded with innovations in marketing, operations, and technology. The main dilemma of deregulation is that the fundamental economics of network systems have not changed. When marginal costs are lower than average costs, as they are for most of the rail system, then competitive pressures cause prices to decline and financial problems to mount. A recent study estimated that the US rail industry had achieved productivity gains equivalent to more than $20 billion per year by 1996 – but given almost all of it back to customers in the form of lower prices (Martland, 1999). From a public policy perspective, this is quite a nice deal. From a railroad perspective, it suggests a continuing problem; despite two decades of rapid productivity growth, the industry was little better off than in the 1960s.

State and local governments have also partnered with the railroads in projects such as the following:

- The development of double stack services in New York and Pennsylvania;
- Public ownership of rail rights-of-way in and around Boston;
- Public assistance in improving highway access to ports and intermodal facilities;
- Public assistance to short lines and regional railroads.

There are a number of more recent case studies where private sector freight providers (e.g., railroads, trucking companies, etc.) have worked successfully in partnership with government agencies to fund and implement needed infrastructure or policy/operations changes. The Alameda Corridor Project is perhaps the largest example of a public/private effort devoted to improving freight operations, but there are many other examples of successful projects, including those described in various conferences (e.g. TRB, 1994; Committee on the Intermodal Challenge, 2001; FHWA, 2001).

2.6.2 Intermodal Case Studies – Public/Private Partnerships

In 1994, the Office of Intermodalism and the various modal administrations within the US DOT sponsored a national conference to discuss how to promote intermodalism (TRB, 1996). The conference featured case studies and policy discussions. For freight, the case studies included discussions of the following major projects, all of which involved public/private partnerships. While the conference is now some years past, several of the projects are more recent in implementation, and the report is useful in describing the objectives, institutional arrangements, financing, and elements of a number of interesting initiatives aimed at improving the rail, intermodal, and highway systems.

- Tchoupitoulas Corridor Project, New Orleans, LA: this $63 million project created a freight access road to ports on the Mississippi River, thereby removing approximately 1,500 trucks per day from three truck routes that formerly were routed through residential neighborhoods.

- Full Freight Access Program, New York, NY: this $300 million program involved several types of improvements to the rail system to allow modern rail freight equipment to gain access to the city. The project was coordinated with proposals for bulk transfer facilities, warehouses, and other industrial facilities. The major elements of the program were:
    - Increased clearances between Albany and the South Bronx;
    - Elimination of size & weight restrictions on the equipment able to move over the Long Island Railroad;
    - Acquisition of and increasing clearances on the Bay Ridge branch to allow intermodal traffic to reach the waterfront in Brooklyn;
    - Terminal improvements and construction.

- Doublestack Clearance Project, Pennsylvania: described at greater length in Chapter 2, this $81 million program cleared 163 obstacles in order to allow double stack trains to reach Philadelphia via Conrail from Ohio and via Canadian Pacific from New York State. The Commonwealth and Conrail each contributed nearly 50% of the cost, with CP contributing the rest. The benefits were expected in terms of lower transportation and logistics costs, increased traffic through the Port of Philadelphia, and more than 6,000 direct and 15,000 “spinoff” jobs by 2000.

The conference also highlighted intermodal freight planning activities at the MPO level. These cases all noted that public transportation officials need better education and information concerning freight transportation and intermodalism. Some of the cases identified specific opportunities for public/private actions:

- Capital District Transportation Committee, four counties surrounding Albany, NY: the MPO was beginning to integrate freight concerns into its planning activities. Five initial deficiencies in the intermodal system were identified, two of which related to rail:
    - Railroad grade crossings: there was a need to "dramatically" reduce at-grade crossings, primarily through closing little-used crossings;
    - Clearances and bridge load limits were problems for rail double stack access.
- Puget Sound Freight Mobility Program: this $200,000 per year planning activity was supported by the Puget Sound Regional Council with help from the private-sector Regional Freight Mobility Roundtable
- Northern New Jersey Transportation Planning Authority: a 1993 intermodal coordination study identified various deficiencies in the intermodal system, including the following:
    - Inadequate highway access to marine and rail terminals;
    - Rail access, clearances, and capacity.

Other resources include reports such as NCHRP 2-14: Public/Private Partnerships for Financing Highway Improvements.

2.6.3 Perspective on Public/Private Investments

Given this rather summary review of the nature of public/private relationships in the rail industry, the current interest in public/private investments can be put in a clearer perspective. The country no longer needs or believes in the Conrail approach to rail problems. Conrail required substantial federal investment and, after a number of years, was returned to the private sector – but congress, the industry, and the public all sought easier and cheaper means of supporting the railroads and other transportation companies, namely deregulation and other changes in transportation laws. After two decades of experience with deregulation, there is recognition that a deregulated, profitable, private sector rail industry either will not or cannot play the role that the public wants it to play. At the same time, the rail industry is beginning to realize that it cannot expand in size or profitability without help from governments in adjusting the network and in providing equitable treatment of all modes.

Thus, the opportunity and the need for more limited, more focused private/public partnerships is emerging (Scheib, 2002). Based upon the various cases cited in this section, it is possible to identify barriers that must be overcome and the types of local factors that will help ensure ultimate success for these initiatives. Barriers such as the following must be acknowledged:

1. The railroads do not want the acceptance of public money for a particular project to be used as a reason for future restrictions or taxes on rail activities in the future. They want to discuss projects on a stand-alone basis.

2. Since the railroads are privately owned, some local and state governments are restricted from direct investment.
3. The railroads have a regional or national perspective that is much different from the focus of local agencies; a railroad may be dealing with dozens of states and MPOs, whereas the public agencies are only dealing with a couple of railroads.
4. Rail costs are complex and rail costing is relevant to certain public policy issues, notably track charges related to passenger use of freight lines and freight use of the Northeast Corridor.
5. The scale of and justifications for public investment are much more complex than what is used by railroads; railroads think small, they are extremely concerned with ROI, and they focus on direct operating impacts. Government agencies have very large projects (especially highway) that are justified in terms of broader concepts of economics, environment and equity.

Success factors can also be identified:

1. It helps to have a clear transportation problem where the public and private benefits can easily be understood.
2. A public agency may be able to justify devoting a portion of its transport investment to rail projects, so long as the public benefits are similar to what is obtained from other transport investments. The standard for investment is not what the board of directors would want, but what the City Council and State Legislature would want. Ensuring competitive service, relieving congestion at the waterfront, promoting attractiveness of the region for development may be convincing to the public and to public officials.

2.7 Concluding Observations

There are many examples of projects indicating that it is feasible to justify public/private projects that result in moving more freight by rail, and ample methods available for evaluating them. There are also an increasing number of public investigations into such projects, some but not all of which support investment in rail. Benefits can be found, but the potential for rail with the clearest economies is high volume or long distance shipments, implying that a great volume of truck traffic will remain whatever is carried by rail. Shorter distance opportunities involving heavily concentrated point-to-point or confluent flows, or tapping unconventional technology, might enlarge the railroad potential but are not widely treated in the literature. Either way, it is necessary for planners to choose projects carefully and to assess the potential shifts in traffic flows for particular market segments.

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3 DETAILED CASE STUDIES

This chapter presents in detail a set of case studies exemplifying public initiatives in rail freight, most of them featuring some form of public-private partnership. The goals of the chapter are to show how investments in the rail freight system can alleviate road congestion, and to show the range of the potentially relevant types of situations and solutions where they may apply. Many of the issues and dynamics identified in the Literature Review appear as live elements in the cases presented here, and a number of the projects are current both chronologically and in their fresh approach to problems.

There are nine case illustrations examining freight rail related projects primarily in the US, but including examples from elsewhere in North America and from overseas. The projects are of four types: intercity corridors, urban corridors, metropolitan citywide initiatives, and facilities. Most illustrations treat a single undertaking, but the two that are concerned with facilities consider groups of projects or programs that are centered around a single theme. Half of the examples are connected to ports, which is a reflection of the importance of foreign trade in railroad transportation, and the ability of ports to concentrate freight traffic volumes into trainload quantities. The nine cases are identified by type and motivation in the Exhibit 3-1:

Exhibit 3-1. Types of Case Studies

Project Type	Case Illustration	Motivation
1. Intercity Corridor	1) PA Doublestack Clearance	Port/Regional Competition
	2) VA I-81 Marketing	1st Safety, 2nd Congestion
	3) Betuweroute Freight Line	Port/National Competition
2. Urban Corridor	4) Alameda Corridor	Port Capacity & Competition
	5) Sheffield (KC) Flyover	Hub Capacity
3. Metropolitan Citywide	6) Vancouver Gateway	Gateway Competition
	7) Chicago Rail Futures	Economic Development
4. Facility	8) State Rail Access	Economic Development
	9) Inland Ports	Port/Regional Competition

The focus of the illustrations is on the relevance of each project to the relief of roadway congestion, and the motivations that caused the project to be funded and done. The treatment of each initiative is not necessarily exhaustive and may not dwell on aspects that in other contexts might be regarded as essential, although the main features of all projects are covered with a fair measure of completeness. Each illustration begins with a description of the project or projects, then examines its motivations and relevance to this research. Lastly, the illustrations review the outcomes and lessons that may be drawn from the case for the guidance of planners, often with emphasis on the practical means of implementation. There are variations in the presentation of projects, mainly because of innate differences in their characteristics and status, but presentations adhere to this general format.

It is of pronounced interest that all of the cases considered here create solutions to roadway congestion, but in almost no case was this the primary motivation for the project. The most common impetus in fact was economic development, or the related matters of port or regional competitiveness. Viewed from the perspective of how projects attract political support and financial backing, these illustrations suggest that the economic card is a strong one to play, and can win relief for roadways where a program based on congestion happens not to suffice. Even so, reduction in road congestion formed an important part of project justification in every instance, and crowded roads are linked to the question of competitiveness. Congestion was a particularly resonant issue where the relief was obvious – as in grade crossing improvements – or was bound up with safety perceptions. Finally, as truck volumes continue to grow and capacity strains increasingly turn acute, congestion may drive more projects, because of the logistical effect on economic performance, and public frustration with deteriorating highway levels of service.

Case Illustration 1: Pennsylvania Double Stack Clearances

Type: Intercity Corridor

The Project [2]

The decade of the 1980's had not been kind to the Port of Philadelphia. While ports across the country were experiencing vigorous growth as international traffic soared, Philadelphia's share of the Delaware River cargo fell from 70 percent in 1980 and to only 42 percent in 1987. The drop in port activity resulted in a loss of high-paying longshoreman's jobs at a rate of six percent per year during that same period.

Efforts to diversify the Port's leadership position as the nation's leading temperature sensitive cargo port[3] had been successful for several "dry" breakbulk commodities such as paper, steel and cocoa beans. Container traffic however, was declining at an alarming rate, idling significant portions of the Tioga and Packer Avenue Marine Terminals.

The Philadelphia Port Corporation's Strategic Business Plan of that period suggested that the Port continue to focus on break bulk cargo – a sector that represented nearly

60% of the Port’s current traffic volume. Opportunities in higher margin traffic, such as long distance international containers and imported motor vehicle would be limited, inasmuch as the regional transportation infrastructure could not accommodate the more efficient double stack containers and multi-level auto racks currently *de rigueur* in the rail industry, and available to several competing ports along the Eastern Seaboard.

Dissatisfied with a future in which Philadelphia’s role as an international cargo destination could be marginalized, the City, State and Port officials undertook a series of bold initiatives to modernize port and regional transportation facilities, and to position Philadelphia to compete with Baltimore, Norfolk and Yew York.

But while the modernization of port facilities and highway connectors was wholly within the control of the state government and port agencies, the regional rail infrastructure was not. Without needed improvements to railroad clearances, the value of the other modernization programs could be lost. Hence the Port of Philadelphia and the Commonwealth of Pennsylvania approached Conrail to outline their vision for the future and to solicit their support – both financial and tactical – to facilitate change. Conrail at the time was the leading provider of Class I rail freight services to the state.

Critical to the public sector coalition’s success with private sector Conrail was the assurance that the clearance investments would not upset the balance of traffic currently enjoyed by the railroad. Similarly, the Canadian Pacific railroad, and an international shipper of dimensional cargo who was one of the Commonwealth’s major employers, sought to improve their competitive position through direct investment in the project.

Ultimately, the $100+ million investment for the Pennsylvania Double Stack Clearance Program was shared among state and local governments, regional port agencies, railroads, and a major shipper. The funding formulas used on the project sought to allocate public funds to common use improvements. In such areas, the State’s matching funds comprised as much as 50 percent of the total. For restricted use segments, Conrail provided the majority of funding, up to 100 percent in many places. Of the total investment, the State provided approximately 38%, Conrail 60%, and the balance was made up from local sources and state-sponsored bonds.

Between 1992 and 1995, the Pennsylvania Department of Transportation (PennDOT) coordinated the work of the railroads and numerous contractors, who “cleared” 163 obstacles (undercutting rail rights-of-way and raising vertical clearances on railroad signal bridges and tunnels, and highway and township road bridges) on Conrail's east-west operating route from the Ohio border to the Port of Philadelphia, and Canadian Pacific's north-south operating route (a portion of which was over Conrail tracks) from the New York border to the Port of Philadelphia. In addition, the project improved horizontal clearances in order to accommodate dimensional movements from Wilkes-Barre to the Port of Philadelphia[4].

The project brought about a variety of benefits in three primary areas:

- *Reduced Shipping Costs & Improved Service* – The improved clearances provided both the commercial incentive and the operating efficiency for Conrail and Canadian Pacific to provide improved service and lower rates to the region's shippers. Although Conrail, as the rail dominant carrier in the region, sought to maintain the existing competitive balance, several commercial and operational concessions were required to achieve the desired public benefits. In a few circumstances, the clearance improvements provided a viable competitive rail alternative where none had previously existed.

- *Competitive Positioning for the Port of Philadelphia* – Clearance improvements for the east-west and north-south routes helped Philadelphia recapture some dimensional traffic lost to other Mid-Atlantic ports, and connected the Port to the national double stack network for inland distribution of international cargo.

- *Improved Economic Development Opportunities* – The clearance program helped Pennsylvania capture a significant amount of regional economic growth. While the National Highway System has long favored Central and Eastern Pennsylvania as an ideal location for manufacturing and distribution activities, the lower cost of double stack intermodal service served to enhance the attractiveness of the region, such that the rate of growth in trucking and warehousing employment more than doubled in years following the completion of the Clearance Project[5].

Relevance

The Pennsylvania Clearance Project is a moderate-scale intercity corridor project that improved the competitiveness of the region's industrial base, and of the Commonwealth's primary distribution and international port facilities. Its stimulus to the development of intermodal freight services diverted traffic from the highways of the host state and its neighbors, and strengthened the national intermodal network. The project is an instructive example of public-private partnership, and at the time of its inception, it was considered a radical departure from traditional railroad – state relationships. Railroads had eschewed public monies fearing an unending demand for commercial and operational concessions. States conversely, had viewed the railroads as obstructionists to economic development and competitive diversity. The successful implementation of the Pennsylvania Clearance Project proved both hypotheses incorrect, and provided a model for future public-private cooperation for rail investment.

From the public sector perspective, the perceived benefits included the following:

- *Preservation of High-Paying Jobs Associated with the Port of Philadelphia* – These included the direct employment jobs at the Port, and the indirect employment of Port related activities.

- *Preservation of Port Competitiveness* – The prospect of improved operating efficiency for the railroad was expected to result in "lower transportation costs for businesses and, ultimately, lower prices for consumers."[6]

- *Highway Traffic Diversion* – Absent the completion of the Pennsylvania Clearance Project, the growth of rail intermodal activities in Pennsylvania were stifled. Two relatively untapped markets prior to the clearance work blossomed following its completion:

  - International containers moving into Pennsylvania and Maryland from the West Coast. The movement of international containers to Pennsylvania and Maryland had previously been accomplished through long-haul drays from railroad terminals in Ohio and Illinois. The completion of the Double Stack Program permitted these containers to move to Harrisburg and Philadelphia respectively, substituting rail movement from highway drayage.

  - Intermodal traffic to and from the Pittsburgh market. The ability to run double stack trains to New York and Philadelphia through Pennsylvania provided the needed critical mass to make serving the Pittsburgh region with rail intermodal service economical. The NS Terminal in Pitcairn, PA (former Conrail) brought long-absent premium intermodal service back to the region.

Motivation

The motivation for the Pennsylvania Double Stack Clearance project can be thought of in terms of the combined effect of opportunity and risk. While the potential for regional and commercial economic benefit was clear to all parties, the public sector officials also recognized the risk of economic harm to their constituents that could result from inaction. Relief to highways was a useful by-product of the initiative, but it was founded on considerations of economic development and preservation.

For Philadelphia, the Port represents a significant factor in the regional economy. The Port employs approximately 3,500 persons directly, and supports an additional 10,000 area jobs in the service, retail, and financial sectors. These jobs provide the region with some $16 million City and State revenues including wage, sales and income taxes[7]. But while the decade of the 1980s saw modernization investments in excess of $250 million by competing ports like Baltimore, New York and Norfolk, Philadelphia's investment was less than $10 million[8]. The Port recognized that without an aggressive investment program, the economic vitality of the region was at risk.

The Pennsylvania Legislature saw the issue in terms of its potential to enhance economic development across the Commonwealth, and to promote industrial development among high-tech industries that rely heavily on imported components from Asia. The legislature commissioned a study by PennDOT that concluded that such benefits could indeed be achieved through the completion of the Double Stack Program.

Conrail recognized the potential of the double stack clearances to improve their competitive position vis-à-vis motor carriers moving manufactured goods into the Mid-Atlantic region. The opportunity to operate stacked containers and fully enclosed multi-level auto carriers would reduce the effective cost of providing transportation, and provide improved cargo handling.

The fortunate alignment of these strategies, and the common urgency of timing resulted in a cooperative venture that succeeded in helping each of the participants achieve their strategic goals. While there was clearly compromise along the way to victory, the parties recognized that the no single issue was worth the loss of the whole project.

Lessons & Outcomes

The Pennsylvania Double Stack Clearance Program has been operating for approximately ten years as of this writing. In addition to its intended benefits, it has produced significant additional benefit to the Commonwealth, and indeed the entire eastern seaboard. It has produced outcomes of interest to this study through its performance and through the implementation of a successful public-private partnership.

Performance

The Pennsylvania Clearance program created a powerful economic development tool for the Commonwealth and for the railroads. At its peak, the Pennsylvania double stack corridor handled approximately ten trains of excess height equipment daily, most of them stack trains laden with 150 or more containers. The hoped-for economic development continues to be realized Lower costs to shippers have solidified Pennsylvania’s position as an East-Coast manufacturing and distribution hub. In recent years, three cities along the Pennsylvania Double Stack Clearance Route have been among the 50 fastest growing manufacturing regions in the nation. These include No. 19: Pittsburgh, No. 26: Allentown-Bethlehem-Easton, and No. 46: Harrisburg-Lebanon-Carlisle[9].

Since their takeover of Conrail, Norfolk Southern and CSXT sought to leverage the benefits of the Pennsylvania Clearance program by expanding the number of cleared routes and the capacity of intermodal terminals along the routes, and by further promoting economic development in the region. The creation of new and the expansion of existing manufacturing and distribution centers is a testament to the foresight of those involved in this project.

In addition, the Clearance Program has generated significant environmental and congestion benefits, transferring a significant portion of long-haul motor carriage to rail intermodal movement. Intermodal traffic growth along the corridor served by the clearance program exceeded the average for the rest of the eastern network, and that growth came quickly. Within the first few months of operation, intermodal loadings increased 10%[10].

Implementation

Part of the importance of the Pennsylvania Double Stack Clearance Project is that it was an early success in the movement towards public-private partnerships, and that it signaled a fundamental shift in the willingness of railroads to accept public funding for infrastructure improvements. Several of the factors that brought this about may be instructive for other rail projects.

- The funding program sought to leverage private capital to accelerate and magnify potential benefits. While a Pennsylvania clearance program might have existed in some fashion absent public-sector involvement, the urgency of timing, and the desire to promote specific economic development opportunities prompted the Commonwealth to initiate a joint-venture development with the railroad.

- Railroad cooperation in the project was negotiated carefully. Conrail as the dominant railroad in the region was unwilling to accept the creation of a state-subsidized competitor through the project. Because this project represented a significant departure from traditional public sector dealings with the railroad, some additional points should be recognized:

  – While the commercial and operational demands of the marketplace were already pressuring Conrail to invest in clearances, the railroad feared that public sector investment would require unreasonable commercial compromise. To avoid the introduction of subsidized competitors, Conrail negotiated investment-matching formulas that served as a threshold for access. Other railroads – if unwilling to commit financial resources to the project – would largely be denied the benefits of the program.

  – The Commonwealth, by negotiating adroitly with the railroad as to the routes to be cleared and the type of access to be provided, was able to divine a solution acceptable to Conrail and ultimately to all parties. PennDOT resisted the temptation to use this initiative as a forum to resolve all outstanding issues between the railroad and the State. By not overreaching the scope of the project, PennDOT earned the trust of the railroad, and opened the door for additional ventures.

- Community support was founded on minimizing the detrimental impact of the construction. Three distinct efforts helped mitigate community backlash:

- The participants made a significant effort to preserve the historical character of the improvements. Even in rural areas, concrete tunnel facings were carved to resemble the original cut-stonework, and historic bridges were undercut or raised rather than replaced wherever possible.

- Aiding community acceptance was the smooth handling of problems and concerns during the most controversial portions of the project. Rock blasting in two tunnels located beneath suburban Philadelphia communities caused numerous broken windows, cracked walls, and smashed household items. This incidental damage was handled quickly, and special call-in numbers were provided to insure prompt and appropriate settlements.

- Through the close coordination of several PennDOT agencies, many communities benefited through the acceleration of bridge replacements and repairs associated with the corridor improvements[11].

Beyond its originally identified goals, the project provided a second cleared access route from the Midwest to the New York Market. This provided Conrail with significantly greater operating flexibility, and ultimately permitted the successful division of Conrail assets to Norfolk Southern and CSX. Shippers in the east continue to reap the rewards of the Clearance Program through lower rates, and industrial development in the region continues to flourish. For the Port however, the competitive advantages brought about by the program may be more difficult to sustain. The port of Norfolk is an unintended beneficiary of the Clearance Project with some trains to the Midwest moving across Pennsylvania to that region.[12] Similarly, competing ports in Wilmington and Baltimore are both seeking to obtain access to the national double stack network through the Pennsylvania clearances. In many ways, the completion of the Pennsylvania Double Stack Clearance project continues to provide benefits far in excess of its anticipated results, and far beyond the region it serves.

Case Illustration 2:
Virginia I-81 Marketing Study

Type: Intercity Corridor

The Project [13]

The Virginia Interstate 81 Marketing Study examined the potential for new railroad freight services to attract truck traffic from Commonwealth highways, for the alleviation of roadway congestion and improvement of safety. The project employed primary market research, competitive and operational analysis, diversion modeling with traffic data, and cooperative planning with railroad officials to establish the product features and attendant costs and investments that would be required to shift varying levels of highway volume to rail. Earlier studies had determined that the direct benefits of freight modal diversion along I-81 were significant, and included improvements in highway user, safety, and pavement maintenance costs, as well as in air quality. While formally concerned with a complex of roads that included I-95, the project chiefly focused on Interstate 81 and the practical means to produce direct benefits in that corridor. The Virginia Department of Rail and Public Transportation undertook the work at the direction of the Commonwealth legislature, with financial support from the Tennessee Department of Transportation and the Federal Railroad Administration, and in-kind support from the Norfolk Southern Railroad.

The evaluation concluded that an efficient and frequent intermodal service in the corridor could divert up to 3 million trucks annually, or approximately 30% of the projected truck traffic in 2020. It further determined that the investment in infrastructure and equipment required to effect such a diversion was between $7 and $8 billion, and identified the location and timing of the proposed expenditures. This evaluation then became a catalyst for three forms of action: a) Commonwealth of Virginia initiatives to seek federal monies for both rail and highway improvements; b) organization of a multi-state I-81 corridor coalition to examine, coordinate, and pursue funding for such improvements; and c) investments by Norfolk Southern in new services consistent with the long-term opportunities identified in the project.

The study has three core elements:

- *Interviews & Surveys* - Primary market research was conducted among the freight users of the Virginia highway corridors. These fell in two general categories: shippers whose goods traveled in Virginia on their way to market, and truck lines who served such shippers. Each made decisions that caused traffic to move by highway and could cause it to move by rail. Shippers did this by their selection of carriers, and truck lines by their choice to perform or purchase linehaul transportation. Decision-makers were identified and questioned about the potential for their use of rail intermodal services, and the performance characteristics required to attract their business.

- *Scenario Development* - Based on the findings from interviews and surveys, and on traffic flow data and the experience of railroad officials, a series of alternative railroad service designs were prepared. These designs included the introduction of new services and technology, and were associated with improvements to facilities and structures that would support higher quality operations. These improvements were calculated to raise railroad performance to levels sufficient for the diversion of traffic from highways. The location, timing, and capital requirements of specific improvements were developed, and their effects were summarized according to whether Virginia acted alone to invest in facilities within its borders, or had cooperation for investments in other states along the corridor.

- *Diversion Analysis* - Scenarios were translated into intermodal cost and service characteristics, for individual origin/destination traffic lanes that contributed to truck volume on Virginia highways. These performance characteristics were compared to those competitively available from all-highway operations, and lane by lane modal diversions were estimated. Freight volumes were evaluated with respect to four major characteristics that influence its divertibility. These were (1) the origin, destination, and routing of traffic in relationship to serving facilities; (2) the density of traffic in lanes and operating paths; (3) the commodity and equipment mix; and (4) the distance traveled door to door. The determination of diversion amounts was accomplished by use of a cross-elasticity model, informed and supported by the findings from interviews and surveys.

The key dynamic in the traffic diversion analysis was public investment that allowed the introduction of new intermodal trains, raised their performance characteristics, and reduced their cost of operation to the point where it could shift the competitive modal balance. Funding of infrastructure improvements was the main form of investment considered, particularly through the upgrading of right of way, and also through the expansion or new development of terminals. The outline and potential from improvements was explored in the development and testing of operational scenarios, and the performance effect and influence on diversion from specific project elements were evaluated in the last stage of the study.

Relevance

The I-81 Marketing Study evaluated a major inter-city corridor for the direct purpose of roadway traffic relief through investment in freight railways. The public projects it pointed to and could impel would be multi-million dollar alternatives to interstate highway spending - not eliminating but probably reducing such spending, and certainly providing additional freight system capacity in a railroad right of way that is naturally segregated from automobile traffic. While the study itself was small in comparison to engineering projects and dealt with prospective analysis instead of accomplished facts, it was substantial as a piece of research and encountered a number of common or important issues in the utilization of rail for highway assistance:

- New rail services considered in this study were exclusively intermodal, because of a joint judgment that carload services could not capture enough traffic to be meaningful for congestion mitigation. This judgment reflected the scale of the project's objective, which was to produce material changes in statewide and multi-state corridor traffic. In less ambitious circumstances, local planners might feel that carload alternatives are sufficiently productive for their smaller geographic area, and for railroads, added carload business normally is attractive if there is capacity for it.

- Deployment of alternative intermodal technology had an important role in the project, for two reasons. First, it extended the reach of rail services beyond the dry van equipment types and long lengths of haul to which they conventionally appeal. Second, it established competitive service for domestic highway trailers, which accounted for the majority of truck volume on I-81 (and on most roadways), but are a declining portion of intermodal traffic. Expressway-style technology[14] in particular proved useful, through its accommodation of flatbed and tank trailer equipment, and its effectiveness for domestic traffic at distances dropping toward 300 miles.

- Lack of alignment between railroad capital priorities and public preference stood out as a clear challenge. Virginia's interest was in parallel rail services to compete with North-South highways. Nevertheless, one railroad had withdrawn North-South service, not because it was unprofitable or unsuccessful, but because it paid less well than East-West services that used the same terminals - and the railroad regarded terminal capacity as fixed. Similarly, the Commonwealth was interested in short as well as long haul services, to more thoroughly erode the traffic volume on highways. However, short haul business had limited attraction for the area's railroads, because profit margins were thinner than for long haul business the carriers had yet to convert - and because railroad capacity was limited, and internal hurdle rates for investment were high. The fundamental problem was that railroads were allocating resources under capacity and capital constraints, and did not utilize public benefits in determining resource priorities. When public resources were introduced to this determination, it raised the priority of public interests.

- Looking toward implementation of investments, Virginia like many states needed to seek regional cooperation, not only between the Commonwealth and its neighbors, but also between the states and their municipalities. This was especially true in regard to terminals and their drayage services, whose location and operation were crucial to the intermodal product and were the dominant component in shorter distance lanes. Sixty percent of Virginia highway traffic began and/or ended its trip outside its borders, rendering Virginia and a number of other states interdependent for intermodal end-point service. This implied as well that the construction Virginia could initiate within its own jurisdiction produced a shared benefit, through the reduction of highway volumes for neighbors. Interdependence and shared benefits constituted an argument for coordinated action and contribution, and led the Commonwealth and its rail partner to a dual strategy: a) identify improvements that could be undertaken independently, and still conform to the larger strategic objectives of the project; and b) form a multi-state coalition to respond to joint, multimodal needs and opportunities. Both arms of this strategy began to be pursued.

Motivation

The I-81 Marketing Study was an intercity corridor project aimed at the reduction of truck volume and improvement of safety on interstate highways, and it could act as a precursor to publicly-backed railway construction for this purpose. It was commissioned as an outgrowth of directives from the Commonwealth legislature, who in two resolutions called for examination of "the potential for shifting Virginia's highway traffic to railroads" through alternative investments in rail facilities. The study had three motivations, as expressed particularly in the resolutions HJR-704 and SJR-55:

- *Safety* – Improvement to highway safety was probably the core political impetus for the study, and was the central theme of SJR-55. The design standard for I-81 allowed for trucks at a maximum of 15% of total vehicle traffic. Truck activity in fact reached 15% during the morning and afternoon peaks, climbed to 20% during the day, and approached 50% overnight.[15] Nearly 30% of Virginia truck volume originated and terminated outside its borders, so a significant subset of I-81 commercial traffic traveled the full length of the state while having little economic connection to the Commonwealth. Finally, the highway itself lay in rolling, often rural terrain. As a result, the common experience of Virginians traveling I-81 was that of being surrounded by large, heavy trucks on dark, hilly roads, with the inevitable consequence that the automobile driver felt unsafe regardless of the actual performance of the trucks. Accidents involving commercial vehicles were said to generate strong local sentiments, presumably because they resonated with this experience, and the weak economic bond of the trucking activity with the community allowed hostility to grow. It is noteworthy that the legislature cited truck volume and not accident statistics in its call to boost safety by removing highway traffic to rail, thereby perhaps recognizing the real source of public support.

- *Congestion* – Relief to highway congestion is a second stated purpose of the study. The legislature cited the effectiveness of intermodal terminals for eliminating trucks from overcrowded highways in eastern Virginia, and sought to extend this benefit to I-81. This was the main theme of HJR-704, and it was echoed in the later SJR-55, with its wish to "alleviate excessive volumes of traffic on Interstate Route 81". Read narrowly, there was no explicit claim in the resolutions that I-81 was an overcrowded interstate – which compared to the more urban and easterly I-95 it was not as yet. Rather, the legislature's emphasis was on the quantity of truck activity per se, because it contributed to such traffic slowdowns as existed, influenced capacity requirements, and shaped perceptions of safety. However, and more broadly, forecasts of congestion were very much part of the picture for state planning agencies responding to the legislature's direction. For these officials, the federal projection of 90% growth in I-81 truck volume by 2020 was a concern specifically for its effect on capacity and congestion, as well as on safety. The planning agencies accordingly pointed to "the critical need to address the existing and future safety and congestion problems on Virginia's highways" in their statement of the study's rationale.

- *Alternative Investment* – Railroads as an additional option for the public provision of overland freight capacity, with an expense profile and implementation schedule that was different from highway investment, formed the third motivation for the study. The legislature in SJR-55 took note of the multi-billion dollar cost and decade-long development required for widening of Interstate 81, and put forward railroad investment for investigation as a shorter term solution.[16]

Another set of motivations were those of the Norfolk Southern railroad, who was a willing partner to the study. The I-81 Corridor was an underdeveloped intermodal market for a variety of historical reasons, and offered large opportunities for rail market share growth with conventional long haul services. As one point of comparison, intermodal market share in the lane between Harrisburg, PA and Atlanta, GA was 5%, versus 40% in the Harrisburg-Chicago lane of similar distance.[17] In addition, the eastern coal business that for generations had been the traffic baseload for Norfolk Southern railroads had gone into decline, and intermodal business built with highway diversions was the only likely replacement. However, additional north-south train services required capacity additions the railroad could not finance on its own, some of it affecting right of way with a meandering, 19th Century configuration, or traversing countryside whose citizens resisted development. While hard issues of resource prioritization made some and not all of the I-81 truck traffic attractive to Norfolk Southern, those priorities could be transformed by public investment. The strategic motivation for Norfolk Southern cooperation in the project was its need to construct a new traffic baseload on a reformed network, calling on new forms of financing to remove the constraints to growth, and to assure a future for its railroad.

4. Lessons & Outcomes

The I-81 Marketing Study produced useful results and approaches. Interviews with shippers and truck lines yielded typical but valuable outcomes, with service reliability, cost of transportation, and transit time predictably named as the key criteria in selecting or changing modes. Railroad performance was acknowledged as less costly yet inadequate in speed and reliability, and the position of the I-81 corridor as under-served in the intermodal system was highlighted. While buyers were willing to trade service for lower cost to an extent, they were not willing to pay more for superior service – although framed as a comparison of intermodal with over-the-road performance; it is not likely that respondents took superior service as a credible option. What did seem clear was that better service required less of a cost discount, and competitive service joined with significant cost reduction probably became a compelling option.

Transit time was less flexible for motor carriers, who were concerned for the utilization of their assets and had made time commitments to their customers; for them, second rate transit pushed rail into a backup role, or out of their picture entirely. Finally, although shippers of the most time sensitive goods claimed to be more willing than others to switch carriers for the sake of small improvements in on-time percentage performance, most respondents utilized somewhat imprecise methods of performance measurement in any case. The consequence was that on-time improvements in the five to ten point range tended to be required in order to be noticeable or material.

Diversion estimates indicated that 700,000 trucks could be taken annually from the I-81 corridor in Virginia in the medium term, or about 14% of its total truck traffic.[18] In the long term, diversions could rise to 3 million trucks annually, or 30% of corridor truck traffic. This represented medium term diversion of one in seven trucks, and long term diversion of one in three. While these proportions were large enough to be meaningful for safety and congestion management, truck growth still was expected to continue on the corridor due to the general increase in commerce. However, because rail would be able to absorb sixty percent of new truck traffic, it could prevent I-81 from becoming more of a truck-dominated highway route than it already was, and this could appeal to citizens concerned about sharing the road with these larger vehicles.

Several strategies were employed to drive up the rate of diversion:

- *Segmentation* – A range of services was utilized to appeal differentially to distinct segments in the market. Through such a combination of appeals, a greater portion of the highway volume could be put into play. The services varied by rail equipment types and their associated terminal requirements, and often called for separate trains. Conventional stack trains were aimed at international trade and such business as that of the Intermodal Marketing Companies (IMCs) that could use domestic containers. Standard TOFC equipment addressed IMCs and truck lines who depend on rail trailers, or who had outfitted their trailer fleets for intermodal lift. Expressway-style service targeted the great majority of motor carriers and their customers who rely on unmodified equipment or non-van trailers, among them the private fleets. This service also shortened the lane distance that could be competed for domestically. A fourth service identified but not adopted in the study was the rolling highway configuration operating in some parts of Europe, where the tractor and driver accompany the trailer on the train. The market segment for which this could appeal consisted of the small truck lines and independent contractors (“owner/operators”) who have no driver or power to meet up with a load they forward by rail. For this group, the train functions as a kind of moving truck stop.

- *Product Strategy* – Rail product design is central to its competitiveness and therefore its capability to divert traffic. The design for the I-81 study stressed speed, frequency, and reliability in order to offer a product that was fully the equivalent of single driver, over-the-road service, and not an inferior good. Its central focus was an appeal to a motor carrier clientele, because of the belief that market penetration may be achieved more rapidly by this route, and because the door-to-door integrity of the product may be stronger and therefore satisfy shippers more fully.

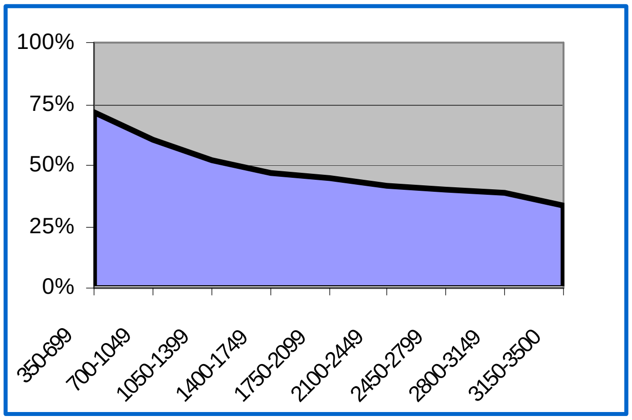
Exhibit 3-2. Interstate 81 Through Virginia Millions of Annual Trucks

The product featured trailer service, particularly through use of Expressway-style technology, due to the versatility of that equipment, and its ability to accommodate trailers just as they are on the highway. This was a very substantial point, since it removed a capital investment requirement for truck lines to move their own equipment by rail, allowed their fleets to remain uniform and retain the efficiency of interchangeability, and reduced (but did not eradicate) the costly problem of trailer imbalance. This kind of equipment also lent itself well to the attraction of confluent volume, in which travel routes from multiple points converge for a time over a section of highway, and then diverge again. These routes are evident in the corridor network for I-81, displayed in Exhibit 3-1.

Trainload volumes could be composed between terminals peripheral to Virginia to divert its through traffic, utilizing long dray stems with low circuity, without necessarily providing terminal service directly to origins and destinations. The flexibility of Expressway-style technology made this kind of long stem service feasible, and it already existed in Canada.

Short Haul Features – The rapidity and low cost of terminal transfers in Expressway-style service also rendered it effective for the high volume, shorter haul traffic, whose capture would raise the productivity of railway alternatives to road investments. Coupled with this was the appeal of the service design to large network motor carriers, through its use of frequent trailer service and transit speeds equivalent to the performance of single-driver trucks. These carriers could provide superior pickup and delivery service, due to the presence of operating assets in virtually all important market areas, and their high degree of control over them. For those with irregular route structures, the ability to balance equipment without return trips drove down drayage costs. The combined factors of terminal lift and dray expenses approached three quarters of the total cost of intermodal operation at shorter distances (see Exhibit 3-2), making the combined influence of Expressway-style service for network carriers a strategic solution for the shorter lengths of haul. Lastly and as a policy option, public allowances that supported drayage service and reduced its cost could be added to aid the viability and penetration of rail. Rebates of the fuel taxes or tolls paid by these trucks were two of the possibilities – and here again, cooperative agreements between Virginia and its neighboring states could be effective, because drayage normally is tied to an interstate rail shipment.

Exhibit 3-2. Dray and Lift Share of Total Cost by Mile Block



Network Strategy – The introduction of highway competitive north/south rail service added a critical link to the national intermodal system, by completing a network circuit in the east that was vital for equipment repositioning. Once large motor carriers could duplicate on the intermodal network the fleet balance economy they achieved on the highway, their use of rail was apt to rise and their cost competitiveness to climb. This had a second order influence on road diversions, because the large network truck line with a low cost structure could win business away from less efficient operators, or cause them to convert to intermodal.

The Virginia I-81 Marketing Study made clear that meaningful relief to highway freight volumes in intercity corridors is possible with rail service, and indicated some of the ways it could be brought about. I-81 in Virginia had certain advantages of location that tended to funnel traffic over sustained distances, but the lessons of the study are generally transferable. The adoption of a portfolio of products to address distinct market segments, frequent service that rises fully to over-the-road standards, and network and technology strategies to deepen penetration and produce systematic effects will be fruitful approaches for highway corridors in many quarters of the country.

Case Illustration 3:
The Betuweroute Freight Line: Netherlands

Type: Intercity Corridor

The Project

The Betuweroute rail freight Line (BRL) is a 160 km, € 4.55 billion (US $5.1 billion) undertaking that will run from the port of Rotterdam in the Netherlands to the German border, linking with the German rail network to continue south to the economic centers of the Rhine/Ruhr region. (See Exhibits 3-3 and 3-4.) From there, connecting lines run to Eastern Europe and through Switzerland to the Italian commercial centers of Milan and Bologna. Scheduled for completion by 2006, the BRL includes five tunnels with a total length of 18km and 130 bridges and viaducts with a total length of 12 km. All tunnels are being built to accommodate double stack trains. The implementation of the new European Rail Traffic Management System and European Train Control System (ERTMS/ETCS) for communications between trains and traffic control on BRL will allow the trains to travel at a speed of 120km/h with up to ten trains per hour in each direction. At this writing, this is the largest freight-only rail project under construction in Europe, although a number of other large rail infrastructure projects with significant freight elements are underway or planned.

Exhibit 3-3 Map of Betuwe Route for Rail Freight

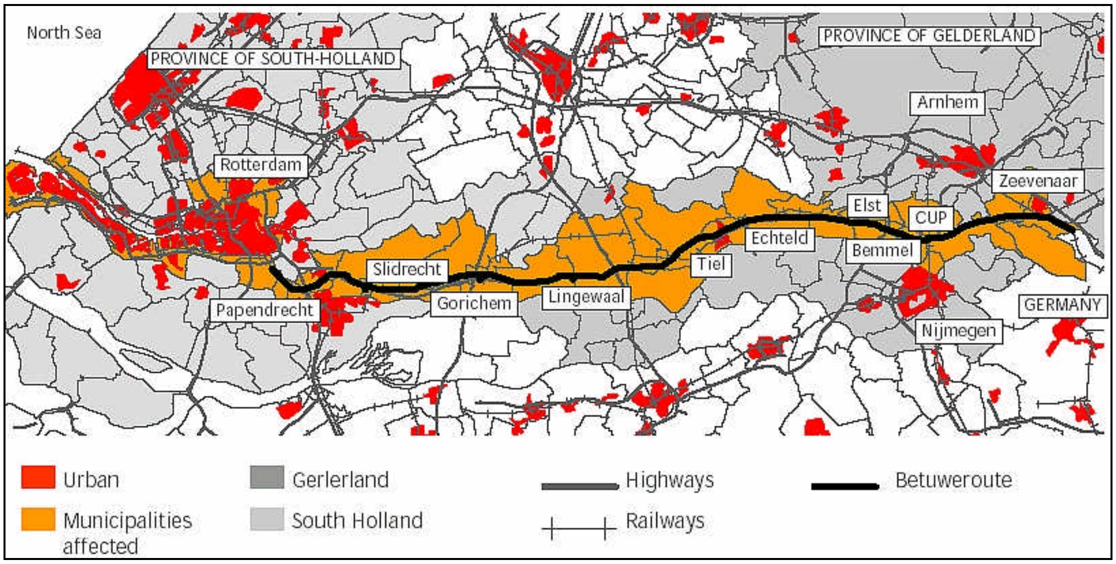


Exhibit 3-4 Photo of Betuwe Route Parallel to a Roadway

The Betuweroute project is made up of two sections: (1) a 48 km railway line between the port of Rotterdam and the Kijfhoek switching yard, and (2) a 112 km connection linking the switching yard and the Emmerich-Oberhausen rail line in Germany. Thirty-five km of the first section involves reconstruction of the existing port railway, with the remaining 13 km entailing construction along new alignments. The second section entails construction of a brand new alignment, of which 95 km is along the existing A15 expressway. The port railway line is designed to provide an efficient rail connection between the seaport and Kijfhoek, a major rail freight hub near the port that provides access to the European rail network. The 112km connection to Germany provides speedy and efficient access to the port's most important hinterlands in Germany and southern Europe. Rail traffic from the port is already substantial – in 2001 around 270 container block trains connected Rotterdam with thirty destinations on a weekly basis.

When construction commenced in 1999, the entire project was planned for completion in 2006. The reconstruction of the existing port railway segment was to be finished first in 2003 with the remaining sections completed around 2006. The project is quite complex, involving not only extensive tunnel and bridge construction, but also adoption of a new-to-the-Netherlands electrification technology (25kv AC instead 1.5kv DC), and the new ERTMS/ECTS, which has only seen limited adoption thus far.

The BRL line is being built by the Betuweroute Project Organization, a cooperation of the Dutch Ministry of Transport's Directorate-General of Freight Transport and NS Railinfrabeheer railroad, which is part of Nederlandse Spoorwegen NV (Dutch Railways) – the rail operating company working for (and under the responsibility of) the national government. NS Railinfrabeheer is charged with ensuring the construction and maintenance of existing and new rail tracks. The Betuweroute Management Group within NS Railinfrabeheer is responsible for construction of the BTR and acts as a contractor and client for the line.

The BRL is funded by the government of the Netherlands, along with some assistance from the European Commission (EC). Germany is funding connector rail improvements in that country. The idea of public private partnerships (PPPs) is a new concept that was not even feasible until changes in Dutch government policy were enacted after the year 2000. However, upon completion it is anticipated that the BRL will be managed by a private organization that will aggressively market the BRL to any qualified train operating company. At this writing, several private freight operators are certified to operate in the Netherlands. By the time that the project is completed, all of the EC rail network should be accessible in a non-discriminatory manner to train operating companies that meet the necessary requirements specified by the EC and the infrastructure providers.

Relevance & Motivation

The Betuweroute is a large-scale intercity corridor designed to expand freight rail capacity and protect the competitive trade position of the Netherlands and its major port. The European Commission appointed the BRL as one of the 14 priority infrastructure projects in Europe. This is one of a series of rail freight projects being supported by the EC as part of its effort to discourage road haulage in favor of rail freight across Europe. As such, the Betuweroute is expected to reduce roadway congestion and yield environmental benefits, which are prominent policy goals of the EC. The BRL line forms a critical link in the European Union Trans European Network (TEN) for railways, and will also link up to the system of Trans European Rail Freight Freeways (TERFFs). It is therefore a network-level investment whose systemic effects would multiply its policy benefits beyond the local area. However, the driving motivation for the project lies in its economic influence on the Netherlands.

The existing railway lines in the Netherlands are primarily used for transport of passengers with only modest use for freight. Over time, changes in the logistics supply chain have led to increasingly flexible, diverse, rapid, and more customized transport systems of frequent small shipments. As a result, the use of road transport has increased by more than 30% between 1980 and 1991 and accounts for about 70% of all freight transport activity in the nation. In recent years, rail has accounted for only 8% of transport output in the EC member countries - a very modest share. By 2010, the transport volume through the Netherlands is expected to grow to 1,106 million tones, an amount that cannot be transported by road alone. Expanding the use of rail to haul freight, particularly in cross-border trade cannot be accomplished without new line construction. Whereas the Netherlands' highway and rail networks provide good cross-border connectivity, its rail network does not. The BRL will address both capacity and cross-border connectivity, by providing a direct rail route to the Netherlands' most important trading partners, and critically needed mainline capacity that can be devoted to freight.

The primary and initial motivation for the BRL was to strengthen the international competitive position of Rotterdam and all of the Netherlands as a transport and distribution hub that serves as gateway to the industrial hinterland of Europe. A 1997 Dutch Study, *Mainports in the 21st Century* (by Gout, MW, RCG Haffner and J Van Sinderen, and published by Wolters Noordhoff) stated the Dutch policy case, which was that the nation's long run economic well-being depended on strengthening airport and seaport facilities and their freight connections to the interior of Europe. Based on a forecast of future growth in international trade, the analysis showed that existing roadways and rail lines could not provide the necessary capacity to allow the Port of Rotterdam to maintain its economic position as the preeminent container port for Europe. The “no build” scenario was for increasing road congestion, ultimately causing a loss of freight growth away from the Port of Rotterdam.

Given this national objective of supporting freight growth, there was still the question of balance between expanding highways for trucking or expanding rail lines. A formal analysis considered issues of energy use, environment impact and traffic congestion implications. Dutch transport policy has been aimed at deploying all forms of transport in the best possible combination, with an emphasis on promoting alternatives that lessen dependence on road haulage. The analysis concluded that a rail line best supported the accessibility and congestion reduction objectives of the Dutch government's traffic and transport policy.

The Betuweroute was thus seen as playing “an important role in maintaining and improving employment levels in the Netherlands.” According to the central planning office of the Netherlands government, the added value of the total direct and indirect effects from the presence of the BRL will range between US $4.0 and US $6.9 billion for 2003-2010, and between US $6.8 and US $12.7 billion for the period 2003-2025.

Lessons & Outcomes

Since the project will not be in operation until 2006, no results or impacts have occurred yet. However, the project has been justified on the basis of achieving certain performance goals.

The estimated future use of the BRL indicates that, by 2010, the total rail freight volume in the Netherlands will triple from 18 million to 65 million metric tons – traffic that most likely would move otherwise by road, or not be seen in the Netherlands at all. A substantial portion of this growth is expected to be absorbed by the Betuweroute rail line:

The port railway segment between Rotterdam and Kijfhoek is anticipated to carry 55 million tons, and the main stem of the BRL to the German border is expected to carry 32 million tons in 2010, or about 50% of the Netherlands’ total rail freight volume. From the perspective of the U.S. economic and political environment, the Betuweroute can be compared to a regional project with national significance. Even though the political and planning environments are very different, significant similarities can be found with Alameda Corridor I in the Los Angeles region. Both are essentially port projects aimed at moving high volumes of international trade to inland locations. Their underlying rationales are also quite similar. Both aim to preserve and advance the market position of a port vis à vis potential competitors through improved land-side transportation efficiencies, while at the same time ameliorating a broad range of negative impacts on local communities resulting from increased traffic. The extended and extensive planning process led policy makers to reach similar conclusions: the most viable route to accommodate and indeed promote growth was through investment in rail infrastructure, and that continued reliance on highways to absorb traffic growth was not feasible. Of course, the institutional arrangements are quite different, and the overall BRL investment is approximately double that of Alameda Corridor I. Moreover, whereas the vast majority of the funding for the Betuweroute will come from the greater public, the Alameda Corridor is being largely paid for through user fees by the private railroads using the facility.

Case Illustration 4: Alameda Corridor

Type: Urban Corridor

The Project [19]

The Alameda Corridor connects on-dock and terminal rail facilities at the San Pedro Bay[20] ports, to terminals and the continental rail network at downtown Los Angeles, California. It is an intra-urban corridor consisting of twenty miles of public, multi-track rail line, half of it grade separated in a sub-street trench, and controlled with centralized traffic management technology. It consolidates and governs access to the country's top international container port by its two serving Class I railroads, and as such is nationally important infrastructure. The corridor accommodates container traffic growth for an expected twenty years, with capacity for one hundred trains per day at speeds of 40 miles per hour, in an urban environment. (See Exhibit 3-5.) The $2.4 billion project opened in April of 2002, after twenty years of development and three years of construction, and is one of the largest public rail infrastructure initiatives in the U.S. A planned second phase would improve connections between the space-constrained downtown operations and the huge goods distribution complex and available land in the so-called Inland Empire, at the rim of the metropolitan region. If finished, the second stage would produce a complete trans-urban rail corridor with a 55-mile span.

Exhibit 3-5(a,b) Alameda Corridor Aerial View and Construction Process

The project brings about a variety of benefits through two primary measures:

- *Route Consolidation* – The Alameda Corridor Transportation Authority acquired and rationalized the network of rail lines serving the San Pedro Bay ports, consolidating all traffic to one route.[21]
- *Right of Way Improvements* – Reconstruction of the consolidated route featured multi-tracking, grade separation, upgraded track material, and traffic control systems.

