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Short Line Rail: Its Role in Intermodalism and Distribution

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16. Abstract

The purpose of this project is to investigate the potential role of short line railroads in the U.S. to perform intermodal terminal operations and distribute/pick-up containers/trailers in metropolitan areas. Included in this project is an investigation of the potential for short line railroads to serve industrial parks and/or freight villages. This research report reviews the literature on short line operations in the U.S., their current role in originating and distributing rail freight traffic and their capacity to take on intermodal terminal operations and functions. Further, we examine transload/transflow operations vis-à-vis short line railroads, as well as the viability of industrial park/freight villages as short line served entities.

The research included discussions with knowledgeable officials at The American Short Line and Regional Railroad Association, FHWA and existing short line operators regarding their current situation, plans and constraints. In addition, discussions were held with senior officials in Class I railroads, senior members of industrial real estate organizations, academics and senior consultants in the transportation industry. These comments, suggestions and recommendations have been incorporated in this report, as noted in the body of the report and citations.

In addition, the report frames some options available to enhance these types of operations on short line railroads. It identifies potential candidate short line railroads for pilot projects to test these options. Finally, beyond this report, the research culminates in proposals for funding the pilot projects by external agencies.

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SHORT LINE RAIL: ITS ROLE IN INTERMODALISM AND DISTRIBUTION: A PERSPECTIVE

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Prologue

The Freight and Maritime Program (FMP), within the Center for Advanced Infrastructure and Transportation at Rutgers University, has identified freight transportation congestion issues as a key research area that it is addressing. Freight transportation congestion manifests itself in ports, border crossings and in and around metropolitan areas. At the initiation of the research reported in this document, a new administration was seeking ways to jump-start the economy with "shovel-ready" projects – many addressing transportation infrastructure issues.

This report focuses upon truck congestion in, through and around metropolitan areas because there are currently Federal and State proposals, in the amounts of billions of dollars that seek to mitigate such congestion issues. FMP believes there is a pressing need to identify alternatives to the most common remedies that have been historically tried, e.g., interchange improvements, lane additions, ramp metering, etc. In the opinion of FMP researchers, short line and regional railroads may offer, in certain metropolitan areas, significant opportunities for reducing truck congestion.

At the same time, port and border crossing congestion has been identified as a key problem. FMP intends to address this area in another project.

Because truck congestion in metropolitan areas is such a large and complex issue – over 111 centuries of annual truck delay in 20+ metropolitan areas in 2004 alone – this report identifies a variety of factors that drive the demand for freight, the impacts of truck traffic, the types of planning models and processes currently in use to address these issues and future trends – both nationally and globally that will impact on freight transportation in the U.S. At the same time the report tries to identify solutions, some longer-term and some very near-term (shovel-ready), that short line and regional railroads could potentially test in pilot projects.

Given this focus, the report mainly provides high-level discussions of the many issues involved in solving truck congestion in metropolitan areas. It does not attempt to address concepts already applied in supply chain management (inventory in motion, vendor managed inventory, etc.). Nor does it go into any detailed exposition of rail/road ramp operations and the research that has been undertaken in this area with regard to intermodal operations.

The report does indentify several areas for further research – beyond the proposed pilot projects – that can become key research foci for FMP going forward. These areas are summarized in the final chapter.

Summary

Freight transportation has a dominant influence in our economy. The freight transportation industry is complex. There are multiple firms and agents, often with conflicting objectives and motives that interact in attempts to maximize or minimize some particular set of objectives. In addition, transportation infrastructure requires huge capital investments, and frequently has significant implementation delays. Further, there is stiff competition among the different players in the freight industry.

Meeting America's surface transportation needs for the future will require a strategy that goes beyond just "more of the same." It requires a multi-modal approach, which preserves what has been built to date, improves system performance, and adds substantial capacity to highways, transit, freight rail, intercity passenger rail, and better connections to ports, airports, and border crossings. Further, meeting America's surface transportation needs will also require solutions that go beyond transportation improvements and include policies addressing land use, energy, global climate change, the environment, and community quality of life.

We argue that it is imperative to develop and implement accurate tools for planning, operation and control in the freight industry, and its various components, so as to improve the cost-effectiveness and efficiency of the economy in the U.S. and mitigate negative environmental consequences. To do this, it is necessary to address the freight transportation industry as a component of the transportation system within the U.S., and to view the various components within that system – and its environment – as linked and interacting in ways not currently captured by any planning, decision-making or policy mechanisms employed today.

In this report, our concern is addressing freight transportation into, out of and through metropolitan areas, specifically congested metropolitan areas. The report seeks to identify opportunities wherein freight rail, specifically short line and regional railroads operating "within the belt" of metropolitan areas may become part of the solution to the ever increasing congestion problems facing the U.S.

The focus here is on short lines and regional railroads that are currently operating in metropolitan areas that have been identified as having significant truck freight bottleneck issues. There are over 20 such metropolitan areas in the U.S. In this analysis, only metropolitan areas having three or more interchange bottlenecks, totaling more than 1 million hours of annual delay, are considered. For purposes of this study, we focus only on areas with multiple bottlenecks as these are less likely to yield to traditional interchange or roadway improvements. In 2004, these metropolitan bottlenecks resulted in almost 100 million hours of delay for truck-hauled freight – that is the equivalent of over 4 million days of delay or more than 11 thousand years, i.e., more than 