Relevance

The Alameda Corridor is a large-scale city project that supplies access capacity and reinforces the competitiveness of a major seaport. In so doing, it restructured portions of the metropolitan rail network and improved operations across it. Roadway congestion relief was not the chief impetus for the project, but congestion benefits certainly were claimed in the case for implementation and in the assembly of financing:

- Two hundred grade crossings were eliminated by rebuilding the right of way and by redirection of traffic to a consolidated route. This was estimated to remove 15,000 daily hours of vehicle delay from Los Angeles roads.
- The street parallel to the rail corridor was widened and improved as part of the right of way reconstruction, leading to better traffic flow.

- The corridor is expected to prevent a large portion of the rapid, sustained growth in port container traffic from generating new truck trips, on highways that already bear up to 28,000 trucks per day. By the year 2020, the access highways are projected to carry 60,000 trucks, and the corridor to handle another 30,000 that would otherwise have gone by road.
  - International containers serving Los Angeles regional consumption, production, and consolidation travel by truck. Containers proceeding further inland by train can be railed directly from the ports or from an adjacent terminal, or drayed over the road to more distant railheads. It is growth in the latter, drayage category that the corridor is projected to mitigate, by substituting direct rail from the port locations. However, no claims were made that current dray volumes would be diverted (and at least one local dray operator believes there is no risk of that occurring, mainly for reasons of service and operating effectiveness).[22]
- Approximately $90 million, or a bit under four percent of total project financing came from grants for reduction of congestion. Part of this money was a State of California Flexible Congestion Relief Grant, but the great majority was sales tax revenue from the Los Angeles County MTA, authorized by local voters for freight rail service in relief of rising traffic congestion.

The viability of a short distance, high volume urban rail project for congestion mitigation is of great interest to public planners, because rail typically is most effective at much longer lengths of haul, and because most truck trips are relatively short. In the dry van markets for which rail intermodal services (like the Alameda Corridor) normally compete, one third of the truck volume is below 100 miles, and railroad market share isn't significant below 500 miles.[23] If rail could penetrate local markets, its effect on congestion might be material.

The difficulty is that the Alameda Corridor isn't really competing in a local market. The rail traffic is continuing to inland destinations largely east of the Rockies, and while the corridor itself is a short distance trip, its appeal is as a *connecting* service. The competitiveness of schedules and costs exists within the context of long haul lanes, and the traditional strengths of railroading. The Alameda Corridor is not contending for Los Angeles metro area traffic, and it isn't thought to be diverting current dray volumes. In addition, it enjoys the advantage of economies of density that are relatively rare in the national marketplace: an enormous, regular baseload of stackable containers going from a single origin to concentrated destinations. The unit of production in railroading is the train, and its efficiency is multiplied when cargo can be stacked; the San Pedro Bay ports routinely generate full trainload stack volumes almost by the score. There are few places like it.

Even so, the corridor underscores the importance of density in making rail operations successful, and the second phase of its program creates intriguing possibilities. Alameda Corridor East extends the original structure 35 miles inland to Ontario, CA through a series of rail crossing, signaling, and road improvement projects, some of which are now underway. Capital requirements approach one billion dollars through 2007. About half of this money is committed,[24] with the majority coming from Los Angeles County and State of California congestion relief funds. The claimed benefits focus on grade separation and attendant gains in road traffic mobility and safety, train speeds, air quality, and direct and indirect employment. Nevertheless, the completed corridor will offer a trans-urban freight bridge through Los Angeles congestion. A rising quantity of container volumes, consisting both of foreign goods that are stripped and consolidated with domestic products for shipping onward, and of imports destined locally to Los Angeles, move from the ports to Inland Empire distribution facilities, around Ontario. The Alameda Corridor makes no assertion that it will capture any of this traffic for rail. Still, it is a worthwhile speculation[25] whether some local containers will choose to ride atop the normal railroad baseload to avoid the highway congestion, and whether rail operators – already possessing frequent train service, and obligated to add terminal capacity that is apt to be near Ontario – will see this as an opportunity.[26]

Motivation

The Alameda Corridor is a port access and grade separation project. It was not motivated by congestion relief, but it provides relief and employed that point in organizing community and financial support. Its chief objectives were these:

- *Raise Access Capacity & Maintain Port Competitiveness* – The economic and logistical performance of the San Pedro Bay ports is dependent on throughput and market access, both of which require adequate landside outlets. The ports' competitiveness substantially has stemmed from the size of the indigenous Los Angeles market and the qualities of the available inland service. With import container traffic growing at a twelve-percent compound annual rate, capacity is a persistent, pressing, and strategic challenge that must be met at the piers and at the outlets. The Alameda Corridor is a response for each, because it facilitates on-dock rail loading and penetrates from the docks to the key inland staging yards.

- *Improve Road Safety & Reduce Delays* – The corridor grade crossing program is aimed at safety through lower accident risk, and wider latitude for incident management on the roads and rails. Elimination of crossings means reduction in crossing delays and backups for traffic traveling the streets and tracks, and for emergency vehicles that may be part of that traffic. This is accomplished first by funneling rail volumes to one corridor and away from alternate routes and their crossing points, and second by radical grade separation of the single remaining route. Route consolidation limits the scope of disruption while the project is under construction, affecting the displacement of people and businesses in addition to traffic.

- *Improve Train Operations* – Train speeds are doubled because of new and multiple tracks in a separated right of way. Reaching 30-40 mph. and assisted by centralized traffic control, locomotive operating hours drop by 30% and the incidence of train passing delays by 75%.

- *Diminish Environmental Impacts* – Environmental benefits from the project are of two sorts. The first is air quality improvement from fewer idling emissions, which is a direct result of better train operations and traffic delay reduction. Emissions by rail were projected to fall 28%, and by autos and trucks up to 54%. Second is improvement in neighborhood noise and vibration, which is produced by better track material, sub-grade right of way, sound walls, and consolidation of traffic to a more industrial route. Both kinds of benefits make living with freight easier for residents – as do the changes to road safety and delay, and the separated route itself.

- *Promote Economic Development* – The project created 10,000 short-term construction jobs and aids the productivity of the region through its congestion benefits. However, its key economic influence is accommodation of growth in foreign trade and improvement to its logistics. This has local and national dimensions, because of the value of the ports to the Los Angeles economy, and the value of international trade to U.S. business. Approximately 70% of total project financing is to be reimbursed from user fees. These are paid by freight carriers and presumably reimbursed by their customers, making the shippers and receivers of freight the ultimate financiers and beneficiaries of the corridor.

Lessons and Outcomes

One year after opening, the Alameda Corridor was meeting its objectives. Through its performance and its implementation, it was producing outcomes of interest to this report.

Performance

The corridor was carrying 33 trains per day after one year,[27], most of them stack trains laden with 200 or more containers. Operations were attaining the 40-mph. design speed, and were performing 98% on schedule. With much faster transit and marked reliability improvements, railroads transferred 100% of their traffic to the new facility and had kept it there from the inauguration of service.

Successful performance meant there were a number of de facto outcomes whose achievement could be taken as presumptive, although they hadn't necessarily been measured. Grade crossing delays will have been eliminated and road congestion therefore reduced. Rail and road emissions will have declined, and the opportunity for accidents decreased. The Burlington Northern Santa Fe reportedly stated that it would have failed to meet its commitments to customers for on-dock rail service, were it not for the corridor. This statement implied that growth in street drayage had been moderated, and the throughput and competitiveness of the ports improved. Finally, as the corridor was operating at one-third of its capacity, the ports' continuing growth had been accommodated and its position as a rail-ready load center protected for a number of years ahead.

Implementation

Part of the importance of the Alameda Corridor is that it was funded and implemented despite the ambitiousness of its scale. Several of the factors that brought this about may be instructive for other rail projects.

- The $1.6 billion in bonds and loans was expected to be repaid by user fees, but the funds were not guaranteed by the port, the railroads, or any government. Instead, the Authority achieved a kind of monopoly control, first by acquiring all of the rail access routes to one of the largest rail traffic generating facilities in the country, and second by assessing the user fee per container, regardless of the mode by which the container actually leaves the ports. The second measure not only guarantees the fee so long as the port is active, it reduces any financial incentive a railroad might have to dray containers to an inland terminal. In combination, the two measures ensure that any port container that moves by rail will use the corridor, and therefore in a pragmatic sense they guarantee the benefits as well as the loans.

- Railroad cooperation in the project was bought. The railways reportedly were not supportive of the corridor in its early stages, and were brought on board by the purchase of their right of way. They contributed to the project's design specifications, but did not make capital investments and in fact received cash. That said, the railroads are directly responsible for payment of the use charges that will retire the corridor's debt, and they jointly agreed to the public sale of a strategic portion of their networks. Because the circumstances of rail cooperation are a sensitive part of the lessons to be taken from this project, two additional points should be made:

    – The nearly two decade gestation period of the Alameda Corridor ran from the years just after rail deregulation, when freedom from government control was a hard-won gain, through a time when private capital was relatively accessible for railways and capacity underutilized, to the more constrained situation of the new century. Railroad needs, their managements, and their perceptions and attitudes toward public projects and financing evolved during this time, if not uniformly. A proposal of the type contained in the Alameda Corridor would not necessarily meet the same railroad reception today, although the corridor's method of winning rail cooperation is often effective in human affairs.

  - There were three railways originally affected by the corridor. One of them – the Southern Pacific, who owned the key piece of infrastructure – was later purchased by another. However, during a large part of the development phase of the Alameda Corridor, the Southern Pacific was independent and in poor financial health, and its principal owner can be speculated to have had as much interest in its real estate as in its operations. While this may not be a unique set of motivations for railroad management, it is not a typical one, and it caused a special stress to be placed on the cash payment.

- Community support was founded on frustration with daily delays at grade crossings, and the recognition that they would grow. Through its use of a trench, the project was able to separate and segregate freight traffic, and still impose no major adverse impacts on the surrounding neighborhoods. Aiding community acceptance were the absence of substantial changes to land use patterns, and a right of way that ran mainly through industrial zones. Finally, a range of steps was taken to beautify the nexus of the corridor with residential areas, some of which were economically depressed. The recognition that grade separation can produce freight segregation in particular is useful for planners, because it simultaneously treats concerns for mobility, safety, and community impacts.

- The national value of the corridor, in U.S. foreign trade and in supply chains reaching across the country, provided justification for the federal loan, which contributed 16% of total program capital. In addition, the dual character of the corridor as a private rail and public highway-grade separation project meant that almost half of the bonds or 21% of total funds, earned tax-exempt status from the Internal Revenue Service. The Alameda Corridor is prominent but not alone in its strategic importance to the national freight network, and many rail initiatives that alleviate congestion will also separate road grades. Consequently, portions of the case that substantiated this project's financing are transferable to other projects of comparable or non-comparable magnitude.

- Establishment of the Alameda Corridor Transportation Authority was an effective institutional step that gave the proponents of a complex, long maturing plan the stamina, resources, focus and power to reach and conclude construction. Even for projects that will not warrant a stand-alone organization, the Authority demonstrates the utility of sustained and dedicated management in some form, to drive a program forward to completion.

By making freight activity easier to live with, exploiting its local and non-local significance, and tightly controlling economic incentives, the Alameda Corridor was able to mitigate roadway congestion, raise the capacity of the freight network, and encourage the growth of trade.

Case Illustration 5: Sheffield Flyover, Kansas City, Missouri

Type: Urban Corridor

The Project[28]

The Sheffield Flyover increased the capacity and improved the performance of a major bottleneck in the rail network in and around Kansas City. At-grade crossing of high-density rail routes had not only led to train backups, but also caused extensive delays to highway traffic when trains blocked local streets. An innovative public/private partnership helped secure funding and ensures the successful implementation of the flyover. (See Exhibit 3-6.) This project demonstrates how public agencies can work with the rail industry to expand capacity and improve the performance of the local transportation system, with benefits to the region and the nation as well. Because of the success of the Sheffield Flyover, the railroads and public agencies decided to build a second major flyover in Kansas City in order to secure similar benefits.

The project is a large-scale urban corridor initiative. It addressed a key bottleneck in the system where the Burlington Northern Santa Fe (BNSF) main line crossed the Union Pacific (UP) and Kansas City Southern (KCS) main lines. With 100 to 120 trains operating on the BNSF, 60 to 80 on the UP and KCS, and another 40 to 60 local trains operating in the area, this was described as the "third busiest railroad intersection in the country". Trains were inevitably delayed as dispatchers worked to route them through the interlockings; the delayed trains blocked intersections for a mile or more. The resulting delays were especially difficult for trucks seeking to enter or exit a major industrial area hemmed in between the main lines.

Exhibit 3-6 Sheffield Flyover

By constructing a flyover, it was possible to eliminate rail and highway delays associated with train interference at the crossovers. The project commenced operation in 2000 and covered nearly 3 route-miles almost entirely constructed on the Kansas

City Terminal Railroad's right-of-way; it included a main bridge of 6,740 feet and two other bridges of 890 and 150 feet. By double-tracking the flyover and keeping the existing tracks, it was possible to greatly increase the capacity of the intersection, improving flow of through trains and allowing better service to local rail customers. From the public's perspective, the most visible benefit was expected to be a reduction in delays at grade crossings. Transystems[29] estimated that 530 vehicle-hours would be saved daily for cars and trucks by elimination of grade crossings, based upon the train volume, the average time that each train blocked a crossing, and the 4,500 daily highway vehicle movements through the area. At $14/hour, this was estimated to amount to a savings of $1.85 million annually. In addition, with fewer trains and vehicles delayed in the area, emissions were expected to be sharply reduced.

Transystems did not provide details on the railway benefits, but indicated they would be approximately 3 times as great as the public benefits. This is borne out by a quick assessment of the benefits from reduced train delay. If 150-180 trains per day each saved 20 minutes in moving through this region (as estimated by Transystems), that would be a savings of more than 60 hours of train delay per day or 20,000 per year. The cost per train-hour is commonly estimated to be on the order of $250/hour based upon the hourly cost of equipment ownership plus the opportunity cost associated with the loads themselves. Hence the delay cost of an average 20-minute delay to these trains would exceed $5 million per year.

The project cost was $75 million. Raising the capital was a stumbling block for the railroads, even though they were willing to pay for the project on a continuing basis. Another problem was that construction would increase the assessed value of the property and therefore the property tax owed by the railroads. Various public agencies were interested in providing financial support, but there were barriers to using public funds. At one point, it appeared that an FHWA Section 129 loan would be approved to finance 25% of the project, based upon the public's share of the project benefits. This loan possibility fell through when trucking interests objected to the use of highway trust money for rail projects. State agencies were interested, but were prohibited from investing in a private sector project.

The financing problem was resolved by creating a "Transportation Corporation", a quasi-governmental entity that can be created under Missouri law that can receive highway funds. A "T-CORP" can issue 20-year, state tax-exempt bonds to fund transport projects, and it receives ad valorem tax abatements. A "T-CORP" is represented jointly by the project owner and the Missouri Highway Department; the T-CORP owns the land and the project until the loans are paid off, at which point the land goes back to the previous owners. The net result for the Sheffield Flyover was that the T-CORP issued the bonds, the US DOT provided a letter of credit, and the railroads agreed to repay the loans. In addition to benefiting from low interest rates, the corporation enjoyed a property tax abatement worth $1.4 million per year (estimated by Transystems as being nearly 20% of the annual amortization costs).

The project required a few other elements of cooperation. The project was supported by the Heartland Freight Coalition and the Greater Kansas City Chamber of Commerce, as well as Missouri DOT, FHWA, and the railroads. Some public land was needed for the flyover, and a land swap was arranged with the City. While the project was underway, work was done to modernize or coordinate 14 different utilities serving this industrial area. Also, a portion of one of the city streets had to be reconstructed and temporarily closed to enable completion of the flyover.

Relevance & Motivation

The Sheffield Flyover enlarged capacity and improved operating performance in a top national rail center, reducing interference with urban road traffic and raising the competitiveness of rail with highway services in the regional and cross-country markets. It affected roadway congestion in each of these dimensions, and it protected the highways from additional demand, by helping to prevent depletion of the rail traffic base.

Kansas City is the second-largest rail freight hub in the country after Chicago. Despite the marked reduction in the number of rail systems in recent decades, Kansas City remains a complex railroad operating environment. It is served by four Class I railroads (BNSF, UP, NS and KCS), while the KCS-owned Gateway Western provides a route that reaches CSXT in St. Louis. The Kansas City Terminal Railroad supplies local switching services (actually performed by the Gateway Western), and various shortline and switching railroads serve the area. The metropolitan area has an intricate network of classification yards, industrial support yards, and through tracks. A major problem within the region is that major rail routes intersect in Kansas City, resulting in extensive delays to both trains and highway vehicles.

The Mid-America Regional Council (the local MPO) has documented the importance of rail to the region (MARC, 2002). Rail handles just over half of the freight tonnage moving through Kansas City. Over 80% of the rail freight is passing through the area, and this traffic amounted to 150 million tons in 2000. Much of this traffic is intermodal. The BNSF's route from Los Angeles to Chicago, which handles 1.6 million containers and trailers annually, goes right through Kansas City. Another 23 million rail tons was received by Kansas City industries, while about 11 million tons were shipped out by Kansas City shippers. Rail's market share varies greatly with the type of movement. Rail accounted for approximately 2/3 of the freight moving into or though the region; truck accounted for all of the intra-regional freight and more than ¾ of the outbound freight. The rail share vs. truck is growing for through traffic, stable for traffic inbound to the region, and declining for outbound traffic.

During the 1990's, it became increasingly evident that various national trends in rail freight traffic were disrupting both rail and highway traffic in the city. System rationalization was concentrating more traffic on fewer routes, leading to congestion and interference within the rail network, as well as increasing delays to highway traffic. Trains waiting for authorization to move through an interlocking often blocked grade crossings, frequently for 20 minutes or longer. Mergers, traffic growth, and shifts in freight traffic patterns required greater capacity along key rail routes within the city, but the bottlenecks where key routes intersected threatened to limit growth of rail traffic.

The project therefore was seen to have both local and national significance. Grade crossings and local air quality were the obvious benefits for the local area. However, the movement of 1.6 million trailers and containers by train rather than by highway was recognized as much more than a local benefit, since these shipments might otherwise be moving on the highways not just through Kansas City, but also through many other cities throughout the country. Expanding the capacity of such an important rail hub was also of major significance for the national rail system. The 150 million tons of freight moving through the rail hub represented at least 7 million truck shipments, including the intermodal trailers and containers mentioned already. This is a good illustration of a network-level investment, whose broad system effects on railroad performance help retain rail traffic while ultimately diverting truck traffic from the roadways.

Lessons & Outcomes

The solution that was adopted involved construction of a rail flyover that separated major flows, expanded capacity of the through routes, improved highway access to existing industrial areas, and reduced congestion related to grade crossings. To implement the project, a mechanism was worked out to use public involvement to

- Obtain a lower interest rate than the railroads could receive on their own
- Reduce property taxes
- Enable related improvements to local streets and utilities
- Attend to details that might otherwise have stopped the project

This project is an excellent example of a public/private partnership that reduces highway congestion through rail investments that expand capacity and improve performance. It is worth emphasizing that the Sheffield Flyover addressed critical infrastructure needs for the national, main line rail network; the benefits were large enough to support substantial investment because of the high volumes of freight already moving over these rail lines. The project demonstrates how public investment can contribute to what might be called the “top of the network”, not just to the light density lines whose preservation has often been an important concern for state and local governments.

Performance

The Sheffield Flyover achieved its goals. Following the opening of the new facility in

2000, travel times for trains dropped from 40 to about 15 minutes (Cookson, 11/05/01). This is a clear improvement in train efficiency that translates directly into the hoped-for reduction in grade crossing delays and air quality. The institutional structure also worked well enough to be expanded. In February, 2002, BNSF announced that a second major flyover would be constructed to provide grade separation at the intersection of two of their main routes and improve access to Argentine Yard, their major freight facility in the region (BNSF, 2/15/02). The "Argentine Flyover", which would cost about $60 million, was initiated using the same institutional arrangements as the Sheffield Flyover.

The project has received broad recognition as an outstanding example of public/private cooperation. The Intermodal Advisory Task Force of the Chicago Area Transportation Study identified this project as one of the few best examples of "holistic" planning "involving major transportation industries, the political decision-makers, plus the industries (shippers and receivers, essentially) that stood to benefit" (Rawlings, 05/08/02). Rawlings noted the key roles played by the Chamber of Commerce and the Mid-America Regional Council, who funded preliminary freight studies and were able to focus interest on and achieve a consensus for the flyover and a few other critical projects.

Implementation

In this case, the train volumes were so high and the benefits so large that it was easy for local parties to agree that the benefits justified the costs of the project. At intersections of busy rail lines, trains back up and clearly block the local highway network. These local costs were easily identifiable and large enough to justify public participation, even though the national significance of the project is what motivated FHWA's interest. The benefits were equally clear to the railroads, as were the costs to operations if action were not taken. This project provides various lessons for promoting public/private partnerships that seek to enhance the role of rail freight in reducing highway congestion:

- The involvement and support of the local freight interests is essential.
- The willingness of the various railroads to work together and to negotiate ways to share the costs is essential.
- Federal, state and local cooperation can provide innovative financing mechanisms and enable a complex project to be completed quickly.
- Environmental benefits may provide part of the story in support of the project, but the financing may need to be based upon a clear understanding that the system improvements – for both highway and railway – translate directly into enough cost savings to justify the project.
- The national scope of the project may add to the story and motivate federal involvement, but it may not directly affect the local assessment of the project. In other

locations, where the local effects are not so evident, it may be necessary to make a stronger case for the indirect and national benefits in order to secure local support and a broader base of funding.

- Once a coalition is formed to identify, finance, and implement projects that fulfill clear needs, then that coalition can quickly move on to additional projects.

Case Illustration 6: Vancouver Gateway Transportation System

Type: Metropolitan Citywide

The Projects[30]

The *"Major Commercial Transportation System"* (MCTS) for the Vancouver region of British Columbia is a system of key transportation facilities and routes that connect the region to external gateways, as well as provide connectivity to the major commercial activity centers.

Vancouver is recognized as the major western gateway to Canada as well as a supporting international gateway for northwestern US. The facilities serving international travel and goods movement include several Marine Ports, Vancouver International Airport, rail yards for three railroads, and four major international border (rail and highway) crossing facilities.

From 2000 to 2003, the MCTS planning process identified a set of surface transportation projects designed to support a balanced flow of rail and truck movements. They were intended to minimize local traffic congestion, while maximizing the economic health of the region's international gateway function – which is the flow of cargo via marine port, airport and international border crossings. The *"Current and Planned Infrastructure List*" made the case for 17 major new investments, comprising highway upgrades, rail links, river crossings, a new rapid transit lines and an additional harbor crossing. These projects are listed in Exhibit 3-7. Preliminary studies put the cost at $6.2 to $6.9 billion.

Exhibit 3-7. Vancouver Major Commercial Transportation System Projects

(A) Freight Rail Projects

Rail Project	Description of Project (motivation is noted in parenthesis)	Trains / Day
New Westminster Rail Bridge	Replacement of the existing 100-year-old rail bridge with two-track tunnel. Tunnel preferred, as this will avoid conflict with marine traffic. (Capacity of existing bridge causes significant delays, which will worsen in the future.)	46 trains per day
Pitt River Rail Bridge	Short-term upgrade and long-term replacement of existing two-track bridge. New bridge to have more efficient swing bridge mechanism (Current swing bridge causes additional marine traffic delays and CP Rail crossing delays.)	45 trains per day
Roberts Bank - 41B Grade Separation	Construct an overpass at 41B Avenue in Delta to provide separation between the rail line to Roberts Bank. (To permit unrestricted switching of trains and to permit longer trains at Roberts Bank. Increases operational efficiency.)	22 trains per day
Mud Bay Area – West Leg of the Wye	Construct a connection between the BNSF line and the BC Rail Line to Roberts Bank to permit the movement of south to west/east to north. (Relieve congestion on Roberts Bank route – shorter route for southbound trains.)	13 trains per day
BN New Yard to Spruce St. – Double Track	Provide two tracks between the New Westminster Rail Bridge and the BN yard. (To provide support for new Fraser River rail crossing as approach track has limited capacity.)	46 trains per day
Siding - Colebrook North & South	Construct new siding on the BNSF line north of east west BC Rail line. (Increases capacity on BNSF line from US Border to NWRB, (necessary for proposed increase in Amtrak usage)	12 trains per day
Siding & Grade Sep- Colebrook East and West	Extend siding on the BC Rail line east of the north section of BNSF line. (Increases capacity on Roberts Bank route. New siding on BC Rail line west of the north section of the BNSF line.)	22 trains per day

(B)Highway and Transit Projects

Highway & Transit Project	**Description of Project (motivation is noted in parenthesis)**
Highway 1 - Vancouver to Langley	Additional capacity on Highway 1 from Grandview Highway to 200th Street. Includes twinning of the Port Mann Bridge, upgrades to the various interchanges, and extension of the HOV lanes to 200th Street. (To address capacity constraints resulting in significant congestion and delays.
South Fraser Perimeter Road, from Hwy 1 to Hwy 91	New connection between Hwy 1 at 176th Street and Hwy 91 at River Road, with extension to Hwy 99 and E. Ladner Bypass. (To provide improved connectivity between major corridors and commercial activity centres. The existing route between Highway 1 and Highway 91 as well as Highway 99 is circuitous and limited in terms of capacity.)
Fraser River Crossing	New river crossing between Maple Ridge / Pitt Meadows and Surrey / Langley. Connection at approximately 200th Street. (This new connection provides a much needed access improvement for the unmet demand between the communities of Pitt Meadows / Maple Ridge and the Surrey / Langley.)
Rapid Transit - Richmond to Airport	New rapid transit line from Richmond and Vancouver International Airport to downtown Vancouver, via Cambie Street corridor. (This corridor has high transit demand that can be expanded with the improvement of service.)
North Fraser Perimeter Road	Improvements and additions to existing road corridors between the Mary Hill Bypass and Queensborough Bridge, incl. segments of United Blvd, Brunette Ave., Columbia St., Front St. and Stewardson Way. (Upgrades to major goods movement route to provide needed efficiencies via reduced congestion).
New Westminster Rail Bridge (with road tunnel)	Road tunnel to parallel proposed rail tunnel under portions of New Westminster and Fraser River, connecting McBride Boulevard and South Fraser Perimeter Road. (Combined with the rail tunnel, this road corridor will provide improved capacity across Fraser River as compared to Patullo Bridge which experiences significant congestion.)
Massey Tunnel (Hwy 99)	Improvements to Hwy 99 corridor at the river crossing, incl. two new lanes under river, extension of HOV lanes from King George Hwy to Westminster Hwy. (This river crossing experiences significant congestion in both directions as the counter-flow system only partially addresses the demand in the peak direction.)
Oak Street Bridge (Hwy 99)	Widening of the Oak Street Bridge from four lanes to six lanes. Two additional lanes to be designated as HOV lanes. This project will tie into the improvements on Hwy 99 associated with the Massey Tunnel. (The bridge experiences significant congestion in the AM peak period which can be mitigated with the inclusion of an HOV lane that gives priority to carpools to bypass the congested area.)
Hwy 15 – Hwy 1 to US Border	Improvements to the Hwy 15 corridor between Hwy 1 and the US Border, incl. increasing capacity from two to four lanes. (Current 2-lanes and signalized intersections limit mobility along this route. Additional capacity is required to relieve congestion.)
Hwy 10 – Hwy 17 to Hwy 1	Improvements to the Hwy 10 corridor between Hwy 1 and Hwy 17. Improvements consist primarily of increasing capacity in the two lane sections to four lanes. (The two lane cross section and various signalized intersections limit mobility along this route. Additional capacity is required to relieve congestion.)
Access to Pacific Border Crossing – Hwy 99	Widening of 8th Avenue between Hwy 99 and Hwy 15 along with interchange improvements at Hwy 99. (Access to the truck crossing at Hwy 15 is limited, and as such needs to be upgraded to protect the level of service.)

The Greater Vancouver Gateway Council is an organization of senior executives from industry and government who subscribe to a common vision that Greater Vancouver become the Gateway of Choice for North America. It includes the gateway facility operators (airport and seaports) and freight transportation companies (airlines, railroads and trucking companies), with the BC Minister of Transport serving as the honorary chair. The MCTS and planned transportation infrastructure improvement projects were identified by members of the Greater Vancouver Gateway Council, working jointly with the Greater Vancouver Transportation Authority ("TransLink") and BC Ministry of Transportation, to address many of these congestion issues on the road (and, by implication, transit) and rail networks.

The specific needs addressed by proposed road and transit infrastructure projects were to:

- relieve congestion on the major highway and arterial routes within the region, either by increasing capacity or by diverting auto drivers to transit;
- provide a bypass or give priority to commercial vehicles on congested routes;
- provide more direct connections to either major gateways or commercial activity centers.

The needs addressed by proposed rail infrastructure projects were to:

- provide capacity to the rail network either though additional tracks or sidings;
- reduce conflicts between rail and road based traffic.

However, underlying those specific needs were several broader objectives for the Major Commercial Transportation System, which were to:

- provide a continuous network for efficient commercial vehicle operations;
- utilize multi-modal solutions (road, rail, and water courses) to alleviate traffic congestion;
- accommodate future growth in (local and international) goods and passenger movements;
- enable 24-hour unrestricted commercial vehicle and rail traffic use;
- provide rail movements free of road intersection constraints;
- enhance connectivity to north-south & east-west trade corridors;
- provide for cost-effective solutions to specific bottlenecks.

While the MCTS focused largely on goods movement, it also recognized that efforts to improve goods movement would also help improve passenger movement. It was explicitly seen that the improved movement of passengers (as well as freight) by rail within the urban area of Greater Vancouver would also improve local conditions on the road network by diverting commuters from their autos. Accordingly, the MCTS project list was coordinated with plans to address the commuting needs of workers. In addition, the MCTS planning effort considered the issue that traditional regional and provincial transportation investment assessment tended to give short shrift to freight and goods movement. By adding consideration of the importance and function of international gateways and their economic function, the MCTS planning effort was also seen as providing a broader perspective to the multiple objectives in evaluation tools such as the Province's Multiple Account Evaluation for rating proposed transportation projects.

Motivation

The primary motivation for the MCTS and its planning initiatives was concern about threats to the economic position of the Greater Vancouver Region as an international gateway and conduit for goods movement. At the outset, the British Columbia Ministry of Transportation and the Canadian Federal Department of Western Economic Diversification became actively involved in funding MCTS needs and planning efforts because they saw major economic threats and opportunities associated with the failure or success of the Vancouver region in addressing surface transportation congestion and capacity for growth of ports and border crossings.

The Greater Vancouver Gateway Council and its reports noted that the current transportation system, in all its modes, was showing signs of neglect and lack of investment as congestion continued at unprecedented levels. They concluded that investment in the Greater Vancouver Region's transportation network was urgently required to reverse the past trends and to provide a transportation system that supported the nationally important gateways located in the region. Many members of the Gateway Council feared that if the current trends continued, the transportation system in the region would erode to a point that the Greater Vancouver Gateway lost its competitive edge along the west coast of North America. This would undoubtedly have significant negative impacts on the regional economy, with impacts also felt across the Western Canadian economy (to speak nothing of the effect on everyday travel conditions in the region).

The economic basis of the rationale was key. The federal department of Western Economic Diversification funded the Greater Vancouver Gateway Council to conduct a study of the implications of the MCTS and its proposed improvements for the economic development of four Canadian provinces. The study[31] showed that Vancouver’s international gateway function had broad economic importance that would be threatened, if capacity constraints and congestion within the region’s surface transportation system undermined the ability of the region to competitively serve international freight movements in the future.

Lessons & Outcomes

Performance

While the MCTS projects were not yet built at the time of this writing, they had been evaluated through baseline forecasts of freight flows in the province. Growth rates for long-distance freight movements in British Columbia were expected to vary significantly across modes, with long distance truck cargo growing slower and air cargo growing most rapidly. However, it was important to note that rail and maritime shipments also included truck deliveries at origin and destinations. As a result, total trucking within Greater Vancouver was expected to grow more than 50% over the 2001 – 2021 period. It was estimated that by 2021, almost 75 million metric tons of product would be transported by truck within the province on an annual basis. Rail tonnage was also expected to grow steadily during the period, with a cumulative increase of 60%. By 2021, almost 300 million tons of freight were expected to move by rail through British Columbia, mostly in the Vancouver region.

As demonstrated in the GVGC consultants' reports, these forecasts reflected expected future changes in domestic and international economies and trade patterns that would increase pressure on the Greater Vancouver regions' transportation system. Key findings from the transport forecasting and economic impact study were that:

- *Economic Performance* - The BC and Western Provincial economies depended significantly on international exports and hence the movement of goods and services to international gateway facilities. Due to its position astride the route to East Asia, Vancouver and its transportation facilities served a critical role in supporting the economies of this large region. The future economic performance of BC and other western provinces would depend on maintaining and improving the performance of the Vancouver region's Major Commercial Transportation System.
- *Commercial Growth* - Forecasts for continued population and economic growth in the Greater Vancouver area would lead to increasing pressure on the region's ground transportation system. The growth of road and rail traffic was expected to be particularly strong for commercial movements, which serve freight cargo moving to and from airport, marine port and international border crossing facilities. As a result, future congestion delays and future capacity constraints would hit commercial traffic particularly hard.
- *Capacity Repercussions* - Projections of future road and rail demand indicated that this demand would surpass the current capacity of significant elements of the current transportation system. As a result, severe impacts on future travel times and travel costs were expected unless there was a significant investment made to upgrade and expand many aspects of the region's transportation facilities. The magnitude of these travel impacts represented very large dollar values.
- *Risk* - The stakes for the future of British Columbia's economy, as well as that of other western provinces (that depend on Vancouver's ports as a gateway to Asia), were high. Without investments made to upgrade the performance and capacity of the

region’s transportation facilities and services, there could be significant losses of business activity as travel times and costs for commercial shipping were increased. To maintain the economy of BC and other western provinces, there would therefore need to be careful attention to making investments necessary so that costs of doing business in this area did not become prohibitive.

Implementation

The initiative to formally designate a Major Commercial Transportation System was initiated by the Greater Vancouver Gateway Council (GVGC) in 2000, following a series of studies in the late 1990’s that showed the strong economic importance of the region’s gateway transportation facilities. Over the 2001-2003 period, the Greater Vancouver Transportation Authority (“TransLink”) developed its three year short-term plan and worked to solidify its long-range investment plan by working closely with the GVGC to affirm and prioritize a list of major infrastructure projects. These lists were coordinated so that the regional list of high priority projects would be consistent with ongoing work on the Major Commercial Transportation System being led by the GVGC. Additional consultations were held with local municipalities, the province and federal agencies, and stakeholders such as the Board of Trade. In 2001, the Greater Vancouver Board of Trade sponsored a public policy forum on “Regional Transportation: Gridlock or What?,” featuring a discussion of the Major Commercial Transportation System and its maps of current infrastructure and planned future infrastructure requirements.

In 2002-2003, the Canadian federal Department of Western Economic Diversification and the BC Ministry of Transport provided support for a study documenting the costs and economic benefits of the recommended infrastructure plan. The study also examined the economic development implications of alternative scenarios for either investing in the MCTS or else maintaining the status quo. This study affirmed that some but not all of the recommended projects passed a traditional user benefit-cost analysis (that effectively valued goods movement based on driver and vehicle operating costs). However, it was also found that the overall package of projects provided even greater economic development benefits when additional issues such as the value and timeliness of goods being transported, and the competitiveness of international ports were also considered.

As of 2003, regional, provincial and federal agencies were discussing options for funding of the 17 major projects. It was expected that the proposed projects would be funded over a period of time through a combination of federal and provincial public funding, as well as public-private partnerships for rail-related facilities and tolling to pay costs of planned bridges and tunnels.

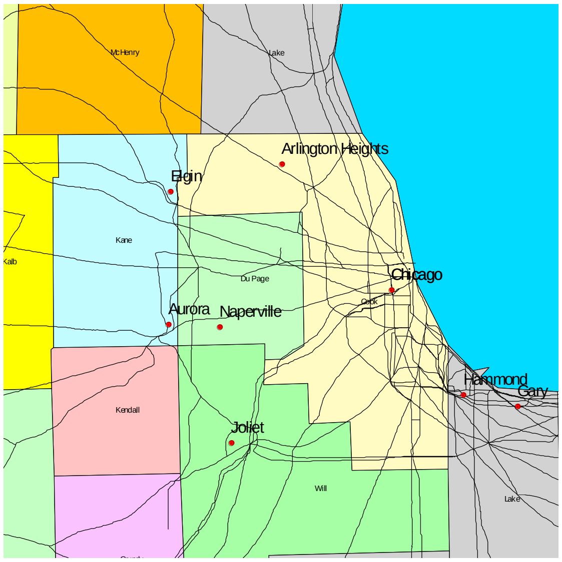
Case Illustration 7: Freight Rail Futures for the City of Chicago

Type: Metropolitan Citywide

The Project [32]

Chicago's undeniable stature as the nation's rail freight hub has immersed that city in the issues of multi-modal policy development. The region's vast network of terminals and track represents the world's most densely packed rail-rail and rail-truck transfer point[33]. Since its emergence as the largest interchange point between the western and the eastern rail carriers during the latter half of the 19th century, Chicago has served as the most important hub of the North American railway network. With the advent of rail intermodal traffic during the 1950's, its significance as the central point of interchange has become even more critical. At present, nearly three-fifths of all U.S. rail intermodal traffic and one-third of all U.S. rail traffic flows through the Chicago region. Despite the massive volumes and transformation in the railroad's business, Chicago's rail infrastructure remains largely unchanged from the early 20th century.

Exhibit 3-8 Chicago's Regional Rail Network



As overall traffic volumes have grown and mergers have concentrated volumes on fewer and fewer traffic corridors, the region faces a rail congestion problem.

Although trains can make the trip from the West Coast to Chicago in a truck-competitive two days, once they get to Chicago they can take three more days just to move across town.

In recent years, expanding traffic and increased competitive pressures have forced the railroads to undertake concrete steps to reduce the delays encountered by traffic moving through the Chicago region. While the primary tactical response has been to improve coordination between the carriers and operational adjustments, over the longer term more extensive changes will be necessary. This includes development of new intermodal terminals (some already constructed) and restructuring of the physical network to better meet present and future needs. Since railroad operations are still largely concentrated in the City of Chicago and the urban core of the region, any major changes in terminals and trunk-lines could have a significant impact on the City.

Recognizing the evolving changes in the railroad industry and its potential impact on the City of Chicago, the City commissioned a study to better understand trends within the railroad industry, and to evaluate whether its economic interests would be better served by preserving its role as the nation's premier rail freight hub, or by supporting other activities in lieu of rail freight. Entitled "Freight Rail Futures for the City of Chicago", the study was sponsored by the Chicago Department of Transportation and undertaken from 2001 to 2003. It assessed the economic impact of rail freight upon the City in terms of its effect on labor, land use, business activity, congestion on roadways and passenger train expansion, and presented development options for the future. Through a combination of interviews and surveys, transportation data analysis, forecasting, and economic modeling, the study estimated the economic consequences for a set of distinct scenarios, each representing a strategic direction for the City and the railroad industry. .

Relevance

Roadway congestion was just one of the many inter-related issues touched by this study, whose real focus was economic and whose ultimate purpose was political. Still, such focus and purpose are relevant to the circumstances commonly faced by planning agencies, which must possess or assemble a body of public support for their projects. The extent to which freight rail is tied to the vitality of a region is the extent to which investments in rail have clear payoffs and are therefore easier to justify - and so long as the investments themselves are productive, roadway conditions may be relieved ipso facto. Chicago admittedly is a case in the extreme, in that it is very large as a city, a rail center, and a freight market, but these elements make the measurement of railroad influence more obvious, and help to point up the benefits of which a healthy rail sector is capable.

There are 600 grade crossings in Chicago; traffic interference at these points is one of the chief road-related issues, and important in the question of network rationalization.

Other prominent roadway concerns in this study were:

- The ability of the rail industry to handle projected growth, particularly for the intermodal traffic that offers the best prospect for relief of highway congestion. This growth can only occur if there is sufficient line and terminal capacity. However, railroads building capacity are content to position terminals in locations outside major cites, where land is cheap, economies of scale are readily achieved, and highway access is good. This trend, evident in Chicago as well as many other cities, may reduce truck traffic on the rural interstates, but it will leave many trucks in dense urban areas where air quality, safety and congestion concerns are greatest. For Chicago, a feasible strategic response appeared to be a twin terminal system, whereby older downtown facilities would operate in tandem with new ones at the urban rim, using shuttle trains to preserve rail service to the urban core.

- Efforts by the railroad industry to improve all-rail connections, and to rationalize infrastructure and operations in a complex operational environment. These have been underway through an industry-wide initiative, the Chicago Coordinating Committee, whose work led to the proposed Chicago CREATE project. The financial ability of private industry to make appropriate investments, however, has been somewhat in doubt, and the form of rationalization it might favor in these circumstances is a concern for public planners, since any traffic shed from rail is probably headed to the highways. Cooperation with the public sector must be established if rail infrastructure investments are to favor the city, where opportunities – but also construction costs, project complexity and collateral impacts - are high.

- Cross-town drayage is the main way railroads inter-connect their intermodal services in Chicago, moving trailers and containers between terminals by truck across city streets. This adds to urban congestion and can be reduced with rationalization in the rail system. However, not all drayage is undesirable. Because car loading sequence and car blocking requirements demand greater destination volume densities for all-rail than for drayage connections, some cross-town trucking actually supports through rail service to more markets than could be accomplished without it.

Motivation

The rail freight system provides a variety of economic benefits to regional and national economies. Direct benefits include employment opportunities in rail and rail-related industries, and access to competitive transportation services to and from major economic centers in the United States, Canada and Mexico. Cost savings resulting from transportation efficiencies and the competitiveness of the freight system permeate the local, regional and national economies. While as a percentage, relatively few people or firms have direct contact with the freight railroads – except at grade crossings - they all benefit from the existence of the national rail freight system.

Chicago sustains a tremendous concentration of rail freight. Over 70 million tons of rail intermodal traffic are hosted by the region's railroads and highways; translated into trailers and containers, this means that 4.6 million loads begin or end their trip in the Chicago region. The City's motivation for undertaking the rail futures study was to understand the economic impacts from this high level of activity, to know whether its infrastructure demands should be accommodated, and to project the consequences of policy courses ranging from status quo to strategic development.

Between 1985 and 1998, overall traffic for the Chicago region grew by over 150%. Rail carload tonnage approximately doubled, while intermodal tripled. At the same time, the volume of traffic moving by highway grew by over 200%. Volume growth is forecast to remain strong over the next two decades, albeit at a somewhat slower rate of 62% between 1998 and 2020. This means that Chicago's transportation infrastructure must accommodate an additional 439 million tons of inter-regional traffic (inbound, outbound, and through), above the 707 million tons handled in 1998. Out of these 439 million tons, 156 million are expected to use rail for at least part of their journey.

Where and how this additional tonnage – and millions of additional vehicle trips - will be handled is dependent on decisions that are being made by private carriers and public planners. For rail, the expected continued growth in traffic could result in significant collateral impacts: more frequent interruption at rail/highway grade crossings, greater noise from more frequent trains, and growing truck traffic over City streets traveling to and from intermodal terminals. The existing rail infrastructure, such as bridges and viaducts, will, without substantial additional investment, become more severely stressed and deteriorated than it already is.

This recent and impending growth, combined with the many changes in Chicago's economy, population, and development trends, have made it apparent that the traditional relationship between the railroads and the City has changed greatly. Effectively addressing these alterations requires a conception of how much of the Chicago economy continues to be linked to the fortunes of the rail industry. The study found that coordinated planning efforts could have the potential to create a more effective and more efficient rail system for passenger and freight services, with lower impacts on neighborhoods and highways. Left to themselves, railroads and their customers will pursue strategies that, while in their own best interest, could be damaging to the City economy. The economic benefits to the City of a coherent planning process for the rail freight system are both significant and attainable.

Lessons & Outcomes

The study determined that it is in the best interests of the City of Chicago to remain the leading rail hub in North America. While rail freight service is no longer the driving force for economic development that it once was, it remains an important underpinning for the City's economy. From an economic development perspective, it was indicated that the City should support continued or improved freight operations rather than seeking to constrain or eliminate them. The best available strategy for the City will be to support the rationalization of freight operations so as to reduce conflicts between rail and highway operations, improve coordination of freight and passenger services, offer better access to intermodal terminals, enhance freight service, and reduce freight costs. The study concluded that rationalization of the rail freight system would increase the City's Gross Regional Product (GRP) by more than $1 billion per year by the year 2020 and provide more than 8,000 additional jobs. The successful redevelopment of land freed up by rationalization would more than double these benefits.

The problem arising from aggressive efforts to move freight operations outside of the City is that some rail users will follow the rail facilities, others will end up using more trucks, and a significant amount of economic development will shift to the suburbs. The City may avoid some problems if rail operations are reduced, but could potentially lose much more than just the trains. Results from the regional economic analysis show that moving freight away from the City would, by 2020, reduce GRP for the City by $1-3 billion annually, while eliminating 5,000-15,000 jobs. Redevelopment opportunities could offset some or all of these losses, but the net benefits would still be substantially lower than under a network rationalization scenario. The total swing between upside and downside is about three percent of GRP, which is quite material as a marginal economic shift.

As this was written, results from the study were being incorporated into strategy development discussions with Chicago's major railroad partners. The study highlighted the role that the railway industry presently played and could continue to play in Chicago, or any other locale's economic firmament. It further suggested that while the focus of planners has traditionally been on the absence or presence of regional infrastructure, the impacts of transportation on the regional economy are more logistical in nature. The presence of infrastructure is a necessary requirement for quality transportation service and economic vitality, but not a guarantee of economic success. To maintain the competitiveness of rail operations in a region, there are four generic strategy options for investment that a public agency might want to consider:

- *Invest to obtain public benefits* – This strategy could include such things as elimination of grade crossings in order to reduce highway congestion and curtail the noise from train whistles; or, reduction of intermodal rubber tire interchange, again to alleviate congestion and to slow the deterioration of pavements. Required by such an approach is the demonstration that rail is an equivalent or superior option to the provision of highway service, and that the potential benefits justify significant public expenditures.

- *Invest to maintain rail infrastructure for long-term growth* – The goal of this strategy is not necessarily to alter current mode share, but to ensure that deficiencies in the rail system do not become a deterrent to regional growth or a significant cost factor for local industry. The economic analysis from the Chicago study suggests that annual economic costs rise far into the millions of dollars if rail infrastructure problems restrict industrial development – and can reach the billions in a major urban network center like Chicago.
- *Invest to relocate rail facilities to allow redevelopment* – This strategy seeks to make better economic use of land and rights-of-way currently used for rail operations. Such a strategy must be carefully implemented however, as the costs and benefits of each such proposal will be highly site specific.
- *Invest to rationalize the system* – This strategy seeks to achieve both the economic and environmental benefits that are possible. This differs from the first approach primarily in the level of coordination, planning, and investment required. Rationalization implies a systems approach to the regional rail network, with considerable restructuring and investment to achieve more efficient operations, better service, more effective control, or higher capacity.

In Chicago, as in other rail-heavy economies, the continued growth of the region is vitally linked to maintaining the capacity and performance of the local railway network. Capacity limited performance will, over time, weaken the attractiveness of a region as a location for businesses and industries that utilize rail service. If transport costs rise and service deteriorates, local firms will have more difficulty competing both regionally and nationally. They will be forced to relocate outside the region, and a significant part of the local economy – and much of the future development of freight-dependent activities – will slowly slip away.

Case Illustration 8: State Rail Access Programs

Type: Facility

The Programs[34]

Many states have local transportation grant programs designed to help fund local rail and/or highway projects that are needed to help attract and expand industry in the state. Several of these states operate separate rail programs that are specifically focused on supporting local projects that address these economic development objectives. Among them, Maine and Ohio offer particularly interesting examples of rail economic development programs, since the programs in those states have documented how their projects have explicitly served to reduce highway demand and associated needs for highway-related investment. These two programs are offered as case study examples, and due to similarities in their design and operation, they are discussed together. Key aspects of the programs are summarized below:

- ***Maine Industrial Rail Access Program*** – IRAP was designed by the Maine Department of Transportation to encourage economic development and increased use of rail transportation. Type of projects eligible for funds includes: accelerated maintenance, rehabilitation, new siding improvements, right-of-way acquisition, and inter-modal facility construction. Project applications are solicited from any and all interested parties and are ranked using a competitive rating scheme that focuses on economic enhancement and public benefit. Project grants are subject to a 50/50 public-private cost sharing agreement.

- ***Ohio Rail Economic Development Program*** – REDP was designed to induce companies to locate or expand in Ohio. REDP funds are available for the construction or rehabilitation of industrial lead tracks, rail spurs or other rail infrastructure and passenger rail facilities. The program provides both grants and loans. Qualified applicants can include railroads, private corporations and industries requiring rail service; political subdivisions, government agencies, boards or commissions; regional transit boards and port authorities. Grants are used for cases with the most need or without a direct revenue stream. Grants are generally limited to less than 50% of project costs and up to $1,000 per each job created or retained.

In both states, most of the projects are new or rehabilitated rail sidings and spur lines, although the eligible projects can (and occasionally do) also include transload facilities, bridges, rail/roadway crossings, track interchanges and rail yards. Examples of specific projects for both states are listed in the section 4.1 discussion of implementation.

Relevance

Rail programs in the two states provide funding for local rail projects that allow new and existing companies to utilize rail rather than trucking, for their incoming and outgoing freight shipments. Local rail projects are funded to facilitate the location of new businesses, and the retention or expansion of existing businesses, at specific sites in the state. This is accomplished by providing new rail facilities and upgrading existing rail facilities to effectively serve those sites.

Among projects that address these basic goals, each state also has a series of additional criteria for evaluating applications. These criteria assess the extent to which the project will lead to effective use of the rail facilities, support economic activity as a result, and lead to environmentally positive benefits in terms of reduced road congestion and truck emissions. There are also criteria to ensure that the level of funding maintains some reasonable ratio of public benefit per dollar of investment. Specific criteria for each state program are as follows:

- ***Maine Industrial Rail Access Program*** -- Project selection criteria are based on five types of attributes: (a) transportation and logistics cost savings for rail users;

(b) employment and economic development opportunities for rail users and the community served by rail; (c) benefit cost ratios justifying expenditure of public funds; (d) the significance of the project for continuous and productive improvement of rail service levels; and (e) environmental benefits through decreased air emissions, decreased highway maintenance requirements, decreased dependence on foreign oil, or decreased levels of highway congestion.

- ***Ohio Rail Economic Development Program*** -- Benefit analysis is often employed to determine eligibility for assistance. Eligible benefits include, but are not limited to: (a) job creation and job retention; (b) transportation cost savings and preservation of existing competitive transportation costs; (c) new investment in plant and facilities by rail users and the associated tax benefits to the state; (d) increased viability of the rail operation; (e) relief of highway congestion and maintenance; and (f) improved safety for Ohio citizens.

Motivation

These programs are all fundamentally justified and funded as a form of support for economic development – specifically to encourage new and expanded business activities in the state, so as to create more jobs and income for state residents. In both states, there are a variety of programs, operated by different state agencies, all focused on supporting this underlying goal. These rail programs are authorized by the state legislatures and administered by the state transportation departments as one aspect of those broader economic development strategies.

Each state Department of Transportation has its own version of the wording that explains the program motivation. These are as follows:

- ***Maine Industrial Rail Access Program*** – "The Industrial Rail Access Program has been designed by the Maine Department of Transportation to encourage economic development and increased use of the rail transportation mode."

- ***Ohio Rail Economic Development Program*** – "The goal of this program is to induce companies to locate or expand in Ohio. The Ohio Rail Development Commission (ORDC) often works closely with the Ohio Department of Development in administering this program."

Lessons & Outcomes

The specific projects and outcomes vary from year to year. Maine DOT has noted that projects improving and expanding rail facilities under this type of program generally have four common outcomes: (1) providing shippers with lower cost transportation; (2) providing railroads with increased revenue; (3) providing the state with reduced highway maintenance costs; and (4) providing the public with reduced highway congestion. The same common outcomes also appear to apply for the Ohio DOT program. However, it is also useful to note that both states fund projects that fall into two categories: (a) projects that primarily enhance existing rail service for *current rail users*, and (b) projects that bring new rail services and *new rail users*. In the context of this report, interest was focused on projects of the latter type, which effectively increase rail use as an alternative to reliance on trucking. Admittedly, projects of the former kind also may prevent the loss of rail traffic to highways.

The following tables provide examples of Maine and Ohio's state-funded projects during FY2001, focusing on the subset of projects which explicitly increase rail use. The tables include notes on the nature of the project and its highway avoidance impacts, as well as other economic development benefits when documented. (Due to differences in the nature of reporting among the states, their project descriptions vary in breadth and detail.)

Exhibit 3-9. Maine Industrial Rail Access Program (Selected Projects, 2001)

- Location - Project - Program Cost	Highway Investment Avoidance
Winterport New rail siding $215,000	75,000 tons/yr of gravel shipped by rail that would otherwise travel by highway, keeping 2,000+ truck trips/yr off highways
Stockton Springs New rail siding $210,000	125,000 tons/yr shipped by rail that would otherwise travel by highway; keeping about 4,000 truck trips/yr off highways
South Portland Rehab siding & new transload facility $570,000	New rail access to gravel pits, shifted clay-carrying truck trips to rail for access to seaport; reduce port truck trips by 100,000 to 150,000/yr; reducing traffic congestion in Maine's largest metro area
Easton New and rehabbed siding $125,000	50,000-75,000 tons/yr of french fries shipped by rail that would otherwise travel by truck; reducing congestion on I-95 from N. Maine to NH border
Hinckley New siding at paper mill $550,000	Created 700 carloads/yr of rail movements, removed 2100 log truck moves from northern Maine to Hinckley (300 +/- miles)

Exhibit 3-10. Ohio Rail Economic Development Program (Selected Projects, 2001)

- Location - Project - Program Cost	Rail Support; Highway Investment Avoidance	Economic Benefits
Nickles Bakery Spur new track from W&LE Brewster Canton Line and Nickles Bakery spur track,; $265,000 grant, $265,500 loan	Re-institute service to Nickles Bakery. Keeps 750-1000 trucks off local roads	Help preserve 550 jobs
Panhandle Georgetown branch reopen track on the Panhandle Georgetown Branch to serve Oxford Mining coal traffic; $138,292 grant	Re-institute rail service, facilitating coal movements to the Conesville Power Plant	Creates 3 new jobs Helps retain 50 coal mining jobs
City of Lebanon New 3800 ft. track to serve Quantum Metals; $340,000 loan, $25,000 grant	Opens up Columbia business to rail service as alternative to trucking	Creates 25 new jobs. Retains 15-20 jobs. Generates 240 rail cars annually
Miami Products & Chemical company New 950 ft. and 545 ft. rail spurs at new chemical company facility in Fairborn, Ohio; $200,000	Generate 64 rail carloads	Creates 12 jobs. Retains 31 jobs.
Walton Agri-Service, Inc. expansion of 39-car spur in Upper Sandusky to handle 65-car unit trains of grains and fertilizer; $25,000 loan	Generate 1926 rail carloads	Retains 38 jobs. Generates more than $400,000 in private investment
New Bakery Co. Transload Track New 2,878 ft track at East Point Industrial Pk (Muskingham County); $200,000 grant	Promotes development of rail use at industrial park	Creates 74 jobs. Retains 230 jobs.
Cloverleaf Cold Storage new 1300 foot rail spur and bridge to serve proposed warehouse in Massillon ; 328,000	Generates 1140 rail carloads	Creates 30 jobs
Jackson warehouse Spur Cost Increase Complete new 3000-foot spur ; $235,250 grant, $160,250 loan	New transload facility	35 jobs created Lower storage cost for food industry.
20/20 Custom Molded Plastics, Ltd new 1500 ft. rail spur for new facility in Holiday City; $50,000 grant	Generates 96 rail carloads	Creates 62 jobs

Implementation

Both Maine and Ohio have programs operated by public state agencies, with most or all of the financing coming from funds allocated by the state legislature. Specific details of the implementation and funding process for each state are shown below:

- *Maine Industrial Rail Access Program* -- The Office of Freight Transportation within Maine's Dept. of Transportation operates the Industrial Rail Access Program. Annual funding has been around $4.4 million/year, with the Maine DOT share being a combination of general obligation bonds (representing over 2/3 of the funding) and federal CMAQ (Congestion Mitigation/Air Quality) dollars accounting for the rest. It is notable that the latter source of funding is targeted for projects that reduce traffic congestion and improve air quality, thus confirming the role of Maine's IRAP in reducing traffic congestion.

- *Ohio Rail Economic Development Program* – The Ohio Rail Development Commission (ORDC) was created by the Ohio General Assembly in 1994 and is governed by fourteen commissioners. ORDC's mission is to plan, promote, and implement the improved movement of people and goods, faster and safer on a rail transportation network connecting Ohio to the nation and the world. In practice, ORDC provides direct loans and grants and may issue bonds for qualified rail projects. It is set up to provide this support to public and private entities. For fiscal year 2002, the legislature allocated nearly $5 million for the agency's annual budget, most of which is spent on grant programs.

The Rail Economic Development Program is just one of ORDC's programs. It is administered by ORDC working closely with the Ohio Department of Development and other public and private development related organizations, to induce companies to locate or expand in Ohio. ORDC has other funding programs for projects that are not related directly to economic development, but rather, to functioning of the state's rail system. This includes special funding for Branch Line Preservation, Branch Line Enhancement, the Rail Acquisition Program (purchasing short lines to prevent cessation of service) and the Strategic Corridor Program (funding improvements on Ohio's mainline system).

Case Illustration 9: Inland Ports

Type: Facility

The Projects[35]

A true "Inland Port" is a remote freight processing facility and body of infrastructure that provides advanced logistics for ground, rail and marine cargo movements outside of the normal boundaries of marine ports. In effect, it extends a marine port to an off-site, inland location by providing (1) a remote, inland multimodal distribution center for marine/rail and marine/truck transfers, with (2) a direct rail or barge shuttle that moves cargo between ocean-going vessels at the main port and the intermodal transfer site on a frequent basis, and (3) advanced scheduling and tracking of cargo so that the inland port is effectively functioning as an extension of the main port.

By relocating the truck and rail distribution facilities away from the main port site, the inland port facility:

- reduces congestion from truck traffic in the area of the main port,

- reduces rail/roadway intersection delays, and
- removes constraints on port expansion that are attributable to truck capacity limitations.

There are several similar examples of inland port infrastructure projects, which are all discussed here because they incorporate similar characteristics. They are: the Virginia Inland Port (VIP), the European Container Terminal (ECT) in the Netherlands, Nilai Inland Port (NIP) in Malaysia, and New York's Port Inland Distribution Network (PIDN). Each of these inland port facilities includes all three of the numbered criteria listed above, and addresses all three of the issues identified in the preceding bullets. Each of them is operated either directly by the main port management or through an entity that is closely integrated and coordinated with the main port management. Following are brief descriptions:

- ***European Container Terminal, Venlo (ECT) –***The ECT is a remote port cargo processing facility located in Venlo, Netherlands, near the German border and also close to the Belgian border. It is 120 miles inland from the Port of Rotterdam. It works as a central processing center for container traffic flowing between the port and other parts of northern and central Europe. Containers are transported by rail to and between the ECT and the Port of Rotterdam, and by truck between the ECT and other locations in Europe. A new rail line to Germany (the Betuweroute) is also under construction. Land is available to steamship lines for container storage. A key feature is that the ECT controls inland port freight rail service and run the trains on schedule, to ensure timely deliveries in an advanced logistics network with the Port of Rotterdam.

- ***Virginia Inland Port (VIP) –*** The VIP was inspired by the Netherlands ECT. Operated as an intermodal container transfer facility, the VIP provides an interface between truck and rail for the transport of ocean-going containers to and from the Port of Virginia. It is located west of Washington, DC in Warren County, VA – 220 miles inland from the Port of Virginia and its marine terminals in Hampton Roads. Containers are transported by truck to the VIP for immediate loading upon a rail car or for short-term storage prior to loading. Containers arriving from Hampton Roads terminals are unloaded from the train and dispatched by truck to inland destinations. Daily trains run between the VIP and the marine port. The VIP allows for both USDA inspections and SGS inspections, and is a US Customs-designated port of entry, with the full range of customs functions.

- ***Nilai Inland Port (NIP) –*** The NIP is a new logistics facility combining the services of a port and a distribution center. The facility is located about 50 km south of Kuala Lumpur, 22 km from the International Airport and roughly 40km from Port Klang. It is directly accessible via an interchange of the North-South Highway and has its own rail spur connected to the main railway line connecting Kuala Lumpur to Thailand in the north and Singapore to the south. The complex includes container handling, port services such as documentation and customs clearance, cargo handling and consolidation, transportation to and from the Port Klang seaport, local and domestic distribution, bonded and third party warehousing, and administrative services. It also features 522 commercial units (for small and medium size factories and commercial businesses), an 8,500 sq. meter bonded warehouse, a container yard, a four story office block, a temperature-controlled building and a Customs office complex. Unlike the other three examples, NIP does not have direct rail service to the seaport. However, it functions as a central location along the main international rail line, from which goods can be efficiently distributed via truck to and from Malaysia's main airport and seaport. As such, it functions as a remote facility for port services and container transfers to the railway system.

- ***NY: Port Inland Distribution Network (PIDN)* –** The PIDN is an emerging network of remote facilities for processing and distributing containers moving into and out of the Port of New York and New Jersey by barge and rail – in addition to trucks. Started in early 2003, the system is designed to represent a "hub and spoke" extension of the Port of NY-NJ, with direct transshipment of containers between ocean-going vessels at the marine terminals, and barges or trains serving the marine terminals and inland regional truck and rail distribution facilities. The remote facilities are to offer cargo handling, consolidation and intermodal logistics for freight movements to and from the Port of NY-NJ, and reduce the need for container storage in the space-constrained NY-NJ Port district. The initial Spring 2003 startup was a direct barge connection to a new container facility in upstate New York, at Albany on the Hudson River. Plans for the subsequent period were to stimulate development by the railroads of remote facilities linked by rail to Pennsylvania (Pittsburgh) and western New York (Buffalo), and to develop additional barge connections to upgraded facilities in New Jersey (Camden or Salem), Connecticut (Bridgeport or New Haven), Rhode Island (Davisville) and Delaware (Wilmington).

- **Other Inland Ports** - Whereas all the above examples effectively operate as extensions of the main port, the term "inland port" is sometimes also applied more loosely, as a marketing concept. In this usage, it is promoting any location that features inland freight warehousing and distribution facilities, with barge or rail connections to international ocean ports. The term was actually introduced with the opening of the *Erie Canal*, and was featured in "The Inland Port, " an article by Nathaniel Hawthorne published in 1835. Today, *St. Louis* promotes the fact that it is "the country's second largest inland port with barge connections to 29 U.S. metropolitan centers and the world via the Mississippi River." The *Greater Columbus Inland Port* (in Ohio) was set up in 1992 as a marketing and coordination effort to promote the fact that the Greater Columbus, Ohio region has a set of transportation infrastructure, freight handling facilities and support services for distribution-sensitive companies that need freight shipped in a timely manner via air, rail and/or sea. The *Kansas City Smartport* is an "Inland Port Trade Processing Demonstration" that markets the Kansas City region by developing and demonstrating the application of super-efficient international trade processing for movements between Mexico, Kansas City and Canada. Finally, there is the *March Inland Port* – the name for an industrial park at the site of March Air Force Base in Riverside, California, which is being marketed as featuring a cargo airport along with freeway access and rail lines that make it desirable for businesses requiring multi-modal access. Each of these other examples uses the term "inland port" to apply loosely to inland locations with transportation connections to seaports. However, none of them work as integrated extensions of the seaport.

Relevance

All four of the examples of Inland Port facilities address the same port transportation goals:

(1) To make specific international seaports more cost-competitive for customers, by reducing dwell times for transshipping containers to trucks and other modes. This is achieved through more efficient intermodal logistics activities that are relocated away from the crowded seaport, and

(2) To reduce space requirements and congestion at the port, by reducing demand for truck traffic. This effectively allows the port to further expand container capacity and throughput, without the limitations of increasing space being needed for truck facilities.

Both of these goals – the reduction in customer cost and the reduction in space constraints on future growth – are directly associated with moving truck traffic out of the port, and substituting a remote logistics facility that furthermore makes it easier to utilize a broad set of rail connections for longer distance ground transport. By encouraging or facilitating rail transfers, the Inland Ports also end up supporting rail options as an alternative to truck movements along congested routes.

Motivation

All four of the examples of Inland Port facilities were motivated by a desire to preserve and enhance the market competitiveness of their associated marine ports. Specifics of these motivations are noted below:

- ***European Container Terminal, Venlo (ECT) –*** The ECT Venlo facility was initiated as a joint venture of the Port of Rotterdam with private sector banking and transportation organizations, as part of a master strategy to maintain the Port of Rotterdam as the world's number one container port. The Betuweroute rail line, profiled elsewhere, is also part of that same strategy of expanding the reach of the Port of Rotterdam into regional distribution centers. A consistent part of this overall strategy has been a recognition that expanded rail connections can provide cost efficiencies and environmental benefits, over alternatives that would further increase truck traffic congestion at the port area and along major regional and international travel routes.

- ***Virginia Inland Port (VIP) –*** The VIP was motivated by a desire for the Virginia Port Authority to strengthen its position as a center of maritime commerce. A market analysis research study showed that the Virginia port was primarily handling cargo traffic originating or destined outside of eastern Virginia, with a significant share of its current traffic (and a higher potential for growth) originating or destined for the US Midwest and Southeast. Following the example of the ECT in Netherlands, the study concluded that an inland port with rail connections to the Midwest could allow the port to expand its business base, add new customers and aid ship lines in protecting their own customer base. In addition, it was noted that the VIP gives operational flexibility and competitive cost savings over existing methods for handling intermodal containers.

- ***Nilai Inland Port (NIP) –*** NIP was initiated by the State Development Corporation of Negeri Sembilan, the Malaysian state that includes Kuala Lumpor. The facility was designed as a distribution and advanced logistics resource to encourage small and medium size businesses to locate and expand in the region, and to utilize the air, sea and rail resources that the region offers. While it offers land and building space for businesses, it was motivated by a desire to provide a resource and advanced service that can work with, rather than compete with, existing transportation and distribution service providers.

- ***NY: Port Inland Distribution Network (PIDN) –*** The PIDN was initiated by the Port Authority of New York and New Jersey. It was motivated by a realization that increasing truck congestion in the New York City metropolitan area can undermine the cost competitiveness of the Port of New York and New Jersey, and in the future threaten its market position as the leading East Coast US port. It was also seen that future increases in truck demand would serve as a factor limiting the future growth of port activity. Of the containers handled at the Port of New York and New Jersey, 84 percent are transported by truck, and truckers at the port already have to wait long hours for pick-ups at local terminals due to increased volume and security. The PIDN program was designed to improve connections to and from the port, reducing the dwell time through transshipping containers by barge and rail, and thus taking demand off trucks and speeding turnaround in the container yards. It was estimated that this could reduce the average cost of inland transport distribution by 20%. With future expansion of the PIDN, there would be the opportunity to locate inland terminals near or at centers of marine custom and service distribution activities in thirteen states.

Lessons & Outcomes

The Inland Ports generally are run by private operators, which limits available information on their level of use. The fact that they work in conjunction with the main ports also limits the availability of data separating inland port activity from total marine port activity. As a result, there are no hard statistics on the observed impacts of inland ports on shifting container handling, or reducing truck traffic at the main ports. However, some information can be gleaned on the actual and expected evolution of these inland port facilities over time, based on past history in the case of the Netherlands ECT and on future expectations in the case of the New York PIDN.

- ***European Container Terminal, Venlo (ECT)* –** The ECT system has expanded from the first inland port facility in Venlo, Netherlands (opened in 1982) to include a second inland port facility in Willebroek, Belgium (opened in 1999) and a third in Duisburg, Germany (opened in 2001), as well as Rotterdam's largest container port (Delta Terminal). The port of Rotterdam opened two new rail service centers in 1999. The ECT Inland Terminal at Venlo started with one daily shuttle train to/from the Port of Rotterdam, but has now expanded that operation to three trains daily – two between ECT Venlo and the Maasvlakte Rail Service Center (at Rotterdam's container port), and one between ECT Venlo and the Waalhaven Rail Service Center (at Rotterdam's bulk port). Container handling growth at the ECT Venlo facility was up by 20 percent in 2002, which ECT attributed to the reliability of the rail link to the main port, and to the reduced level of congestion on national motorways that had helped improve truck access to/from the distribution center.

- ***NY: Port Inland Distribution Network (PIDN)* –** The inaugural barge service to Albany lasted about three years and moved approximately 8,500 containers. It was terminated because of the lack of long-term funding commitments able to support the service through five years or more. However, the constraints and congestion at New York remained severe, and the promise of PIDN for systematic reduction of these problems still remained attractive to the Port and its regional partners. Consequently, the lessons from the Albany experience have since been applied to the development of roll-on/roll-off barge service across Long Island Sound to Bridgeport, CT. Not ready for launch at the time this is written – and a short-sea initiative instead of a rail-based one – the Bridgeport service is appealing because of its potential for economic stimulation in a lagging area of Connecticut, and its ability to reduce truck travel on the busy Interstate 95. The original projections for the PIDN program held that when all of the regional ports were in place, the percentage of marine containers moved by truck would fall by one-third, and almost 1,000 truck trips a day would be diverted from New York State roadways to other transportation options. Possible traffic shifts of this magnitude sustain interest in overcoming the program's setbacks.

Implementation

All four of the inland port facilities were set up by public initiatives involving local or regional public agencies, working in concert with private operators of shipping, rail or barge lines.

- ***European Container Terminal, Venlo (ECT) –*** ECT is a private limited liability company (BV) that provides advanced logistics and operation of container services for three-fourths of the container traffic at the Port of Amsterdam. ECT is an entity set up by three organizations – the public port operator (Rotterdam Municipal Port Management), a private company (Hutchison Netherlands BV) and the financing bank (ABN AMRO). ECT first established the Inland Terminal at Venlo in 1982, with daily rail service to the Port of Rotterdam. ECT has fully incorporated the Venlo facility into ECT's container control system at the main port, allowing for seamless scheduling and handling of containers that successfully allows users to view the inland port as an extension of the main port.

- ***Virginia Inland Port (VIP) –*** The Virginia Port Authority (VPA) is a state agency that operates marine thermals at Newport News, Norfolk and Portsmouth, VA. In 1983, VPA set up a separate company, Virginia International Terminals, to operate its marine terminals. In 1984, VPA and VIT conducted a study mission to Europe, which examined the success of the new ECT inland terminal in the Netherlands. Subsequent discussions with Norfolk Southern Railway led to common interest in the concept, and the development of a plan to establish an inland port facility in Warren County, near Washington, DC. In 1987, the Governor of Virginia announced plans for state funding to establish the facility, to be owned by VPA and operated by VIT, working with the railroad. In 1989, the Virginia Inland Port was opened. VIT has linked the inland port into its computer operations at the main ports, thereby coordinating all container movements with rail availability and ship line departures and arrivals. With the addition of the inland port VPA operates at a profit, although it receives capital development and maintenance support from the state through its Transport Trust Fund and its Commonwealth Port Fund.

- ***Nilai Inland Port (NIP) –*** NIP was set up as a public-private joint venture, involving Syabinas Holdings Sdn. Bhd and the State Development Corporation of Negeri Sembilan (Perbadanan Kemajuan Negeri, Negeri Sembilan-PKNNS) Seventy percent of the equity is owned by Syabinas Holdings and thirty percent by PKNNS. NIP commenced operations in mid-1995. The facility was developed at a total investment cost of RM120 million (US $32 million). That includes the building of offices, factories, shop houses, a warehouse, and a container yard. The built up factory units were specifically designed to cater for small and medium scale industries.

- ***NY: Port Inland Distribution Network (PIDN) –*** The PIDN is a public/private partnership. Its partners include the Port Authority of New York and New Jersey, prospective feeder port operators, and state and local government agencies that support PIDN development. The Port Authority of New York and New Jersey initially committed $6 million to assist with the start up costs for the new distribution system, beginning in 2001. With an estimated total cost of $1.8 billion, the PIDN development process was expected to go through mid-decade in order to be completed. Federal Congestion Management Air Quality Program (CMAQ) money was used to provide almost three years of capital and operating funding for the initial PIDN service, which ran barges up the Hudson River to an inland container port at Albany, NY. Even so, this service did not become self-sustaining during the period and ultimately was discontinued for lack of funds. While other potential ports in surrounding states have been slated for possible start-ups in subsequent years, a major obstacle to development of the full PIDN program remains the lack of external funding commitments to cover anticipated deficits in operating and investment capital, during the long periods required for services to mature in the market.

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4 SHIPPER NEEDS & STRUCTURAL FACTORS

4.1 Introduction

For railways to produce material relief for the congested roads of the nation, the rail system must capture highway traffic. Therefore in many ways, diversion of traffic from road to rail is the heart of the issue that forms the subject of this report. This chapter examines shipper needs and structural factors that produce conditions favoring diversion or constraints that hamper it. Its chief objective is to assist planners in coming to a realistic judgment of the market and operating conditions that shape and show the probable payoff from rail solutions to congestion.

Analysis of diversion options becomes quite complex when it takes in the interaction of factors and motivations at the level of individual shipments. The purpose of this chapter is to reduce those factors to broad, true outlines that offer a compass to planners, by which they can navigate the forest from amid the trees. In a sense, diversion can be brought down to a simple proposition: good, low cost service wins business from competitors, and the obstacles and advantages for rail in delivering this are what have to be understood. An evaluation in practice will not play out simply, yet this perspective is important for testing whether a result makes sense: diversion analysis is competitive analysis, and strongly competitive service should succeed.

Since the overarching goal of this report is reduced congestion, and greater effective capacity for the highway system, then preservation of rail traffic is important, because it prevents additional, often heavily laden volume from being introduced to the highways and further eroding their performance. It means that the problem of pickup and delivery is important, because these trip-end services occur more frequently in urban areas. If they must operate by truck instead of direct rail, then there will be limited rail relief in urban areas, which are among the most congested. Lastly, as the Guidebook discussed, incremental traffic has a greater detrimental effect on system performance in already congested networks. This implies that as freight traffic on the roadways continues to build, the value of diversion to rail grows greater.

This chapter moves through five additional sections, beginning with a presentation of basic customer motivations, then builds toward an understanding of the limitations and opportunities for diversion, and concludes with a review of diversion's effects.

- Section 3.2 – *Shipper Needs*. Understanding of modal preference starts from the foundation of customer needs. Their portrayal in this section ranges from service, cost, and other requirements to carrier selection. The market positions of modes are indicated, and the discussion introduces the concepts of equivalence, conversion, and categorical distinctions in service.

- Section 3.3 – *Structural Factors*. Important limitations to rail are posed by the conditions of access, and the addressable extent of the highway market. The characteristics of truck fleets are described as modal competitors and intermodal partners, and the challenge of interoperability as well as the urban problem are highlighted in this section.

- Section 3.4 – *Market Segmentation*. Recognition of the differential nature of market sectors helps to uncover diversion opportunities, and to verify their realism. Markets are considered in this section from the demand and supply sides, in retail and wholesale aspects. A freight rail typology and market benchmarks are presented, and the discussion concludes with a framework for market segmentation, useful as a basis for diversion evaluation.

- Section 3.5 – *Diversion Opportunities*. The prospects for highway diversion are different for the railcar and the intermodal businesses, while the short-haul freight market is large, significant for congestion relief, and difficult to approach. This section considers the singular qualities of opportunity in each of these areas, employing a number of case examples and distinguishing prospects of national magnitude from those with local promise.

- Section 3.6 – *Impacts of Diversion*. Modal diversion alters the locational impact of freight, creating new traffic concentrations on rail lines and around transload facilities, yet improving mobility for other traffic left on the roads. The marginal effects of diversion in economic and social dimensions are reviewed in this section, including congestion, economic development, environmental, safety, and community consequences.

4.2 Shipper Needs

Purchasers of freight transportation are motivated by a series of factors in their selection of providers. Chiefly they are concerned with performance specifications and value, within the overall context of the logistics of their business and its contribution to customer satisfaction. These factors are variously described as purchasing criteria or selection requirements, but are most simply called shipper needs (although the purchasers of transportation may be receivers or managers of freight, and not properly shippers at all). Adopting simple terms for this discussion, the two primary needs of shippers are service and cost.

4.2.1 Service

Service fundamentally means the reliability with which goods are picked up and delivered as scheduled or expected, and the transit time or speed of that process. Reliability can be understood as the variability of performance versus a standard, which typically is an appointment time and a tolerance range around it. An example of a reliability measurement would be "95% of deliveries on time", where 'on time' means within one hour of the appointed moment. Precision arises as an aspect of service when the tolerance range narrows, down to fifteen-minute windows around appointments, or with financial guarantees for a fixed, daily deadline. Service on the pickup end also entails equipment capacity to collect the shipment, and the turnaround time for equipment to cycle back. Examples would be the railcar supply during the harvest season, or the availability of trucks around big retail distribution centers, and it is routine for shippers to require commitments of equipment from their freight carriers. Finally, frequency of service effectively is a facet of transit time, because it adds to the hours elapsed between the point when a shipment is ready for pickup, and the point when it can be delivered. In irregular route systems (like significant parts of the US truckload business), frequency is a direct function of equipment supply, but in regular route operations the availability, number, and timing of departures is a major determinant of effective service. In railroading, departures correspond to the number of trains running per day and per week; in other planned route networks the departures might be planes (in air freight) or linehaul trucks (in LTL and small package trucking). It's worth noting in these systems that departures have a high fixed cost component that tends to depress service frequency, and creates a temptation to consolidate departures, thereby reducing costs but downgrading performance.

Two additional points should be made about service. First, it is measured door-to-door, which means from the shipper's door to the door of the receiver. This is a salient point for railroading in the context of highway relief, because in the commonplace absence of direct rail access to the customer facility, goods must be transloaded and drayed, and this can[36] add to time and cost. Furthermore, the railroad and the drayage truck performing pickup and/or delivery normally are not under common operating control, implying that door-to-door service performance depends on the cooperation of independent agents. This issue of cooperation affecting service also exists for interline handoffs between the major rail systems prevailing today in the eastern US, the western US, Mexico and Canada.

Second, there is a common misperception that the speed of transit is not especially important so long as deliveries are predictable. Reliability or predictability is the most crucial feature of service, and shippers may exist who value it to the exclusion of transit time, but speed of transit is an essential factor in modern logistics:

- There is a well-documented movement in industrial management to reduce the cash-to-cash cycle time of business, which refers to the time between the purchase of inputs or merchandise, and the point when goods are sold and paid for. Time compression is sought in every aspect of the cycle, implying that speed is important everywhere. One core motivation for this trend is market responsiveness, whereby the productive capacity of a supply chain reacts swiftly and flexibly to local activity at the points of sale. Adoption of low inventory, high speed logistics systems is key to this capability. In a large survey of freight shippers released by Morgan Stanley Equity Research, the number one reason that shippers had not shifted more truck freight to rail intermodal was slow transit, followed closely by unpredictability of service.[37]

- Truck lines form an important intermediate customer group for rail intermodal services, providing both the pickup and delivery operations and the retail marketing to shippers. In market research conducted for the Virginia I-81 corridor, motor carriers made the significance of transit time performance quite clear. For fixed route truck lines that have published schedules, rail must meet or improve the schedule or it cannot be used; for irregular route truck lines, the standard of comparison is the over-the-road speed of a single driver, and the utility of rail is diminished if it cannot match or improve upon the standard. An additional finding in this research was that transit time performance behaved as a step function measured in whole or half days. Speed improvements are significant when they cross this threshold, but are not very meaningful in smaller increments. Coupled with the fact that speed is evaluated door-to-door, this finding points up a competitive hindrance to rail in short distance lanes, which will be explored further on in this chapter.

4.2.2 Cost

Cost considered narrowly is the price charged by the carrier for the shipment, but more broadly and substantially it is the total set of costs attendant to doing business with the carrier and mode. Like service, it must be totaled door-to-door, and include any separate charges for pickup, delivery, and transfer. Costs are compared by unit shipped – per piece or per pound, for example – and thus are sensitive to the loading capacity of transport equipment and to the size of the shipment. Comparisons also have to be aligned by miles traveled (commonly called length of haul), first because distance is a primary and obvious driver of transportation costs, and second because of the changing proportion of pickup and delivery to linehaul costs, as miles lengthen. Pickup and delivery tend to be time and therefore asset intensive; railroads in particular find their comparative advantage lies in the efficiency of linehaul.

Total logistics cost is the most comprehensive way to view the sum of the expenses attached to doing business with a carrier or mode. The term 'logistics' especially brings in the inventory carrying costs associated with the lot sizes, transit time, and service reliability offered by the carrier. The inventory itself expands into the building space, the staff, and the administrative expense required to support it. Provided the value of the goods shipped is known, the inventory financing charges for lot sizes and transit time are calculable; however, the cost of some of the other elements can be difficult to measure, notably for analysts (like public planners) who are not privy to shipper's internal information. From a practical standpoint, there are two observations to make about logistics cost and its effect on carrier selection and diversion:

- Low inventory logistics are a manifestation of a deeper business process. When just-in-time practices were introduced to industry, they were focused not so much on stock reduction as on eliminating the process failures that inventory covered over. As the evolution of supply chain strategies has turned the focus to market responsiveness, the value of that strategy to business overwhelms other considerations,[38] and logistics practices are engineered to execute it. Shippers in this sense are seeking the right transportation products in terms of service performance and carrying capacity; while transportation costs matter, additional logistics factors have been obviated by the performance standard. In other words, if a transportation product imposes significant inventory burdens on the logistics system, it can't meet the engineering requirements and doesn't qualify for purchase.

- Apart from rates, the logistics cost differences between carriers are largely a function of modal technology. Motor carriers certainly compete on service, but they are broadly substitutable one for another in terms of their logistics effects. The logistical implications of rail carload service can be significantly different from motor carriage, on the other hand, and are an impediment to diversion. Even so, the class of railroad service that competes most aggressively with highway transportation and is most likely to produce congestion relief is the intermodal product, which strives to emulate truck performance and offers the shipper equivalent loading characteristics. As the rail product becomes substitutable for all-highway service, supply chain effects start to become immaterial, and total logistics costs collapse to the difference in transportation costs.

Transportation costs are structurally dependent on modal technology, and are fundamentally influenced by two forms of volume efficiency: consolidation economies, and economies of density. Consolidation denotes the ability to combine shipments into larger lots by grouping or unitizing them, or by accumulating them to travel together. It can be performed by the shipper in tendering larger amounts of freight, or by the carrier or intermediary in combining freight from many shippers into quantities that will fill a truck, or make up a block of cars on a train

Density refers to the concentration of market volume in time and space. Its major components are:

- *Balance* – the ratio of delivering (inbound) shipments to originating (outbound shipments in an area;

- *Proximity* – the distance between delivering and originating shipments, or the interval distance between sequential deliveries or pickups in a chain;
- *Vector* – the direction of volume, often characterized as a lane;
- *Confluence* – the joining of vector volumes in common, arterial sections of a network. Vector and confluence are critical to railroading, because its unit of production – the train – depends on directional traffic concentration;
- *Frequency* – the timing of volume, as it determines the immediate relationships of balance, proximity, vector and confluence in a spatial zone.

Consolidation and density both are concerned with the organization and dynamics of traffic flow, and in turn are determinants of transportation asset utilization. Utilization measures the productive work of assets – facilities, right of way, and especially mobile equipment – in terms like revenue per day, cycle time, and loaded to empty proportions, and it keenly affects return on investment. A strong positive relationship usually exists between density and utilization on the one side, and service performance on the other, such that quality and efficiency can be mutually reinforcing attributes. Because of this, the advantage of density can be thought of as conferring a service economy. Finally, carriers can control utilization by a variety of means; an important one is management of the dispersion of assets across geographic territory, where less concentration is detrimental. This is equivalent to the military principle, under which the effectiveness of armies is related to the force they exert, in ratio to the space in which they operate.

4.2.3 Other Needs

Beyond the two primary requirements, shippers consider a series of additional factors in carrier selection: geographic coverage, affecting lane service and the ability to single-source; relationship, including customer communication and incumbency; and ease of doing business. Three of the most prominent are visibility, risk elimination, and specialization, which are discussed below. The relative significance of these factors varies with the shipper's industry, and can rise to the importance of service and cost in some cases. The chemical industry, for example, values risk elimination highly, while shippers of produce care about the equipment and knowledge specialization that delivers their products fresh and unbruised to the market.

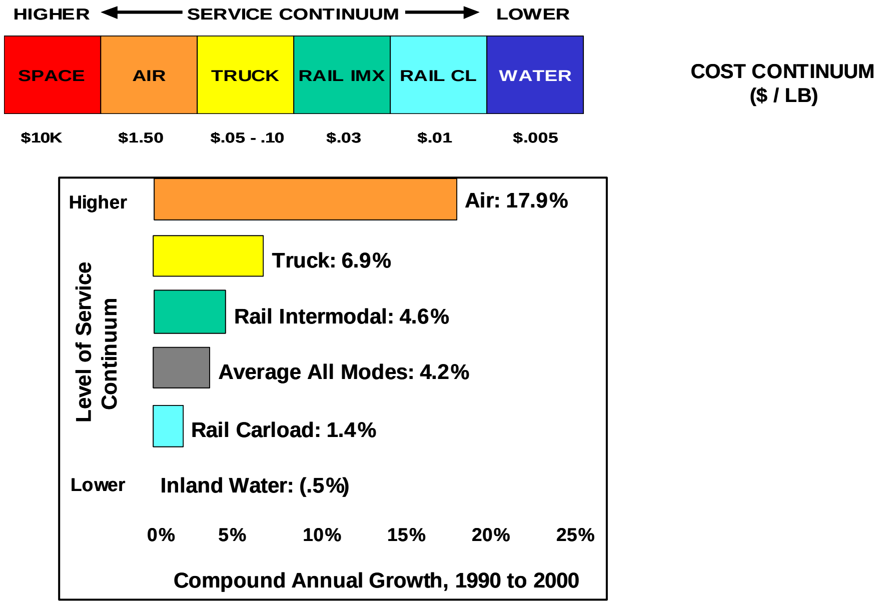
- *Visibility* – The movement to low inventory, market responsive supply chains has caused the visibility of product inside the system to become vital. The objective ideally is to be able to locate and affect any item in real time anywhere in the chain: at the factory, the warehouse, the store, or aboard the freight carrier. The traditional role of inventory as a guarantee of goods to customers has been transferred to information systems, transportation systems, and integrated supplier management. Shipment tracking historically was a carrier support function for service assurance; under fast cycle logistics, it makes a crucial contribution to total supply chain management. Development and adoption of a range of mobile communications tracking technologies have created the ability to follow and direct the movement of power units; trailers, containers, or cars; and the goods inside them. A carrier who provides visibility to a customer offers a combination of technology (transponders, cellular devices, bar codes and radio tags are examples as this is written), data processing and communication systems (currently including web-based platforms for shippers to tap carrier data), and operational controls, all combining to produce actionable information about goods in transit.

- *Risk Elimination* – The components of risk are safety, claims, and environmental protection; equipment maintenance; insurance; security procedures; and the stability of finances and labor. They are directed at four issues: a) the safe handling of goods, including hazardous goods, and the ability to respond and make recompense in the event of incidents or loss; b) the protection[39] of goods from theft, vandalism, and violence, and of the transportation system from highjack and terrorism; c) the safe conduct of transportation, and the avoidance of accidents harming people and property; and d) the dependability of the carrier as a going concern, so that shipments tendered and logistics programs built around the company can be expected to proceed without disruption.
- *Specialization* – Expertise in the shipper's business is helpful to the client in many industrial segments, and is critical in some. Specialized equipment is a prerequisite in numerous areas: temperature controlled goods, automobiles, apparel, and heavy machinery are examples. Equipment (specialized or not) may be dedicated to a shipper, or an entire operation may be contracted, including motive power and on-site staff. Training or simply experience in product handling and plant procedures turn carrier personnel into approximate extensions of the shipper's staff. Where dedicated or specially trained work forces are used, the carrier may assume logistics functions such as preparing store-ready merchandise with tagging and displays. Specialization in these instances crosses into out-sourcing and third party logistics.

4.2.4 Carrier Selection

Freight modes offer a characteristic mix of service and transportation cost advantages, and can be arrayed in a continuum as shown in the first chart of the accompanying Figure 4-1. Individual carriers and operations may perform above or below the tendency of their mode, but it generally holds that motor carriage offers superior service to railroading and earns a higher price, while the intermodal product for rail is the closest to truck performance. The importance of service is borne out by modal growth rates in the 1990's, which directly correspond to position along the continuum (seen in the second chart of the accompanying Figure 4-1). These illustrations suggest the fronts of modal competition, and the areas of the market where traffic diversion is most apt to take place: intermodal versus highway, highway versus air, barge versus carload rail. Two points should be acknowledged about this profile:

Figure 4-1 Transportation Cost Advantage Continuum

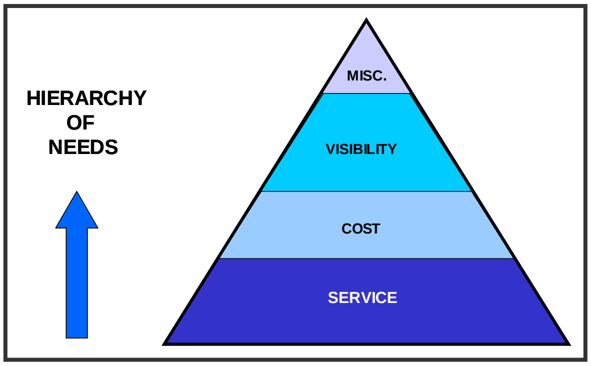


- Shippers may employ a portfolio of carriers and modes, according to the span of their logistics requirements, geographic exigencies, and movements in their markets. Their needs therefore may require a diversity of solution.
- Freight carriers or companies seek to transfer the portfolio function from shippers to themselves, by utilizing multiple modes beyond the one they may be known for. A current expression for this is mode neutrality, indicating that carriers market certain performance specifications to shippers, while trying to reserve to themselves the responsibility for deciding the method of accomplishment. Of course, the selection of modes and sub-modes matters to the execution. In practice, some specifications are synonymous with a particular mode, and some shippers will penetrate the veil of neutrality if they are concerned for the risks that a mode may pose, or want to assure themselves a share of a cost advantage.

Shippers consistently rank their needs as service first and cost second. Numerous studies through the years[40] demonstrate this, and typically stress reliability or on-time delivery as the foremost feature, followed by transit time. Priorities after the cost feature fluctuate by industry group, as noted above, and of course individual shippers may deviate from the norms. Freight carriers nevertheless react with cynicism to the primary ranking of service, because their competitive experience is that shippers care chiefly about cost.[41] Understanding this apparent discrepancy is useful, because it points up dynamics that influence analysis of diversion.

Figure 4-2 presents the prioritization of shipper needs in the terms of Maslow's hierarchy. Abraham Maslow was an American psychologist who posited a theory of human needs, under which basic requirements like food and shelter had precedence over emotional requirements like social esteem, but each level of the hierarchy formed a threshold below the next. This meant that, so long as more fundamental requirements were being met, the focus and object of behavior would move up to higher levels of need, and the basic needs would recede as motivations unless they were threatened. Clear examples were available from the Second World War, when the survival needs of middle class citizens rose strongly to the fore, then fell back behind social concerns after the conflict ended.

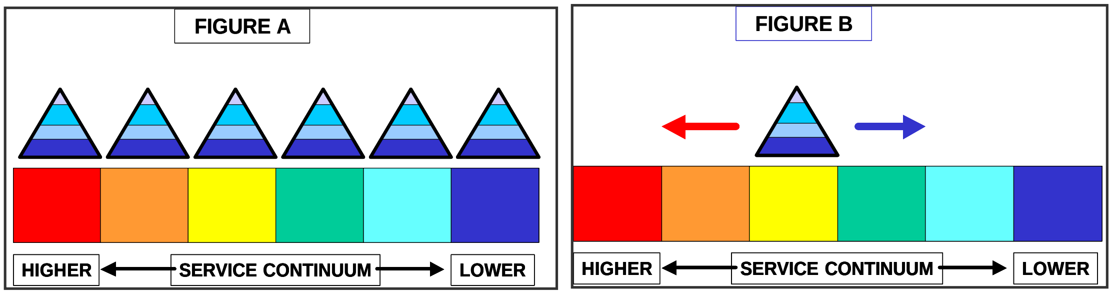
Figure 4-2 Hierarchy of Shipper Needs



As an interpretation of shipper behavior, the hierarchy places service at the level of basic needs.[42] Because the first job of the shipper is to satisfy such needs, normally they have already done so, and the focus of their behavior has moved up to cost. In competitive markets cost is so often malleable (and shippers work hard at improving their power over it), that even when shippers are seeking to satisfy higher-level demands, cost is rarely a wholly resolved need and doesn't drop out of the picture. This explains the carrier perception that customers care chiefly for price. The precedence of service is evident from the vigorous and early steps shippers take to respond to the threat of a strike or the collapse of a carrier: traffic is diverted to more stable, even more costly alternatives, until the disruption is ended.[43] Service disruption is not the normal state of affairs, of course, and in the condition of normalcy service needs stand as satisfied

However, the modal differences function as *categorical* distinctions in service – meaningful and plain – and shippers manifestly do observe these distinctions in their modal portfolios. Interpreting this in terms of the Maslow model, shipper satisfaction at the basic level of service is touched by disruption or carrier failure, or by categorical differences such as the several modal technologies produce. The service positions of modes, then, can be conceived as a series of hierarchies along the continuum (Figure A), or as a shifting of the hierarchy across its line (Figure B) in **Figure 4-3**. To summarize, shippers slot their carriers into logistical roles according to their categorical levels of service, and within those roles in an everyday way, carriers principally compete on cost.

Figure 4-3 Mode Service Position Hierarchies



The upshot of this is to render service as a step function in the dimension of reliability, as well as in the dimension of transit time. This is reinforced by two factors:

- Reliability entails a measure of trust. For that reason, a carrier who has proven reliable wins loyalty and is not easily abandoned, except for another who is equivalently trusted. Therefore, there is a certain amount of resistance to shifting of carriers over issues of reliability: the prevailing sense of satisfaction has to be disproven or disrupted, and shippers take time to change their position.

- Carrier performance in the aspect of reliability is not finely measured, because of the structure of business relationships. Shippers typically select the carrier, pay freight charges, and are held responsible for delivery failures – but they do not directly observe delivery.[44] Instead, they depend on customer complaints and exception reporting, on statistical shipment sampling or tracking of urgent shipments, and on carrier-generated performance reports (which allow slippage through tactics like resetting appointments). Hence, shippers 'know' carrier performance, but not precisely and not with complete data, and the implication is that shippers will not be sensitive to small gradients of reliability due to the imprecision of measurement. Prominent exceptions include cases where shippers control their inbound freight and so have direct data on performance (some of the large retail chains do this),[45] and cases where a carrier purchases contract linehaul transportation (such as a truck line buying intermodal service from a railroad).

Carriers within modes consequently are operating, and are perceived to be operating, all on the same plateau of the step function. Clear product differentiation in such circumstances is difficult – and this is what carriers report. To the extent differentiation exists, it is usually related to a cost advantage derived from network service economies, or to a transit time advantage produced either by the service economies or by specialization.[46] Railroads competing with motor carriers are a step behind and contend as an inferior good: shippers have to be offered a substantial risk premium to offset service deficiencies, provided they can utilize rail service at all.

For the purpose of diverting highway traffic sufficiently to affect congestion, rail services must climb to the step that motor carriers occupy. Small gradients in speed and reliability will not matter much, but equivalent performance is a categorical change in the railroad product proposition. Equivalence is achieved today in market segments that play to traditional railroad strengths, and is rewarded with market share. Intermodal rail, to use an obvious example, holds a commanding position for long haul transportation of containerized goods in dense intercity lanes. In these conditions, density supports dedicated trainload operations, and linehaul distance offsets inefficiencies in pickup and delivery; the result is that rail performs as well as a truck, with a lower cost.

Railroads are not likely to improve on truck performance and don't really need to; when the service plateau is reached, the shipper's objective turns to cost, and advantages in cost will win business. The objective is *equivalence*, and since motor carriage already can be equaled by rail in some circumstances, the core question in traffic diversion is, how broadly can equivalence be produced?

A final point on the value of parity is that it is an effective way to win motor carriers as allies of railroads, and through them to transform product equivalence into significant modal market share gains. Truck lines need cost superiority for their competition with one another, and some view intermodal linehaul as one method to obtain it, so long as a) the rail product matches their competitor's performance over the road; b) rail linehaul blends smoothly into their fleet operation; and c) rail usage can be translated into sustainable advantage. This last provision can be satisfied through a number of means: specialized equipment, knowledge of how to utilize railroads productively, train ownership, yard and slot priority, price preference, and pickup and delivery costs. Motor carriers have to develop trust in the railroad, but once they acquire it, their existing relationships with shippers help to reduce the resistance to change, and accelerate the diversion of traffic. Equivalence in this way is an instrument of *conversion*, in the sense of persuading opponents to cross over to a position of support.

4.3 Structural Factors

4.3.1 Access

Railroad sidings as a feature of industrial facilities have been declining for decades. Many businesses that possessed them have paved them over, or allowed them to fall into disrepair, and new industrial development for generations has been widely heedless of access to the rail system. Meanwhile, the long-term rationalization of the railroad network has caused it to shrink away from many areas that it once closely served, and left it far smaller than the highway system. A network whose major development ended early in the 20th Century has adapted to shifts in economic geography primarily through contraction, not growth.

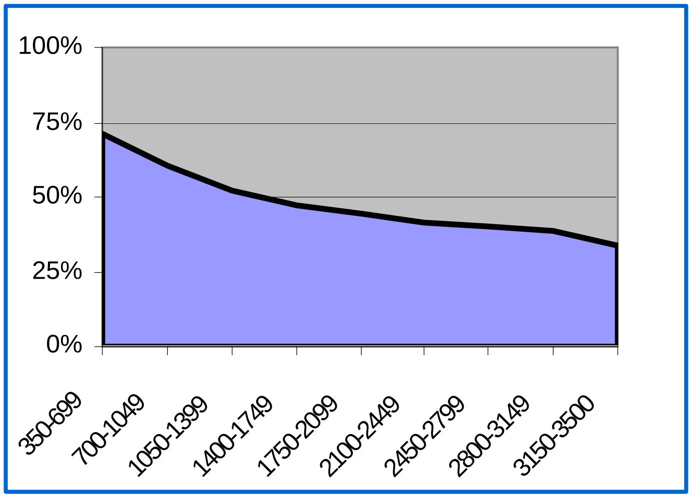
The trends reflected in these conditions are explored in the next chapter of this report. To indicate the consequences for traffic diversion, an illustration was prepared using a commercial database of American businesses, consisting of all manufacturing establishments with twenty or more employees. Establishment addresses first were geocoded to prepare them for cartographic examination. This process successfully coded 61% of the establishments, or about 100,000 businesses; additional effort could have raised the proportion captured, but with no evident bias to the coding failures, the result was an adequate sample for analytic purposes. Then, the coded establishments were checked for their proximity to rail lines, using a cut off of 500 yards (about a quarter mile) from the current, active network. This process found that just 34% of manufacturing businesses were within the cutoff distance, representing perhaps 35% of shipping volume. This assessment is not fine enough to identify the presence or absence of sidings,[47] but it is safe to say that a number of these businesses near the network will not possess an active or indeed any spur. The conclusion suggested by this exercise is that at least two-thirds, and perhaps four-fifths of US manufacturing sites have no on-line access to the railroad system.

The upshot is that most shippers require pick up and delivery at their facility to be handled by a truck, and utilization of rail service is predicated on transloading between modes. There are two primary types of transload and many subtypes:

- *Conventional Intermodal* involves the transfer of freight-carrying equipment – truck trailers or containers – between a rail and a road unit. The rail unit usually is some variant of a platform like a flat car, and the road unit is either a truck tractor to which a trailer may be hitched, or a tractor with trailing chassis, onto which containers may be placed. In most cases the equipment is designed or outfitted to permit transfer via a lift or crane, and thus is specialized for the rail environment in ways unnecessary for road operation. Subtypes includes bi-modal equipment (where the rail unit instead of a platform is a set of steel wheels swapped onto a modified trailer), Expressway-style equipment (where the rail car is a roll-on, roll-off platform that accepts standard, non-specialized highway trailers), and arrangements where tractors together with trailers ride on the rail platform (seen in some circumstances in Europe, but not currently in North America).
- *Carload Transfer* involves the transloading of goods between an ordinary rail car and a standard highway trailer. Subtypes include bulk transfer (such as the transloading of liquids via hose from railroad tank cars to tank trailers), break-bulk (such as the movement of metals via outdoor or indoor crane, from rail flatcars or gondolas to flatbed trailers), and finished automobiles (which are driven via ramp from railroad auto racks onto highway car trailers). This also is a form of intermodal transportation in the pure sense of the word, but for ease of reference, we will limit the term ‘intermodal’ to the transfer of equipment not goods.

Provision of rail access via transloading requires networks of on-rail facilities equipped to conduct the various forms of transfer, and trucking operations at each facility suited to handle the intermodal units or goods. The full spectrum of transload business demands multiple networks with distinct operations and few efficiencies of combination, and they need management and information support systems as well. Access costs are a major contributor to door-to-door transportation expense, and are the primary component of cost at shorter distances. Figure 4-4 "Intermodal Access Costs by Mile Block" demonstrates this for intermodal service. Extracted from the Virginia I-81 study and reproduced from the Chapter 2 case study, it displays lift costs plus pickup and delivery drayage as a percentage of total expense, by mileage door-to-door. As distance drops to 350 miles (the shortest haul examined in the study), access costs climb to 75% of the total.

Figure 4-4 Intermodal Access Costs by Mile Block (2-End Dray)



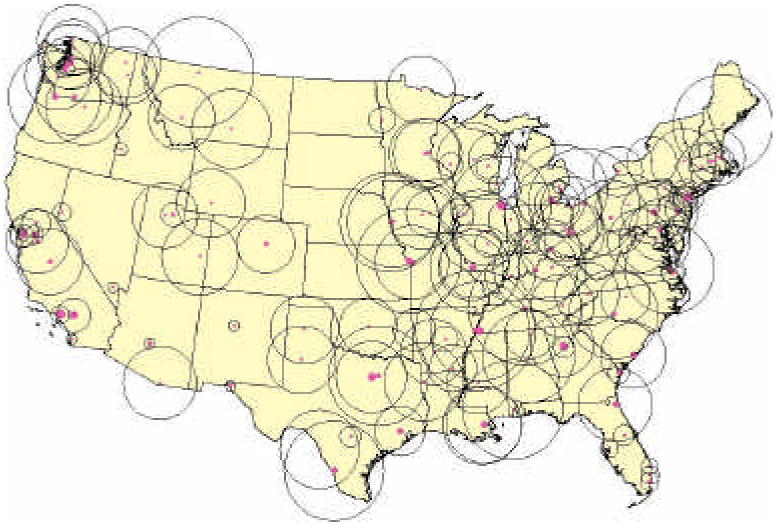
Two important implications should be drawn from this:

- Given the importance of access cost, the requirement for transload and drayage at one end or both ends of a freight shipment becomes an essential consideration. Direct loading to rail in shipside or auto plant environments, for example, produces one-end drays that improve the economics for those shipments, and clearly single-end drays matter to the viability of short-haul rail. The carload transfer business is most often a one-end, destination dray.
- The composition of access costs emerges as a critical factor. The absence of cranes and the heavy pavement to support them are an advantage to ramp-style terminals. The high rates of empty return associated with local intermodal drayage drive up its cost. An advantage to intermodal services with network motor carriers can be better load balance, produced by the situation of intermodal inside a larger trucking operation, and by the interchangeability of equipment.

The significance of access expense also points up a public planning policy lever. If public investment in terminal connections and facilities reduces transload expense, it improves the capability of rail to attract traffic. An experiment conducted for the Virginia I-81 project tested the influence of a diesel fuel tax credit aimed at intermodal drayage. The result was a boost in diversion from highway to rail, especially at shorter lengths of haul.

The effectiveness of the intermodal system at producing access is shown partially in the accompanying map "Intermodal Dray Coverage". It displays the dray radius[48] within which 80% of pickup and delivery activity occurs, for rail facilities that handle at least 1,000 annual units. Larger facilities appear as larger dots; the underlying data are drawn from TRANSEARCH, and reflect operations both of local draymen and network motor carriers. The map suggests reasonably thorough coverage of urban markets, and of territory as a whole in the East. Even so, there are gaps - notably in the Southwest and along the Gulf - and large portions of the less populated West are not served. Dray distances tend to be longer where there are fewer terminals or population is less concentrated, and at the East/West rail gateways along the Mississippi, where railroads will dray instead of interlining with one another. An important caveat to this display is that it does not capture the lanes where these terminals do and do not offer service. A full picture of traffic coverage addresses the questions of whether shippers can be reached by a terminal, and whether the railroad runs trains to the right destination markets. The map (Figure 4-5) shows the first, not the second.

Figure 4-5 Intermodal Dray Coverage



A final and major implication of the conditions of access is the *urban problem*. As shown by the FHWA maps reproduced in the next chapter of this report, congestion at root is an urban challenge, expanding through time from metropolitan districts into the roads between adjacent city pairs. The marginal public cost of heavy truck operation is materially higher as well on urban versus rural roads, for pavement, environmental, and particularly congestion elements.[49] Nevertheless, if railroad access is to be primarily via truck drayage, then it is precisely the urban areas that railways will find most difficult to relieve. Benefits from highway diversion will accrue to the regions through which the rail linehaul travels, but pickup and delivery will be consigned as before to the road.

The urban problem as an instance of access limitation is one of the chief obstacles to solving road congestion with rail diversion. While it is difficult, still it is neither a one-dimensional nor wholly intractable problem, as the following considerations demonstrate:

- Through truck traffic can be a substantial contributor to urban highway congestion in some segments, and is substitutable by linehaul rail. Moreover, as congestion threatens to grow well beyond city limits, its appearance on intercity routes can be headed off, at least in part, by rail alternatives.

- Direct rail access continues to exist, and can be exploited or extended in some circumstances. The competitiveness of carload service probably does not justify broad expectations for diversion (this is discussed further below), and this is the normal form for direct rail service to shipper doors. However, there are pockets of traffic where carload works and can work well, notably in dedicated train operations where service quality improves. Single-end drays are an important example of direct rail usage in the intermodal sector; port cities encouraging on or near dock rail, and factories capable of loading to rail at or beside their property, keep appreciable volumes of truck traffic off city streets. Capabilities of this sort can be developed, negotiated, or possibly zoned by city planners.

- Proximal rail access is an attempt to establish or retain transload facilities so as to hold down drayage distances (and truck VMT). The next chapter highlights the national trend for railroad terminals to move to the urban periphery, where land is cheaper and more plentiful, the neighborhoods sometimes more accommodating and the roads less congested. This trend results in central business districts losing close-in rail service; a twin terminal strategy like that recommended in the Chicago Rail Futures Study (described in Chapter 2) offers a resolution. In this approach, the peripheral terminal becomes a hub for suburban and exurban shipments, and builds shuttle trains for a downtown facility. Plentiful freight traffic in the Chicago market supplies density to justify the shuttle and the second terminal; in a smaller city, a public and/or share use facility could consolidate traffic, or underwrite costs with congestion tolls. A virtue of the ramp-style intermodal technology is that terminals are less costly and need less land, so it may be well suited for multiple facilities and central business district locations.

- Trans-urban corridors are a fourth way for rail to target city trucks. Motivation for existing examples[50] include line rationalization and reduction of road/rail interference, but they also diminish rail-based truck drayage, and conceivably could be directed toward cross-town truck traffic streams. An instance of the latter is the Chicago Transit Authority (CTA) air package express[51] scheme, described in the accompanying inset box. While this service was still in the planning stages and the associated volumes were light, it removed some of the most time-sensitive trucks from the city's most clogged roadways at the most valuable times of day. Here, as elsewhere, the support and conversion of the truck operators is essential to the prospects for success.

Case Study 1: Chicago Transit Authority Air Package Express

In 2003, The City of Chicago Department of Transportation, with the Chicago Transit Authority (CTA), launched a market study to determine the demand for scheduled rail freight service between a downtown terminal and the two major Chicago airports, O'Hare and Midway. The goal was to tap spare capacity in dedicated baggage cars aboard the Airport Express transit service to carry freight, thereby by-passing the region’s congested roadway network. The study found that the large integrated package express companies (such as UPS, FedEx, USPS, etc.) operating out of O’Hare saw significant benefits to using the proposed service to reduce the need for large scale trucking along urban freeways during peak travel hours. Initially, the primary interest would have been to use the rail service as a 'fallback' mode for when delivery deadlines were jeopardized as a result of severe congestion on the Kennedy Expressway. Progressively, as logistics chains were re-engineered to take advantage of the reliable service and the region’s roadways became even more congested, the rail freight solution could become the least cost mode and an effective means to maintaining a high-quality service into the Chicago downtown. The primary contribution of rail freight in this case was to leverage the schedule reliability associated with a dedicated right-of-way transit service to allow a later last-pickup and a more efficient sorting at airport cargo facilities. If recurring highway congestion prevented reasonable package delivery windows from being met, the package express firm would suffer, but the productivity of downtown firms would also decrease, and Chicago would become less competitive for businesses relative to the suburbs and other cities.

The Chicago Express case demonstrated several important concepts in applying rail freight solutions to roadway congestion. Firstly, the direct benefit of removing trucks from highways may be marginal, and contributes relatively little to easing congestion that is predominantly attributed to commuting automobiles that demonstrate high time-of-day demand peaking and poor utilization of highway capacity. The entire Chicago Express scheme could remove about 20 trucks per hour in total, against a background of approximately 4,800 peak-direction vehicles that could theoretically move along the highway. However, the impacts of such schemes may be far more important than the marginally diminished congestion that motorists may experience as a result. The Chicago Express scheme attacks freight congestion in an area that is most leveraged: small packages are highly time-sensitive, urban corridors are highly congested, and removal of peak-hour vehicles has the highest value. The net contribution to the Chicago economy due to expedited freight packages may be substantial. Although such schemes may not have the system-wide impacts associated with the Kansas City Flyover and the Alameda Corridor, its significance for the City of Chicago should not be understated. Since congestion occurs mainly in dense urban areas, intra-urban schemes such as this could be as effective as large-scale highway or railroad capacity expansion to provide for time-critical freight needs. Infrastructure investment in rail freight could allow rail to become competitive in commodities that require a higher level of service, and the efficiencies associated with rail transport may provide significant benefits to regional economies over other options, such as continued expansion of highway networks to accommodate peak-period traffic. An Urban Intermodal Network constituted from dilapidated branch lines and underutilized city yards could conceivably reduce both congestion and intermodal drayage times by minimizing truck moves through congested urban street network and funneling intermodal traffic to the intermodal 'terminals' located in suburban and rural areas more efficiently.

3.3.2 Addressable Market – Five hundred miles is the rule of thumb limit for the distance a truck can travel overnight in the US; originally it reflected the typical performance of a rested single driver on good roads over a ten hour shift. Like any rule of thumb, it is not always and everywhere true. The hours of service regulations introduced by the US Department of Transportation in 2004 lengthened the driving shift to eleven hours, but straitened the definition of off-duty time. The effect was that a pure line haul driver (like LTL carriers use, or truckload operators when pickup and delivery is a quick ‘drop and hook’) could take the overnight distance out to 550 miles and more; conversely, a driver tied up waiting for pickup or delivery, or physically loading and unloading trailers, could travel less far. Driver teams can manage a longer distance if they get an early start; distances are shorter when drivers are not fresh, or run many miles empty before starting off with a load.

Table 4-1 Length of Haul Distribution by Trucking Segment

Distance	All Truck	Fleet Operation		
		Truckload	LTL	Private
200 Miles & Under	74%	71%	55%	78%
500 Miles & Under	91%	87%	75%	95%
Over 500 Miles	9%	13%	25%	5%
Proportion by Segment:		47%	1%	51%
Proportion 200 Miles & Under:		45%	1%	54%
Proportion Over 200 Miles:		53%	2%	44%
Proportion Over 500 Miles:		69%	4%	27%

Distance	All Truck	Trailer Type						
		Dry Van	Reefer	Flatbed	Bulk	Tank	Auto	Livestock
200 Miles & Under	74%	75%	39%	61%	85%	70%	27%	52%
500 Miles & Under	91%	92%	71%	85%	92%	92%	51%	68%
Over 500 Miles	9%	8%	29%	15%	8%	8%	49%	32%
Proportion by Segment:		69%	2%	5%	10%	14%	0%	0%
Proportion 200 Miles & Under:		70%	1%	4%	11%	14%	0%	0%
Proportion Over 200 Miles:		66%	4%	7%	6%	17%	0%	0%
Proportion Over 500 Miles:		64%	6%	9%	9%	13%	0%	0%

The outcome of all this is that 500 miles probably remains an adequate measure for overnight distance over the road. In the most common business arrangement, shippers tender freight at the conclusion of the day and want to receive at the beginning, so the overnight distance describes the transportation service standard between the end of the work day and start of the next. Ninety-one percent of truck freight shipping falls within this limit, as the accompanying Table 3-1 "Length of Haul Distribution by Trucking Segment" demonstrates, and some three-quarters of it lie within 200 miles.[52] Interestingly, 44% of all rail freight tonnage also moves within 500 miles, and 22% within 200 miles; however, rail transit times typically are much longer than overnight.[53] In intermodal services, which are the chief alternative when direct rail access is absent, and are the most substitutable for truck transportation, just 14% of rail tonnage is below 500 miles and perhaps 2% is below 200.[54] For service reasons, and for reasons of access and costs that were explored above, it is difficult for rail to address the distance segment of the freight market where most of the truck traffic lies. This explains the acute interest among public planners in short-haul rail, and that subject is treated in detail further on in this report. Of course, greater inroads by rail into the medium and long distance markets still would reduce freight highway traffic by an appreciable amount, and matter to congestion in many localities. However, there are meaningful ways that these markets, too, are not being addressed by prevalent rail technology and practice.

Fifty-eight percent of intermodal unit volume in 2005 was international containers ultimately tied to international trade, according to figures from the Intermodal Association of North America (IANA).[55] This proportion had climbed from 52% in 2000, and international units accounted for 78% of the intermodal volume growth during this period. Truck tonnage on US highways, on the other hand, runs 95% domestic, and of the part that is international trade, about 40% is NAFTA traffic.[56] While rail intermodal has done a very good job in absorbing the transportation burden of US foreign trade, it has not been aggressively addressing the domestic highway market.

Domestic intermodal unit volume grew 14% from 2000 to 2005, compared to 49% for international units, again according to IANA. All of this growth was in domestic containers, since the trailer traffic dropped by 2%. Trailers accounted for only 19% of the intermodal business in 2005, down from 26% five years previously. The significance of these shifts is this: the domestic container is another specialized piece of intermodal equipment. It is designed to capture the cost saving of container stacking in linehaul train service; while the longer 53' units (which not all are)[57] have the same carrying capacity as a standard highway trailer, they have to be matched to and mounted on wheeled chasses to function over the road. The added expense, maintenance and management of a separate chassis fleet renders containers an inferior option for highway operations, and motor carriers normally don't deploy them. In consequence, the standard truck equipment seen on the road is not compatible with the principal type of intermodal service.

Highway trailers can be and are handled intermodally, but they require modification to suit the lift devices that transfer trailers onto railcars. Again, there is a need for specialized equipment. Moreover, and returning to information about trucking segments in the Table, there are significant portions of trailer activity that cannot be outfitted for intermodal lift: the box-type equipment (dry vans and refrigerated units) can be adapted, but 30% of truck traffic in medium and long haul lanes is flatbeds, tanks, and bulk trailers that cannot. Although there are alternatives – the isotainer, for instance, is a tank rigged for handling as a container – the equipment is even more specialized and less efficient. As a result, intermodal usage imposes a barrier of customized equipment, and even then there are important segments of the market it does not really address. One solution is the ramp-style intermodal railcar that accommodates *any* style of highway trailer, without modification; while these cars see very limited service today, they substantially enlarge the addressable market for intermodal rail.

The Table additionally points up the distinct characteristics of truck fleets:

- The private carriage of shippers and distributors that works mainly as a cost center in support of customer service and logistics strategy, and is heavily short distance;
- The much lower volume LTL segment that consolidates and distributes small shipments through terminal networks, runs full-load linehaul on regular routes between terminals, and is split between regional and long-haul service (although regional has grown more);
- The fragmented full truckload group, whose for-hire members range from national irregular route network carriers, through small regional lines and draymen, to the freelance independent contractors (owner/operators), and is the principal form of long-haul motor carriage but also figures prominently in regional and local markets.

The various segments also intermingle: truckload carriers make multiple stop pickups and deliveries and contract for LTL linehaul, while some LTL operators avoid terminals. The private fleet group is particularly fluid; it will add or subtract traffic with common carriers according to how its flows balance, and it will outsource operations entirely to commercial fleets, whose dedicated carriage adopts the functions of the private truck line.

The characteristics of truck fleets are pertinent for at least three reasons. First, to the extent that the intermodal customers are motor carriers whose linehaul is to be converted to rail, the nature of their business influences the requirements for operational integration. For example, LTL volume is concentrated in nightly departures with a fixed schedule to which the railroad must conform; truckload volume is spread during the day and has greater need for more frequent trains. Second, the traffic capture experience of railroads differs by segment. Private fleet business typically is difficult for railroads to attract, yet the Canadian Pacific has had success through its Expressway service; alternately, the outsourcing of private traffic to commercial truck lines can produce greater opportunity for rail participation.[58] Third, utilization of intermodal services requires trucking capacity to be in place at the pickup and delivery ends. For an independent contractor with one or a handful of trucks, this is out of the question, unless the load is (improbably) interchanged with another operator. The equipment and driver deployment of regional and private fleets is similarly sparse, so that railroads cannot convert these loads and must win them away from their current carrier. One way this can be done,[59] however, is truck-to-truck diversion: when large network carriers capture business from smaller operators, the deployment obstacle is reduced and the traffic becomes rail-convertible. From this perspective, defragmentation of the trucking industry is desirable for rail

Another, more subtle aspect of compatibility is concerned with the integration of rail with highway operations. Because intermodal services are dependent on trucks, they should be understood as a variant form of motor carriage, as much as they are a variant of rail, and they need to be effective as such. American intermodal trucking falls into two broad categories:[60]

- Intermodal marketing companies (IMCs), who are specialists in rail-based services, historically depended on equipment owned by other parties (but increasingly supply some of their own), and provide pickup and delivery as draymen; and,
- Network motor carriers, who offer road-based services, own their equipment, and perform intermodal pickup and delivery as a subset of their larger operation.

Inevitably there are ways these distinctions become blurred, but both categories need density to be efficient: loads must be balanced, and assets must be deployed in proximity to traffic sources. High rates of empty return are typical for rail-based services (as they are for most local trucking); for cost and performance reasons, this tends to keep equipment deployment near the ramp, and more remote business isn't handled. Road-based operations have greater loading options, and the balance advantage of an irregular route, non-local, multimodal system. Equipment deployment tends to be more ubiquitous and so closer to more shippers, and empty return rates probably are better; it is certainly true that the serving radius from an intermodal ramp is longer with road-based than with rail-based operations.[61] Highway operations also boost the feasibility of the extended length, enroute dray. While the normal intermodal dray is under 100 miles, extended drays are run like a highway load, traveling hundreds of road miles toward the delivery point, then intercepting and using rail ramps along the way with little out-of-route[62] mileage. The service area of intermodal ramps is orders of magnitude longer for the lanes that lie enroute.

Compatibility of equipment between intermodal and over-the-road *operations* becomes important, because the blending of highway with rail networks creates greater drayage efficiency and wider rail access. The stress on the word 'operations' is significant in distinction from 'environment': the specialized equipment that dominates the intermodal rail environment all functions on the road, yet it is not the equipment of choice for carriers in the highway network. In consequence, the specialized units are leashed to the railway network, and fleet balance[63] must be produced inside a system that is far smaller than the roadway and has many fewer balancing flows. Utilization of intermodal services thereby is constrained and the size of the addressable market again is reduced;[64] conversely, free flow of equipment between railroad and highway operations substantially releases this constraint.

These considerations can be summarized as the issue of *interoperability* between highway and rail, and it is another of the key barriers to traffic diversion. Equipment compatibility restrains the integration of networks, narrows the breadth of access, and limits the size of the market railroad solutions can target, with the result that intermodal as a class of truck operation is less effective. Thus, there are strictures upon the segments of the highway freight market that rail is able, or else currently designed to address. They are due to the emphasis on international container trains and the problem of interoperability, the character of truck fleets, and to the effect of transloading on serviceable distance. The question of design is made more difficult by the limits that also exist on railroad capacity and capital, coupled with the fixed cost of train starts. The fact is that a container stack train can carry more revenue-producing boxes than a trailer train simply because of its second tier, and so usually produces a better return per unit of capacity, capital, and train commitment. Stack trains then are favored for a good reason. However, railroad decisions about the market they prefer to address tend to institutionalize their preference in technology and methods of operation that are not the best suited to the domestic freight market. While the many containers hauled by rail should be appreciated as relief of the roads, they also denote an *institutional* barrier to diversion of the common highway trailer tied up in most of the traffic jams of the country.[65]

4.4 Market Segmentation

Market segmentation is a basic approach to understanding buying behavior, establishing the differential requirements of customers, and determining where a product or service would or could find its best appeal. Buying behavior and service appeal, in a competitive context, lie at the core of diversion dynamics for any kind of business. The question becomes, what is a practical way to employ segmentation to describe the barriers and opportunities, for the shifting of freight business between highway and rail.

4.4.1 Demand Side

To this point, market and diversion issues have been discussed in terms of shipper needs and trucking characteristics. These can be called the retail and the wholesale perspectives:

- *Retail* encompasses shipper supply chain factors, such as industrial, commodity, and geographic composition; time performance requirements; and the configuration of customer orders, because it is a determinant of the size, frequency, and volume of shipments.
- *Wholesale* takes in the service requirements, equipment specifications, and operational features of the carriers of goods, who may tender their loads to railroads: parcel, LTL, and full load truck lines, independent contractors, private operators, steamship companies, and intermediaries.

The retail perspective is a traditional level for market research and would seem to be basic for diversion analysis. However, information about its components is not systematically available from transportation sources, and can be fragmented so as to be heteroskedastic for analytic purposes. This doesn’t demean its value and there are ways to use it,[66] but there are other methods that more readily produce planning guidance.

Use of the wholesale perspective is one. It is informed and shaped by the retail (because wholesale needs incorporate and respond to retail needs), captures aspects of service and shipment size through summary dimensions like equipment types, and it is the wholesale level at which major railroads for the most part try to do business. For example, temperature-controlled equipment (which includes refrigerated vans, or “reefers”) describes a segment of the market that tenders mainly full loads outside of the local sphere, can be adapted for intermodal loading, but has stringent service and monitoring requirements that are challenging for railroads to meet. Shippers in this market are not all alike – frozen goods and produce are more sensitive than chilled foods, and differ from chemicals that need temperature protection – but they are broadly alike, and this forms a constructive way to distinguish a sector of the market. The wholesale level also is quite effective for the competitive analysis that is essential for diversion estimation, because in a number of instances the wholesale customer is both a potential client and a modal rival, so that the client’s needs from the railroad reflect the rival’s performance characteristics.

4.4.2 Supply Side

These are demand-side factors. There are benefits, too, from examining the supply side. The chief of these is that it gets at the operating economics that are critical, both to the qualities of service and to the transportation costs on which customers are acutely focused. A primary analysis starts from division of rail operations into the three classes used elsewhere in this report: unit train, carload, and intermodal services. The Chart “Rail Freight Typology” (Figure 4-6) lays out these classes and shows how they differ in the dimensions of markets and economics. (It identifies differences in public benefits as well, which will not be discussed here; the chart is reproduced from Chapter 3 of the Guidebook, which considers them). Like any set of generalizations, some elements of the typology will be found arguable by some observers; it is intended, however, as an overview of the major railroad business groups, and it is functional as such.

Figure 4-6 Rail Freight Typology

RAIL FREIGHT TYPOLOGY

DIMENSION	ELEMENT	UNIT TRAIN	CARLOAD	INTERMODAL
Markets	Commodities	Coal, grain, minerals	Chemicals, forest, bulk food, metals, waste, auto parts	Merchandise, automobiles
	Competitive dynamic	Rail dominion	Eroded dominion Network access issue	Competitive, divertable
	Intermodality	Water; truck gathering	Truck (bulk transfer, breakbulk)	Marine & truck
	Service requirement	Equipment turnaround	Equipment supply	Speed & reliability
	Captivity	Some	Some	Little or none
	ASPECT	**UNIT TRAIN**	**CARLOAD**	**INTERMODAL**
Economics	High empty return	☑	☑	No (but imbalance affects)
	Private/Sequestered equipment	☑ (not grain)	☑	Box, not car
	Heavy, periodic eqpt. demand	☑	No	International marine
	Long haul	Mixed	Mixed	☑
	High lane density	☑	No	☑
	Heavy axle loads	☑	☑	No
	Serves commodity business	☑	Usually	No (but transport a commodity)
	Operational	Door-to-door Non-stop	Door-to-door Intermediate switch & interchange	Ramp-to-ramp Intermediate mixing & interchange
	Capital	Self-funded Traditional Baseload (sine qua non)	Mainly unfunded	Under-funded New Baseload
	BENEFIT	**UNIT TRAIN**	**CARLOAD**	**INTERMODAL**
Public Benefits	Bridges & pavements *(heavy axle loads)*	☑	☑	No
	Congestion & capacity	Avoided traffic	No (but rail is door-to-door)	Avoidable traffic (highway relief)
	Private maintenance & security *(pertinent if public investment)*	☑	☑	☑
	Economic development	Cost of production Viability of plant	Production costs Rural communication	Supply chain efficiency
	Defense	☑	minor	☑
	Emissions	☑	☑	☑
	Fuel efficiency *(today, a national security benefit)*	☑	☑	☑
	Safety *(truck perception; freight separation)*	Avoided trucks	Hazmats; positive record	Avoidable trucks

- The Unit Train business handles high volume bulks like coal and grain in trainload quantities. Dedicated operations make time performance fairly good, and the emphasis of service principally is the turnaround time of equipment to keep shippers resupplied. Dense, non-stop, door-to-door transportation in imbalanced lanes conforms to railroad strengths, and this is the traditional baseload of the industry.
- The Carload group carries industrial goods, chiefly for further processing, in mixed train consists that require intermediate switches (which is essentially a kind of hubbing). Shippers who can use this service typically are focused on equipment supply and low cost transportation for higher lading weights, because performance can be slow and erratic: in a 2004 anecdote, a metals shipper reported to a researcher carload transit between seven and forty days over a 1,400 mile haul (truck transit would consistently be three days).[67] The time and cost challenges of handling non-unitized carloads has caused this historical traffic of the railroads to contract steadily, as heavy manufacturing also has diminished in the American economy.
- The Intermodal business[68] moves consumer goods and general merchandise, half of it imports and exports, primarily in solid trains with some intermediate hubbing. Service is among the railroad's best, and although it is mostly slower than highway, on premium trains or in well-developed lanes like Los Angeles – Chicago, it is fully the equivalent of over-the-road. Intermodal trains run in a smaller, more concentrated network than carload traffic, but in these markets they are at the front of modal competition between highway and rail. The Intermodal business became the top source of Class I revenue in 2003, surpassing coal and in some ways rendering itself the new baseload of the industry.

The Table 4-2 "Rail Volume by Rail Miles & Class of Operation" shows the relative magnitudes of the three business groups in physical terms. Using a minimum block size of fifty cars to define a unit train, the carload and the unit train groups are about even in volume and account for most of the tonnage, with the light-loading intermodal much smaller. However, substituting unit volume to adjust for load factors makes the three groups roughly equal in size at around one-third of the traffic each, with the carload somewhat the larger and unit trains somewhat the smaller. The Table depicts in addition the length of haul profile of the groups, displaying substantial short-haul activity for carload and unit train yet not for intermodal, as mentioned before. (Applying the units instead of the tonnage measure has no effect on the distance distribution of the three operating classes.) It is important to notice the way the traffic split changes when the definition of a unit train is reduced to thirty or more cars from fifty: the unitized business climbs to become clearly the tonnage leader. This underscores how consequential car blocks are to railroad traffic, especially under 500 miles where 80% of the definitional shift occurs. Below the thirty-car threshold are smaller groups of five, ten, and twenty, all of them aiding operating economics and forming major constituents of trains. Carloads by no means come just in singles and pairs.

Table 4-2 Rail Volume by Rail Miles and Class of Operation

RAIL VOLUME BY RAIL MILES & CLASS OF OPERATION

Source: 2002 CWS; no rebill adjustment

TONNAGE (000's)	TOTAL	UNIT TRAIN ≥ 50 CARS	CARLOAD < 50 CARS	INTER-MODAL	TOTAL	UNIT TRAIN ≥ 30 CARS	CARLOAD < 30 CARS	INTER-MODAL
All Tons	2,090,835	982,644	935,778	172,413	2,090,835	1,061,617	856,805	172,413
% of Tons	100%	47%	45%	8%	100%	51%	41%	8%
< 100 Miles	260,929	149,343	109,187	2,399	260,929	174,449	84,082	2,399
% of Tons	12%	15%	12%	1%	12%	16%	10%	1%
< 200 Miles	456,647	240,722	212,331	3,594	456,647	282,738	170,315	3,594
% of Tons	22%	24%	23%	2%	22%	27%	20%	2%
< 500 Miles	927,566	443,100	460,476	23,990	927,566	508,278	395,298	23,990
% of Tons	44%	45%	49%	14%	44%	48%	46%	14%
> 500 Miles	1,163,269	539,544	475,302	148,422	1,163,269	553,339	461,507	148,422
% of Tons	56%	55%	51%	86%	56%	52%	54%	86%
UNITS (000's):								
All Units	33,366	9,187	12,641	11,537	33,366	10,014	11,814	11,537
% of Units	100%	28%	38%	35%	100%	30%	35%	35%

There are two further points in this context:

- The size of trains is variable. They have a heavy fixed cost component for crew, power, and marshalling, so there is a potent reason to run them large, up to the limits of siding lengths (sidings allow trains to pass one another). However, solid blocks improve the marshalling (pickup, delivery, hubbing and interchange) costs of trains, and keep smaller ones viable. Capacity is another consideration. When track space is constrained, consolidation of traffic into fewer, bigger trains uses less of it.
- Car blocks normally are multiple cars moving under a single bill from one shipper to one receiver. In the conventional intermodal and carload transfer business, it is different, because transloading performs a kind of consolidation function, allowing blocks to derive from multiple shippers grouped around single *geographic* origin and destination points. This is the same benefit small package and LTL truck lines obtain from consolidating intercity freight at terminals, which in turn permits rail to participate in the small shipment market through terminal linehaul transportation. The development of railroad logistics parks take this one step further, by concentrating multiple transload functions at a single location in order to build up car block and even trainload volume.

Car blocks signify lane density, and lane density both augments and trades off with distance in its competitive influence. This is demonstrated in the matrix Table 4-3 “Modal Market Share by Lane Density & Distance” (reproduced from Chapter 3 of the Guidebook), which presents the progression of market share for conventional intermodal rail, as highway miles lengthen and lane volumes grow. The market here is defined as over-the-road dry van trucking, that being the wholesale sector where the standard intermodal product competes; it is also the largest sector of the trucking market accounting for two-thirds of the volume, as was shown in an earlier part of this chapter. Lanes are origin-destination pairs of Business Economic Areas (BEA) metropolitan markets,[69] this being a pragmatic way to reflect the consolidation effect of terminals within the definition of an economic region. Two additional technical factors affect the table: a) it excludes truck volume outbound from wholesalers and distribution centers, because this is regional and local traffic for which rail intermodal does not compete – if included, over-the-road (OTR) market share below 500 miles would go up; and b) an attempt has been made to correct for rebilling in railroad statistics, which diminishes intermodal (IMX) tonnage and locates more of it in long-haul lanes.

Table 4-3 Modal Market Share by Lane Density and Distance

MODAL MARKET SHARE BY LANE DENSITY & DISTANCE
RAIL INTERMODAL (IMX) Vs OVER-THE-ROAD (OTR) DRY VAN TRUCK

Source: TRANSEARCH 2000

HIGHWAY MILES	LANE DENSITY (Annual Tons [000] by IMX+OTR)							
	< 100		100 - 400		> 400		Total	
	IMX	OTR	IMX	OTR	IMX	OTR	IMX	OTR
1-100	0.1%	99.9%	0.1%	99.9%	0.4%	99.6%	0.4%	99.6%
100 - 299	0.3%	99.7%	1.1%	98.9%	1.4%	98.6%	1.3%	98.7%
300 - 499	0.8%	99.2%	2.3%	97.7%	3.6%	96.4%	3.0%	97.0%
500 - 699	1.3%	98.7%	5.8%	94.2%	11.1%	88.9%	6.6%	93.4%
700 - 999	1.3%	98.7%	8.3%	91.7%	27.2%	72.8%	12.6%	87.4%
1000 - 1499	2.6%	97.4%	8.7%	91.3%	28.1%	71.9%	11.4%	88.6%
>1500	7.3%	92.7%	24.8%	75.2%	62.0%	38.0%	37.1%	62.9%
Total	2.4%	97.6%	6.6%	93.4%	8.2%	91.8%	7.0%	93.0%
Total > 500	3.0%	97.0%	10.8%	89.2%	33.8%	66.2%	16.8%	83.2%
Total < 500	0.6%	99.4%	1.5%	98.5%	1.5%	98.5%	1.4%	98.6%

MARKET SHARE KEY:

OTR TRUCK ≥ 80%	BOTH < 80%	IMX RAIL ≥ 80%
🟨	🟦	■

The matrix displays intermodal market share clearly and consistently climbing with distance and lane density. It rises as mileage rises within each category of density, it rises as lane volume rises within each category of distance, and the combined influence of these elements (the diagonal vector of the table) generates the strongest gains. This share pattern is a direct result of service economies: railroad service performance and unit costs both improve as the linehaul component overtakes pickup and delivery in the transportation mix, and as the railroad production function is satisfied with train-lot quantities. Over-the-road trucking shares the economies, but less strongly, and the competitive balance moves in the direction of rail. The same relationship holds for other equipment types, and it has held historically:

- Matrix analyses for flatbed and bulk equipment showed an equivalent pattern, although the progression was less pronounced and rail share was greater in cells where short distance unit trains operate.[70]
- A version of the dry van/intermodal matrix prepared[71] five years earlier exhibited a like progression, and higher market shares. The railroad service disruptions of the latter 1990's, combined with vigorous economic growth that rail was not positioned to enjoy, drove intermodal market shares downward in the intervening years.

As a method of market segmentation, the intermodal matrix reflects a hybrid of demand and supply-side features. Equipment type captures demand at the wholesale level, in the market sector where intermodal principally operates. Distance and density are supply elements in that they embed, and in a sense are proxies for, service and cost characteristics of the intermodal product, which are the properties that customers care most for. They are demand elements as well, because they are descriptions of market activity, just as equipment type has a supply-side facet through its connection to technology. Market share introduces a competitive dynamic that is critical to the understanding of diversion and its opportunities, and is helpful as a depiction of competitive fronts. The upper left half of the matrix can be understood as a truck domain, and the lower right corner as something of one for rail. For rail to improve its penetration and produce relief to highways, it must be able to exploit business in its own domain with capacity and additional services, and it must be able to push across the matrix vertically and horizontally for smaller gains, and diagonally for larger ones, with new classes of product. The location of push is the front. For intermodal in the latter 90's, the line was rolled backward, but for the rail business as a whole, it has been on the intermodal front that traffic gains have been made.

A final supply-side factor with telling influence on the competitiveness of rail is access. The conditions of access, and the forms of drayage and transfer when access is not rail direct, are determinants of service, cost, and the addressable market. These points were explored earlier in this chapter; suffice it to say here that pickup, delivery, and transfer are major ingredients, and sometimes the principal ingredient, of door-to-door performance. Their demand-side implications are straightforward and profound.

In summary, the freight market can be segmented in three primary dimensions that are both meaningful, and broadly measurable for the question of rail relief to roadways. They are the classes of rail operation, the conditions of access, and economic geography, by which is meant the combination of wholesale trucking characteristics with geographic service economies that was condensed in the competitive matrix. The Table 3-4 "Dimensions for Market Segmentation" recapitulates these classes. They utilize supply and demand-side features, and in the former there are demand elements also signified or embedded. They are not the only productive method for segmenting freight markets, but they are usually a relevant method, and treat questions about business conditions that need to be answered.

Table 4-4 Dimensions for Market Segmentation

RAIL OPERATION	ACCESS CONDITIONS	ECONOMIC GEOGRAPHY
▪ Intermodal ▪ Unit Train ▪ Carload	▪ Drayage • Rail Direct • 1-End, 2-End Dray ▪ Transload • Unitized Lift, Ramp • Bulk Transfer • Break-bulk	▪ Distance ▪ Lane Density ▪ Equipment Type ▪ Competitive Modal Share

For diversion estimation in particular, segmented market shares offer benchmarks by which to categorize susceptible traffic, or can be developed further into predictive models. Data for this can be assembled from sources like the Carload Waybill Sample, public information like the federal Commodity Flow Survey, commercial databases, traffic surveys, and even planning model trip tables if they are robust enough. Equipment types can be observed directly, found in some data sources, or extrapolated from industry or commodity information using bridge tables, or with carrier cooperation. The differentiated comprehension of markets produced in this way supplies a basis for understanding the significance of barriers to diversion, and the opportunities to reduce them.

4.5 Diversion Opportunities

This chapter began with an examination of shipper needs and structural factors, developing from there a segmentation scheme to consider rail projects in their market and operational contexts. There remains to review the opportunities that may exist for diversion, and to classify them for planning purposes. Railroads typically approach this in terms of markets, lanes, and corridors, which is the terrain that terminals can cover and where trains will run. Public agencies are oriented to the elements of infrastructure, reflecting their mandate and the objects that congestion afflicts and railways may relieve. They can be defined as five types:

- Facilities and districts, like bridges and ports;
- Urban corridors, such as prime arteries;
- Citywide networks, or the urban grid;
- Intercity corridors, like interstate highways; and,
- Regional networks, such as statewide or multi-state systems.

Four of the five types appeared as categories of rail project in the Chapter 2 case studies, but they work equally well as classifications of congested roadways and road-dependent structures. The fifth – regional networks – is broader in scope than recent rail projects really have been, and it also points up the need for comprehensive, coordinated strategies in pursuit of road relief. While state rail plans do establish programs with more of a territory-wide purpose, the key consideration is that harmonized initiatives at multiple levels – facilities, cities, corridors – not only are mutually reinforcing, they can produce cumulative effects: within networks, within markets by changing load availability, and upon fronts of competition. In this way regional networks are a kind of meta-category, because individual projects in fulfillment of broader strategy may accomplish more than sensible, yet stand-alone initiatives.

For the mitigation of congestion on these classes of infrastructure, the questions are what sets of traffic can be removed (or prevented from appearing), and what forms of rail service will yield results. Traffic can be considered simply as originated/terminated or overhead, meaning freight that derives from the locale of the infrastructure, or freight between external points that passes through. It can be further categorized or grouped in four ways, by utilizing variations of density as a way to uncover diversion options:

- *Lane volume* is the basic form of traffic concentration. Sufficient volume between an origin and destination may support train block or direct train operation, each representing a step up in competitive service performance.
- *Confluent volume* is intermediate or combinant concentration, supporting train operation where the strands of a network come together and before they part. This is produced inside the rail system by the way traffic is marshaled and directed, or in the highway system by the dispatch routes of trucks. In the latter case, confluent volume can be intercepted in train or train block lots, provided efficient shipper door service is available through interoperability with motor carriage, or through equivalence in direct rail.
- *End point density* is concentration produced at the start or finish of a series of routes, by a common path prior to dispersion, or by funneling into a termination point. Examples might include all of the truck traffic leaving Houston for the Northeast, or all of the highway freight destined to South Florida. It can be generated by physical or network geography, or by logistics strategies like forward distribution, and it supports train or train block operation through the juncture where traffic is dispersed. Like confluence, end point concentration may be divertible, provided efficient service is available to the shipper door.
- *Hub or terminal concentration* is produced by logistical staging. One important type is truck traffic resulting from railroad systems. This occurs at some rail-to-rail interchanges, where cross-town drayage substitutes for direct rail connection; at territorial gateways, where trucks instead of a connecting railroad carry shipments to and from the network border; and at end point terminals, where dray

trucks debouching from rail may travel an extra distance, because of the remote location of the transload facility. These cases are highly divertible to a continuous or extended rail haul, on the grounds that the business already supports train operations. On the other hand, there can be numerous difficulties in keeping the traffic on rail; for example, volume may be staged at the point of dispersion; land or land use obstacles may be prohibitive; or institutional structures may be impractical to overcome. Truck concentration at hubs and terminals can be created by other modes (such as ship lines, or the motor carriers themselves), by facilities (like an inland port), and by shippers (at distribution centers). While this can present a significant business prospect for rail, it won't always present one. Block or train lot volume typically exists either on the inbound or outbound side of the facility, but not on both, and in instances like a motor carrier hub, the rail opportunity may not be larger than single shipments that are fanned out in multiple directions.

In each of these four groups, volume enroute to market either offers density, or is brought together to offer it, and this improves the likelihood that effective rail service will be possible. Concentrated traffic sections may be shorter than the total lengths of haul and may consolidate multiple lanes, but diversions remain dependent on door-to-door performance. Enlarging this perspective to the full dimensions of market segmentation – moving from density to the wider scope of economic geography, and examining the conditions of access – then begins to reveal the traffic that rail might remove from infrastructure, and provides a foundation for analysis and evaluation with market participants. From this the questions of viability and readiness, and of appropriate levers to use, start to be answerable.

Rail operations are the remaining dimension of market segmentation, and have different abilities to yield traffic results. The general opportunity for railcar and intermodal services to capture highway business is discussed next, along with treatment of the special circumstances for short haul rail.

4.5.1 Railcar

In the ten years from 1990 to 2000, railroad coal tonnage grew at a compound rate exceeding 2%, intermodal tonnage rose at a rate close to 5%, intercity trucking expanded at a pace of almost 7%, and growth in the rest of the rail business was under 1% annually.[72] Clearly the carload traffic[73] was losing market share; this is the customary business of the Class I railroad industry, and it has been in long-term decline. It is also the mainstay of shortline railways and principally transports heavy loading goods that are damaging to pavements, and slow moving in the traffic stream, if they should divert to highways. The AASHTO Freight Rail Bottom Line Report estimates that the national road network annually avoids 20 billion truck miles traveled due to the existence of carload service, and 25 billion miles due to unit trains.[74]

Concerned that the carload business might cease to be financially supportable, a 2004

Federal Railroad Administration report evaluated the potential for scheduled train operations to keep the carload segment viable.[75] Scheduling works against the tendency of operating departments to delay train departures until more cars arrive, which improves train productivity but disrupts service (this tendency is discussed in Chapter 2 of the Guidebook under the subject of start-up risk). The FRA report found that utilization benefits and the associated cost savings would meet the viability objective and retain the traffic on rail. Nevertheless, according to railroad officers interviewed for the study, the service improvements brought by scheduling would not win significant new traffic from highways. The most optimistic of a range of opinions was that carload growth might come close to the GDP expansion rate in some lanes – in other words, the business would expand far more than it has in decades, but it would not gain market share.

Setting aside the merits of these findings, the position that the carload sector is not a major venue for diversion is consistent with the Class I outlook from other contexts. Railroad merger applications during the 1990's claimed carload gains from their combinations, yet never as the primary source of traffic new to rail; for that, they looked to intermodal. In another perspective, a railroad executive who had reviewed company marketing plans for a generation concluded that carload prospects always held some promise, but for an engine of corporate growth or a meaningful alternative for highway planners, it was the wrong candidate.[76]

It isn't necessary to foresee the future of the carload sector for the purposes of this chapter. It is possible that scheduled operations may do more than seems anticipated, or that different yard technology or transloading strategies may aid them, or that they may be spurred by combination with some other development. It is nonetheless true that the sector has important handicaps: marshalling is costly and time consuming, the historical business base is a shrinking part of the economy, and direct access continues to diminish. Transloading works, yet it is somewhat less efficient than the unitized intermodal: intermodal lift at $30-$35 per box translates to $2.00-$2.50 per ton, versus $5-$6 per ton for carload goods like steel and chemicals, and the vans used for intermodal dray have better reloading options than flatbeds or tank trailers.[77] At the high volume end where large unit trains operate, railroads vigorously pursue and invest in the business, and can be counted on to do so; while sidings, line extensions, and other access requirements may attract public support, the utility of rail should be apparent.

Rail retention of carload traffic is of clear benefit to the congested highway system, in urban districts as well as on intercity routes, and it is necessary to take this into competitive account during development of public road programs and policies. As carloads segue into unit trains, the importance of retention intensifies, and since rail can do well with trainload volumes of carload goods if access is solved, repeating shipment lots starting from 2,000-3,000 tons apiece in a lane can become opportunities. Most substantially, the local outlook for diversion will vary from the national. If carload prospects seem underwhelming on the grand scale, their effect on an urban heavy truck corridor can be penetrating and deep. The shortline rail industry plainly has been successful at diverting or withholding bulk and other freight from congested urban areas and inadequate rural roads, and its influence primarily is on specific and local infrastructure. Three examples follow:

- The New Hampshire Northcoast (Conway Branch) operation hauls aggregates from Ossipee, NH to the Boston Sand & Gravel transloading terminal in Somerville, MA, a distance of 100 miles.[78] In addition to removing an estimated 100 aggregate trucks per day from the parallel I-93 and I-95, the carrier also delivers plastic and propane to Rochester, NH as needed. The line carries 8,950 carloads annually[79] and benefits the region in two distinct ways: removal of heavy trucks improves air quality and reduces congestion; and lower cost of transportation allows New Hampshire quarries to be competitive in the Boston metropolitan area, lowering construction costs.
- Many short lines carry seasonal bulk traffic (particularly grain) in the Midwest. One such carrier is the Iowa Interstate Railroad, owned by Railroad Development Corporation. The 687-mile regional carries 6.1 million tons per year,[80] or approximately 75,000 carloads. The IAIS transports grain, steel, scrap, intermodal, chemicals and forest products. In addition to handling 'bridge' traffic that substitutes for barges in the winter, or providing access for bulk customers, IAIS switches many industries along its route, including major customers at Newton, Iowa City, Cedar Rapids, and Rock Island.[81] Although the bridge traffic is an important source of revenue, chairman Posner claims, "our bread and butter really is serving private-siding customers with a local freight schedule. A lot of IAIS' traffic originates or terminates on branch lines served by short trains."[82] This type of operation can be very effective in removing trucks from local roads, and in the right circumstances may generate substantial profit.
- On the West Coast, a 2003 study[83] found that the 372-mile, 10,700 carloads per annum, grain-hauling system known as the Palouse River and Coulee City Railroad (PCC), is highly susceptible to abandonment in private ownership. However, the PCC saves shippers $2.2 million per year, in addition to keeping 29,000 heavy trucks off county roadways - creating a benefit of $4.2 million per year in avoided highway damage. By all standards, this is a very light density line. However, even at this level of density, substantial diversions and resulting benefits are generated.

The core advantage of a shortline railroad is its low cost function, gained from a combination of inexpensive equipment, flexible labor agreements, and light track. They act as efficient pickup and delivery networks that consolidate traffic for Class I roads, and they provide viable, light volume local service on their own systems. Studies[84] have demonstrated some lines can operate with significantly less than 50 loaded cars per mile per year. Shortlines operable at low traffic densities are able to compete for seasonal traffic, or to focus on a single bulk commodity, or even a single shipper. This kind of adaptability can be a powerful answer to particular traffic problems, so that reviving disused but intact shortline railroads, or increasing traffic volumes on existing ones, in a local setting may be highly productive for roadway relief.

4.5.2 Intermodal

Standing on the front line of modal competition with the highway, the railroad intermodal business faces aggressive and routine rate pressure, and is sometimes perceived as questionably profitable. At Conrail in the 1990's[85], however, standard costing formulae were modified to unburden this business of expense allocations for features that Intermodal did not require – heavyweight track, and certain yards and branch line networks would be examples. The restated Intermodal financial picture was then found to be one of the more profitable operations on the railroad, and thereafter earned a higher priority for capital usage.

There is rich and ample opportunity for railroad expansion in the intermodal sector, more than the carriers have resources to pursue.[86] If Intermodal did no more than recover the ten points in long-haul, dry van market share that it lost during the service disruptions of the latter 1990's,[87] it would take six million trucks off the road. In the 800-mile, dense and mature traffic lane between Chicago and New York, Intermodal carries 25% of the *total* traffic (intermodal plus all truck types combined); if it achieved such penetration across the board in long-haul, medium and high density lanes, fourteen million trucks would come off intercity roads.

The Virginia I-81 study[88] utilized alternative technology to resolve the problem of interoperability, and called for major, corridor-wide public investment to improve capacity, terminal coverage, and track speeds. The study found that 14% of I-81 AADTT (average annual daily truck traffic) in Virginia could be diverted to Intermodal over three to five years, and 30% in the longer term. However, the majority of I-81 truck traffic is overhead to Virginia and therefore longer haul; the rail services proposed for development did not address traffic shorter than 350 miles. Even so, employing interoperable technology and applying the same distance-sensitive diversion rates to national traffic, Intermodal would attract 9 million highway loads in the medium term, and 27 million loads when services reached maturity. The latter represents two to three percent of current nationwide truck volume, but a three-fold increase in intermodal activity, and would require considerable new capacity in lines, terminals, systems, equipment, and crews.

These are illustrations of possibilities. They focus mainly on longer distances, and they still leave dray trucks on the road. While short-haul options are reviewed in the next section, for the purposes of congestion reduction and roadway relief, the long-haul opportunities nevertheless have impact. Table 4-5 "Length of Haul Distribution: Truck VMT" offers a different perspective on highway volumes: where three-quarters of truck trips are concentrated under 200 miles, just one-quarter of truck VMT (vehicle miles traveled) falls in this bracket. This profile comes from TRANSEARCH, and even allowing that this data source does not capture all local truck activity, it is plain that rail reduction of medium and long-haul truck traffic has real repercussions for road demand. The consequences for highway relief are clearer than the consequences for congestion: rural roads will account for a greater proportion of truck VMT than they will for over-capacity road miles. Diversion of through trucks certainly matters for congestion mitigation, but interior cities will derive more benefit than a metropolis like Los Angeles or Miami situated in a kind of geographic corner, and for all of them the urban problem looms large.

Table 4-5 Length of Haul Distribution: Truck VMT

LENGTH OF HAUL DISTRIBUTION: TRUCK VMT (Loads & Empties)

Source: TRANSEARCH

Distance	All Truck VMT
200 Miles & Under	25%
500 Miles & Under	53%
Over 500 Miles	47%

It was stated earlier in this chapter that the core question in traffic diversion was, how broadly could equivalence be produced? In fact this is a two-fold question, because it is not only a matter of comparable product performance between rail and over-the-road services, and of interoperability. It is also a matter of the breadth of deployment, and breadth requires capacity and capital beyond what is available as this is written. Public investment to moderate the capital intensity of railroading can lift the limits on possible opportunity, and modify the markets to which rail services are introduced. The bottom line for traffic diversion lies in the two-fold nature of this core question: can the product be good enough, and can enough of it come to market?

4.5.3 Short-Haul Rail

Three out of four loaded truck trips travel within 200 miles, and nine out of ten within 500 miles. The short-haul market draws the attention of planners because the truck volume is found there, and because diversion of short city and intercity trips will relieve congestion where it is most common, and where highways are most costly. The distance definition of short-haul varies. To some interpreters, it is the twenty miles of the Alameda corridor; to others, it is many times longer. This chapter will use 500 miles for inclusiveness, and on the grounds that it is the overnight distance for a truck. Within this, it will distinguish local traffic up to 200 miles (which is the out-and-back distance for a truck in a work day), and regional traffic from 200 to 500 miles.

As observed before, approximately one-fourth of the carload and unit train business is local, and another fourth is regional. The intermodal business is entirely different: only a bit over ten percent is regional, and the local activity is minor. There is an assortment of caveats with these numbers, of course: rebills overstate the short-haul tonnage, shortline traffic is underrepresented, and Alameda Corridor volume is long haul because it is an end-point shuttle feeding inland trains. The obvious reason for the distinction in length of haul profiles is access: intermodal by definition is a transloaded operation, whereas railcar traffic enjoys direct access to a significant degree. A second reason is service: the majority of short-haul railcar activity is in train blocks or unit trains, implying that it is sensitive to equipment capacity and can be handled through the rail network with relative expedition. Moreover, after decades of traffic erosion, it is safe to conclude that the remnant railcar business can tolerate the service it receives, and disappears slowly because better alternatives (or industrial changes) are slow to arise. The general merchandise market where Intermodal competes doesn't travel by rail because it requires better door-to-door service, it encounters important barriers of interoperability, and its volume is comparatively fragmented on a per-shipment basis.

These are explanations of the status quo. Since an objective of this report is diversion, the true interest is in new traffic opportunities, and there the profile alters. Whereas Intermodal retains the difficulties that depress its participation in short-haul markets, the railcar sector loses its advantages: access for new customers becomes much more of an issue, block volumes have to be sought, and service has to stand up to incumbent competition. The biggest obstacle for both sectors is the time factor. Regional overnight truck transit is eleven hours or less; local transit is four to five hours, and can be same day delivery. High speed rail operations don't help much, because there isn't enough distance over which to gain time – freight rail usually benefits from higher speed when it can run for twenty-four hours straight through. Delivery windows are vital: customers who can accept next afternoon or evening receipt are much more serviceable by rail, and yet this is not the normal pattern of business. Finally, complexity of operation is the enemy of transit time, and of reliability. Solid trains that can be quickly assembled may be successful if yards and main lines are uncongested; conversely, marshalling requirements and scheduling conflicts bring delays and service failures.

The second major obstacle is the relative profitability of traffic. The Florida East Coast Railroad (FEC) is a regional line offering corridor services between Jacksonville and Miami.[89] Multiple intermodal trains operate daily on the 350-mile lane along the Florida coast, supporting local service but especially providing interchange at Jacksonville to motor carriers and Class I railroads traveling further into the continental US Railcar business includes unit trains of stone and cement; in one operation, two to three million tons of rock are brought 200 miles from south Florida to Cocoa, then transloaded and drayed fifty miles to construction sites around Orlando. Traffic of this kind is attractive to the FEC for at least two reasons. First, the peninsular structure and economic geography of Florida makes for famously imbalanced traffic, and channels it into dense lanes. These features play to the strengths of railroading, they keep rate levels high, and they discourage motor carriers from committing their own assets to the territory. Second, as a regional network in isolated geography, the FEC is not considering other prospects.

Profit contribution is a function of margin and quantity, and in freight transportation the quantity is composed of shipment volume and distance. Shipments of equivalent size and margin are more attractive to carriers at longer distance, and when the efficiency of linehaul is factored in, there is sound reason for railroads to prefer long-haul business. Even so, the decisive element for Class I railroads in considering traffic opportunities is the rationing of capacity and capital. The business prospects for these carriers are not seriously limited by the size of the market, but rather by what they can act upon. In most cases, the profit contribution from short-haul traffic is lower than from long-haul, causing assets to migrate from one to the other, and depriving the regional and local business of any exclusive investment. Class I choices will continue to favor the long distance options unless the ground rules are changed by new resources.

The motivations for shortline railroads stand in contrast. On light-density networks, the non-traffic related maintenance-renewal burden (such as corrosion, weather, and degradation) dominates the capital requirements, and the shortline business model therefore has tended to focus on generating traffic to build up traffic density.[90] This is a different and more accepting regimen than asset rationing, although it is unclear what happens when capacity is tapped out. As to business mix, opinions differ as to whether interchange traffic or local, single-line traffic is the primary money generator on a shortline.

For a carrier that is not a switching road (whose rates are tied to the serving Class I's), the dollars generated from interchange traffic can depend mainly on negotiating ability with larger carriers over revenue splits, and on Class I strategy with respect to shortlines and carload shippers. The local traffic, on the other hand, is entirely under shortline control, and has various cost advantages over interchange business - more intensive equipment utilization is possible, for instance, and much reduced management overhead - so that the lower revenue per car in local lanes still is very attractive. Shortlines also can extend their role as low cost carriers to contract for trackage rights, and operate over secondary Class I right-of-way, turning interchange into single-line business. Where the Class I track space is not constrained, such tactics may be productive and generate additional profits for the smaller railroad. Shortline strategy directed at single-line opportunities thus can be effective at combating local congestion, since goods may be moved in volume, and at lower rates than interchange traffic. A prominent[91] example is the Nittany & Bald Eagle division of the North Shore Railroad Company, which operates a dozen-car shuttle train twice daily on an eight-mile run, bearing 1.1 million tons of stone annually and keeping trucks in the tens of thousands off central Pennsylvania roads.

Figure 4-7 Rail Expressway

Class I Railroad officials discussed short-haul operations in Intermodal at the Transportation Research Board meeting at Washington, DC, in January of 2003.[92] Only two of the active examples cited actually were under 500 miles, but the success factors identified were notable: routes were single-line and not circuitous, drayage requirements were significantly curtailed, traffic was concentrated, volume was balanced by the lane or network, terminals were efficient and well situated, and trains were fast, reliable, and sufficiently frequent. One highlighted service was the CP Rail Expressway, which is believed to carry two to three percent of the truck volume on the continuous corridor from Montreal to Toronto (330 miles), and then on to Detroit (230 miles). Using ramp-style intermodal technology, Expressway is highly interoperable with motor carrier fleets, and its twice-daily departures in each direction produce dependable overnight service. The mature potential of the operation was estimated at 12-15% of corridor volume without capacity expansion, and with expansion, one out of three trucks was projected to be divertible. All rail officials including CP Rail's stressed the necessity of high (or excess) capacity corridors for short distance intermodal operations, not because the services specifically required it, but because the short-haul profit contribution would not justify right-of-way investment, barring public support.

The local and independent intermodal corridor service of Northwest Container is described in the inset box. This company has stepped outside of pure freight carriage in order to boost financial returns, and uses a management approach comparable to truck lines to drive out utilization inefficiency. As a business model, this firm represents a homegrown version of open access, and is reminiscent of the efficient regional players in the trucking industry, who construct an effective set of operating economies within disciplined territorial bounds. The operation is analogous to a shortline taking on Class I trackage rights, in that both produce some control of train service, and yet neither one ever escapes the problem of capacity. Northwest Container is able to acquire a contract train because its payment is competitive with other uses for the Class I track; if high volume, long-haul corridor service began to consume track space, the Northwest train slot (or its financial feasibility) might be jeopardized. Moreover, as a case study in short-haul highway relief, Northwest Container is instructive for what it does not do as well as for what it does. In the view of this company, conventional intermodal service is not competitive for the truly local domestic market.

Thus, the two major barriers of time factors and relative profitability remain in place. Shortlines and purchased transportation can be effective, but eventually they will reach capacity constraints, and must deal with the limits of geography and density (and be helped by industrial development programs). Short-haul rail plainly does work in niches, perhaps including trans-urban corridors like the Chicago Airport Express, and it certainly can function as an end-point service feeding longer haul traffic. Nevertheless, without public investment to change the profit comparison, short distance rail is not likely to succeed as a broad alternative to road congestion, and with public investment, the predicament of time performance may be intractable in very many instances, or require unconventional technology or exceptional innovation. The truck VMT distribution suggested that road relief reached through the regional and long-haul markets can have a material result for congestion. In the local and urban markets, there are strategies to employ that will touch the problem, but there is also a dilemma.

Case Study 2: Northwest Container Services [93]

The core operation of Northwest Container Services is a daily stack train supplied to the international trade, between the Portland, OR market and the seaports at Seattle and Tacoma, WA. Containers drayed through a Portland terminal are railed 170 miles to Seattle piers. Trains run north and south five to six days a week, bearing 110-140 units and removing 60,000 trucks annually from the crowded I-5 highway corridor. The company claims 99% on-time performance against container-ship cutoff times, and backs up rail with over-the road service if necessary. Northwest owns the terminal and the railroad wellcars used in the operation, and purchases dedicated trainload service from the Union Pacific, who provides track (including maintenance and signaling), power, and crews. The firm is Oregon-based and privately held, receives no public funds and is neither a railroad nor a motor carrier.

The economic geography of the Pacific Northwest supports this operation by creating a north/south funnel for freight in a strong foreign trade basin. The call pattern of container ships has rendered Seattle/Tacoma a major load center port, and has placed Portland in a feeder role, so that there is heavy traffic between the two. Containers are in ample supply because of trade imbalances, and those bearing the region's forest products load above interstate highway weight limits, which rail is able to accommodate. These natural advantages help to establish a niche market, and stack train economics paired with a single-end dray help rail to contend for it, but the critical factor for this short-haul corridor is the service window of the ship lines. Sailing schedules create slack time at either the origin or destination of every load, covering for the terminal handling and dray delays attendant to rail, and allowing it compete against four-hour highway drive times in a way the domestic market does not allow. Rail intermodal can meet the ship schedule without being as fast as a truck door-to-door, and according to the company, this is the key reason Northwest has stayed out of the domestic business.

Beyond these market factors, the company succeeds for three critical reasons:

- A high degree of operational control is created by asset ownership and train purchase. The Union Pacific can change the time of train departures, but it does not decide whether a train will run. This is strengthened by local, hands-on staff, motor carrier alliances, and good customer relationships, so that Northwest knows the full logistics detail for any load.

- The Northwest approach to managing train utilization is comparable to truck line tactics. Customer service representatives book loads and work with customers on individual container schedules, in order to keep trains full. The company also builds up inventories of loaded containers and uses them to balance trains.
- Northwest markets a full service transportation package, which has two important advantages. First, the product is a turnkey *set* of services, which together make it easier to do business intermodally. The firm inspects and maintains equipment, handles logistics, and offers complete container yard functions, with chasses, repair, storage, and pre-tripping. Second, the profitability of the operation derives from the *cumulative* contribution of the set of services, each of which has thin margins; the company believes that the rail service alone would be insufficient to sustain itself.

4.6 Social and Economic Impacts of Diversion

Modal diversion changes the location and technology of freight carriage. This implies that its social and economic impacts mainly are incremental, modifying an incumbent body of traffic rather than introducing a fresh influence[94] to a region. Diversion brings more volume to rail routes and rail facilities, where the relatively favorable rail emissions profile, for example, may still mean more total emissions in the vicinity. Diversion reduces traffic on highway routes, providing a better operating environment for trucks that remain on the road, and safer, faster travel for passenger vehicles. Given the service characteristics and network density of the US rail system, most opportunities for diversion from highway to rail will require transloading of freight; thus, trucks performing pickup and delivery will stay on the road, and will acquire new patterns of traffic concentration. Analysis of the effects of modal shift thus requires a careful examination of the complete logistics chain, for direct and indirect impacts.

The societal impacts of diversion of freight from highway to rail can be classified into four areas: shipper related; direct highway; direct rail system; and indirect or collateral effects. In addition, there are four main drivers of negative social externalities for freight movements: (1) physical volume; (2) traffic distribution, in space and in time; (3) load characteristics; and (4) operating profile. These underlying variables related to the way freight flows, combine to place a burden on the host community through their collateral impacts, resulting in effects such as accident risk, noise, vibrations, visual quality impacts, detriment to community cohesion, impact on property values, and vehicle pollution such as particulates and nitrous oxides. Beyond their negative consequences, freight flows reflect economic vitality and generate economic benefits. As freight is produced or consumed, value is being added in supply chains and gross regional product is augmented.

Diversion produces a new net result from these varying influences, transferred in location and transformed in the method of operation. This section reviews the classes of incremental impact and the factors that affect them, and it closes with an overview of diversion models.

4.6.1 Forms of Incremental Impact

The ways in which freight transportation affects a community are many of the same ways that modal diversion affects it marginally: through economic development and competitiveness, safety and security, congestion, and quality of life. In each category, however, there are circumstances and implications that are particular to the character of modes, so that the ramifications are complex and diversions involve trade-offs. Truck traffic removed from the highway, for example, shrinks the highway's maintenance requirements by eliminating some of its costliest vehicles, and the burden is moved to the private maintenance budgets of the railroad right-of way. On the one hand, the added traffic may strain railway capacity and cause it to seek public support for expansion. On the other hand, capital injection may be a one-time expense, while maintenance costs are permanent and ongoing, and the latter might be recovered from shippers through freight rates, instead of through the general funds of DOTs. The major forms of impact and some of their multiple facets are:

▪ *Economic Development and Competitiveness:* A primary benefit of more efficient transportation systems is enhanced economic productivity, development and competitiveness. In various periods during US history, evolution in transportation technology from canals to railroads to interstate highways allowed much of the interior to be developed through improved accessibility. Today, as the transportation system continues to evolve, the focus has turned to using intermodal networks and choosing an appropriate mode for each flow, allowing transportation costs to be diminished and the accessibility benefits of a multimodal freight transportation system to better realize its potential.

Freight transportation upgrades raise the productivity of businesses in a region in one or more of the following ways:

- Reducing the cost of shipping;
- Reducing the time-variability of shipping (thereby improving supply chain performance);

- Reducing the time for shipping (also improving supply chain performance); and,
- Reducing the risk associated with shipping (thereby avoiding cargo loss and damage)
- Improving access and responsiveness to markets.

Diversion from truck to rail normally will reduce transportation costs at the expense of a longer journey time. In highway-congested areas, rail can have lower time-variability, although rail typically is less dependable; in rail-congested areas, highway drayage is often offered as a by-pass route. For low-valued bulk commodities that divert to rail, the net effect of time and expense will be lower total logistics costs, and in some instances, a rail-connected distribution center may be replacing a local processing site. For rail intermodal, in lanes where it offers genuine truck-equivalence, transit time will match the highway and overall service performance will be competitive. In these cases, total costs will be lower because rail will reduce the transportation component, and equivalence will render the logistical effects immaterial – but there will be no logistical gain. Cost reductions produced in these ways have impact by generating a direct benefit to the shipper's business and a trickle-down benefit to the rest of the regional economy, leading to increased economic competitiveness. In the aspect of loss and damage, rail haulage changes the nature of risks associated with these factors, as is discussed below.

- *Safety and Perceived Safety:* When truck freight activity is replaced by rail freight activity, risks in rail accidents are substituted for risks in highway accidents. The risks are different in nature and cause different problems, although both can be mitigated effectively with appropriate safety programs. The highway is an open environment; other than driver licensing programs and DOT inspections, there is little centralized control over the movement and condition of driver and vehicles. It is also a shared facility – accident involving trucks usually result in many more fatalities than auto-only accidents; disruption caused by truck accidents can inconvenience many autos. However, compared to rail accidents, even major truck accidents seem non-catastrophic. Routine railroad incidents usually result in lesser consequences than a comparable incident involving a truck, because of the design of railcars, but a major rail incident can result in the evacuation of a neighborhood or an entire town. When railcars fail, damage to freight, equipment and the environment tend to be much more severe simply because of the much greater equipment capacity.

In the chemicals sector, replacing truck flows of bulk dangerous chemicals with rail improves safety in transit and loading. Tank railcars, by design, allow a more controlled discharge process and have a smaller likelihood of spills per volume of liquid transported (Ensuring Railroad Tank Car Safety, TRB Special Report 243). The safety benefit extends beyond the terminals. Diversion also changes the risk exposure profile, shifting the spill risk from public highways and main streets to private railroads. Tank cars in addition are engineered to much higher standards and are usually not ruptured in derailments. In general, conversion of bulk chemical flows from truck to rail is considered a safety improvement, especially in the public perception because of its obvious effect in removing large chemical tankers from the highways.

Evaluation of safety benefits is based on risk assessment and risk mitigation. Risk assessment involves identifying accidents that may potentially occur and estimating the likelihood of their occurrence. Probabilities are generally calculated by taking an average over a number of past years. Risk mitigation means to devise a scheme that can reduce the probabilities of accidents occurring, or given that the accident will occur, how their severity and public impact could be reduced. Relating to chemicals transportation safety, this might mean making funding available for training of operating and emergency-response personnel. In the context of rail freight solutions, rail diversion might be explicitly stated as a mitigation strategy that could reduce the probability of spills and highway accidents. In some cases, for highly hazardous commodities, the cost of delay associated with rail shipments could be budgeted as a risk mitigation item, which the government, or a particular shipper, could commit to as a part of a deal to reduce unacceptable levels of risk.

▪ *Security Impacts:* Rail and highway transport plainly present different security risk exposures. However, the extent and direction of these impacts are not well understood. Rail operations, by design, occur in a loosely supervised environment where ensuring cargo accountability is more difficult; in instances where direct rail service is not available, transloading will be required, which is inherently less secure than a single truck movement. However, trucks are more mobile, and it is far easier to disrupt truck operations than train operations. Hijacking a train is exceptionally difficult, while thieves and others sometimes intercept truck shipments. Railcars also tend to carry far larger quantities, but it may be easier to keep track of one unit-train or block of cars, versus hundreds of truck movements. Thus, diversion to rail will change the security risk profile, creating different types of risks. It is not clear which mode will be more secure, but it is possible to mitigate the risks associated with both modes through staff training, advanced technology, and other security enhancements.

▪ *Quality-of-Life Effects:* There are many quality-of-life impacts associated with freight traffic moving by rail; some of these are found in Weisbrod and Vary (2001, NCHRP Report 456):

- Pollution: Particulate Matters, NO_X, Volatile Organic Compounds, and CO;
- Noise and Vibrations;

- Visual Quality;
- Community Cohesion;
- Property Values.

Rail carriage generates less air pollution per unit of freight than motor carriage. Diversion to direct rail shipments produces a fairly straightforward benefit in this respect. Transloaded rail is more complicated, because while emissions are lower during linehaul, trucks performing pickup and delivery concentrate around terminals instead of being dispersed, and can drive circuitous loaded miles, and additional empty miles by comparison to an all-highway operation. The net result normally is positive, but it is dependent on linehaul distance, and thus is lessened in shorter lengths of haul. Whether direct or transloaded rail is the recipient of diverted freight, the travel route almost always is different and will affect new zones, while the smaller rail network may tend to channel traffic volume to a greater degree than highways.

Noise and vibrations relate mainly to residential neighborhoods, and are particularly prevalent where interstate corridors or railroad corridors run adjacent to highly developed urban areas. Visual quality is difficult to assess. Transportation facilities generate visual impacts in proportion with their size. Diversion to rail normally would not solve this problem; it merely changes the location where such cosmetic problems occur.

The adverse effect of transportation arteries on community cohesion is well documented in the literature.[95] The issues relate mostly to the existence of infrastructure, but also to an extent their operations. A new bulk traffic generator, such as a transload facility, could aversely affect formerly cohesive small towns along the route of the new freight movement. The town may have to trade off potential for economic development against drayage congestion or grade crossing traffic, when deciding whether or not to allow new facilities to be constructed. Property values may change, attracting commercial interests but harming the residential; similarly, removal of freight traffic from roadways can be an adverse development for businesses that serve it, yet may make the facility more benign for dwellings in the area.

- *Congestion:* Trucks are slower in acceleration and deceleration than automobiles, and are both larger vehicles and possessed of a larger footprint in highway capacity. Volume delay curves show that incremental trucks contribute disproportionately to deterioration in highway levels of service, and imply that small amounts of diversion have extra leverage in their impacts. As they did for emissions, the conditions of access matter for congestion effects, with diversion to transloaded rail offering less benefit and possibly introducing new issues. Road-rail interaction at grade crossings grows with diversion unless it is explicitly headed off in project plans. Finally, undiverted trucks operate in less congested, more efficient conditions, making them more difficult to capture as rail services mature.

The consequences of diversion for congestion also are two-sided. Although an interstate lane nominally carries 1,200 vehicles per hour,[96] at super saturation the capacity can be much lower. Removal of perhaps, thirty heavy vehicles per hour, each with a passenger-car-equivalent (PCE) of 3.0-4.0 during the rush contributes ten percent more capacity to a single lane. This impact can be significant if the roadway does not attract additional traffic as a result of its decreased impedance.

On the rail side, removal of thirty trucks per hour translates to about 240 boxcars per day – perhaps two to three merchandise trains, and a somewhat larger number of intermodal trains, depending on the equipment profile. The impact of this on rail system congestion varies, depending on the system. Most rail lines can support one additional train per day without great difficulty, but if the yards or lines are already running near capacity, the incremental traffic removes any delay recovery margin, which can lead to a gridlock of rail systems.

Rail congestion can have additional impacts on abutters. If existing trains are lengthened, the gate downtime at grade crossings could increase. Yard congestion potentially leads to more yard movements, which produce more noise. If a significant amount of traffic is diverted, formerly quiet mainlines could become quite busy, increasing risks for trespassers and others.

4.6.2 Factors Affecting Incremental Impact

The burdens and benefits that diverted freight flows produce for a host community have several determinants. Some are inherent characteristics of the freight, and are dependent on the economic geography of the area, and thus not easily changed – diversion will tend to reduce congestion on some highways and increase congestion on the railroads and near transload centers. Others could change over time or be modified by operational design. The prominent factors are:

- Volume of freight diverted;
- Persistence of traffic diverted;
- Economic value of flow;
- Operational profile of modes;
- Local conditions.

The influence of volume is obvious, since the externalities generated by freight movements are proportional to the number of discrete equipment movements that take place. It is modified by operational profiles in ways that this chapter previously has described: by modal loading characteristics, network geography, routing and consolidation, and access. Transloading, for example, replaces trucks operating over a variety of routes - thereby spreading the congestive effect through a wide area – with routes consolidated around rail terminals. The smaller rail network with its need for trainload volume favors traffic concentration even as it relieves the highway, so that externalities also become concentrated. Communities that will tolerate small and gradual growth around existing rail facilities – particularly when such growth is attained by increased terminal utilization without major construction or property taking – will react differently to the substantial new volumes and infrastructure, that material reduction in road congestion may entail.

The local considerations this points up are manifold. Heavy truck traffic through residential neighborhoods, on narrow streets, near schools and other public gathering places tends to get more attention than that traveling on the interstate highway system. Rail solutions may relieve these situations (as with direct rail service to ports), or they may create them. On some interstates, where trucks make up a proportion of total traffic that becomes meaningful to motorists, diversion of freight can develop political urgency, but its rerouting can meet resistance. For example, increased traffic on rail lines, or truck concentrations around intermodal terminals may be found objectionable. (One possible solution is to borrow from the interest in truck-only lanes and create exclusive truck connectors between interstates and intermodal facilities, especially when the distances are short.) The diversity and conflict of the local conditions that surround freight traffic – social justice concerns, jurisdictional layers and turf, residential versus employment interests – can exceed what railroads have the ability or the stakeholder mandate to balance. As such conditions shape the impact of diversion, their effect may be to stifle it, simply because the conflicts are too troublesome to reconcile.

The persistence and economic value of flow bear on the impact of diversion from a number of angles:

- *Persistence of Traffic:* Some traffic is a short-term, one-off movement of a single significant shipment – for example, a large transformer, space-shuttle parts, or tent rigging and scaffolding for a special event. Some traffic is of a one-off nature, but occurs over a number of months due to the volume of material that requires shipping – such as a large construction project, or the decommissioning of a nuclear plant. The remainder of traffic is broadly continuous and cyclical – a flow expected to continue for an indefinite amount of time, fluctuating depending on marketing, seasonality and other periodic factors, like the movement of grain after harvest, movement of ores for processing, coal going to power plants, imported apparel moving to stores, and manufactured parts or products moving from factories to the consumer.

The environmental damage done by large volumes moving in a short period or small volumes moving throughout the year might be the same, yet the public perception of the problem is likely to differ, and therefore evaluation of potential impacts of diversion should account for this perception factor. Since setting up rail access requires substantial infrastructure investment, traffic that could be ongoing is more likely to succeed than one-off moves, making rail diversion better suited to traffic that is sufficiently persistent to be considered consistently problematic. Investment could be effective for peak level traffic that is highly seasonal, such as grain gathering, or construction traffic that is concentrated in the summer months, as well as steady if cyclical traffic such as container flows from large ports.

- *Economic Value of Flow:* Different commodities correspond to distinct industries and supply chains, with characteristic job densities, job features, and economic relationships. These variables in turn determine to what extent transportation infrastructure investments produce local development (or indeed, how diversion to slower modes or how lack of suitable capacity will retard local economic progress). Value of goods also is related to the risk of transportation failure: if a single truckload of seasonal goods does not arrive on time due to road or rail congestion, loss of revenues from a single one-day delay can be significant - perishable goods may perish, fashionable goods may miss a day of their ephemeral market. Diversion from road to rail may increase such risk, since rail disruptions affect full trainloads of goods. An open question is the degree to which current logistics and supply-chain processes can be re-engineered to take advantage of rail; where this happens, it changes the influence of rail services. Private enterprises undertake such evaluations on their own and public planners may not be privy to them, but dialogue could be revealing.

4.6.3 Modal Diversion Models

Modal diversion of freight traffic follows from the creation of a shift in the competitive balance. Typically this comes about through a change in the available door-to-door service or cost, or through the lifting of a constraint. The shift will be greater if the change is structural, such as a rise in input costs, a technological advance for service, or an expansion of network. More commonly, though, the change is the introduction of a grade of transportation that is offered in other markets but is new to the one in question, or that sometimes represents a new generation of product offering. Assessment of the diversion prospects for a project or program should examine first its competitive dynamics, and the durability of the modal advantage it ought to produce. It should next consider the barriers to diversion, as they are relevant to the case, and how satisfactorily they will be answered. Projects that make sense in basic ways can then be subjected to deeper analysis.

This chapter has reviewed the use of market segmentation, traffic benchmarking, and classification of opportunities to commence such analysis. Diversion models are tools for further and detailed assessment, at the level of individual lanes and commodity, equipment, or industry groups. The latter function as a way to generalize retail or wholesale customer needs, and the former to isolate and differentiate competitive performance, with volume reckoned in both dimensions. Three types of models in active use focus on logistics cost, market share, and customer preference. They are designed to construct quantitative estimates of traffic swings, and all of them in some form call for market data, establishment of algorithms, and the contrasting of rival transportation products.

- *Total Logistics Cost* models aim to compare the comprehensive costs of modal choice alternatives, including direct transportation expense, and inventory dollars associated with modal lot sizes and service profiles. The models assume that customers rationally select the lowest cost option, and they require extensive information about logistical factors in transportation and industry to produce this comparison. They can be deterministic in that shipments become assigned to one mode or another, while retaining stochastic features to treat inventory risk and carrier performance, or they can allow for probability in the modal choice itself. The US Federal Highway Administration has employed a model of this type in its truck size and weight studies.
- *Market Share* models develop a statistical correlation between modal performance factors and traffic capture, then project traffic swings when relative performance changes. The correlation is derived from historical traffic patterns and in that sense is experiential, reflecting the results of carrier behavior as embedded in share. Performance factors typically include comparative transportation but not total logistics costs, first because transportation costs by themselves produce strong correlations, and second because logistics burdens can be regarded as accounted for, or 'discounted' in historical capture rates. The models assume that experience is a rational basis for projection, they require historical information for their preparation, and they produce probable shifts in share from the alteration of competitive position. A model of this type has been employed by Class I railroads in a number of merger applications.[97]
- *Stated Preference* models are developed from structured interviews with transportation purchasers. Through an extended set of forced choice comparisons by which the buyer makes trade-offs between performance characteristics, the process seeks to reveal decision points for mode shift. Statistical analysis of interview results can then be applied to project probable traffic diversions in response to changes in competitive service offerings. The models assume that statements replicate decision conditions and behavior, they require a program of interviews for their preparation, and they can be targeted to retail or wholesale participants. Models of this type have been employed for customer research at some railroads, and for public rail initiatives like the New York Cross Harbor major investment study.

It is important to realize that freight flow is not a constant. In some circumstances, the traffic will evaporate due to factors outside the transportation arena – for example, local labor rates or exhaustion of natural resources may force certain industries to relocate out of the region, however much the transportation costs are minimized. For very high volume flows and modest investment, it is possible to set up rail flows that pay back the initial investment within a short period. For more ambitious schemes, a more general local economic assessment is required, to ascertain whether the target flows will remain for the foreseeable future.

Summation: This chapter has considered how shipper needs and structural factors 33 delimit the expansion of rail freight, how market analysis techniques can point toward promising segments where diversion challenges might be overcome, and where real opportunities are more and less likely to lie. It has summarized the effects of diversion when it occurs – and these effects in turn may form the justification for programs that produce it. Railroad solutions clearly can be an effective method to reduce road congestion, and just as clearly have their own limitations and consequences.

5 TRENDS AFFECTING FREIGHT MOVEMENT

5.1 Overview of Trends Discussion

5.1.1 Objective

This chapter is focused on a single straightforward objective – to summarize key transportation and economic trends that affect the nature of roadway congestion and potential opportunities for using rail freight as a solution to that problem. Since this need to address congestion and the opportunity to use rail freight is already presumed in the justification for this very report, informed transportation planners may consider many of these trends to be self-evident. However, the priority that politicians and decision-makers may give to rail freight solutions will in fact be driven by first establishing the strength of the case that: (a) congestion is a growing problem, (b) it is changing in its nature due to shifting economic and land development trends, and (c) rail freight can sometimes be part of the solution.

5.1.2 Organization

Accordingly, this Chapter is organized in five additional sections:

- Section 4.2 – *Congestion Cost Trends*. This section documents the fact that growing traffic levels are leading to increasing road congestion problems. In addition, rising transportation labor costs are exacerbating the costs of congestion delay to shippers. These factors help to justify increased public attention to the business costs of congestion and the need for solutions that reduce those costs in the future.
- Section 4.3 – *Role of Trucks in Congestion*. This section provides summary data illustrating the fact that truck traffic is a major contributor to overall roadway traffic. As more and more roadways approach full capacity, the incremental impact of trucks on congestion delays is also rising. These facts help to explain the need for attention to trucks as an increasingly important part of the congestion problem, and thus an important part of its solution.
- Section 4.4 – *Growth in Freight Activity Levels*. This section examines how changes in the US economy are increasing freight volumes but particularly for small

size, shorter distance and higher value shipments. These trends are useful to highlight, since the feasibility of rail freight alternatives to truck shipments also vary systematically by distance, commodity value/weight ratio and ultimate destination. Freight diversion and public investment decision models, discussed later in this interim report, will build upon this type of information.

- Section 4.5 – *Business Location and Land Development*. This section examines how business location and urban land development patterns are systematically moving towards a dispersion of activities that tends to favor highway shipping and disfavor rail shipping. This helps to explain what is already known – that truck is growing faster than rail as a mode for freight movements. However, this information has further use, for it also helps to establish a basis for determining the situations under which rail can (or cannot) be a potentially feasible alternative to truck for freight movements.

- Section 4.6 – *Technology Trends*. This section outlines key aspects of technological change affecting the feasibility and cost-effectiveness of both rail and truck to serve freight movements. There is still much debate in the industry over which technologies will blossom in the years to come, so this discussion is focused on documenting what is now occurring and how potential future changes may affect future tradeoffs among rail and truck to move freight in some congested areas and corridors.

Note on Freight Data Sources: Some of the information contained here derives from the FHWA's Freight Analysis Framework. This body of information is undergoing an update that was not completed when this chapter was assembled. Similarly, some of the national estimates of freight shipment characteristics presented in this report are based on Commodity Flow Surveys (CFS), conducted by the Bureau of Transportation Statistics and the Census Bureau every five years. Conducted first in 1992 and then in 1997, the CFS is the nation’s primary and most comprehensive federal data source on domestic freight movement. Earlier commodity surveys were conducted between 1962 and 1982, but data for 1982 were not published. No data were collected for 1987. When the information presented in this chapter was assembled, a preliminary report on CFS 2002 had been published. Final CFS data were still coming, so some of the traffic and commodity flow trends shown here could be displayed to 2002, and some only go through 1997. Nevertheless, these variations in data availability do not affect the nature of validity of the trends illustrated here.

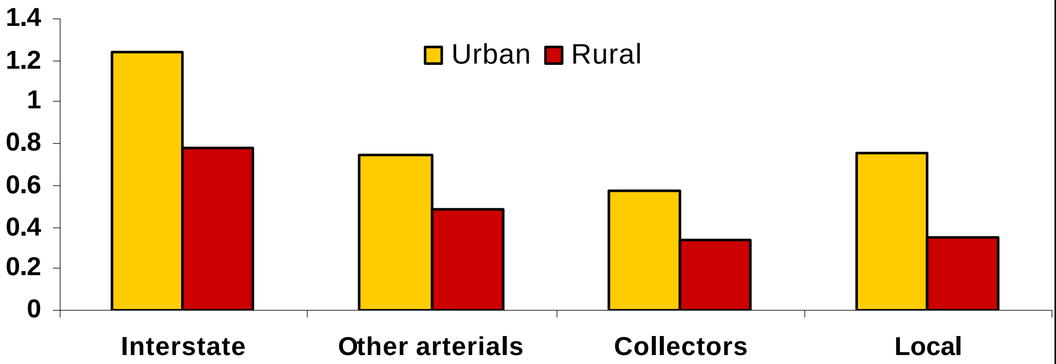
5.2 Congestion Cost Trends

This section provides summary data illustrating the key fact that traffic demand is growing and leading to increasing road congestion over time. Additional factors are also increasing the economic stakes, in terms of the unit cost of congestion delay to shippers. While these facts may seem obvious to informed transportation planners, the depth and breadth of this growing problem is not universally known to all public decision-makers. Yet, an appreciation of the problem is a necessary first step for even considering the investment of time in exploring multi-modal solutions and public-private cooperation.

5.2.1 Road Travel Demand Continues to Increase

Total vehicle-miles traveled (VMT) on public roads has continued to grow. It increased 68% between 1980 and 1997. The urban VMT growth (83%) outpaced rural VMT growth (49%) over this period, which is a reflection of population shift from rural to urban areas. (See Figure 5-1.)

Figure 5-1. Highway Vehicle-Miles Traveled by Functional Class, Percent Change 1980-97



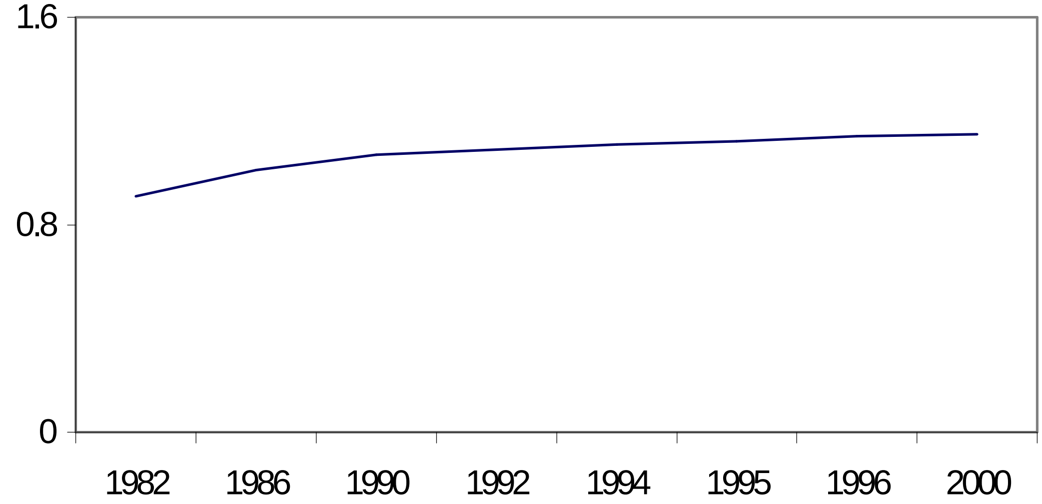
Source: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics

5.2.2 Rising Congestion as Supply Does Not Keep Up with Demand

According to the Texas Transportation Institute's (TTI) annual report, the average highway congestion index (measured by volume per road lane) has been steadily rising over time. It increased 25% between 1982 (average value of .91) and the year 2000 (average value of 1.15). (See Figure 5-2.)

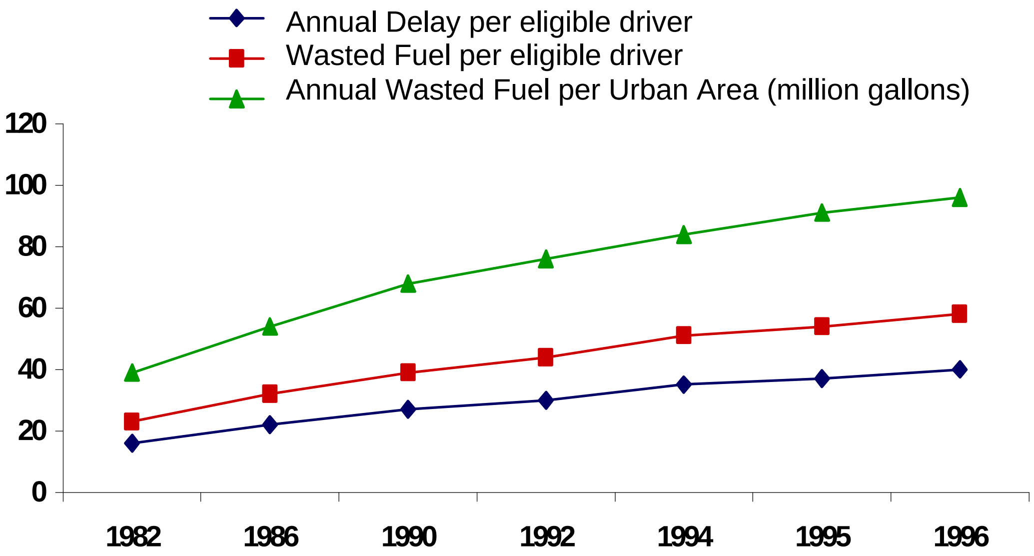
Urban highway congestion and traffic delay in the US is particularly rising. According to the urban congestion indicators for 70 urban areas compiled by TTI, drivers experienced an average 40 hours of delay in 1996. This was 8% more than in 1990, and 150% more than in 1982. (See Figure 5-3.)

Figure 5-2. Average Roadway Congestion Index



Source: Texas Transportation Institute

Figure 5-3. Urban Congestion Indicators for 70 Urban Areas (selected years)

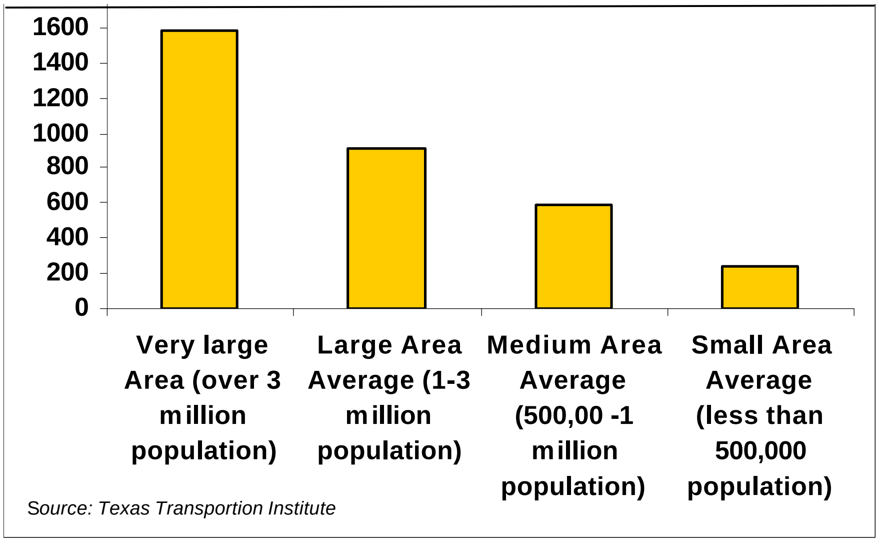


Source: Texas Transportation Institute

5.2.3 Rising Cost of Congestion

The TTI study estimated that, the total annual cost of congestion in 75 urban areas reached $67.5 billion by the year 2000. That value is estimated to include $58.5 billion due to time delay (labor productivity loss) and $9 billion due to wasted fuel. Average costs of congestion ranged from $595 per driver in smaller cities to $ 1,590 in large cities. (See Figure 5-4.)

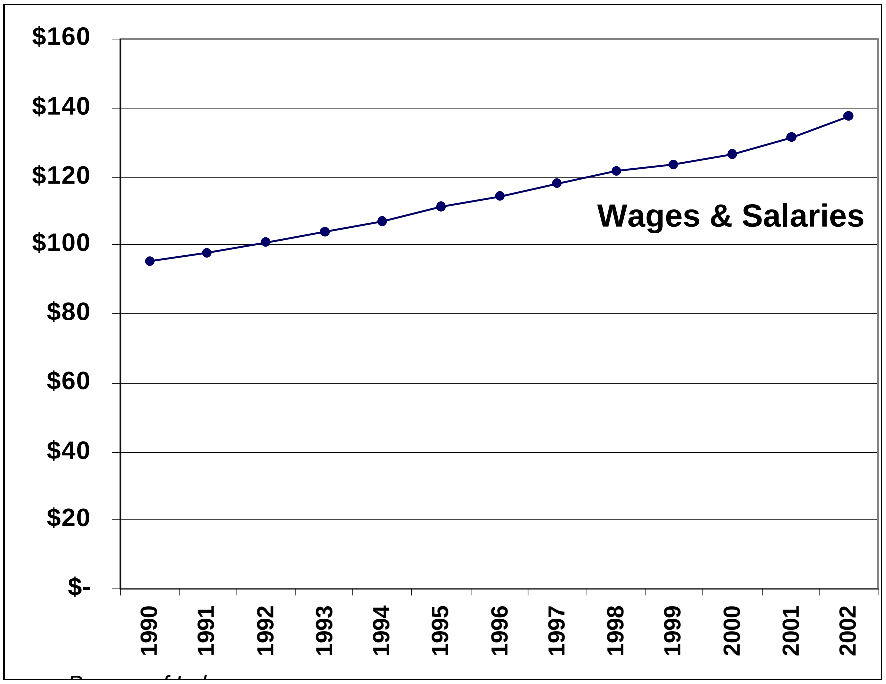
Figure 5-4. Average Cost of Congestion per Driver



Source: Texas Transportion Institute

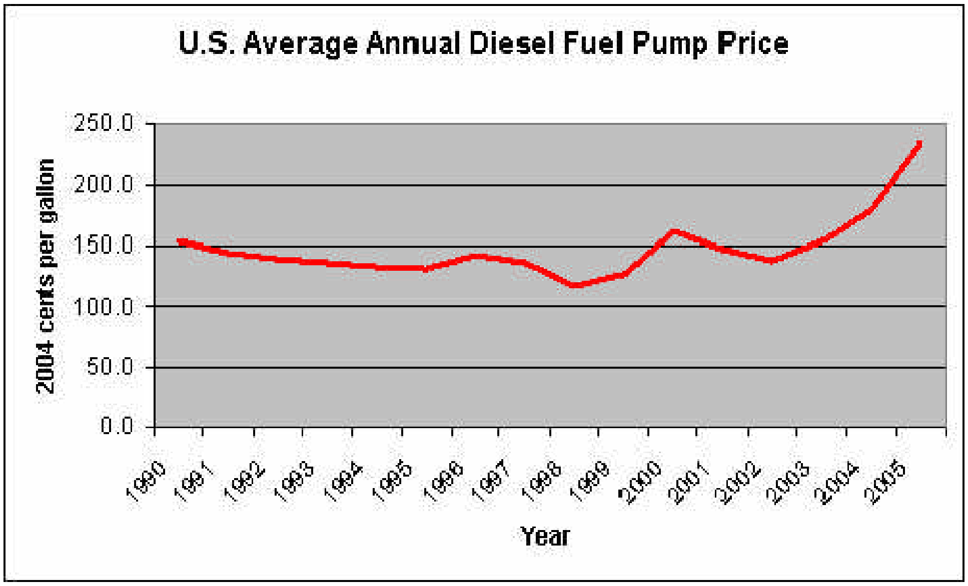
Even after adjusting for inflation, the unit cost of labor in transportation industries has continued to grow. Between 1990 and 2002, transportation labor costs increased by 47% (Figure 5-5). In trucking operations, driver wages constitute about 30-50% of the costs of trucking operations. Altogether, this means that the unit cost of truck driver time delay is continuing to rise, making the total business cost of congestion rise even faster than the growth in congestion time delay. Recent increases in the cost of motor fuel since 2003 (Figure 5-6) represent another factor exacerbating the increasing costs of congestion over time.

Figure 5-5. Labor Cost for Transportation Industries



Source: Bureau of Labor Statistics; all values are adjusted for Inflation and shown in constant 1992 dollars)

Figure 5-6. Cost of Truck Motor Fuel



Source: Global Insight; All values are in (current dollars (not adjusted for inflation)

5.2.4 Increasing Breadth of Congestion

Traffic congestion is expanding across the US. Figures 5-7 and 5-8 were developed by Battelle Memorial Institute from FHWA data, and they show the geographic breadth of highways that are over-capacity (shown in red) and approaching full capacity (shown in blue), for both 1998 conditions and forecast 2020 conditions. The growth of congestion among inter-city corridors is particularly striking.

Figure 5-7. Traffic and Congested Segments – 1998

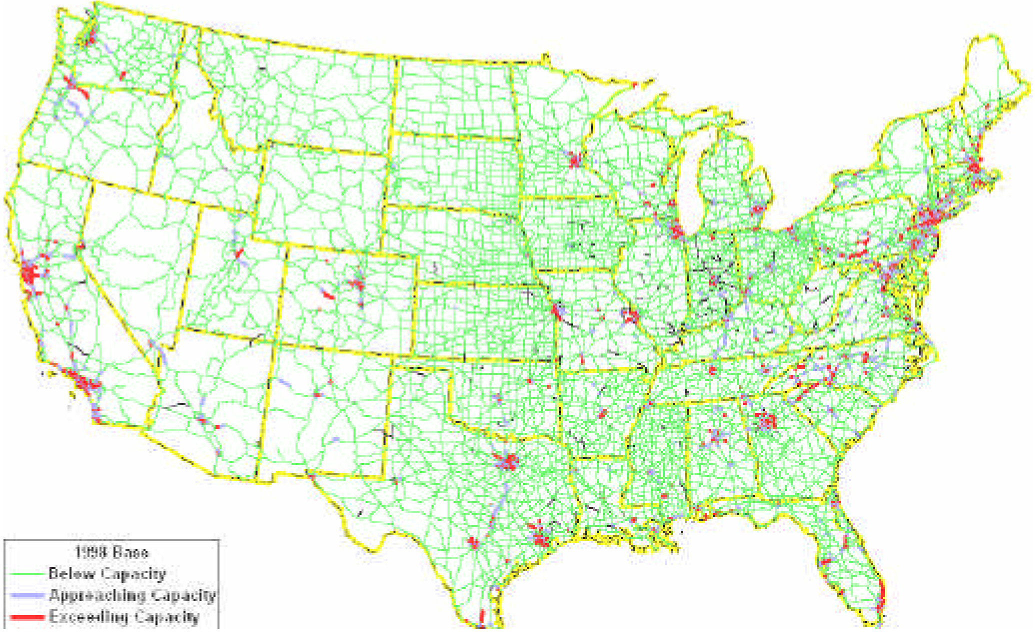
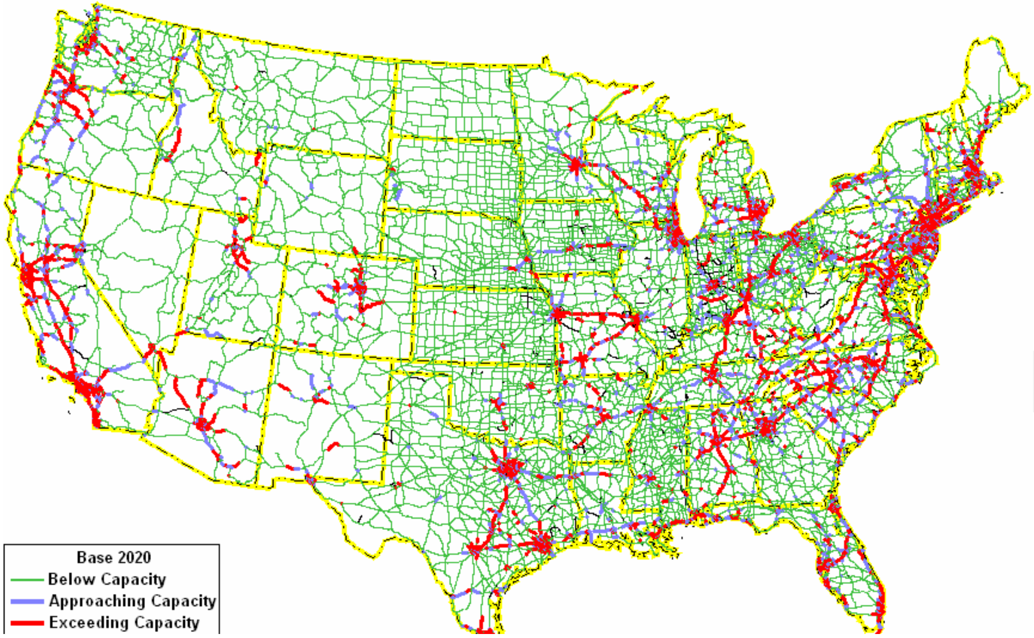


Figure 5-8. Traffic and Congested Segments - 2020 Forecast



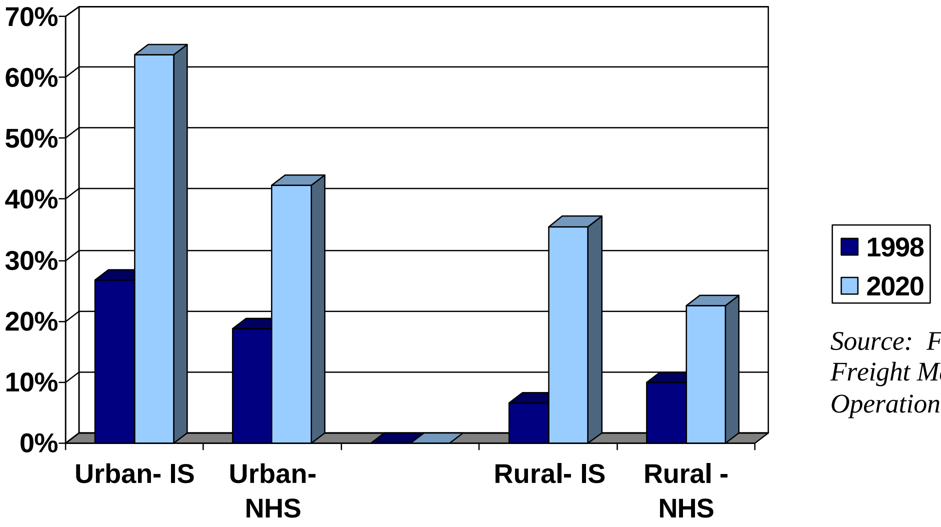
5.3 Role of Trucks in Congestion

This section provides data illustrating how truck traffic is a major contributor to overall roadway traffic, in addition to passenger cars. As more roadways approach full capacity, the incremental impact of trucks on congestion delays is also rising. Again, many of these facts are well known to informed transportation planners, but public decision-makers can sometimes consider congestion to be largely a problem of nuisance among rush-hour commuters. It is therefore important to help public decision-makers to understand the critical role that trucks and freight flow patterns can play as part of the congestion problem and its solution.

5.3.1 High Volume Truck Routes

Figure 5-9 shows data from FHWA's Freight Analysis Framework, showing that the portion of national highway segments with over 10,000 trucks is forecast to rise dramatically between 1998 and 2020, for both urban and rural segments of the Interstate Highway System (IS) and the rest of the National Highway System (NHS).

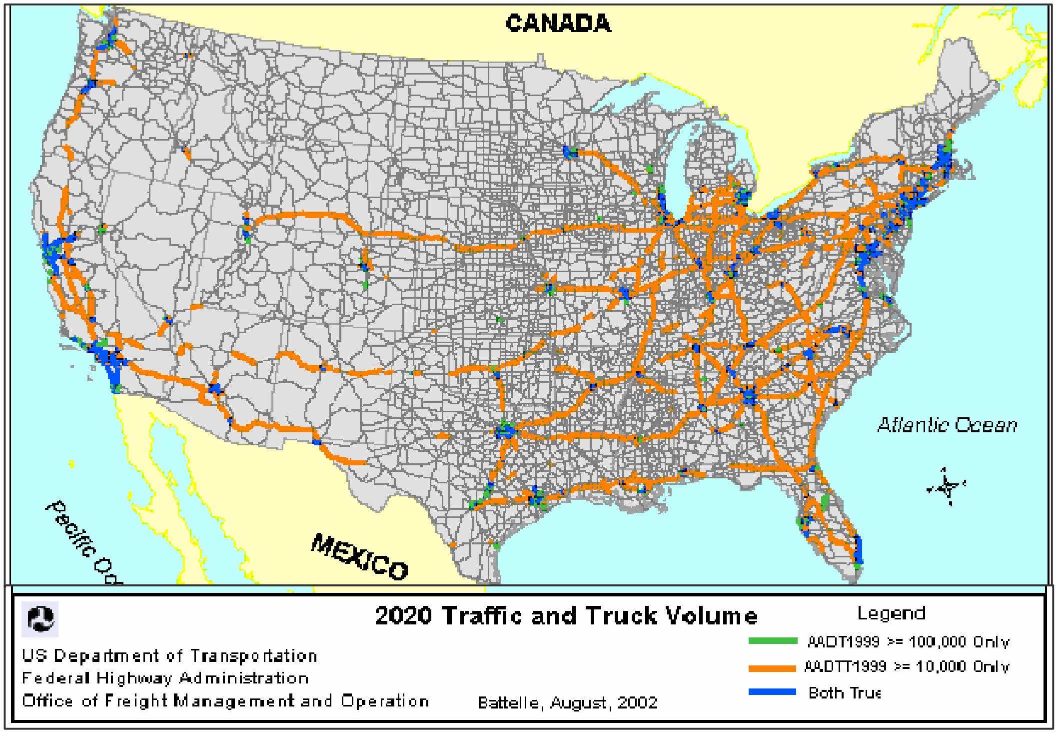
Figure 5-9. % of National Highway Segments with Over 10,000 Trucks/Day



Source: FHWA, Office of Freight Management and Operation

Figure 5-10 shows that a large and growing amount of highway mileage in the US is forecast to have *both* high total traffic levels (average total daily traffic over 100,000 vehicles) and high truck volumes (average daily truck traffic over 10,000 trucks). These segments are located among many inter-city corridors all across the nation, as shown in the map.

Figure 5-10. Highway segments with high traffic & truck volume – 2020



When trucks are added to other traffic on the National Highway System, there is a doubling of the highway miles that approaches or exceeds capacity. This is true for current conditions (1998 values) and it remains true as congestion is forecast to grow over time (through 2010, and 2020 forecasts). (See Figure 5-11.) This effect becomes even more dramatic when viewed cartographically. Figures 5-12 and 5-13 map the breadth of rising congestion, when truck traffic is added to forecast car traffic levels.

Figure 5-11. Mileage and Portion of NHS that is Under Approaching or Over-Capacity (Current and Forecast Future)

Source: FHWA, Office of Freight Management and Operation

V/C Ratio	1998 NHS Mileage (%)		2010 NHS Mileage (%)		2020 NHS Mileage (%)	
	No Trucks	WithTrucks	No Trucks	WithTrucks	No Trucks	WithTrucks
v/c < 0.8	151,457 (95.7%)	145,969 (92.2%)	144,792 (91.5%)	131,203 (82.9%)	139,933 (88.4%)	118,839 (75.1%)
0.8 < v/c <1.0 (Approaching)	3,731 (2.4%)	6,577 (4.2%)	5,707 (3.6%)	11,940 (7.5%)	7,078 (4.5%)	14,849 (9.4%)
v/c > 1.0 (Over capacity)	3,076 (1.9%)	5,716 (3.6%)	7,764 (4.9%)	15,120 (9.6%)	11,253 (7.1%)	24,576 (15.5%)

Figure 5-12. 2020 Congestion without Trucks

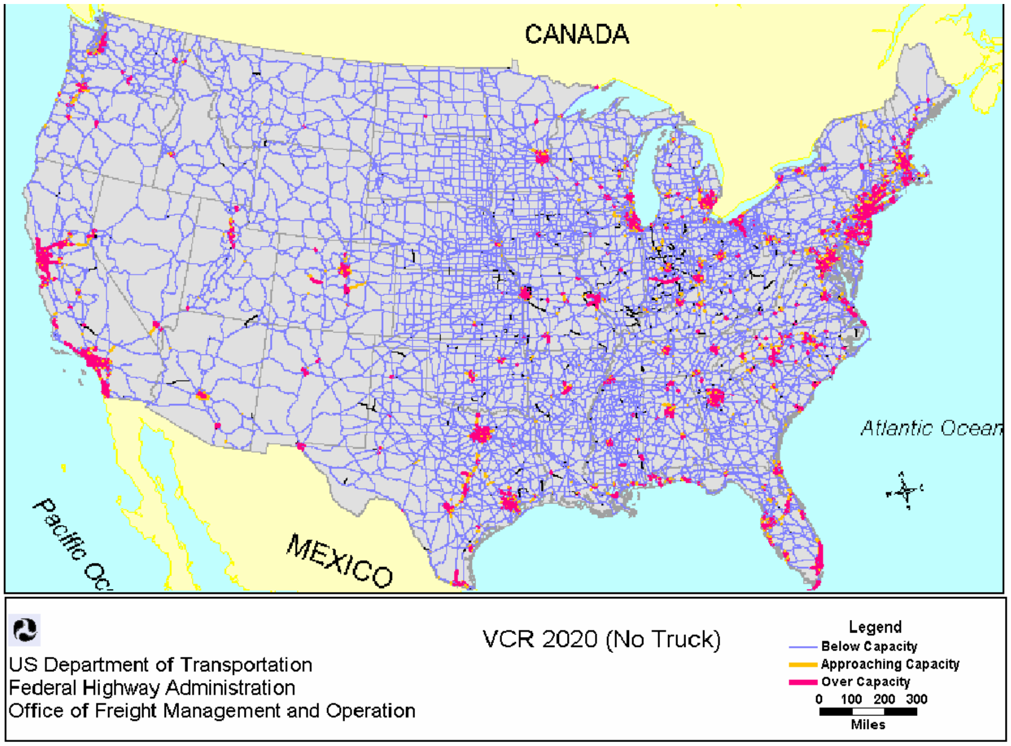
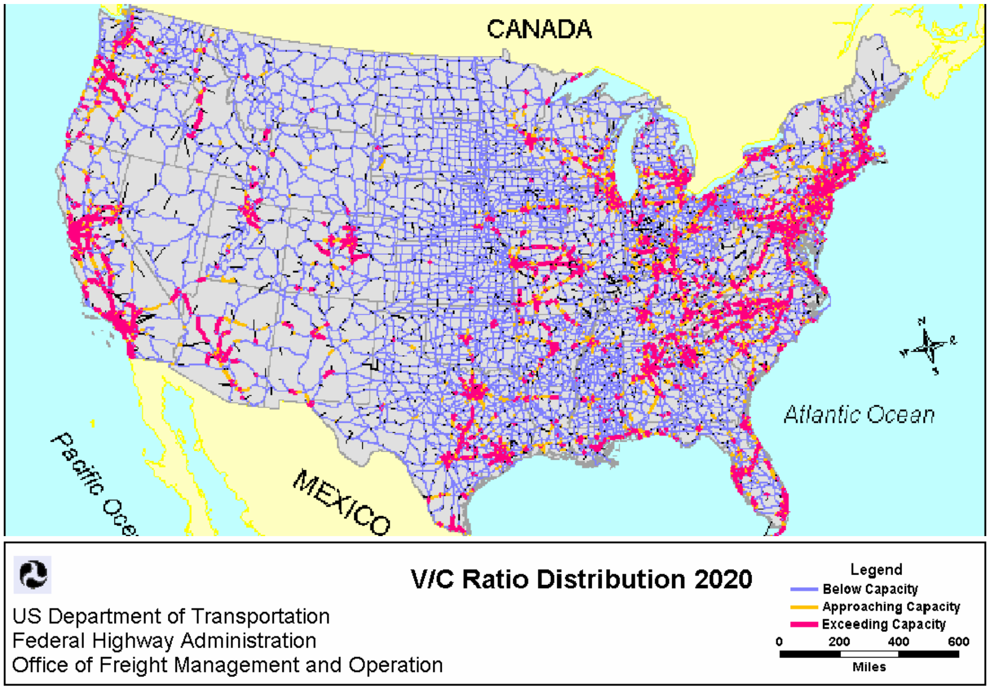


Figure 5-13. 2020 Congestion with Trucks Added



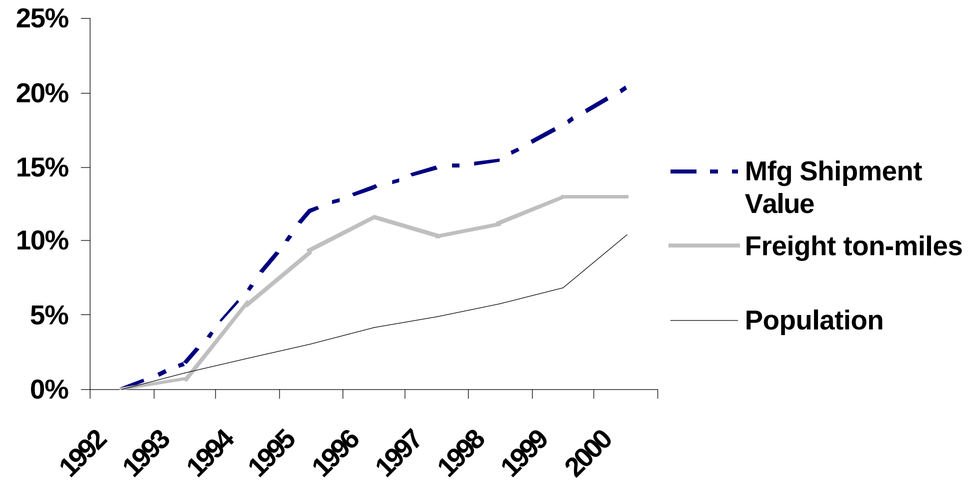
5.4 Growth in Freight Activity Levels

This section examines how change in the US economy is leading to continued growth in freight volumes, and also focusing that growth on smaller size, shorter distance and higher value shipments. These trends are useful to highlight, since the feasibility of rail freight alternatives to truck shipments also vary systematically by distance, commodity value/weight ratio and ultimate destination. Freight diversion and public investment decision models, discussed in later chapters of this interim report, build upon this type of information.

5.4.1 Rates of Freight Growth

In general, population growth and economic activity growth are commonly viewed as key factors determining freight demand growth. However, with much news about the loss of manufacturing jobs in the US, there is a common belief as well that freight output also is declining. All of these beliefs are wrong, as freight value and volume continues to grow at rates exceeding population growth. While population increased 9% between 1990 and 2000, total employment increased 18% due to a robust service economy. During this same period, freight ton-miles increased 19% and the value of manufacturing shipments increased 38% after controlling for inflation. Sales by the manufacturing sector, wholesale sector, and retail trade sector grew (in constant dollars) by 38%, 57% and 70%, respectively. Figure 5-14 show the relationship between manufacturing value of output, freight tons and population growth.

Figure 5-14. Growth in Shipment Value, Ton-Miles and Population

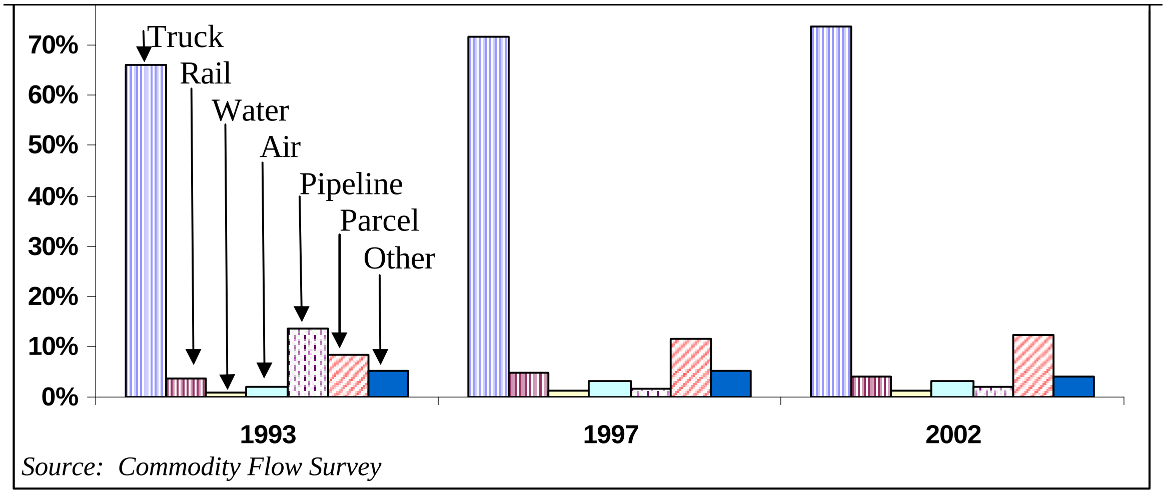


Source: Ton-Miles: Bureau of Transportation Statistics, Transportation Statistics Annual Report 2001; Population: U.S. Department of Commerce, Census Bureau, Statistical Abstract of the United States, 2000, table 2; Manufacturing: US Census Bureau, Annual Surveys of Manufactures 2001.

Trucks account for over two-thirds of the total value of all shipments in the US, as shown in Figure 5-15. This dominant share held by trucking has continued to grow over time, though air travel has the fastest growth rate (as shown in Figure 5-16).

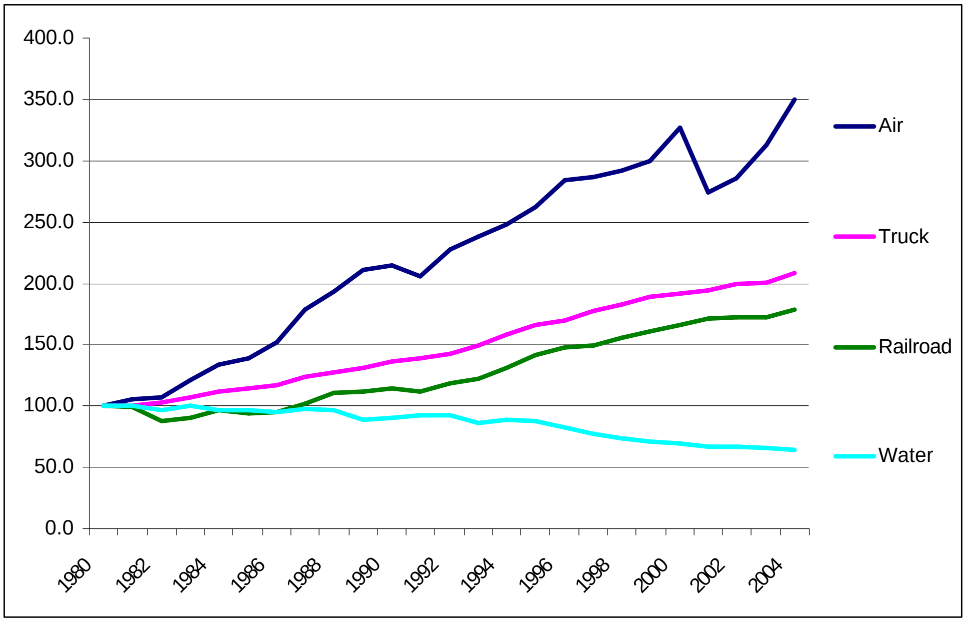
Figure 5-15. Domestic and Export Bound Shipments Within the US, by Mode

Percent of Total Value, 1993-2002 (in constant 1997 $)



Source: Commodity Flow Survey

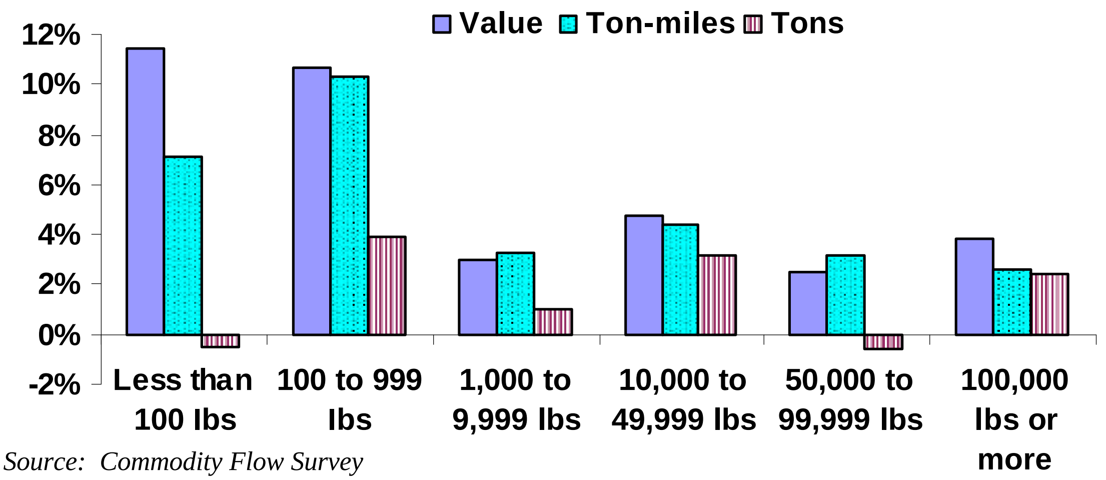
Figure 5-16. Growth in Ton-Miles by Mode (index 1980=100)



5.4.3 Shipment Value and Weight

Over this same ten-year period, there has been a continuing trend towards growth of higher value, lower weight and longer distance freight shipments. Figure 5-17 shows the growth in freight shipments among different weight classes. When measured in terms of either *total value* or *ton-miles*, the rate of growth was greatest in the lower two weight classes. In most weight classes, there was faster growth in value than in tons or ton-miles, implying a shift towards higher value shipments. In all weight classes, there was also faster growth in ton-miles than in total tons, implying a shift towards longer average distance for freight movements.

Figure 5-17. Shipment Size Percent Growth, 1993-2002



Source: Commodity Flow Survey

5.4.4 Shipment Distance

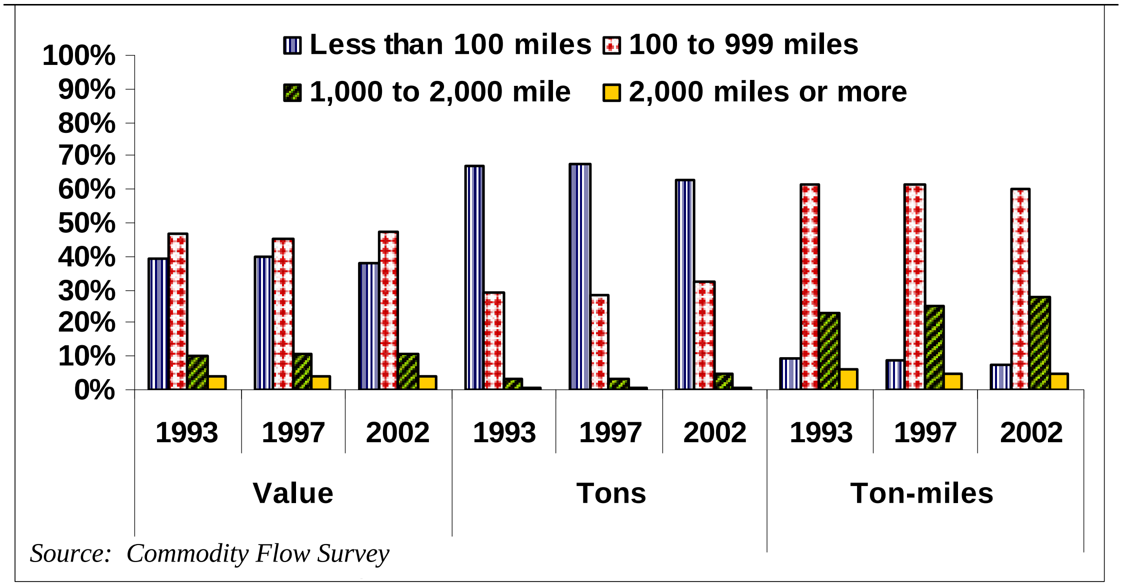
The complexity of weight, value and distance trends becomes more apparent when viewed from the perspective of Figure 5-18. Using the same database and the same study period as the prior two figures, this figure shows profiles of total value, total tonnage and total ton-miles by distance class:

- The very short distance class of deliveries (0-99 miles) accounted for the greatest share of total tonnage.
- The second shortest distance class of deliveries (100-999 miles) accounted for

the greatest share of total value and ton-miles.

- Together, the two shortest distance classes account for approximately 45% of the value of goods shipped, 29% of tons shipped, and 62% of ton-miles shipped.

Figure 5-18. US Freight Shipment by Distance Shipped



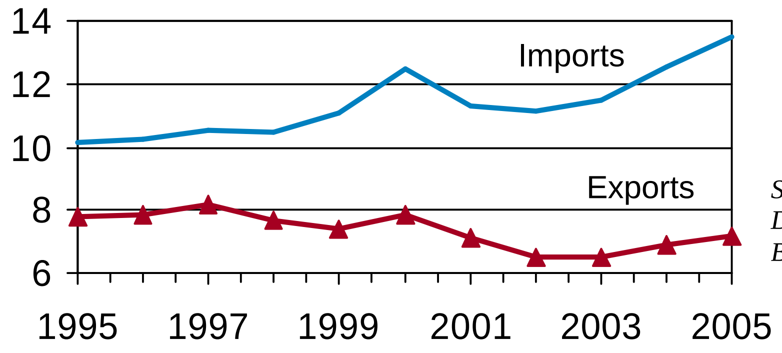
Source: Commodity Flow Survey

Changes in the location of manufacturing plants and assembly units, and increases in just-in-time (JIT) productions and distribution systems over the last two decades, are partially responsible for the notable increases in interregional (1,000 to 2,000 mile) freight shipment in ton-miles.

5.4.5 Import and Export Shipment Patterns

With continued globalization of business markets, it is becoming increasingly important to understand the pattern of freight flows to and from international borders and ports. First, it is notable that imports are growing at a rate faster than the US economy (measured in Gross Domestic Product), while exports are growing at a rate slightly lagging the national rate of economic growth. (See Figure 5-19.)

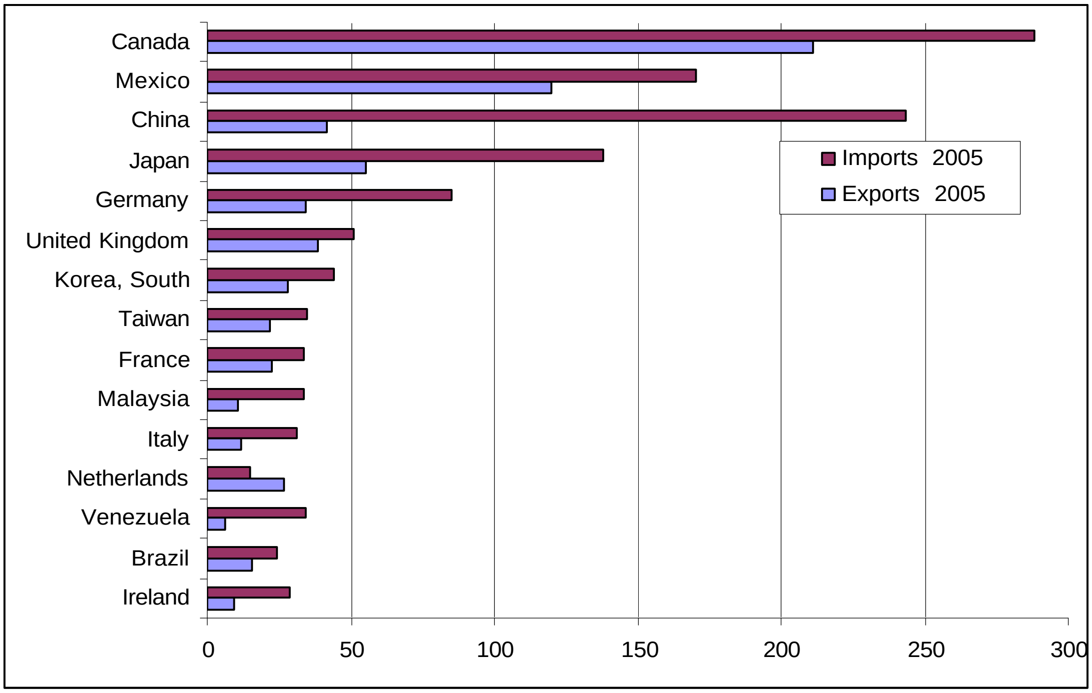
Figure 5-19 Value of Imports and Exports as a % of US GDP



Source: Foreign Trade Division, U.S. Census Bureau and Global Insight

Canada and Mexico continues to represent the top two trading partners for the US, accounting for 32 % of all US foreign trade. (See Figure 5-19.) Of course, nearly all of the freight flows to/from Canada and Mexico are transborder movements via surface modes – road and rail. However, the fastest rate of growth in imports and US exports is with Asian nations, and China has already recently passed Mexico as the #2 source of US imports. Of course, the growing overseas trade requires increasing reliance on sea and air freight, and that puts additional demand on the major US international seaports and international airports. That trend is accentuating the problem of congestion along major highway freight corridors.

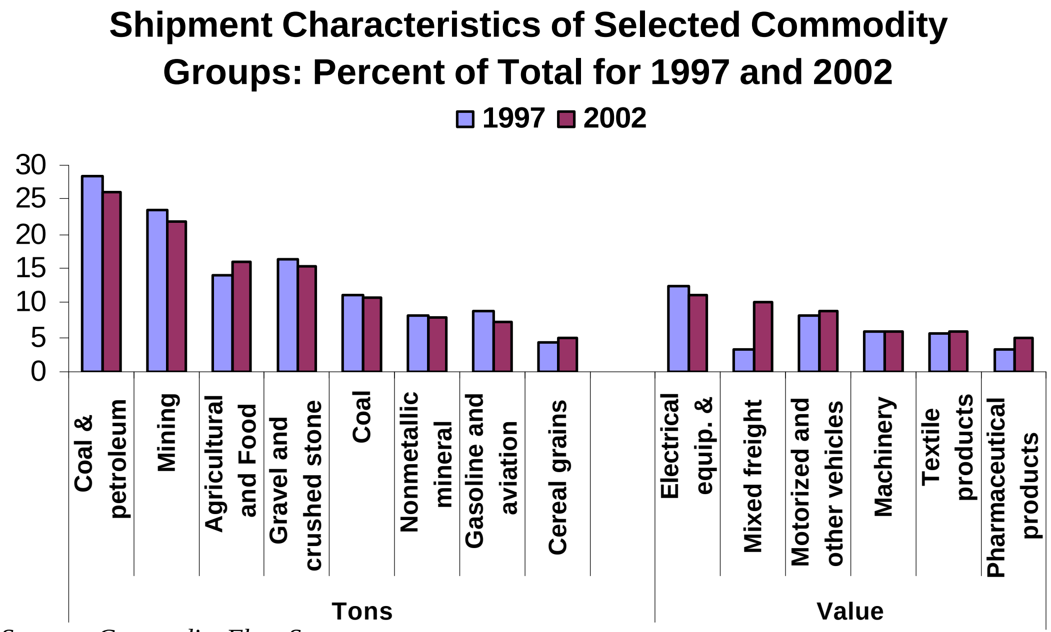
Figure 5-20 Value of US Imports and Exports, by Trading Partner ($ billions)



Source: Foreign Trade Division, U.S. Census Bureau

The commodity mix of export shipments shows that agriculture and fish products, coal and petroleum products, and wood, textile, and leather products represented the highest trade share of tonnage. Waterway is the most common mode of transportation used for these exports. However, when viewed in terms of shipment value, then we see that motor vehicles, computers, telecom equipments, and aircraft are among the top U.S export commodities. (See Figure 5-21.)

Figure 5-21. Shipment Characteristics of Selected Commodity Groups – Percent of Total for 1997 and 2002



Source: Commodity Flow Survey

Altogether, we see that the changing nature of freight activity is involving some systematic shifts in products, weight, distance, and destination patterns. Shifts towards smaller size and shorter distance shipments[98] are related in part to increasing attention to tight scheduling and logistics planning. Shifts towards higher value exports reflect emerging global trade patterns that are increasingly concentrating export movements at key border and air/seaport sites. However, while a growing portion of the higher value exports are being shipped via air, it is still important to keep in mind that *all* exports going via airport or seaport still have to travel via surface modes (truck or rail) to those ports. Thus, these trends serve to underscore that the pricing and the economic feasibility of rail diversion will be defined in large part by emerging freight movement patterns.

5.5 Business Location Trends

This section examines how business location and urban land development patterns are systematically moving towards a dispersion of activities within urbanized areas that in many (but not all) cases serves to favor highway shipping and disfavor rail shipping. This helps to explain what is already known – that truck is growing faster than rail as a mode for freight movements. However, this information has further use, for it also helps to establish a basis for determining the situations under which rail can (or cannot) be a potentially feasible alternative to truck for freight movements.

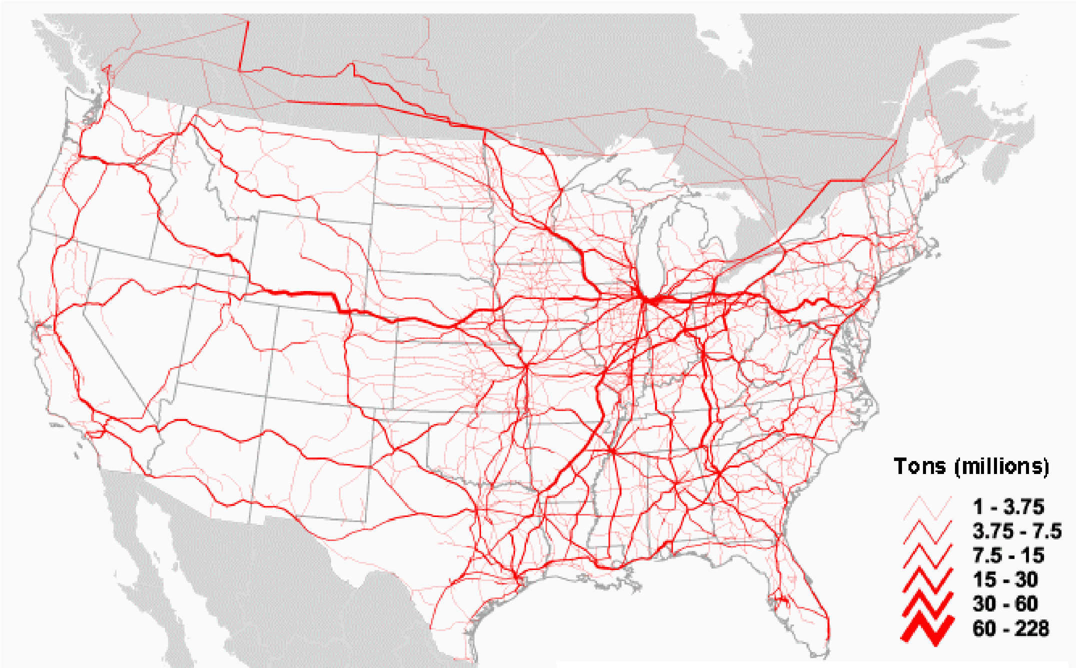
5.5.1 Development of Rail and Urban Industry

In the latter half of the 19th century and first half of the 20th century, industrial businesses were most commonly characterized by firms located to serve their surrounding regions. Business location surveys showed that industrial sites were often located where there was good accessibility to large labor pools, transportation (rail and canal), industrial supplies and raw materials, and major markets. This resulted in concentrations of industrial sites which minimized the costs of inbound and outbound freight movement and worker commute logistics.

During that period, the locations of manufacturing facilities were often close to the inner core of metropolitan areas. Because of the relatively high cost of constructing railroad rights-of-way and more constrained engineering parameters, rail lines tended to take more circuitous routes than today's highway network. The resulting network was often a hub-and-spoke type operation with sidings woven together to form branches, which merged to form mainlines and trunk routes – taking its cues from the natural system of waterways which often provided logical rights-of-way that decreased the costs of engineering.

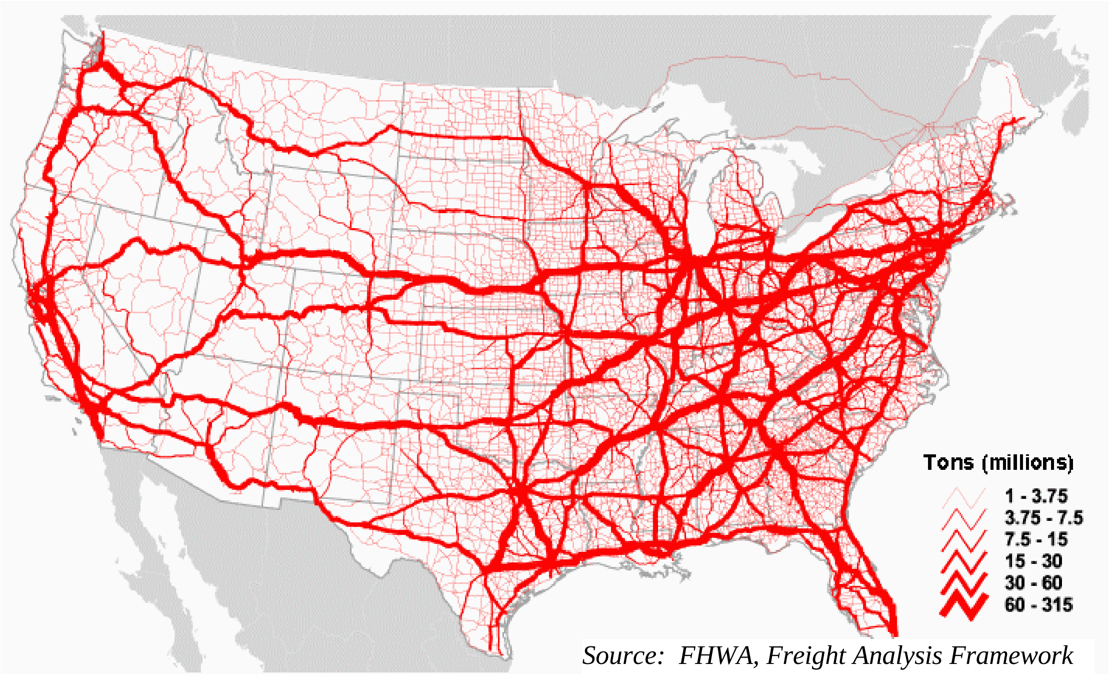
The national rail network, which developed during that period, still reflects pattern of industrial development and freight shipping. Figure 5-22 shows that the US national rail freight network has clearly identifiable hubs in Chicago, Kansas City, St. Louis, Cincinnati, Cleveland and other cities. Hub by-pass flows exist, but less on a local level (as evidenced by the streaking lines throughout most of Nebraska, and the lack of direct connections between some large city pairs.)

Figure 5-22. Rail Freight Network



Source: FHWA, Freight Analysis Framework

Figure 5-23. Truck Freight Network



Source: FHWA, Freight Analysis Framework

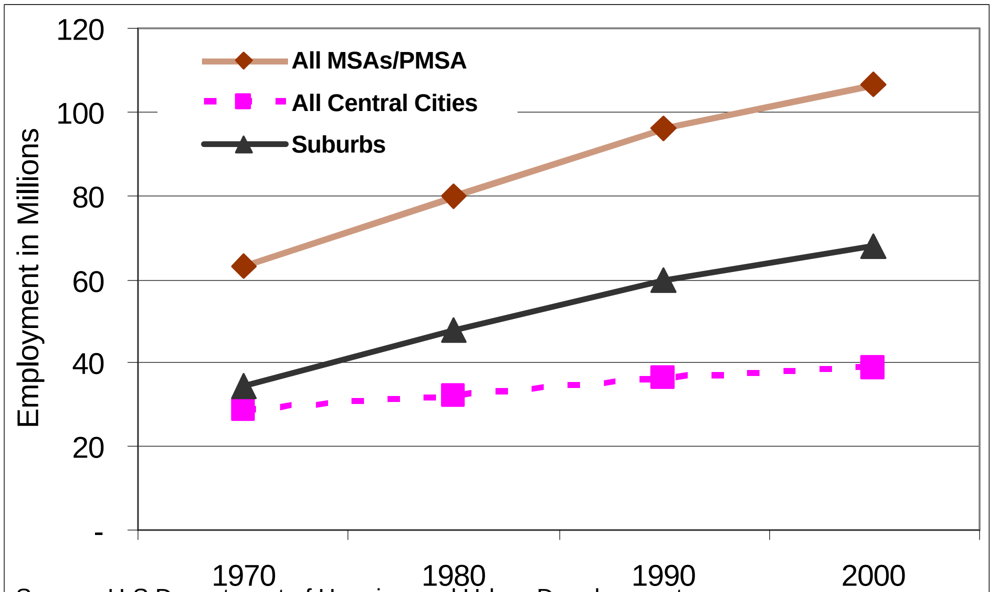
5.5.2 Development of Highways and Dispersed Industry

The national interstate highway network, on the other hand, was developed during the latter half of the 20th century. Figure 5-23 shows that the highway network reflects a different sort of spatial pattern in which origins and destinations are more diffused than the hub-oriented rail network. It clearly has visible ‘mainlines’, but even the smaller cities have direct connection with one another.

Today’s more dispersed pattern of development and industrial activities is almost entirely the logical result of the development of automobiles and highways – a transportation system that handles capacity in smaller chunks. This more dispersed pattern of highways and truck movements helped to grow a pattern of industrial activities and freight flows that does not always lend itself to more consolidated shipping methods such as rail. This becomes a key issue in screening alternatives, as the Guidebook discusses.

Today, we see that the evolution of business location and freight movement patterns has caused a shift towards increasing dispersion of business locations. This is evident at two different spatial levels. Figure 5-24 shows the relative shift of business growth within metropolitan areas towards suburban locations. Employment in suburban areas increased by 39% over 1970 - 1980, and by nearly 14% over 1990 - 2000.

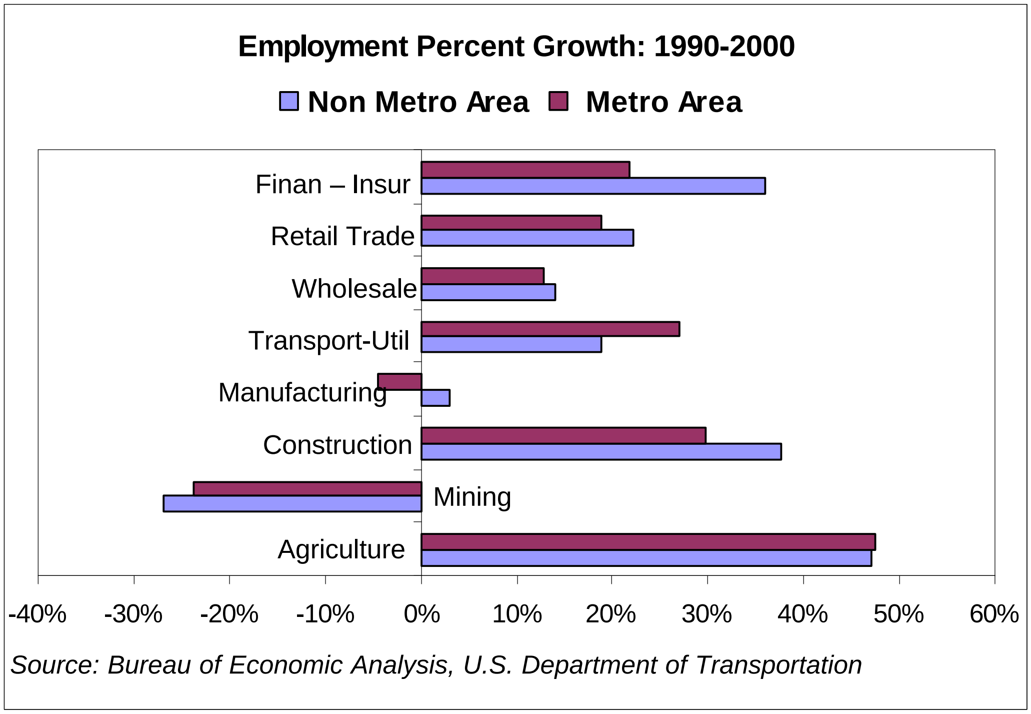
Figure 5-24. Level of Employment by Urban/Suburban Location



Source: U.S Department of Housing and Urban Development

Figure 5-25 shows that there was also an increase in manufacturing employment in non-metro areas and a decline in manufacturing employment within metro areas between 1990 and 2000.

Figure 5-25. Percent Growth in Non-Farm Employment by Location Type



Source: Bureau of Economic Analysis, U.S. Department of Transportation

Along with the dispersion of manufacturing and freight shipping patterns, there has also been a location shift in manufacturing across America during the last three decades of the 20th century. In general, the pattern has been a loss of manufacturing employment from the North Atlantic and New England regions toward the west, northwest and Midwest region. However, the South and Midwest regions still dominate as main manufacturing regions.

5.5.3 Industry Examples

Automobile and textile industries provide two examples of location shifts in the manufacturing sector. In early times, transportation cost was the decisive factor in industry location. Hence, traditional U.S manufacturing industries were based in big cities, with access to transportation (rail and canal), near major markets, and near industrial supplies. With modern times, markets opened, trade policies changed, and most important as operation cost rose, new manufacturing methods, like JIT penetrated, thus leading to shift in the industrial location.

In the 1950s, automobile manufacturers had assembly plants distributed across the country. As the U.S. share in automobile production declined, fewer plants were needed. In the 1990s, new plants were located in the center of the country in order to minimize distribution costs and vehicles had to be shipped to the rest of the country. (See Figure 5-26.) However, the changing manufacturing and supply relationships, the use of JIT systems, and the impact of the Internet on supply chains have further complicated the manufacturing process. Today, two types of automobile plants are in existence – a few auto and truck assembly plants and several thousand component plants that manufacture parts. Consequently, manufacture, assembly, and the sale of a single product may involve several different facilities located hundreds or even thousands of miles apart from each other.

Figure 5-26. Employment in Motor Industry: 2001-2002

State	Main Manufacturers	Numbers Employed	Year
Alabama	Honda, Hyundai, Daimler Chrysler (Mercedes-Benz)	83,710	2002
Georgia	Ford, General Motors	64,000	2002
Kentucky	Ford, General Motors, Toyota	87,659	2003
Mississippi	Nissan	30,000	n/a
South Carolina	BMW	42,000	2001
Tennessee	General Motors (Saturn), Nissan	62,273	2001
Source: State Statistics; includes part supplies			

The textile, clothing, and apparel industry is another example of a business that has taken on a "global dimension" in the location shift pattern. In the 1960's and 1970's, Taiwan and Korea were the dominant textile export countries. However, in the 1980's and 1990's China, Malaysia, and Indonesia emerged as leading exporters.

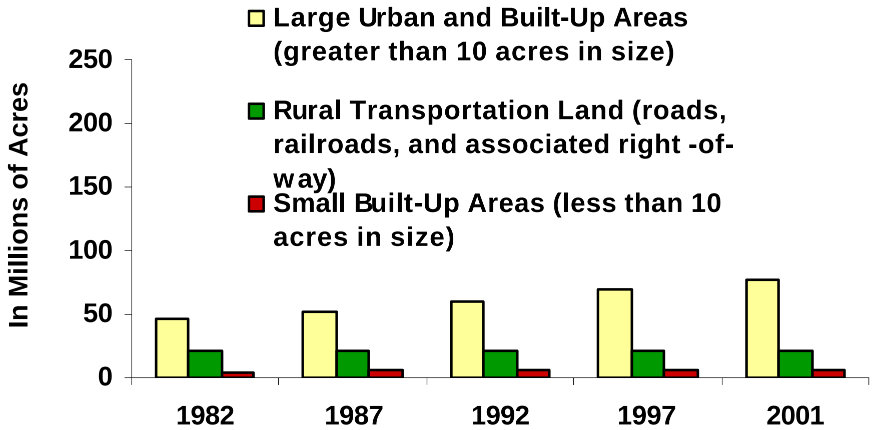
Lastly, the freight railroads' share has been declining in part because freight railroads are inherently less flexible than trucks. The freight railroads have slower speed and hence are often less compatible with just-in-time delivery methods. Railroads can complete direct movements only on a network of 100,000 miles and must transfer loads or cars between railroads. Such transfers take a significant amount of time. In addition, the operating environment of railroads is far more complex than that of trucks. Railroads are one of the nation's most capital intensive industries. As a result, it is especially challenging for railroads to maintain and expand infrastructure.

Altogether, these trends and examples illustrate the need for any economically-realistic analysis of rail freight diversion to focus clearly on differentiating commodity markets, and then focusing on those which are most conducive to increasing use of rail freight options.

5.5.4 Land Development Trends

While industrial locations are dispersing across the country, localized development is being concentrated in built up parts of metropolitan areas. According to the Annual NRI "Urbanization and Development of Rural Land" Report for 2001, growth in urban land area development increased by 65% between 1982 and 2001, while total land area development increased by a much lower 46% (See Figure 5-27.)

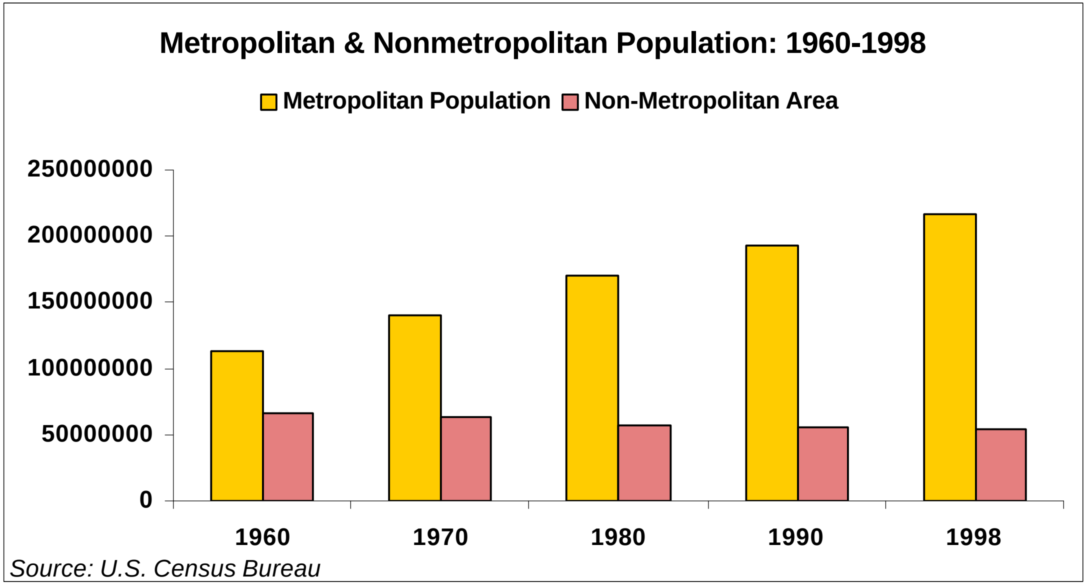
Figure 5-27. Trend in Developed Land by Location Type



Source: National Resource Inventory, U.S. Department of Agricultural's Natural Resources Conservation Service

This same trend towards urbanization in terms of population can be seen in Figure 5-28. It shows the concentration of population growth in metropolitan areas, while there was population loss in non-metropolitan areas. This trend towards metropolitan areas is partially responsible for increasing urban traffic (vehicle-miles traveled) and congestion levels.

Figure 5-28. Trends in Metropolitan and Non-Metropolitan Population



Source: U.S. Census Bureau

5.5.5 The Example of Chicago

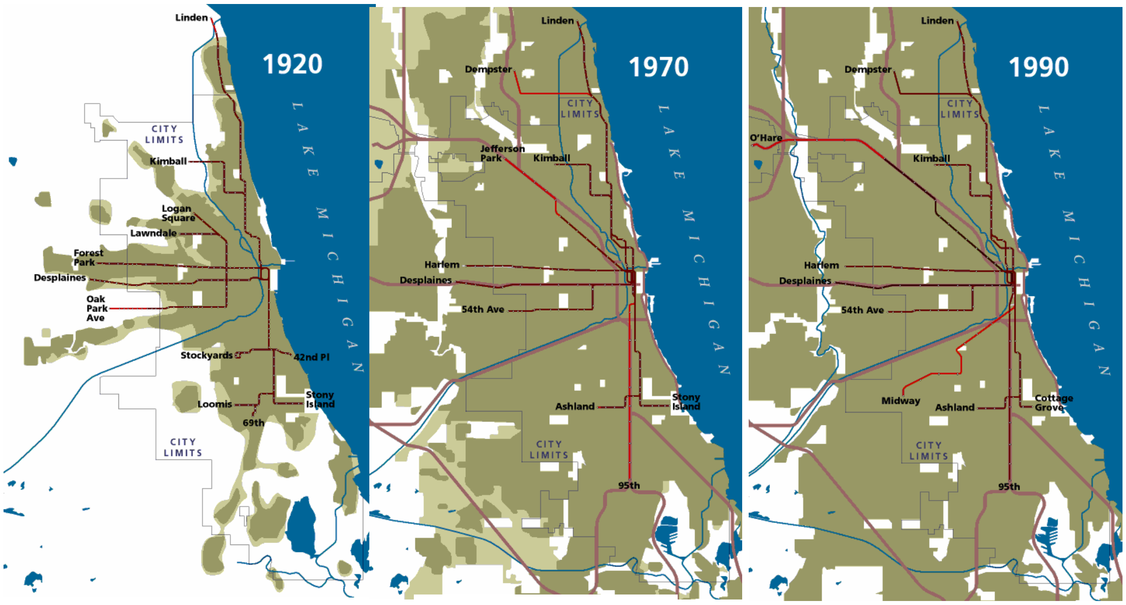
The evolution of freight railroads in Chicago illustrates the type of transformation occurring across America. Chicago has long had the highest concentration of railroad activity in the US since the first railroad reached there in 1850. Recently, as the railroad industry transitioned from the boxcar age to the intermodal age, Chicago's many classification yards were re-cast as intermodal yards in a series of widely documented schemes. Union Pacific's recent effort to focus its resources on growing the intermodal business has seen the construction of Global III, a dedicated intermodal facility, at Rochelle, Illinois, about 80 miles from The Loop. The inability to expand its capacity at the downtown and inner-suburban sites, plus protests at a number of suburban sites closer to the downtown, contributed to the decision to construct the facility in the exurban area. Higher property values in the inner urban core also contributed to the decision.

This is not the first time freight facilities have been moved away from the downtown in Chicago. The Rock Island Railroad's Chicago Terminal, LaSalle Street Station, was a large station with a head house and an adjoining break bulk freight facility constructed in 1903. After the demise of the Rock Island Railroad in 1975, the facility fell into disuse and was replaced by office buildings.

The opportunity cost of land in the downtown is clearly extremely high, and not all of Chicago's downtown freight facilities of yesteryear would be relevant today (for instance, transfer freight terminals that were intended as warehousing for break bulk cargoes are no longer required). However, it is not clear that rail freight options were considered at the time when the cityscape was being dramatically altered – during the transition from an industrial-based economy focusing on warehouses and factories to a service-based economy focusing on office towers.

Figure 5-29 below shows a sequence of three maps illustrating the evolution of developed land in the Chicago region over the period from 1920 – 1990. The original pattern in 1920 shows land development extending radially along the rail lines (illustrated by the lines on the page). By 1970, motor vehicles using the road network had become more important and land development became more dispersed, filling in areas not served by rail lines. By 1990, that trend had increased further. These Chicago examples thus illustrate how the role of rail freight today is necessarily different from the role it originally played as the city first developed.

Figure 5-29. Urban Development Pattern in Chicago Relative to Rail Lines



Chicago 1920 **Chicago 1970** **Chicago 1990**

5.6 Technology Trends

This section identifies examples of technology trends affecting the feasibility and cost-effectiveness of both rail and truck to serve freight movements. Technology trends clearly have great significance for the determination of economic feasibility of truck to rail freight diversion. Diversion feasibility is accordingly discussed in detail in the next chapter of this report, so the overview provided here is merely intended to illustrate the existence of long-term technology shifts that are coincident with shifts in economic, freight and business location patterns.

5.6.1 Intermodalism

On the macro level and apart from information systems, transportation technology has changed relatively little in the past twenty years. Although legislation has forced truck manufacturers to produce more fuel-efficient and less polluting vehicles, and size limits expanded, the basic form of the truck has not changed. The ocean-going container cube standard, at 20’ × 8’ × 8½’ (and the double-length 40’ types), has also remained fixed. Operations of trailer-on-flatcar trains, pioneered by the Chesapeake & Ohio in the 1950s, and later pushed into production phase by the New York Central, have remained largely unchanged since the advent of stack trains in the 1980’s. The ‘intermodal’ revolution is more of an evolution than a revolution, in the sense that the traffic mix on the railroad evolved from one dominated by carload traffic to one becoming dominated by intermodal traffic.

5.6.2 Motor Carriage

There has been a variety of “extensions” to truck size and weight standards, which have modified the economics of trucking and shipping in the background. Domestic trailers and containers, for traffic in the United States, were progressively extended from 40’ to 45’, 48’, and finally to 53’ at the beginning of the 1990’s. Progressive changes in highway design standards have allowed these longer trailers to run without causing safety problems. The hi-cube containers have also made an impact, extending the height from 8½’ to 9½’. The newer domestic trailers with low-profile wheels, low floor, 9½’ minimum height and 53’ length, could replace ocean-going containers on a two-for-three basis. This has contributed to increased transloading activities at West Coast ports for light density imports that ‘cube-out’ before they ‘weigh-out’.

Driven by changes in highway standards, many states allowed double and triple trailers to operate. Increases in tractor diesel engine performance have allowed higher tractive effort, thus making it possible for a single tractor to tow multiple trailers at acceptable operating speeds. Engine improvements also boosted fuel efficiency and prolonged operating life. Although these changes have been incremental, they expanded competitiveness and market reach for trucks as operating costs were reduced. Costs and business capture have been further improved by the substantial gains in equipment utilization and service quality afforded by control technology. Two-way mobile voice and data communication, global positioning systems, truck monitoring devices, optical readers, and information software have made assets in the field more productive, and more responsive to customer requirements.

5.6.3 Railroads

In general, railroad technology improvement in the last twenty years has been focused on: (1) larger/longer equipment or consists; (2) lower operating and maintenance costs, including signaling; (3) the double-stack innovation; (4) the auto-rack innovation; and (5) safety improvements. To understand the philosophy 'bigger is better', one simply needs to examine a list of equipment that has increased in size in the past twenty years: the boxcar, the coal hopper, the grain hopper, the articulated flatcar, the locomotive horsepower, and the length of train. The only piece of equipment that has not evolved much in this manner is the plain gondola car.

Lower operating and maintenance costs have come from a variety of sources. The elimination of the caboose and of crew positions, and the use of the remote-controlled locomotives, have allowed railroads to compete for freight at even lower costs. Changes in network and operating practices have also decreased the railroad's cost base – by cutting maintenance of way, concentrating trains on increasingly fewer core lines, and by eliminating intermediate classification yards while focusing on long-haul through traffic. The incremental improvements in both maintenance of way equipment and the components (such as concrete ties and Pandrol fasteners) have allowed railroads to achieve higher axle loads, higher tonnages, lower costs, and less downtime. Signaling improvements have allowed many towers to close while centralized dispatching evolved to deal with trains with increasingly tighter headways. As a result, railroads have become capable of handling large loads more efficiently while becoming less efficient at handling smaller loads. This has allowed them to conquer certain dense traffic markets while continuing to cede carload traffic to trucks.

The double-stack and auto-rack innovations permitted the carriers to make more effective use of a great rail asset: the ability to carry heavy, consolidated loads with efficiency. Double-stack trains almost halved the cost of intermodal operations, making it much more competitive with road-based transport – to the extent that the majority of marine import freight today travels by train. The three-level auto-racks made much more effective use of train capacity while protecting the cargo (compared to finished autos carried on flatcars). Since 1980, railroads have also developed a safer operating environment, due to incremental improvements in tank car design. Development of new types of couplers, defect detectors, and fiber-optic network have both reduced the instances of failures and enhanced the railroad's ability to detect problems.

5.6.4 Marine

Technological changes in marine shipping have been dominated by the quest to build increasingly larger ships. As the volume of containers being shipped throughout the world increased, the generation of very large 'Panamax' class ships - the largest that could fit through the Panama Canal – was surpassed, and it became economical to construct super-size vessels and routes without dependence on the Panama passage. In the meantime, clearance-restricted routes, such as the St Lawrence Seaway, became less important as railroads replaced ships in those trade lanes. On the whole, propulsion and loading/unloading technologies have not changed a great deal in the shipping industry. There have been incremental improvements in coatings and engines, and environmental regulations have forced changes from single to double hull, separate ballast and cargo tanks, but all of the ‘breakthrough’ technologies proposed, including nuclear propulsion, ‘fast-ship’, and hovercraft, have received limited niche acceptance or none at all. Navigation has greatly benefited since global positioning systems were developed and satellite communication improved. This has made it cheaper to transmit information about shipments and increase safety by allowing advance notice of dangers.

5.6.5 Commodities

While the technology of sea transport has not changed a great deal over the past twenty years, technologies behind the commodities that are being shipped have undergone fundamental transition. The advanced technology and high degrees of automation, along with the high level of wealth generated by technological innovations at the turn of the 21st Century, have allowed many everyday items to migrate from the durable to the disposable category. Greater information technology and data processing capability have allowed a much greater degree of customization than in the past.

Technology-driven economies, rather than manufacturing-driven economies, have a tendency towards generating non-material products such as intellectual property, software, banking, medical and legal services, and highly customized products in small batches such as scientific instruments, created to order in smaller production facilities. This has contributed to some regeneration of cities and higher degrees of congestion, as it is now possible to be productive without consuming great tracts of land area to set up mass-production plants.

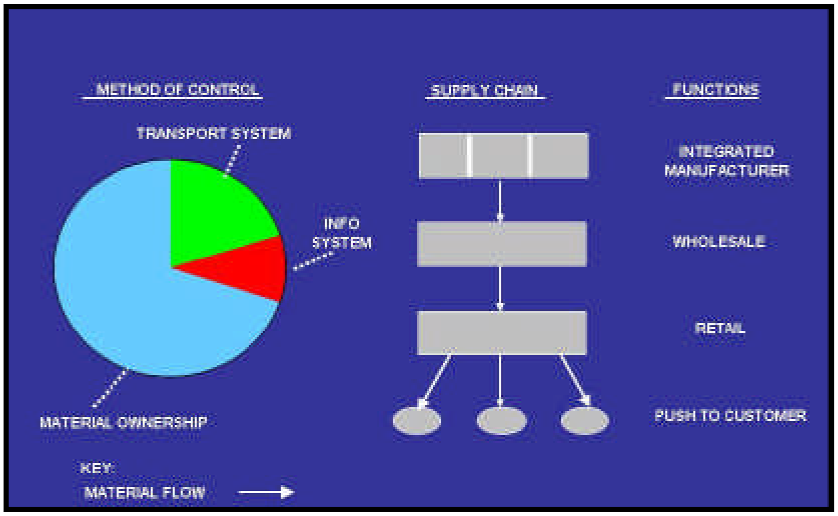
For the freight industry, this has meant trends towards: (a) disposable goods, with higher use rates and more shipments; (b) greater customization, with more seasonal product categories; (c) non-material or made-to-order products, with smaller shipment sizes; and (d) miniaturized goods, with high cost per unit volume, higher logistics costs and higher speeds required.

Although some goods are still sold with methods similar to those of twenty years ago (e.g. gravel or coal), others have migrated to the Internet and mail-order market, resulting in more small packages than before. Goods distribution and supply chains have become based more on a “totally-connected network” than a “hub-and-spoke network”, and the network itself has begun to define the business enterprise. New forms of knowledge-based specialization have occurred, where design may take place in one location, production in several others, and assembly in a third.

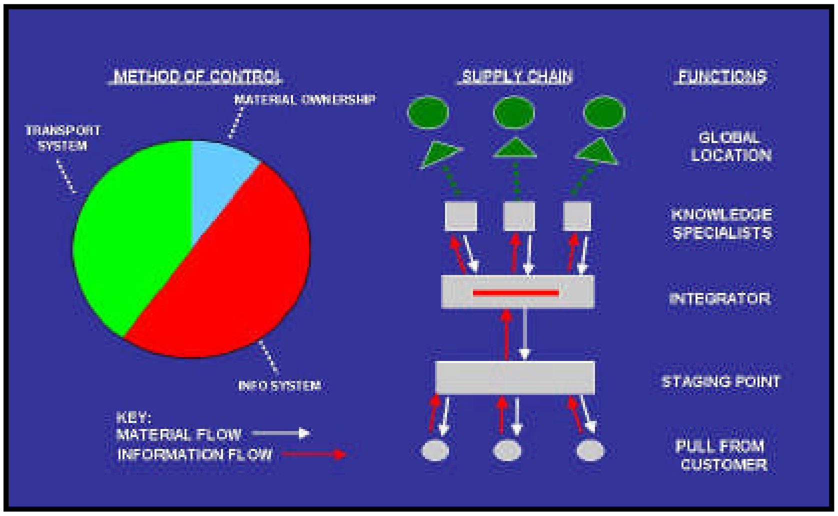
This is one of the mechanisms of globalization; linkages take place in the information and transportations systems, which replace inventory and centralized structure as the methods of control. The organization typically aims to produce and locate goods according to immediate demand rapidly communicated up the chain, and this form of demand-oriented pull logistics has begun to dominate over production-oriented push-logistics. (As illustrated in Figure 5-29, "Pull" means that events at the consumption point draw product through the system, instead of product being pushed down toward an expected demand.) Consolidation of freight is increasingly difficult due to small order sizes issued frequently, and this leads to new methods being created to organize product flow. Thus, the staging of goods and the integration of the far-flung supply chain become critically important functions, and the precision of transportation along with its operational information are made vital parts of the system. These changes in the logistics market have created opportunities for rail through the growth of containerized imports, yet they are also changing consolidation patterns and are placing new demands on all carriers for their cost and level of service.

Figure 5-29 Urban Development Pattern in Chicago Relative to Rail Lines

(A) Push Logistics



(B) Pull Logistics



5.6.6 Economy

New technologies such as radio frequency and computer directed storage and handling systems, satellite supported ground positioning systems (GPS) for tracking and expediting shipments, and use of the Internet to connect trading partners and customers are being widely used to create more effective and efficient distribution of raw material and goods.

Internet-based catalogues offer everything ranging from consumer electronics, luxury goods, sports goods, freshly produced foods, prescription medicines, and replacement parts. Customers are expecting overnight deliveries of this Internet based e-commerce. This is leading to either a network of market-based distribution centers filled with inventory, or fewer fulfillment hubs requiring much less inventory, where overnight delivery is possible.

The movement towards globalization with the emerging markets, cheap supply sources, new trading partners, and increasing industry competitiveness is compelling enterprises to develop new strategies to track orders and react to changes in real time in the handling and transporting of materials, as they move across the supply chain from originating suppliers to end customers.

Summation: This chapter has reviewed the spread of congestion and the rising dependence on trucks, the expansion in freight activity and shifts in business location, and the changes to technology and business forms. Together these trends make for steady ferment in the transportation industry. The need is growing for alternatives of the sort that rail can represent, while the factors that shape its economic feasibility are offering new opportunities and imposing higher demands.

6 DATA SOURCES

6.1 Introduction

The purpose of this chapter is to review for planners and analysts the range of data sources that are useful for assessing rail freight solutions to highway congestion. It describes each type of data source in turn, explains why it is useful, and tells how to collect or acquire the data. This chapter also assesses the adequacy and limitations of the currently available data, and suggests ways in which information could be further enriched. Its central focus is data sources that can support the modeling framework presented in the Guidebook. It is meant as a companion to that framework, and generally will not repeat treatments (including data points and rules of thumb) that may be found there.

There are various levels of knowledge, and increasing degrees of detail and sophistication in collecting data. What is appropriate can depend on the size of the project or opportunity, its phase of development, and the capabilities and resources of the decision makers. To come to grips with the options for rail, there is a need to understand how well the system is functioning, where it could do better, and where there are opportunities. A motivated and informed group of public officials, freight carrier officials, and chamber of commerce people may be able to provide workable answers to the central questions, if they can be brought together to look at them. In this sense an “expert system” can substitute for data in some stages, dimensions, or magnitudes of projects. Ultimately, data are a means to an end: they are vital, but there can be alternate ways to reach an objective, both in the kinds of information utilized and the kinds of approach taken. The Guidebook's framework moves progressively through analyses of increasing complexity, and data should be thought of as following in its path.

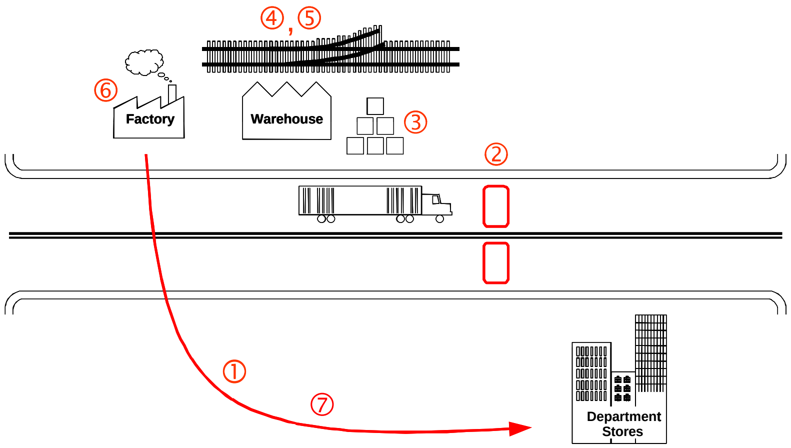
Data of several sorts may be needed to support freight planning studies:

- Traffic flows, depicting freight by lane and mode – for identifying trends, traffic distances and densities, and diversion possibilities;
- Traffic volumes on infrastructure – for determining truck contribution to highway demand, overall traffic activity, and rail requirements;
- Congestion on highways – which is the specific problem being addressed, and information will be needed in areas like level of service, recurring and non-recurring problems, and temporal variations;

- Freight customer characteristics – such as who is shipping or receiving what commodities within the area of interest, annual volumes, service sensitivity, loading/unloading needs and capabilities, rail access, and modal usage;
- Commodity characteristics – value per pound, product density, perishability, storage requirements, equipment needs, and so forth;
- Carrier characteristics – such as actual or typical service, cost parameters, capacity indications, and asset ownership.

The different data needs are diagrammed in Exhibit 6-1. Commodity flow data document various aspects of shipments, which go from a particular origin by a particular mode to a particular destination. Commodity flow data will identify the type of goods, but will not directly give important attributes of the commodity, such as value, density, shelf-life, special packaging requirements, etc. Nor will the flow data provide direct information about the shipper or the receiver, although they will give a degree of indication. Attribute and customer information, which are pertinent to mode choice, must be obtained from another source.

Exhibit 6-1 Rail Freight Diversion Data Needs



1. **1.** Commodity flow data
2. **2.** Traffic flow data
3. **3.** Commodity characteristics
4. **4.** Rail facility inventory
5. **5.** Rail engineering cost
6. **6.** Establishment data
7. **7.** Service performance data

State and local transportation planning typically is less well supported for freight than for passenger planning. Local movements are the predominant form of passenger travel, with most travelers beginning and ending the day at home. Planning procedures have developed that include sophisticated network models, frequent surveys of travelers, well-funded data collection efforts, and large planning groups at the state or regional levels. Freight is much different. Freight travel covers a broader region, with trip lengths an order of magnitude longer than passenger trips. Surveying is difficult because a diverse range of industries is involved, with a significant portion of mode and route decisions not made locally, and shaped by shipment staging and supply chain structures. Trips typically are one-way, displaying seasonal as well as diurnal patterns to flows. Planning procedures on the whole are not well developed, nor are the data sources as good as those available for passenger planning. The private sector is much more dominant in freight transportation, so that knowledge about the freight infrastructure, freight flows, and the characteristics affecting freight demand is seldom automatically accessible to public agencies.

Nevertheless, a great deal of information about freight and freight transportation is available. This chapter discusses various sources of data and the procedures that planners might use to obtain relevant input. It is beyond the scope of this report to present detailed strategies for assembling comprehensive databases suitable for all levels of freight planning. Instead, this chapter considers the primary data sources and discusses each of them. It does not demonstrate how disparate sources of data could be joined together or manipulated to derive insights regarding freight transportation or economic development. To understand data joining and manipulating techniques, other NCHRP reports on freight and economic planning[99] should be reviewed, particularly NCHRP 8-43 which treats freight planning in the statewide context.

Many of the data sources discussed are readily available, either as part of the data sets that State DOTs, economic development agencies, toll authorities and other public agencies already collect or as part of a commercial data service. However, it is also important to note that there are many incremental ways in which State DOTs could further leverage their freight data streams. With some effort and outreach, public agencies should be able to collect or assemble data and gain analytical insights that may not be immediately at hand.

6.2 Practicalities

Together with the Guidebook, this report considers how the public sector can work more effectively with the rail industry to allow the rail system to carry more intercity freight. If there is a public/private partnership for a study, then some of the problems of data collection will disappear. The railroads are well aware of the strengths and weaknesses of their own services and facilities; freight customers know why they use trucks instead of rail and what it would take for them to shift freight to rail; highway officials know where roads are congested and where heavy trucks are most common. The challenge is for the various parties in such a study to combine their knowledge and expertise in order to a) identify areas where rail solutions may be effective; and b) evaluate specific options for improving rail mode share. For freight, the questions, data requirements, and solutions are different from those commonly used in the 4-step planning process for transportation planning, but it is possible to assemble groups of knowledgeable people who can, as a group, identify workable strategies. One way to begin is with Freight Advisory Councils, which are becoming common fixtures in state and urban jurisdictions and are employed by the federal government as well. They offer a proven and available method for making realistic assessments of the public planning options, and for opening doors to other stakeholders who can contribute requisite data and participate in project opportunities.

These points suggest a basic and pragmatic orientation that planners should remember. Information is required to meet the objective of roadway congestion relief. Data are one way to supply this information; direct observation and professional judgment are others. Data are especially useful as inputs into analytical models, but when they encounter limitations - and they often will - there are estimations that can be adopted (as the Guidebook demonstrates). A combination of all these methods can be and usually is the way that projects get done. This means that while better data are desirable, a data challenge often can be reframed as an information challenge and solved in another way.

For example, each of the remaining sections of this chapter addresses a specific kind of data, and begins with a short summary of why such data are needed. In each case, planners may only require general information, such as “where are the most congested highways where heavy trucks account for a significant portion of VMT?” A set of observant truck drivers who worked throughout the region could answer this question, probably with details concerning the time of day. The individuals who report traffic conditions for the local radio stations, or who monitor operations for the DOT could also answer this question. Alternately, public agencies ordinarily have databases that incorporate traffic counts and estimates of congestion levels for segments of major roadways; from those, a planner can derive a list of segments with a level of service of D or worse where heavy trucks make up at least 15% of the traffic. Both kinds of sources produce practical information – yet it is helpful to note that it is not necessary to create a database to get a reasonable answer to the initial question.

In general, any MPO or state transportation agency should be collecting data related to freight, including such things as potential rail customers, truck usage of highways, trends in truck traffic, and congestion levels on major roads. If they lack such data, they should initiate data collection efforts. However, the lack of such data should not be taken as an impediment sufficient to defer freight planning efforts. As the Guidebook describes, analyses can vary widely in their data intensity, depending on the scope of the problem and its stage of development, and there are a number of ways to get at them. It is usually possible to proceed on some basis, if not with detailed material then with the information and insights that can be provided by carriers and their customers, along with rules of thumb and whatever data is available to the public agencies.

This chapter therefore is not a checklist of data sets required to begin a freight study. Rather, it is a guide to possible data sources that a planner will use flexibly, imaginatively, and differently, according to the needs of the problem and the options open at the time. It emphasizes alternative ways of developing information, because this is a practical and productive approach. Previous chapters of this report have cited almost two dozen rail freight projects in North America that have assembled information by the means described here, leading to investments of public funds across the range from small to very large. Exhibit 6-2 shows the types of data that are most commonly collected and used for assessing rail freight solutions.

Exhibit 6-2. Data Types and Factors

- Commodity Flow Data
- Traffic Count Data
- Commodity Characteristics
- Maps & Inventories of Rail Infrastructure and Service
- Railroad Engineering Cost Data
- Shipper Characteristics & Needs – Establishment Data
- Modal Service and Cost Parameters
- Trend Data – Traffic & Economic Projections
- Institutional and Privacy Factors

The remainder of this chapter reviews eight types of data, and concludes with a look at the institutional and privacy factors that can affect the accessibility of information and the rules governing its use. (The chapter sections are summarized in Exhibit 2.) The eight types correspond to the seven needs diagrammed above, with the addition of trend and forecast data. For each type, four sets of considerations are discussed:

- What is the problem? What kind of data would be useful?
- Are there readily available sources for the data?
- How can the data be collected?
- Levels of accuracy and precision

6.3 Commodity Flow Data

What is the problem? What kind of data would be useful?

Commodity flow data are needed for two reasons: (1) to understand what type of freight is causing congestion, and (2) to determine whether such freight can, in fact, be feasibly diverted with a suitable rail freight service. When used in conjunction with other data, the information can also be used in determining a suitable rail freight service program.

Commodity flow data also are an important driver for many types of forecasting activities. As a measure of freight activity levels from an economic perspective, they give insight into not only how much freight is moving, but also what type of freight is moving, which will begin to imply *why* the flow exists. The reason for freight movement can be important in predicting whether shipments will continue and whether they can be expected to grow.

Are there readily available sources for the data?

For rail traffic information, the key source is the Carload Waybill Sample (CWS), issued annually by the Surface Transportation Board. The Waybill Sample is a statistically based stratified random sample of shipments terminated by US rail carriers. All carriers terminating 4,000 or more carloads per year are required to report and 62 railroad systems thus are captured, encompassing all Class I and II roads, and the more prominent short lines. (Carriers smaller than 4,000 annual loads may be sampled when they act as haulage agents for larger railroads, and the latter appears as the carrier of record on a shipment.)

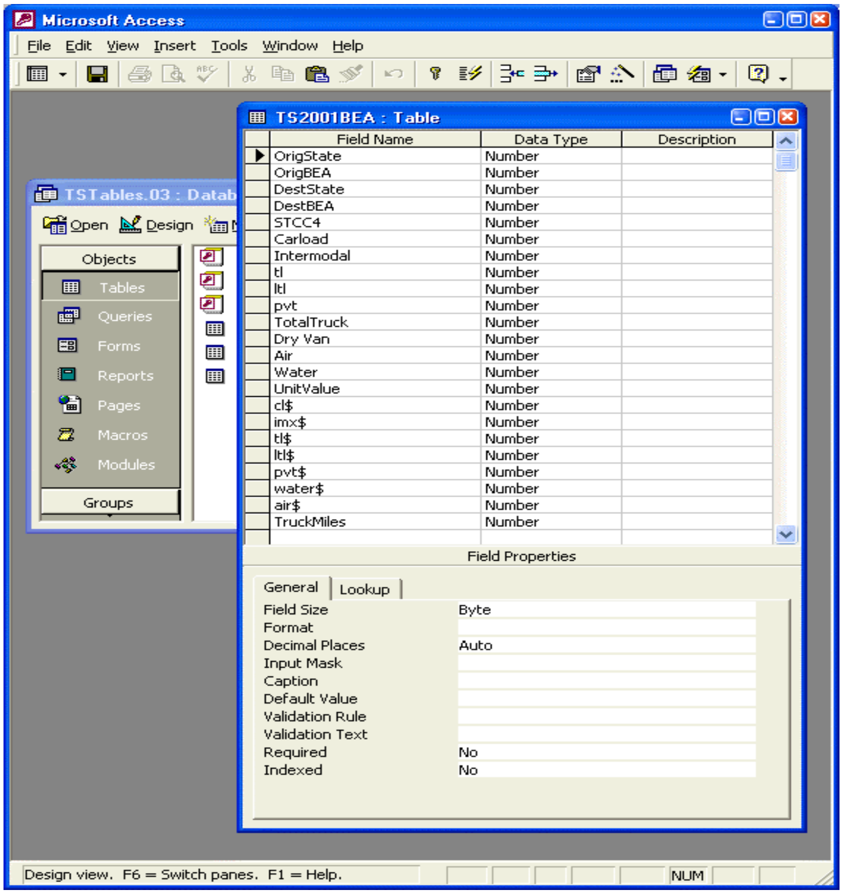
The full (and confidential) Waybill Sample file contains highly detailed information on the origin, destination, commodity and volume of each sampled movement. Intermodal and unit train traffic can be separated from single or small block carload, and the rail carriers handling the traffic are identified. State Departments of Transportation have access to this data source for activity in their state, subject to certain requirements on the confidential handling of the information. MPOs may petition their State for access, and usually can gain it. A public edition of the Waybill also is available, with far less detail released but without privacy restrictions; in addition, there are commercial versions of the public data that interpolate some of the missing detail and can make it easier to use. A separate, semi-commercial source exclusively for intermodal traffic data is the Intermodal Association of North America (IANA), who publishes monthly flow volumes by trailer/container type between large geographic regions. These data have less specificity but more currency than the CWS.

For truck data in the public domain, the US Bureau of Census publishes the Commodity Flow Survey every five years, as part of its economic census. It provides a sound, basic body of information on the flow of goods between US markets by mode, with highway freight traffic separated into for-hire and private fleet volume, and multimodal activity identified. (The CFS also has information on shipments by other modes, although for rail the CWS offers more detail and usually is more current). Flows in the CFS are released by state and major metropolitan markets, which can be adequate for some applications and are a good scaling tool for sketch planning. (The Guidebook presents an example of this.)

The most recent CFS at this writing was completed in 2002. In addition, the FHWA's Freight Analysis Framework contains a database of 1998 commodity flows for several classes of truck (and other modal) traffic, on a state-to-state basis. FHWA has begun the update of this information, and issued a 2002 data set based on the CFS that a) interpolates traffic flow information covered but not released by the CFS; and b) supplements CFS coverage with modeled information, much of it covering truck activity. The geographic units in this FAF II data are the 114 regions utilized by the CFS.

Truck data are available from commercial sources as well. Commodity flows between counties, based on proprietary samples and incorporating public information, are updated annually for various classes of truck fleets and equipment types. Data of this kind have been used in a variety of rail studies, including complex truck diversion analyses. Such databases usually incorporate the STB Waybill to facilitate modal comparisons; a typical example appears in Exhibit 6-3. Finally, truck trip tables often are a part of state and urban transportation models, and can be adapted for other kinds of analysis. While commodity information sometimes is absent, the tables can be reflections of local survey work, or an amalgam of public and commercial data with local observations.

Exhibit 6-3. Illustration of Waybill Database



TS2001BEA : Table

Field Name	Data Type	Description
OrigState	Number	
OrigBEA	Number	
DestState	Number	
DestBEA	Number	
STCC4	Number	
Carload	Number	
Intermodal	Number	
tl	Number	
ltl	Number	
pvt	Number	
TotalTruck	Number	
Dry Van	Number	
Air	Number	
Water	Number	
UnitValue	Number	
cl$	Number	
imx$	Number	
tl$	Number	
ltl$	Number	
pvt$	Number	
water$	Number	
air$	Number	
TruckMiles	Number	

Field Properties

General | Lookup

Field Size	Byte
Format	
Decimal Places	Auto
Input Mask	
Caption	
Default Value	
Validation Rule	
Validation Text	
Required	No
Indexed	No

How can the data be collected?

Intercity commodity flow data is collected through surveys, exchanges, or legal reporting requirements. The STB Waybill sample is a mandated collection from rail carrier records, and the CFS as an aspect of the Census also is a legal obligation on freight shippers, who are its respondents. There are no similar reporting requirements for motor carriers, and data sharing from this source has been accomplished through voluntary surveys, or through commercial trading of information.

Data procured through a survey of selected shippers and receivers can be effective for locally based shipments, but will not pick up overhead traffic. Intercept surveys can detect overhead truck traffic as well as that locally based, although a comprehensive set of information can be challenging to obtain. Both methods can be time-consuming and expensive, yet many studies have been successfully completed which relied on the use of survey data. Responsiveness is a further obstacle. Because of growing privacy concerns and aversion to government monitoring (as well as the explosion of surveying and tracking in modern society), cooperation in surveys increasingly is difficult to obtain. One solution is the use of an intermediary (such as an external contractor) as a way to ensure confidentiality. Data collected by an independent third party and blended with other information before delivery to the public agency can avoid subjection to the Freedom of Information Act, and encourage participation by transportation stakeholders in data compilation efforts.

Combining and cross-referencing information derived from multiple sources is one of the key techniques used by planners to assemble truck information. One or more forms of data collection – such as the shipper interviews, truck driver surveys, or intercept data mentioned above - are employed together with commercial or national information to produce a local picture against a regional backdrop. Data assembly is done within the processes of an urban or statewide travel demand model, or processed more narrowly to answer the immediate needs of project or program development. Numerous state, urban, and project studies have been approached in this way, for overall freight planning as well as for rail initiatives.[100]

Levels of Accuracy and Precision

Commodity flow data is available at different levels of granularity. Geographically, the data can be collected at the state or county level, or even by zipcode or railroad freight station. Time-wise, the data might be compiled daily, monthly, quarterly, or annually. Different resolution is also possible along dimensions of vehicle types, commodity detail, and so forth.

Daily or monthly data will capture diurnal variation and the effect of seasonality, whereas annual data will capture effects of longer-term business cycles. It also tends to be more difficult to get accurate samples with shorter time periods or finer geographic granularity, because a larger sample size would be required to estimate flow data with higher precision.

Commodity flow data may be quoted to the ton or vehicle unit, but whatever its degree of historical accuracy, the current picture is subject to change. Variability from month to month or year to year can be significant, due to economic, seasonal, and random effects. However, when considering rail freight diversions, a reliable base volume is going to be important, but fine precision often isn't as critical. A 10% error in the average base volume may only have a small impact on the viability of the service, compared to other factors such as the quality of performance or the condition of pre-existing rail freight infrastructure.

6.4 Traffic Count Data

What is the problem? What kind of data would be useful?

The first step in the analysis is to find sections of the highway system that (a) are congested and (b) have a significant portion of heavy truck traffic. Facility-level traffic count data are needed first and foremost to assess the level of congestion on existing roads and highways and to determine whether or not trucks are prevalent in the congested area. Detailed facility-level traffic data will provide a base case for the development and evaluation of suitable strategies and solutions. The greater the congestion and the greater the proportion of heavy trucks, the more likely that a rail freight solution may be feasible.

If traffic counts are available for multiple years, they may illustrate trends in congestion and in truck traffic. Since traffic counts do not show the origin or the destination of the traffic, this type of data is not sufficient for modeling flows over the network, although they are commonly used for calibrating trip tables and flow model constraints. Moreover, detailed facility data (including breakouts at the equipment-type level) can be very helpful in determining the impact of proposed solutions and developing relief performance measures. Similarly, volumes and trends for rail facilities are important if there are concerns for railroad capacity, or to understand capital investment needs.

Are there readily available sources for the data?

Captured in the Federal Highway Performance Monitoring System (HPMS), state DOTs maintain databases of historical and current facility levels-of-service (LOS) between A and F, which is an indicator of roadway traffic flow and degree of congestion (traffic tie-ups are at level F). DOTs mainly derive this type of data through continuous or spot placements of automated loop count equipment, whose raw data streams are informative but require some processing to remove anomalies prior to use. The counts specifically measure the passage and timing of vehicle axles;

algorithms then are used to provide an interpretation of vehicle type and other details, which may be stored in a DOT database. Counts have the additional virtue of depicting temporal patterns: time of day and day of week volume variations, and seasonal fluctuations when traffic is monitored often enough.

How can the data be collected?

Traffic count data in fact are collected in a number of different ways. The commonplace loop count data are regularly compiled by states along major routes and at strategic intersections to determine the passage of traffic. More advanced systems will differentiate between automobiles, light trucks, and heavy truck classes. Other advanced methods of monitoring traffic exist and can enrich the data substantially beyond interpreted counts. Weigh-in-motion stations, traffic cam sites (as shown in Exhibit 6-4) joined with the appropriate data-extraction software, and aerial photography all can be used to identify vehicle volumes by type, assess the degree of congestion, and characterize and understand some of its causes.

Exhibit 6-4: Traffic camera can also generate flow data.

(Courtesy of Maryland DOT)

In toll facility territory, data from collections can also be used to develop enriched traffic count data, especially with advanced billing and information systems such as EZ-Pass. Truck counts by vehicle size and time of day can be taken from bridge and turnpike records. However, past attempts to use advanced information (such as operator identification and histories) for traffic demand management or transportation planning have been met with resistance due to valid privacy concerns on the part of the users. With toll territory apparently set to expand aggressively and nationally, mechanisms and opportunities for utilizing these data are apt to expand in parallel, and a legal framework similar to that applied to the STB private waybill sample might finally allow the more detailed data to be used in planning. Another issue with collecting traffic count data is that counting devices may be owned and operated by different entities; state DOTs traditionally controlled inductive loops on non-toll routes, while turnpike authorities controlled tollbooths, and traffic cams may be privately owned or operated by a state contractor.

Railroad counts can be constructed for current and historical years from the CWS, with the aid of a routing model. Waybill records have indicators for the path traveled by shipments, and a model can turn these into a complete picture of linehaul traffic provided carrier operating preferences are observed. Railroads also prepare and can make available track density figures; many state DOTs have access to these. Pickup and delivery traffic at intermodal transfer centers can be estimated from the CWS, although railroads may be willing to offer lift figures as well. Volumes at other kinds of terminal are harder to derive because they are a function of blocking practices and train configurations. There are models that can estimate this information, but if it is important to have it, it is probably best to request it directly from carriers.

Levels of Accuracy and Precision

Rail counts of the sort just described are reasonably detailed and accurate. On the highway side, traffic count data is available at different levels of granularity. Geographically, the data may be collected simply for a given highway segment, although more sophisticated systems will differentiate between northbound/southbound, turning or passing vehicles, vehicles using exit ramps, and different classes of trucks. Some systems will also convert vehicle counts into rates at different resolutions, e.g. counts per hour, per day, and per year. One conventional output is the quantification of Average Annual Daily Truck Trips (AADTT).

Vehicle identification by means of interpretative algorithms presents two kinds of difficulty: the conversion of axle observations to truck counts may be off, and the definition of “trucks” may include light vehicles (and even pickups) that have almost no susceptibility for rail. The more advanced systems do a much better job of isolating the heavier freight that rail can remove from the roadway, but thus far there is much less of this data available. In addition, when using data at the hourly level or daily level, the usual caution about spurious accuracy from small sample sizes applies; if the truck count during a given hour on a given day is 30, the truly representative value might actually be somewhere between 15 and 50. An average of counts during the same hour over a number of days will give a narrower confidence interval of the normal range.

Rail freight diversions may make the most noticeable reductions in the number of trucks, or observable reductions in congestion, in specific circumstances. For example, there will be locations where a large portion of the highway traffic is attributed to a few bulk truck trip generators, such as ports or major manufacturing plants. Also, in certain locations on the highway network, through trucking may be fill one or more lanes of highway, especially where multiple routes converge at or near major cities, or geography causes traffic to be funneled along a coast or mountain range. In that sense, the accuracy of the traffic count, which gives an idea of overall levels of congestion, is less critical than the accuracy of the distribution of vehicle types that measure proportion of total congestion for which trucks or heavy trucks are responsible.

6.5 Commodity Characteristics

What is the problem? What kind of data would be useful?

Commodity characteristics are important, because certain types of commodities are more suited to rail than others. Bulk commodities, lower-value general merchandise, and commodities that are shipped in large quantities are typical targets for rail. Commodity price data can also be used to assess the impact of changing freight flows on the economy and on economic development.

Conversions of commodity weight information to price information (e.g. dollars per ton) are useful in this connection. Note that the prices of commodities may not simply depend on the physical goods, but also on their location and other factors like packaging or extent of processing – for example, paper may be more valuable in consuming markets than in production regions, due to added transportation costs and localized demand-supply equilibrium.

In addition to price, other commodity characteristics may be important in considering rail freight diversion feasibility. These can include such factors as equipment requirements, storage needs, loading and unloading demands, perishability, and product density.

Are there readily available sources for the data?

Several federal publications have been good sources for key elements of this data. Until its discontinuation in 2006, the Vehicle Inventory and Use Survey (VIUS)101 supplied equipment types and payload (loading) factors for broad categories of commodities hauled by truck; the same things can be derived in even greater detail for rail commodities from the CWS. The CFS contains commodity values overall and by mode; in addition, the Bureau of Transportation Statistics produces the Surface Transborder Commodity Data, which contain flows of nafta goods and their declared values at the border crossings. The Bureau of Economic Analysis also produces various input-output tables and accounts, which can be used to derive the value of goods traded per ton when combined with a commodity flow database and a matrix to map such flows to specific industrial sectors.

Other sources on commodity pricing are available from various industry associations and government departments, such as the US Department of Agriculture, Department of Energy, and the Western Wood Products Association. Some web news services and investment information services also carry up-to-the-minute as well as historical commodity price data for selected commodities on their websites; however, getting it to a form usable for rail freight assessment may represent significant work.

Tonnage-to-volume and tonnage-to-value conversion matrices also can be an element of commercial freight flow databases, whose equipment type classifications help to address storage and equipment requirements as well. Example metrics based on the FHWA Freight Analysis Framework, representing an amalgam of federal and commercial resources, are given in Exhibits 6-5 and 6- 6.

Exhibit 6-5: Tonnage to Truckload Volume Conversion by Commodity Type

Source: derived from FHWA Freight Analysis Framework

Exhibit 6-6: Value to Tonnage conversion by Commodity Type

STCC2	Description	Tons /Load	STCC2	Description	Tons /Load
20	Food and Kindred Products	18	31	Leather Products	11
21	Tobacco Products	17	32	Concrete, Clay, Glass,Stone	14
22	Textile & Mill Products	17	33	Primary Metals	20
23	Apparel Products	13	34	Fabricated Metals	14
24	Lumber & Wood Products	21	35	Machinery	11
25	Furniture	11	36	Electrical Equipment	13
26	Pulp or Paper Products	19	37	Transportation Equipment	11
27	Printer Matter	14	38	Instruments	10
28	Chemical Products	17	39	Misc. Manufactured Goods	15
29	Petroleum or Coal Products	22	41	Misc. Freight	16
30	Rubber & Plastics	9	50	Secondary Traffic	8

Source: derived from FHWA Freight Analysis Framework

STCC2	Description	$$/Ton	STCC2	Description	$/Ton
1	Farm Products	230	27	Printer Matter	37000
8	Forest Products	470	28	Chemical Products	690
9	Marine Products	1000	29	Petroleum or Coal Products	200
10	Metallic Ores	140	30	Rubber & Plastics	1600
11	Coal	30	31	Leather Products	15000
14	Non-Metallic Minerals	10	32	Concrete, Clay, Glass, Stone	100
20	Food or Kindred Products	850	33	Primary Metals	770
21	Tobacco Products	6900	34	Fabricated Metals	2400
22	Textile & Mill Products	4100	35	Machinery	9300
23	Apparel Products	6500	36	Electrical Equipment	19000
24	Lumber & Wood Products	210	37	Transportation Equipment	9400
25	Furniture	3700	38	Instruments	11000
26	Pulp or Paper Products	910	39	Misc. Manufactured Goods	3500

How can the data be collected?

The information sources described above are readily available and adequate for most planning purposes, making the collection of original data unnecessary. Moreover, some published elements can be sufficient proxies for others that are harder to come by: equipment and commodity payload characteristics can stand in for product density, for example, and also shed light on storage and handling aspects. When more current or specific price data are needed, it can be possible to compile it from web and other reference sources into a database with modest effort. However, results should be scrutinized to be sure that values are reported on the same basis: some figures may relate to wholesale, retail, delivered bulk, or spot-market prices, and others to costs of production. Collecting such data from empirical observations or through calls to vendors probably is impractical except as cross-checks; alternately, local chambers of commerce, economic development agencies, or economic research consultants may have some pre-existing data points that they use for internal purposes.

On a limited basis, for very specific freight flows and economic sectors (e.g. cement, coal, building materials, wood, and other such bulk materials), shippers and producers may be willing to provide rough price data for planning purposes. If special equipment or storage requirements apply, these will become evident during the course of dialogues with the shippers.

Levels of Accuracy and Precision

High degrees of accuracy in commodity value data are not critical to developing a successful rail freight diversion scheme, and the information resources described in this section normally are adequate indicators. If a scheme can be shown to be possible and likely to deliver a positive return on investment, it is unlikely that short-term changes in commodity value will overturn it, and other features like handling characteristics ordinarily don’t shift very much. It is not usually prudent to pursue plans or schemes where the diversion hinges on having a low estimate for commodity values. In most cases, relatively modest changes to the plan, particularly in infrastructure or operating requirements, can strengthen its business case substantially.

Two exceptions that planners should keep in mind pertain to long term market trends. New entrants or new production sources, especially in commodity markets where transportation is a significant component of delivered cost, can cause an otherwise viable rail service to become uncompetitive. Usually the traffic pattern then will change completely, with the commodity production moving elsewhere instead of just switching mode (although that may happen, too), but this certainly can disrupt the return on a rail investment. Modification to logistics practices are a second way the ground can shift: the move to low inventory, high speed supply chains, for instance, favors smaller shipment sizes and tends to reduce commodity payloads over time.

6.6 Maps & Inventories of Rail Infrastructure and Service

What is the problem? What kind of data would be useful?

Knowledge about the location, design, condition, and utilization of rail facilities is basic information for strategies and policies aimed at increasing the role of rail to relieve congestion. There are several questions that should be asked at the beginning of any study:

- Does the rail system have the capacity to handle more freight?
- If not, what are the limitations and where are the key bottlenecks?
- Do the railroads have plans (and capabilities) to expand the system to meet traffic growth?
- Are rail terminals well located in terms of handling additional freight?
- How important are grade crossings (rail-highway and also rail-rail) in terms of delays to highway traffic and to rail traffic?
- How well are the facilities performing?

Information about the current system is necessary in order to determine how much and what kinds of changes might be needed to improve its performance or increase its capacity. The essential question is where a public investment, or a program of investments can be made that will make rail transportation more attractive or more available, and induce a traffic shift.

The answer will begin with access: the location of prospective shippers along the network, their connection to it through sidings or transfer terminals, and the distances involved. Public initiatives here may be able to establish or improve the conditions of access, shorten distances, or even encourage a different pattern of location among shippers. The next part of the answer will consider the physical conditions that affect service: track speeds and geometry, terminal functions and design, network connections and circuity, and grade crossings. In addition are the network features through which performance is bound up with capacity, including such elements as double tracking, siding profiles, and signaling. Public initiatives here will seek out the sensitive components, in order to make them targets of a set of investments that may enable system performance and competitiveness to rise. Capacity itself is the third part of the answer, and perhaps the most complex. Its obvious importance is to assure that if rail performance improves, the network is able to accommodate the diverted traffic - or, if rail performance already is high, that the network can be marketed for additional volume and can accept growth. Basic elements of capacity include features of line (tracks, siding lengths and frequencies, speeds and limitations, weight restrictions, and train controls), yards (total and receiving tracks, track lengths, humps), and terminals (chiefly track length and storage). Public investment at least nominally is able to address any of these elements, and expand the traffic volume available to rail.

By no means is it necessary to have all of these pieces assembled in order to evaluate the prospects for rail. An overview of the line and terminal network, the kinds of traffic it serves, expert but subjective views of capacity, and performance indicators like train speeds may be sufficient to get started. Greater specifics then can be sought where they seem most warranted by conditions and opportunities.

Are there readily available sources for the data?

The Carload Waybill Sample and a compendium of operators and networks like the railroad Official Guide are a way any planner can start looking at the system in their district. Going further, statewide rail plans setting forth an inventory of freight rail infrastructure are in existence around the country, with varying degrees of depth, detail, and currency. In some cases, the state plan will also describe the operations of railroads within its jurisdictional boundary briefly, giving an insight into what kinds of service might be available and how intensively, and in what manner the infrastructure is utilized. Class I and smaller railways report a range of information on their web sites, including schedules and in some cases performance figures. The web site of the Surface Transportation Board also carries current and historical Class I performance measures, with data like train speeds and cars on line.

Access information can be obtained directly from large shippers if it is a question of sidings; rail carriers also will have this for facilities with recent activity, or where sites are known to have been constructed off line. Transfer terminals and the kind of traffic they support will be published and more or less readily available. Engineering charts kept by owning railroads and public authorities will contain detailed information on types of signaling installed, location of infrastructure, and the state of infrastructure. Large railroads keep computer-based asset registers that will contain similar information. However, neither the plans nor the computer database may be totally up to date unless the maintenance of way and signal departments make a routine effort to maintain it.

Third party mapping companies or GIS solution providers, such as DeskMap Systems, Delorme, or ESRI, often will have databases of rail infrastructure covering entire regions, with some more complete than others. However, unless the company specializes in rail operations, it is unlikely to have information such as signaling systems, and location of yards, sidings, interchanges, and switches. Equivalent rail networks for carload freight and intermodal also can be obtained from the Oak Ridge National Laboratory, although (as with other sources) the network may not be entirely current. In some communities, digital or aerial mapping of rail infrastructure would have already been carried out for specific projects. Those are often the most accurate source for the condition of local rail infrastructure.

Capacity assessments for the most part will not be ready to hand, unless either the rail carrier or a public agency has conducted a local study of the network. Capacity assessment can be conducted with models, and with railroad cooperation in the assembly of input data, but this detailed exercise rarely is appropriate in the early stages of project evaluation. The most practical initial measure probably is professional evaluation by persons familiar with the operation - railroad personnel, or sometimes their customers – whose subjective views nevertheless can be well informed and directionally or entirely correct

When dealing with previously abandoned lines, local historical and railroad societies may produce publications detailing the status of local rail lines, and some will include detailed civil surveys. Independent producers have produced detailed US rail atlases, some of which are more accurate than those provided in generic GIS sources.

How can the data be collected?

Maps, or GIS databases and routing networks, can generally be acquired from third-party providers (an example appears in Exhibit 6-7). Some agencies may also have internal teams who develop the data, or will have done so in the past for rail plans. Railroad carriers ordinarily can provide much of the information needed if they feel motivated to do so, deriving it from a variety of sources – operations databases, asset registers, and their own capital planning team. Service plans can usually be obtained from the railroad or a knowledgeable intermediary such as an intermodal marketing company, or publishers of railroad freight information and schedules.

Exhibit 6-7: Maps Can Be a Rich Source of Rail Facility Data

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Where there is a need for information not presented on typical rail network maps, railroad engineering departments represent effectively the sole source of information. Track maps can be found from third party sources, but these can become outdated and do not contain often vital signaling capacity information. When the question concerns abandoned lines, or an uncooperative railroad, approved field visits and dialogue with knowledgeable personnel (such as retired employees) can be useful to obtain information.

Levels of Accuracy and Precision

For existing and operational infrastructure, railroad operating and engineering departments are the authoritative and most accurate source of information. Elements like yard and mainline condition and utilization can be reliably defined, and be substantive indicators of performance and capacity. Public agencies planning rail freight schemes with capital components based on upgrade of rail infrastructure must ensure that railroad carriers are part of the dialogue and planning process. Planners considering operational changes in ways the railroad infrastructure is used, should also contact the railroad operating department to assess the feasibility of the plan that is being proposed, and identify any infrastructure upgrade or additional maintenance costs that may be incurred by changes in operations. Conditions shape project specifications and investment requirements, so dependable figures are important. One method of checking carrier-supplied numbers is to have them reviewed by an experienced, independent party who is able to judge magnitudes, calculations, consistency, and overall reasonableness.

For planning purposes with abandoned infrastructure, cost assumptions can be made based on information gathered from maps, aerial photographs, asset databases, and reference figures to the extent that they are available. These "planning only" numbers should not be used in cost-benefit calculations, as the physical condition of the plant may be substantially different from the planners' assumptions, leading to inaccuracies in service restoration cost.

Field visits can be another, direct and accurate way to determine infrastructure conditions, if undertaken by knowledgeable personnel. They can also be relatively cost effective, given the time required to research and reconcile different reference sources, or reaching out to engineering departments and other stakeholders. They are one of the fundamental ways that short line investors evaluate properties, and it is usually helpful for planners as well to have on the ground exposure to facilities, in order to develop a practical understanding of issues.

6.7 Railroad Engineering Cost Data

What is the problem? What kind of data would be useful?

The investment costs in proposed engineering projects obviously have to be quantified, and generally have three major components: materials, construction labor, and equipment. In addition, there may be other outlays associated with a capital improvement scheme, such as land acquisition, design, permitting, management and planning. The most detailed cost estimation falls into the domain of engineers, but with intelligent use of data points and a grasp of the physical requirements, planners are able to develop good estimates of the cost of projects.

The Guidebook presents a variety of figures and contextual information to help understand the range of costs associated with different kinds of rail investments. These will not be repeated here, but they generally employ two types of data. First, costs from past construction contracts (and actual costs once construction is completed) give an idea of what the cost would be if a similar project were carried out – for example, the addition of a siding or a spur. Second, financial factors such as the cost of railroad materials, lease rates for equipment, and labor rates can be used to estimate expenditures by enumerating each activity. The first method offers a view of the way various project components may total up, and the second allows for dissimilarities, and gives a way to proceed if comparisons to analogous projects aren't obtainable.

Are there readily available sources for the data?

Again, a series of factors and applications appear in the Guidebook that can act as a resource for project evaluations. For additional specifics, there are many alternatives. Costs of track and other materials are available from vendors, industry associations, and some independent publishers. Labor rates can be found in past cost estimations and contracts, or from trade unions. Some reports will cite a standard cost per mile of track given a set of assumptions; this type of number is quite useful for planning purposes, although it is important to be aware that changes in the assumptions can lead to different costs.

Similarly, when using costs derived from past construction, it is important to understand the conditions under which the work was done. Constructing a railway from scratch can be cheaper than upgrading an existing one if the upgrade requires the use of restrictive work-windows between trains. Installing a new siding on a heavily traveled mainline will cost more than the same siding on a branch line. The amount of earthwork required and foundation stabilization can vary greatly from site to site (also, depending on the line speeds and load ratings required from the new track), resulting in very different costs and schedules.

If signaling work is required, it should be understood that its cost estimation is difficult without some preliminary design work. Most of the cost involved in commissioning new signaling relates to specialist labor for installation and testing, and the solid-state equipment to be installed. Costs tend to be dissimilar from contract to contract. Moreover, seemingly routine work such as moving an existing signal head from one location to another could be a minor or major expense, depending on the amount of other work required as a result of the change.

How can the data be collected?

Research into the kinds of primary and secondary sources cited above will yield the requisite data. Another alternative is to turn to civil engineers with rail project experience; many will have estimation methods that allow a cost projection to be done in a few hours. For more detailed cost estimation, an on-call contract with an engineering consulting firm is a way to assemble anticipated expenses before a formal project bid is released.

Levels of Accuracy and Precision

Cost estimation is vital for project evaluation, financing, and job management. This means accuracy is essential, and the need for precision will increase as a project moves toward programming. The methods presented in the Guidebook and touched on here, are capable of producing sensible estimates whose reliability is appropriate to the stage of project development. Any engineering project faces an assortment of contingencies touching on anything from market cost changes to permitting and job management, and rail (like highway) projects are certainly subject to them. Allowing for this, information resources nonetheless are sufficient to the needs for precision and accuracy.

6.8 Shipper Characteristics & Needs – Establishment Data

What is the problem? What kind of data would be useful?

Railroads or their intermediaries ultimately must be able to determine which companies might be willing or able to shift some of their freight from truck to rail. Planners will want to engage with some of them on subjects ranging from access to service design and divertible volume. Candidates would include companies originating or terminating large amounts of freight, port authorities, and national corporations that are known to ship substantial volumes through the region. Many of the relevant companies will be well-known, because of their importance to the local economy; others, particularly shippers of low-cost bulk materials, may have a low profile and generate significant tonnages with a modest number of local employees. The geographic dispersion or clustering of important businesses also is essential to understand, because of its effect on operating density.

The available databases about commercial establishments (see 7.2) are useful for a number of reasons. On a macro level, establishment data is used to assess economic geography. Establishments are classified in terms of their Standard Industrial Classification (SIC), or North American Industrial Classification System (NAICS). Based on these codes, the nature of the state's economy can be understood and the corridors where rail freight solutions have leverage can be identified.

On the micro level, establishment data are used to create a list of potential stakeholders to interview, and to organize them into logical groups based on their characteristics and likely freight needs. Typical business databases contain not only the physical location and the name of the establishment, but also the number of employees, and an indication whether the firm is a subsidiary of a larger corporation, and in some cases the input-output relationships (i.e. the industrial codes of any upstream and downstream industries, as well as non-core production activities). SIC or NAICS codes can usually be translated into commodities to determine what types of goods are being shipped. Establishment databases by themselves are decidedly helpful, but when joined to other information resources discussed in this chapter, they help create a potent analytical system to determine freight needs and traffic

Are there readily available sources for the data?

Several commercial databases are available, each with different coverage and pricing options. A basic list of establishments is often within reach from the local chamber of commerce or phone book, or from web-based equivalents. Some state governments also keep internal or public establishment databases as part of a census or other research support activity. Three of the main vendors providing data in the private sector are Dun & Bradstreet, InfoUSA, and Harris InfoSource; all are able to supply data at the level of detail described above. Other vendors, such as ZipInfo, offer less detail, but may represent a cost-effective solution. These data normally do not reveal the existence of rail access, yet normally are geocoded. GIS analysis of establishment data alongside a reasonably detailed rail network will show the proximity of businesses to rail lines, and this can be used for a first approximation of access.

How can the data be collected?

There are different approaches to collecting establishment data. A simple, if laborious approach is to work through the business telephone directory, especially if it can be organized by geography. Another is through field visits – if the question is ``find all businesses abutting a given rail branch line'', field visit can actually be a cost-effective way to conduct research and may generate much more information than any database (Exhibit 8 illustrates this). A third approach is to use maps, charts, zoning records, and aerial photographs, combined with other reference material, to locate large industries near the rail line.

If a comprehensive database is not available from a commercial vendor, information can be extracted by joining data from the local chambers of commerce, zoning records, local knowledge, and postal or phone book address records. Zoning records will help locate industrial activity, and sometimes SIC or NAICS codes of businesses can be ascertained either from the name of the establishment, from a chamber of commerce database, a quick phone call, through locally knowledgeable persons, or a short site visit. Railroads will have information about line access at least for recently active customers; for inactive ones, phone calls may be required to define status because a former siding may have been paved over. Sometimes a site visit is the only way to ascertain the industrial activity and freight requirements at certain brownfield sites.

Exhibit 6-8: Some Potential Rail Freight Shippers' Activities are Self-Evident from a Field Visit

The importance of fieldwork should not be underestimated. No database fully replaces it, and sometimes fieldwork is simply a matter of driving by, observing signs, and taking digital photographs of commercial activity.

Levels of Accuracy and Precision

The accuracy of establishment data in general is good for the existence of activity, reasonable for employment levels and business mix, and less good for business levels. Surveys are utilized to obtain the data and some information is considered confidential by the respondents; furthermore, there is no integrated mandatory reporting process for commercial establishments, except for financial data on publicly held companies (which do not report site-specific data in any case). Analysts need to be careful that employment estimates are particular to the local address, and watch for misleading codes suggesting that manufacturing takes place in a location that is really dedicated to services.

Commercial activity is also highly dynamic. Some industries that are transportation intensive (such as building materials, scrapping, and some chemicals) tend to be cyclical in nature, and business levels can be tied to discrete contracts. A plant may shut down or start up again in a matter of months, or production locations may shift. Thus, maintaining up-to-date establishment information requires ongoing effort, and databases should be renewed to assure currency.

Commercial databases are clearly useful for systematic planning and the identification of opportunities. Nevertheless, for development of a specific rail freight initiative whose success may hinge on several major customers, locally knowledgeable persons can be a great resource, and early contact with major shippers should be considered a vital part of the planning process.

6.9 Modal Service and Cost Parameters

What is the problem? What kind of data would be useful?

Modal service and cost parameters are used to assess whether a rail freight solution is in fact feasible from a shipper's point of view. If shippers are unable to reduce their overall private logistics costs by moving to rail, either a different incentive would have to be provided, or they will continue to ship by truck. On the service side, the shipper must be able to manage their logistics chain in such a way that their business activity is compatible with typical rail performance. Except for premium intermodal and some other operations, rail shipments may be slower, require longer lead times, and perform less reliably than trucks. The business may be able to adapt, but the service it can expect to receive should be understood.

An extensive treatment of logistics cost factors appears in the Guidebook. Here, it is sufficient to say that performance indicators, operating costs for both truck and rail, and information relating to inventory and handling expenses all are useful in a comparative modal assessment.

Are there readily available sources for the data?

Shippers ought to possess accounting records of logistics costs, including the cost of transportation, warehousing, and value of inventory in-transit. Without shipper contact, it is still possible to calculate a likely range of costs using standard cost functions for trucking, generic commodity dollar values (see the section on Commodity Characteristics), and estimates of the cost of storage. The most difficult step sometimes is in approximating the significance of inventory in-transit, since business decisions affecting transit time requirements can be linked to the strategic value associated with tight channel control and point of sale response.

For railroads costs, there are commercial products that will estimate the cost of railroad shipments between intermodal terminals or freight stations. Most of these models are based on the Uniform Rail Costing System (URCS) methodology developed by the Surface Transportation Board (STB) and its predecessor, the Interstate Commerce Commission; the STB makes available an URCS-type cost model as well. The AAR also publishes a quarterly Rail Cost Adjustment Factor (RCAF), as part of its Railroad Cost Report (RCR). For a general idea of costs, a simple cost function with a cost per mile could be used. Most rail users and rail service marketing companies will have such rule-of-thumbs, and a variety of them are presented in the Guidebook.

The key trucking costs for rail comparisons are full truckload, which will also serve as a profile for linehaul costs in LTL. Up through 2005 there had been good information from which these could be derived in the M-1 financial reports, which larger motor carriers were required to submit to the federal government. The discontinuance of reporting in that year meant that trucking costs eventually would have to be estimated from engineering factors, although the historical figures would offer a reasonable template to work from for a fair period of time. Truckload service characteristics are reasonably well known, and are shaped by distance, travel speeds, the number of drivers, and hours of service regulations. Overnight trucking service with a single driver is typically difficult for rail to divert, as is the premium team service where two drivers alternate shifts. Longer distance trucking service that involves a layover for a single driver (thus, with a dock-to-dock average speed lower than about 50mph) can often be diverted with rail intermodal. Beyond intermodal, rail service tends to compete on characteristics other than speed, such as costs, safety, size of shipment, or other factors.

Rail service characteristics can vary with the type of rail service purchased, proximity to major yards and mainlines, train frequencies, and other system-wide factors. Thus, predicting the service level in a given rail lane is much more difficult than for trucking. If the rail freight diversion proposed relies on existing services, then the railroads would usually have a fairly good time estimate for the shipment. If new service is being planned, then the sponsor may have more flexibility over cost and service levels – with the caveat that truck-equivalent service levels tend to be more expensive except in high volume service lanes. Generally, the best way to validate proposed service levels is through careful operations planning, followed by test runs designed to determine the feasibility of the operating plan and its impact on other railroad operations.

The major Class I railroads (and the two Canadian majors, CN and CP) are required to report service performance levels to the STB on a weekly and quarterly basis. Although these numbers are available from a website maintained by the AAR[102], the highly aggregated performance data is of limited value for prediction of service levels within particular service lanes. Nonetheless, they are a good indicator of broad service trends – e.g. whether the probability of a regular shipment arriving on time is increasing or decreasing.

How can the data be collected?

There are two major types of service performance data – (a) empirical results, which must come from the carrier, the shipper, the agent, or another interested party who has kept historical records such as the sources mentioned above; (b) performance simulations, which can be estimated with knowledge of current operating practices, plans, and infrastructure conditions by either a consultant or the carrier's operating managers, but must be validated by actual service performance or test-runs. Ultimately, the data must be obtained from one of these sources. Unlike passenger rail, it is generally costly and difficult to ascertain rail freight performance by direct field observation, because of the long variability of run-times and difficulty of tracking the operations without using one of the railroad's proprietary information systems.

There are also two major types of cost data – (a) accounting data, which may be available from shippers or carriers willing to make them public, or share them through an intermediary conducting a study on behalf of a public agency; (b) cost model data, which are calibrated by a knowledgeable party based on known expense and operating factors. Price data is rarely possible to directly observe and therefore must be obtained through modeling, interviews, and other cooperative methods.

Levels of Accuracy and Precision

For typical rail freight diversion applications, service times need to be known to within one day, or perhaps half a day. Service time precisely to the hour is usually less important than the reliability factor. Under unconstrained conditions, a train may be able to move from siding to siding in a standard number of hours; however, for a feasible service plan the number of intermediate switching moves and the probability of delay at each location must be accounted for. Even for bulk commodities, a missed delivery can lead to problems at the receiving plant unless a sufficient stockpile is maintained – which drives up the total logistics costs. Thus, errors in reliability estimations may lead to excessive costs being incurred by the shipper, resulting in a seemingly promising operation becoming an uneconomic one.

For intermodal diversion, time performance can be especially critical, since the truck-like performance it aims for is often associated with low levels of inventory. Nevertheless, typical services still are discussed in terms of morning, afternoon, or evening delivery, instead of a specific hour within which the shipment must arrive. While there are premium intermodal products that do guarantee certain time windows and cut-offs, those normally are geared to the requirements of a particular customer or group.

Operating costs are an important factor in determining whether services can be sustained. Prior to investment in expensive infrastructure, comparative analyses of modal costs should be conducted. The cost savings of moving from truck to rail need to be significant, in order to allow an annual contribution towards paying off the infrastructure. If the cost savings are not significant, then even if the infrastructure is constructed, the traffic may not materialize. Thus a compelling case is required before an investment decision is made – but having made such a case, and given the magnitude of infrastructure costs, minor errors in rail operating costs are unlikely to change the fundamental conclusions in a freight diversion project.

6.10 Trend Data – Traffic & Economic Projections

What is the problem? What kind of data would be useful?

In planning, trend data are sometimes used to illustrate a future scenario and to convince the stakeholders that changes are needed now in order to prepare for the future. Congestion tends to worsen with economic growth, and if rail freight investment can keep ahead of growth while highway investment remains stagnant, railroads will become comparatively more attractive to some shippers. Trend data is therefore needed to illustrate the effect of both highway and railroad congestion if nothing were to be done, and the payoff from taking action.

In general, trend data fall in two broad categories: (a) economic trends, and (b) traffic trends. Economic trends serve to suggest how fast the economy might grow in future, and could be used to infer how costs, service levels, and other attributes of freight transportation may change over a long planning horizon. Traffic trends serve a shorter term purpose – if congestion is growing by a certain percentage per year on one highway route, it can be conjectured that the congestion will continue to grow at a similar rate until the facility becomes comparatively less attractive versus substitutable facilities, or versus alternatives such as supply source substitution.

Are there readily available sources for the data?

Economic forecasting is a specialized discipline, and forecasting data is made available both by governmental agencies and commercial vendors. Past economic trends can be found in various reports made available by the Department of Commerce,[103] Bureau of Economic Analysis, and the Economics and Statistics Administration, in addition to private economic research resources. However, the federal-level data may not contain enough regional detail, and state-level data should be consulted. Many states have official projections of population and other economic drivers, and some have invested in forecasts that are directly aimed at transportation, or are reasonably pertinent to it. In addition, a number of regional economic models are available[104] in the marketplace.

The previous chapter of this report presented a cross-section of trend and forecast information, and cited relevant sources that may be consulted. For the tracking of traffic congestion, it displayed data from the Texas Transportation Institute, whose annual Urban Mobility Study[105] is the standard compilation of developments across the nation. TTI indexes and ranks traffic congestion problems for the 85 major U.S. urban areas, and its data can be compared and extended in time series. However, forecasting future traffic congestion based exclusively on its current trend is not advisable beyond about five years; to understand the extent of long-range congestion, long term economic trends should be used.

For more information on forecasting future freight congestion, a good source is the NCHRP report 8-43: Guidebook on Statewide Freight Planning. Although this manual does not specifically deal with rail freight, using the methodologies demonstrated therein to understand where future congestion and bottlenecks may occur could be a helpful exercise. Once these potential hotspots are identified, the methods in this guidebook can help planners decide if a rail freight diversion scheme is apt to alleviate the likely problem.

How can the data be collected?

The economic and traffic trends rely on a large number of data sources, and it is generally not cost-effective to duplicate the data collection effort. Economic trends require data about trade activity, which is collected by the Department of Commerce through business reporting requirements. Traffic trend data and projections may be based on Highway Performance Monitoring System (HPMS) and automated data-collection devices. The source data are publicly available.

Levels of Accuracy and Precision

Economic and traffic trends are usually reliable, if their data are sound and their dynamics are accurately understood. Projecting from trends is another story, because of the underlying presumption that past events will continue on a logical course towards a future conclusion, which is not always the case. More sophisticated forecasting tries to anticipate course changes and the interaction of trends, and while inevitably imperfect, it will give a better result. Econometric forecasts of this type can be purchased from a number of sources, and banks and news services like the Wall Street Journal offer comparative performance ratings for vendors.

In many cases, predicting economic growth itself is not as important as predicting political decisions. Lack of highway investment is one catalyst for rail freight investment; however, if congestion becomes too severe, citizens may demand highway or mass-transit improvements. When planning rail freight investments, many such factors should be taken into account and weighed through a scenario analysis. Planners should prefer not to rely on a single set of traffic or economic assumptions being completely correct, or base the viability of a specific rail freight plan on a single scenario. The best rail freight plans will view an investment case under a range of development assumptions, and test its success across them.

6.11 Institutional and Privacy Factors

To develop a successful rail freight diversion scheme or other rail freight solutions, three basic types of data are needed. The planner should have an understanding of (1) the markets in which freight travels and levels of demand; (2) the supply cost of providing freight services and infrastructure to meet that demand at appropriate levels of service; (3) the economic trend data that reflect how the supply and demand, the associated congestion, and the area's economic development can be expected to change in the near and farther future. There are a series of sources for satisfying each, with options that can be scaled to the size or phase of a project or program, from small or preliminary to very large or well-advanced.

State DOTs, MPOs and other organizations should make an active effort to make freight data collection part of their regular data collection efforts. In some cases, data collected for passenger facility performance monitoring and/or for optimization of facility maintenance strategies can be leveraged to produce informative freight data streams. Alternately, it may be possible to add features to a data collection program that will partially feed freight planning applications. Freight activity is also heavily connected to economic activities; thus, as part of an area-wide economic development or re-development effort, data streams might have already been collected that could assist freight planning. Since ownership of these data could lie outside the domain of DOTs, it is important to establish contacts in other public organizations with overarching responsibility for economic development, and become familiar with the information they may have available. Examples of such organizations include:

- Local economic development agencies (e.g. the Boston Redevelopment Authority);
- Local port authorities (e.g. the Delaware River Port Authority);
- Multi-state agencies (e.g. the Tennessee Valley Authority).

Developing a data program and encouraging working relationships with entities that may become sources of information, introduces a number of institutional and privacy issues. Some of these issues are explored below.

Privacy Concerns

Private sector carriers in both trucking and rail are rightly concerned that their competitors might use information about the flows on their network (and by inference, about their customers) to their own advantage. The negative effects can include customer poaching, disruption of density, and loss of network balance. This type of competition also may result in destructive price wars that can harm individual carriers or delay reinvestment by an industry. Shippers of freight have similar concerns. In addition, rail carriers may worry that any new reporting of market data begins an unwelcome return of government oversight, such as prevailed prior to the Staggers Act.

For reasons such as these, the STB waybill sample is protected by law. Decisions on using its detailed version are reviewed by the Federal Railroad Administration, and state-level governments have access only in a controlled fashion. On the occasions when a private enterprise is permitted to make use of these data, strict guidelines must be adhered to. In most cases, the data processing must be done by an intermediary, who then must use the data only for the specified purpose and destroy it after the work is completed. When primary data from motor carriers have been tapped for some public studies, it has been done voluntarily, instead of on the compulsory basis that applies to the rail waybill. Nevertheless, restrictions and protections have been built in for the benefit of cooperating truck lines: information has been aggregated, intermediaries have been employed to avoid subjection to the Freedom of Information Act, and reuse has been prohibited.

If State DOTs and other governmental organizations expect to develop the trust of industry in conducting planning studies and sharing data and plans to mutual advantage, these privacy concerns must be taken very seriously. Demonstrating a good understanding of the issues and why privacy is necessary, honoring the commitments, having a codified policy on how data may be used and distributed, and never using data in less than good faith, will go a long way toward building a successful and fruitful relationship with industry partners. In joint planning, it is always important to achieve a win-win outcome; the industry cannot `win' if the data provided for planning purposes are not treated with care and caution by trusted agencies.

Financial Data

Publicly held companies are required to report certain financial data to the Securities and Exchange Commission (SEC), for example, on the Form 10-K[106]. However, 10-K information typically is not very useful to the transportation planner, as it is rolled up for the whole corporation (most likely a multi-state enterprise), and there are a number of ways to report the information such that it is difficult to understand the company's cost structure. In addition, there are some very large freight carriers that are held by private entities, who are under no obligation to disclose financial results to the SEC. On the other hand, railways in the United States are required annually to submit R-1 reports, which set forth a substantial body of financial and operating statistics, some of it like conventional balance sheet and income statements, and some of it quite different and oriented, for example, to operating assets. (Discontinuance of the comparable if less detailed M-1 reporting for motor carriers was noted above.)

Railroad capital programs normally are published annually, and can both be helpful and unhelpful to the public planner. The capital budgets will be defined in terms of number of ties to install, bridges to rebuild, and sidings or track miles to add. In addition, ongoing projects may have special line items that highlight the investment that railroads are planning using their own capital. However, it is generally difficult to extract specific cost numbers from such documents. Moreover, public agencies rarely are invited into the strategic planning process at private railroads, so public planners may feel that they have little influence.

Still, many Class I railroads have a government-relations department. Taking a proactive approach towards railroad capital planning at a state level sometimes can yield fruitful results. In several states, there are standing funds available for railroad infrastructure upgrades, which can be a good way to become engaged in railroad capital planning. With a stake in the process, it becomes much easier to acquire financial data needed for planning and budgeting on the public side; also, planners will develop a better understanding of whether rail freight diversion plans can work or not, and how much they may cost.

Railroad Capacity & Reliability

There is awareness among public planners that it can be difficult to persuade railroads to release seemingly `spare’ capacity on their tracks that is not currently in use. The reason is because, once an operating agreement is entered into, it will be difficult for the railway to remove that traffic, replace it with more profitable business, and not cause a public-relations problem. Without removing existing traffic, infrastructure upgrades typically are required when additional capacity is needed. These can be time-consuming and costly, especially in metropolitan areas. Thus, spare capacity on a not-yet-congested portion of railroad is still an expensive commodity, even if infrastructure upgrades are not immediately required for new traffic. Public agencies wishing to utilize capacity on private railroads must understand that not only do they have to cover the operating cost of the train, they must offer a premium to out-bid any future use of that capacity the railroad may have planned. A pragmatic solution to this problem is to have the public agency upgrade a piece of private railroad infrastructure at public expense, in lieu of premium payment for a spare train path.

In some cases, loading a network with additional traffic can cause a number of sometimes-subtle effects that lead to increased costs. For example, spare capacity may be required at strategic points about the network to prevent cascading congestion when long-distance traffic is delayed. The cost of this capacity is usually borne by the railroad. Cascading congestion can be extremely expensive, requiring many more crews and power units to move the same amount of freight compared to an uncongested network. Increasing traffic can dramatically increase the cost of recovering from such an incident, and is a cost that public planners should be aware of when aiming to utilize apparently untapped capacity.

Data Collection is a Cost

In addition to the concerns discussed above, two further issues may give carrier management pause in respect to sharing data:

- Rate of Return on Data Collection Activities: Developing a relationship with public authorities, and finding new freight with public support, can be profitable activities for railroads in the long run. Even so, rail managers may feel they lack the current resources to manage a data collection exercise, or doubt that new business is going to arise from the effort. Even in a business development environment, managers will be reluctant to do extensive data collection or grant high priority to the proposals of public planners unless the prospects of rewards are substantial. When requesting data, it is helpful to state upfront what the rewards might be – for instance, by showing that investment funds will become available through a certain feature or channel. Railroad partners may be more likely to engage in data collection if such data are made a part of the application for a specific grant, or if the data are being offered on the understanding that public officials will pursue available funds and take over some of the development work based on the data.

- The Litigation Threat: Freight carriers, like other corporations, have a healthy respect for the legal system, and some of their caution with information release may stem from the lack of clearly codified limits on how data may be handled. The US Census, and the STB waybill sample achieve successful data collection in part because there are clear laws on how the public may use and disseminate the data. Confidentiality is guaranteed and exemptions plainly exclude certain data-mining activities. Steps such as those outlined in the discussion of privacy issues will allow public planners to assuage concerns about litigation exposure. The establishment of clear contracts limiting the application of data for planning purposes, and the use of vetted intermediaries to process it, help to create a trusted framework for information exchange.

6.12 Data Environment

There are special issues concerning the electronic data environment in railroad and motor carriers alike that are worth understanding. Some data systems are legacies from development early on in the computer revolution, when each carrier sought to acquire IT capability for its own internal financial planning and operations purposes. As such, data formats occasionally predate the concept of relational databases and data mining, and are driven by transactions far more than analysis. Because the systems are intended mainly for internal use, there may be limited standardization on what kind of data are kept, how they are kept, and what format they're kept in. Public planners should understand that data simple to generate in an environment powered by latter-day data centers are not necessarily easy for every carrier to compile, despite their best intentions.

With that in mind, it is important to be patient and flexible when requesting data that may require downloading from legacy systems. It is possible that carriers in these environments will have to expend substantial effort to find the data that are being sought by public planners. Once the data are found, they might be available only as a line-printer output, requiring optical character recognition software to translate into machine-readable form. It is likely that carriers would want to further process such data before handing it to the public planner, in order to elide commercially sensitive information, and this imposes an expense on the carrier. Offering compensation for such expenses, or maintaining a confidential data-processing expertise in-house, can be ways to ensure that data collected by the private sector for private purposes are not lost as a planning resource.

7 FRAMEWORK STRUCTURE

All of the preceding sections on research literature, case studies, mode choice factors, freight trends and data together provide a structural foundation for the final product of this project, which is a guide for planners. This last chapter of the Final Report describes the structure of an analysis framework that form the foundation and structure for the guide. This structure has three dimensions:

- *Planning Process Framework* – the methodology described in the guide must be designed to address the relevant issues and needs faced by transportation planners at both public agencies and private transportation companies.
- *Decision-Making Framework* – the methodology described in the guide must be structured to encompass the benefit and cost considerations involved in the mode choice decisions made by freight shippers and the investment decisions made by public agencies.
- *Structured Sequence of Steps* – the methodology must provide a structured series of steps that can be adapted to apply for a broad set of circumstances, ranging from simple to complex multi-modal projects.

The guidebook itself is a separate document, and the parts of the text that follows does mirror the introductory discussion in Chapter 1 of that guide. The guidebook will be available for download from the NCHRP section of TRB's web site *(www.trb.org)*.

7.1 Planning Process Framework

As this gap between highway demand and capacity is forecast to accelerate in the future, there has been increasing recognition of the importance of multi-modal planning and specifically the need for more attention to rail freight issues and opportunities in the transportation planning process. This has led both public agency planners and private transportation company officials to recognize a need for tools and methods that they can use to address freight transportation planning issues. These needs fall into three broad topic areas:

- *Processes for Public Investment Planning* – Traditionally, most state DOTs and MPOs have focused their infrastructure planning largely on highways and given less attention to rail investment, for the fundamental reason that they control investment in highways while they typically do not own or control investment in railroads or rail right of way. However, there is a growing recognition that (a) more multi-modal public planning is needed for freight movement, (b) that such planning should include rail as well as highway options for freight movement, and (c) that rail freight planning, if done well, can help address a wide range of issues relating to security, congestion, safety and air quality.

- *Methods to Identify Transportation Issues and Assess Potential Solutions* – Before expanding multi-modal investment analysis for freight movement, it is necessary for state and regional transportation planning agencies to: (a) clarify the range of possible transportation issues that should be addressed, (b) define the range of potentially feasible rail and highway solutions to be assessed, and (c) apply appropriate methods to assess their relative benefits and costs. For instance, while there is a current emphasis on addressing problems of growing highway congestion, planners need workable ways of assessing these needs and identifying feasible rail-freight solutions for them.
- *Approaches for Private-Public Cooperation* – Given the private ownership of many railroad and truck-rail intermodal facilities, it is clearly necessary for rail freight planning to involve both private and public sectors. At the same time, key representatives of cargo shipping, trucking and railroad companies also have a strong interest in seeing improved planning and investment, as they are keenly aware of the current shortcomings and needs for improvement in existing road and rail infrastructure systems serving freight movement. Thus, there is clear opportunity for enhancing private-public cooperative relationships in freight infrastructure planning.

To address these three sets of needs, the guide must (and does) have separate sections providing: (1) screening criteria to identify situations where analysis of rail freight solutions is warranted, (2) steps for calculating benefits and costs of rail freight alternatives, and (3) instructions on how the information can be best used as part of a broader public-private dialogue between transportation agencies and railroads..

7.2 Decision Making Framework

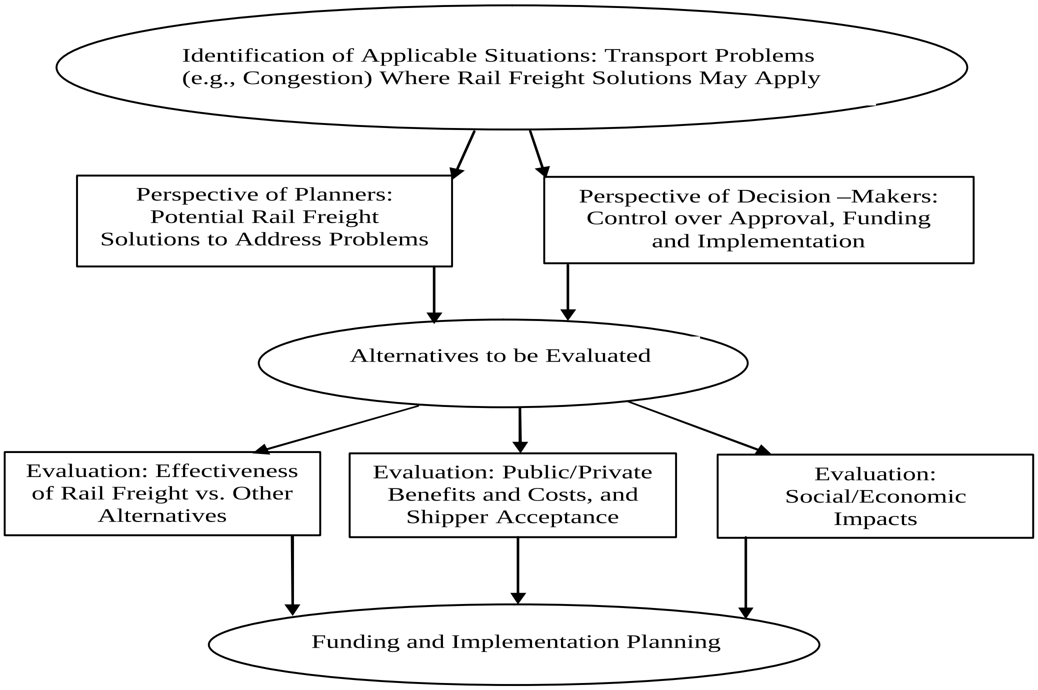
The core of the guide is a set of analysis steps for assessing the relative benefits, costs and practical feasibility of implementing alternative policies, programs or investments to encourage rail freight solutions as a way of reducing roadway congestion. Exhibit 7-1 shows the elements of decision-making. It can be summarized as follows:

- The first part of the process is to identify applicable situations where rail freight solutions are potentially applicable, and focus only on them.
- The second part of the process is to evaluate rail freight alternatives by taking into consideration the technical feasibility (benefit measurement) perspective of

planners and the practical feasibility (funding and regulation) perspective of decision-makers.

- The third part of the process is to develop funding and implementation plans that account for differences in the distribution of benefits and costs, as well as effectiveness, among public and private parties. That is necessary to enable the public-private cooperation required for any strategy involving shippers, railroads and roadway planning/operating agencies, and to help assure its success.

Exhibit 7-1. Decision-Making Process for Rail Freight Investment



To carry out this process, the guidebook lays out a strategy involving three phases of analysis:

- Preliminary assessment: situations where rail solutions appear feasible
- Detailed analysis: evaluation of rail options
- Decision-Making: Multi-criteria & Benefit-cost analysis.

These phases are shown in Exhibit 7-2 and explained in the text that follows.

Exhibit 7-2. Major Phases of the Decision-Making Process

Phase	Major Activities	Main Question & Desired Outcome	Methodology
1	**Preliminary assessment:** situations where rail solutions appear feasible	- Can rail help relieve highway congestion by handling more freight? - *Identification of promising rail projects or programs aimed at specific solutions to congestion problems*	- Review information on freight facilities & traffic flows - Use framework to identify problems& potential solutions - Use simple models to estimate costs & benefits of potential solutions
2	**Detailed analysis:** evaluation of rail options	- Do benefits of proposed actions justify their costs? - *Analysis of costs & benefits of rail solutions, including economic & environmental factors.*	- Estimate project costs and impacts on rail service - Traffic diversion study - Benefits analysis
3	**Decision-Making:** Multi-criteria & Benefit-cost analysis	- Is this project or program as good as or better than other approaches? - *Comparative analysis of major alternatives*	- Consider alternatives including rail, highway investments and public policy regarding taxation & finance.

Phase 1 – Initial Screening. In general, public agencies are looking for particular rail projects or programs that can help to relieve highway congestion. As such, there is a need for guidance in identifying the types of situations where rail might help; expected benefits associated with congestion relief; and the specific types of projects or programs that might be appropriate given local conditions. These assessments are part of the first phase of the analysis, which focuses on determining whether there is a reasonable chance that the costs of rail projects or programs can be justified in terms of their contribution to congestion relief. This phase involves carrying out five steps to: (1) screen for relevancy of rail freight solutions, (2) gauge magnitude of the road congestion problem, (3) characterize the local pattern of freight shipping, (4) characterize available rail resources, and (5) use "sketch planning" approaches to assess the potential viability (benefit and cost) of available options.

Phase 2 – Detailed Analysis. Only if there does seem to be potential for a particular project or program, then the analysis should proceed to Phase 2 for a more detailed analysis of the proposed options. The logical place to begin is by looking at specific rail investment options and estimating how they could affect cost or any of the service factors that influence total logistics costs. The next step is to use a logistics cost or mode split model to determine whether service improvements, if obtained, would be likely to affect road/rail choices and, if so, to estimate how many trucks might be diverted to rail. Given the potential diversion, it is then possible to estimate the effects on highway performance using various highway models. The changes in highway performance can then be compared to the costs associated with the rail initiatives to see if further consideration is warranted. Thus, Phase 2 makes use of: (1) rail cost or performance analysis, (2) logistics cost or mode split analysis, (3) highway performance analysis, and (4) economic and financial evaluation.

Phase 3 – Decision-making Support. The final phase puts results in the context of decision choices. First, findings must be placed in the context of other options, such as doing nothing and living with congestion, building more highways, expanding the capacity of existing highways, or using tolls, fees or regulations to restrict traffic flows. Second, each option must be considered from the perspective of its economic, political and practical feasibility for the various participants. This includes consideration of the levels and types of benefits that might accrue to each party, and confirmation of the sufficiency of benefits for shippers to accept a change of mode. It requires direct interaction with the shipping community in any of several ways, and an assortment of steps for the assurance of traffic volumes. Third, for the public evaluation component, additional analysis of social and broader economic impacts might be needed. Thus, Phase 3 makes use of procedures for comparing alternatives in a broader context that may include regional economic models and/or multi-criteria assessment tools.

7.3 Structured Sequence of Steps

The guidebook is designed as a set of sections that readers can consult or ignore as appropriate for their particular situations. The sections fall into the following groups:

Initial Grounding **–** Guidebook chapters 1 and 2 provide a basic grounding in freight analysis issues.

- *Chapter 1(Introduction)* defines the coverage of this guide. It classifies the types of situations, issues and solutions that can be considered in planning and evaluation of rail freight solutions to traffic congestion.

- *Chapter 2 (Background: Context)* provides information for readers who are not already experts on rail freight planning. It discusses the process of rail freight planning and factors affecting rail/truck diversion.

General Guidance **–** Guidebook chapters 3 and 4 provide the basic core guidance on technical analysis and discussions to ascertain the potential for rail freight to help reduce traffic congestion growth.

- *Chapter 3 (Guidance for Evaluation of Alternatives)* outlines a series of five basic analysis steps that can be conducted by planners at relatively low cost, to screen available rail freight options for reducing congestion and identify when further discussion and analysis is warranted.

- *Chapter 4 (Guidance for Public Private Dialogue)* discusses needs, uses and procedures for bringing highway and freight planners in discussion with representatives of institutional players and private sector freight operators, in order to design cooperative strategies that can be acceptable to key parties.

Technical Analysis Methods **–** The Guidebook's final chapter provides material for advanced use in analyzing options and presenting results in ways that can potentially gain support among diverse parties.

- *Chapter 5 (Detailed Analysis Methods)* describes the availability and application of various analysis tools, methods and data sources for assessing road and rail options, diversion between them, and the relative benefits and costs involved.

Exhibit 7-3. Guidebook Table of Contents

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ENDNOTES

[1] The truck line that made the greatest investment in high-cube containers for domestic use –which it did for the sake of tapping stack train economies – was J.B. Hunt Transport. It did so with the original intention of running a blended network. However, this eventually was abandoned and the intermodal and OTR systems were separated, with the over-the-road component returning to conventional trailers.

[2] The material presented here is based on presentations made by and conversations conducted with representatives of the Pennsylvania Department of Transportation, former Conrail employees, and several secondary research sources. Nevertheless, opinions expressed herein are those of the author.

[3] http://www.inventpa.com/

[4] http://www.fhwa.dot.gov/freightplanning/

[5] http://www.bea.doc.gov/bea/regional/gsp/

[6] http://www.cgp.upenn.edu/CGPDocLib.nsf/

[7] http://www.cgp.upenn.edu/CGPDocLib.nsf/

[8] Ibid.

[9] *Expansion Management;* January 2003; "50 Hottest Cities for Manufacturing Expansions and Relocations"

[10] http://www.fool.com/decathlon/1996/decathlon961004.htm

[11] http://www.fhwa.dot.gov/freightplanning/

[12] This will change as the advent of the Heartland Intermodal corridor opens a direct doublestack route from the Port of Norfolk to the Ohio valley.

[13] The material presented here is taken from the final report of the project issued December, 2003, and from project papers. The author of this case illustration was a participant in the study.

[14] Expressway is a trade name used by the Canadian Pacific railroad to describe a long, articulated, roll-on/roll-off platform set that is designed for highway trailers. The platform can be split at many points and accessed with removable ramps. Loading and unloading is fast, terminals are cheap, but platform sets are not. Its primary advantage is a high degree of compatibility with over-the-road operations, both in equipment accommodation and in service capability. An earlier generation of the technology was known in the U.S. as the Iron Highway.

[15] The time of day figures were based on Virginia DOT observations outside Roanoke. The corridor-wide daylong average for I-81 in Virginia was 29%, according to other VaDOT statistics.

[16] During the period of the marketing study, Virginia transportation agencies also began to entertain proposals for expansion of the I-81 roadway. Proposals include truck-only lanes aimed at highway safety through segregation, and were to be coordinated with railroad planning.

[17] Market figures are from Global Insight's TRANSEARCH database, employed in the I-81 project.

[18] Based on capture of traffic measured in TRANSEARCH, versus the average AADTT of I-81 in Virginia. The scenario in which Virginia acted alone produced attractive but much lower diversions, because of the interstate character of truck traffic in the corridor.

[19] The material presented here is based on a case study prepared for NCHRP 8-39, publications by Alameda Corridor East, and on presentations made by and conversations conducted with a representative of the Alameda Corridor Transportation Authority. Nevertheless, opinions expressed herein are those of the author.

[20] Comprised of the Ports of Long Beach and Los Angeles.

[21] This kind of rationalization is one of the effects railroads seek when they merge their networks.

[22] From a field interview conducted for the National I-10 Freight Corridor Feasibility project.

[23] From Global Insight's TRANSEARCH freight traffic database.

[24] As of March 2003.

[25] At least one Los Angeles area distributor makes this point in an article from The Journal of Commerce, Volume 4, Issue 16, 4/21-27, 2003, page 17, entitled “Wide Open Spaces”.

[26] The Alameda East projects affect Union Pacific right of way and are organized under a joint powers

authority that is independent of the Alameda Corridor Transportation Authority. A separate set of proposed and partially funded projects affect BNSF right of way, also from the downtown end of the Alameda Corridor eastward to the Inland Empire. These projects feature triple-tracking and grade separations, and include a 5-mile trench structure; sponsors of different sections are the Metrolink commuter service, CalTrans, and yet another joint powers authority with the acronym OnTrac. (Source: NCI Weekly Newsletter, 7/7/03 and conversations with local agencies.)

[27] By the beginning of its fourth year, train volume had reached fifty per day.

[28] The project was highlighted in an FHWA conference on "Financing Freight Transportation Improvements" (Transystems Corporation, 2001). The presentation to that conference provides many details concerning the project, including the steps taken to coordinate public and private efforts as well a description of the physical improvements to the system.

[29] Transystems is the engineering firm who coordinated the project.

[30] The material presented here is taken from project papers. The author of this case illustration was a participant in the study.

[31] The economic study was prepared by DelCan and Economic Research Development Group

[32] The material presented here is based on an analysis performed by Global Insight for the Chicago Department of Transportation. Nevertheless, opinions expressed herein are those of the author.

[33] Rawling, Gerald F.; *"Are we still eligible for the Yellow Jersey?"; C.A.T.S ; 08/29/00*

[34] The material presented here is drawn from State sources.

[35] The material presented here is taken from reports and presentations of the various projects.

[36] For customers with direct rail access, the switching of cars between the rail yard and their facilities also consumes time and expense.

[37] "Freight Pulse Survey: Second Round Insights", 1/9/02, Morgan Stanley Equity Research.

[38] The "International Trade Flow Study" by the Fleet Management Department of TTX Corporation (9/03) describes retail importers stopping, stripping, and transloading international containers for the purpose of delaying a decision about the final destination for goods. This is done so as to react most optimally to point of sale information from stores. Market considerations in a case like this completely offset the added logistics expense.

[39] It is worth noting in this context that railroads maintain private police forces that are licensed and armed as peace officers.

[40] One particular reference is a 1996 paper "Shipper Carrier Decision Making: Post Deregulation Quality Factors" by Professor Bud LaLonde, formerly of Ohio State University. LaLonde in turn references the findings of Michael McGiniss and others. A 1997 shipper survey by Cahners Publishing is another of many sources (Logistics Management magazine, September 1997, "The High Rollers", page 72.) Private research by the authors for railroads, motor carriers, and public agencies from the 1980's through 2003 show the same thing.

[41] This is the author's long-standing experience.

[42] This interpretation is principally the author's conclusion from observation of behavior. Others have drawn the same conclusion, however, nor is application of the hierarchy unique. LaLonde states, quoting McGiniss, "performance and quality requirements are constraints to be satisfied before rates become a significant issue in logistics service provider selection."

[43] The West Coast port strike of 2002 and the UPS strike in the mid-90's are well-reported examples.

[44] These issues were explored in research for the Virginia I-81 market study, detailed in the Chapter 2 case reports.

[45] Even here, information quality is mixed. A study of major retailers by the Soleus Group (reported in trafficWORLD, 2/2/04, page 16, "Retailers in the Dark") reveals that less than 70% of truck lines are able to provide electronic shipment updates to retail customers, and 50% of those who can have accuracy problems.

[46] Carriers commonly complain of commoditization in their markets and struggle to separate themselves from their brethren. Examples of transit time differentiation are regional LTL lines who use network density and labor flexibility to lengthen the distance limit on overnight service, and truckload lines specializing in team driver operations.

[47] In other words, the GIS network doesn't capture sidings. The 500-yard figure is a reasonable limit, and it is imposed as the crow flies, so that track distance may be greater and still fall within the cutoff.

Longer sidings exist (some stretch a couple of miles), but they require large traffic volumes to sustain them, and topographical problems grow with distance. When the Mercedes auto plant opened in Alabama, its siding was perhaps half a mile long, and track construction required major investment by the State for highway bridging.

[48] Radii for a given lane really have an elliptical, not circular shape, with most of the coverage area extending beyond the terminal and extending in the lane direction of travel. The reason is that a shipment is less likely to backtrack to a terminal and more likely to use one that lays enroute, because the former adds to cost and time versus an all-highway route, and the latter does not. Circles nevertheless are a reasonable display of coverage for the total collection of lanes that a terminal serves.

[49] 1997 Federal Highway Cost Allocation Study (FHWA)

[50] The Kansas City Flyover and the Alameda Corridor presented in the Chapter 2 case studies are some, as are aspects of the proposed Chicago CREATE project.

[51] The CDOT/CTA-sponsored study was led by Global Insight, one of the authors of this NCHRP Report.

[52] The table is derived from Global Insight's TRANSEARCH database. TRANSEARCH coverage does not extend to some portions of local truck activity, which would raise the proportion at the shortest distances.

[53] The figures are from the 2002 Surface Transportation Board (STB) Carload Waybill Sample. The miles are rail miles, which are approximately 10% circuitous (longer) than highway miles, so the tonnage proportions on a highway mile basis would be somewhat less. The sample also is subject to rebilling error, which causes overstatement of short distance rail volume and understatement of long distance. It is nevertheless true that rail traffic outside of the intermodal business has a significant short haul component. The Table ‘Rail Volume by Rail Miles and Class of Operation’ appearing later in this chapter, presents a detailed mileage distribution.

[54] These percentages derive from the Carload Waybill Sample, which does not capture traffic that is local to shortline railroads. For the intermodal business this will not miss much, but there will be an under-statement of short distance carload traffic.

[55] From IANA’s “Intermodal Market Trends & Statistics”, fourth quarter publications for the corresponding years.

[56] Based on a Reebie Associates analysis conducted for the American Association of State Highway and Transportation Officials (AASHTO), using 1998 FHWA Freight Analysis Framework tonnage data, further adjusted for the international portion of intermodal dray. The international contribution to truck tonnage may have risen since then.

[57] International containers also appear in domestic service, but their smaller size (40’ is the most common length) limit their utility against the standard 53’ highway trailers.

[58] These conclusions come from conversations by researchers with railroad officers, and from direct observation.

[59] The obstacle also is eliminated when the tractor and driver travel by rail with the load, as some European services allow.

[60] American railroads for the most part do not supply intermodal trucking services. Currently, the most prominent exception is the Norfolk Southern Triple Crown division, which nevertheless accounts for a minority of NS intermodal business.

[61] Internal analysis by Global Insight from primary sources found the road-based intermodal serving radius to be 50% larger than the rail-based radius.

[62] Out-of-route mileage is deviation from the normal highway route of operation, and is an inefficiency because of the added cost and time of extra, circuitous travel distance.

[63] These issues are prominent in the thinking of major network motor carriers working with rail: the carriers restrict their rail usage to assure fleet balance, and they press their rail partners for expansion of the high performance intermodal network to enlarge their options.

[64] Fleet balance is the way equipment is resupplied to a shipper after it departs with a load. Simplistically, the unit can come straight back empty, or reloaded with a different shipment, or it can work its way back through triangulation, or a more complex irregular route loading pattern.

[65] This barrier may be undermined in some ways. A 2003 study by the railroad equipment cooperative TTX (TTX op cit) documented a trend toward container stripping at West Coast ports; the phenomenon has since grown, though on-dock and near-dock rail services may be holding it in check. It signifies that containerized import goods are being transloaded and remixed with domestic product into highway

trailers, and it reflects a) an effort by retail chains to defer selection of the final destination of consumer goods, in order to respond to point-of-sale information; and b) an effort by marine container lines to keep boxes close to port, by reducing free time and increasing fees. On the one hand, this development could stimulate a concentrated demand for trailer services; on the other, railroads have preferred to respond with domestic containers.

[66] The treatment of diversion modeling, below, shows one.

[67] Train speeds are another measure. The manifest trains that bear carload traffic are regularly the slowest, and intermodal trains the fastest class of service, with unit trains lying in between. Railroads publish such statistics, but one citation showing this pattern is trafficWORLD, 3/8/04, page 30, where there is a table of comparative speeds on the Union Pacific.

[68] Finished automobiles have been grouped with conventional intermodal here, while carload transfer business has been classified with carload.

[69] The federal Bureau of Economic Analysis divides the nation into 172 metropolitan areas, based on the economic relationships of counties and covering all of the geographic territory of the fifty United States.

[70] These were 1996 Global Insight analyses conducted for the FHWA Truck Size & Weight study, comparing non-intermodal rail to over-the-road trucking in these equipment groups.

[71] For Global Insight internal research.

[72] Source: TRANSEARCH

[73] A breakout of unit train versus carload volume isn't readily available for 1990; railcar tonnage excluding coal acts as a proxy.

[74] Table 2, page 26 of the cited report.

[75] Comprehensive train scheduling is a relatively new practice among Class I railroads in the first years of the 21st Century, and has been credited for contributing to the strong service and industry-leading financial performance at the CN. It had been used prior to this overseas, and on at least one US regional railroad, The FRA report is titled "Scheduled Railroading and the Viability of Carload Service"; citations here derive from a press article in trafficWORLD, 4/5/04, page 24.

[76] From a private conversation with a researcher.

[77] Transload costs come from 2004 quotations obtained in the Pittsburgh and Houston markets; costs may be less in lower cost labor markets or in high volume operations, like logistics parks. Vans are the most versatile equipment and have the lowest empty return ratios – though ratios still may be high in local markets.

[78] Blanchard (2003) http://www.rblanchard.com/resources/texts/NE%20Railroads%2030900.html

[79] ANRP (2004) http://www.atlanticnortheast.com/regn/railroads.html

[80] RRDC (2002) http://www.rrdc.com/company_overview.html

[81] Atkinson (2001) http://www.drgw.net/iais/railguide/operations.html

[82] Posner (2003) http://www.rrdc.com/spch_london_rsa_2003_pg_1.html

[83] Tolliver (2003) http://www.wsdot.wa.gov/rail/plans/pdf/grainhauling_rpt.pdf

[84] "The Experience with New Small and Regional Railroads, 1997-2001" JF Due, et al, Transportation Journal, Volume 42 Issue 1, pages 5-19, 2002.

[85] The source of this anecdote is a former Conrail executive who was on the scene at the time. There do not appear to be any published accounts.

[86] This at any rate was the opinion of one Intermodal officer who talked to researchers, and was speaking just of *immediate* opportunities.

[87] Alluded to earlier, internal Global Insight reports show Intermodal with 30% of the 1995 dry van business over 500 miles, versus 17% five years later. The numbers are not entirely comparable because of corrections for rebills in the later and not the earlier figures, but share losses in the ten-point range are reasonable. Because of merger-related service disorders during this time frame, Intermodal grew only moderately, while the economy expanded with vigor and logistics requirements became more stringent, so that the volume went to trucks. Traffic data here and elsewhere in this section are from TRANSEARCH, and the term 'long-haul' means beyond 500 miles.

[88] Referenced in the Chapter 2 case studies.

[89] The information presented comes from the Florida East Coast web site, and from the Freight Goods and Services Mobility Plan of MetroPlan Orlando (the MPO for Orlando, FL region).

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[90] There had been much research into the economics of shortline railroads, most of it treating the cost aspect of the business. References include "Success and Failure of Newly Formed Railroad Companies", John Due and Carrie Meyer for US DOT, 1988; "Short-Line Railroads Performance", Michael Babcock et al, Transportation Quarterly, 49.2, (1995), pages 73-86; "Financial and Demographic Conditions Associated with Local and Regional Railroad Service Failures", Eric Wolfe, Transportation Quarterly, 43.1, (1989), pages 3-28.

[91] Prominent because it earned an American Short Line and Regional Railroad Association 2003 marketing award. The information is from the North Shore web site.

[92] Points are taken from notes at the session by the author of this chapter, and from subsequent interviews in Canada.

[93] Information presented here is taken from an on-site interview by the author with executives of the company. Conclusions about success factors are those of the author, unless specifically attributed to Northwest.

[94] Due to the configuration of the rail network and the way it is operated, traffic diversion of long-haul shipments sometimes moves the route of travel into a new region of the country, in contrast to the highway route.

[95] For example, see Community Impact Assessment Website at: http://www.ciatrans.net/ciahome.shtml.

[96] Highway Capacity Manual – NCHRP 350

[97] One of the authors of this report provided the model referred to here.

[98] While absolute length-of-haul is rising, shipment growth still is concentrated in the low end of the distance spectrum.

[99] NCHRP 20-29 Development of a Multimodal Framework for Freight Transportation, NCHRP 2-19(2) Economic Development Toolbox, NCHRP Report 456 Methods to Assess Social and Economic Effects of Transportation Projects, NCHRP Report 463 Economic Costs of Congestion, NCHRP Synthesis 290 Economic Effects of Transportation Investments.

[100] The Metroplan Orlando (FL) Freight Goods & Services Mobility Strategy Plan and the New Jersey Portway Extensions project are just two of many.

[101] VIUS data were collected on a five-year cycle. The last collection was in 2002, and the data were released substantially later. Thus under the traditional cycle, the 2002 VIUS would remain current through about 2009.

[102] The website is located at http://www.railroadpm.org/ and features such performance measures as: Total Cars On Line, Average Train Speed, Average Terminal Dwell Time, and Bill of Lading Timeliness. Performance measures of shortlines have not generally been available.

[103] See http://www.commerce.gov/ and http://www.bea.doc.gov/ for more details on the types of data that are provided.

[104] Examples include REMI from Regional Economic Models, Inc.; REDYN from Regional Dynamics, Global Insight (DRI*WEFA); Fair Model (Yale University) – as well as many consultants who produce forecasts based customized versions on one or more different models.

[105] See http://mobility.tamu.edu/ums/congestion_data/ for more details about this study.

[106] See http://www.sec.gov/answers/form10k.htm for more details. The Securities and Exchange Commission is at http://www.sec.gov/.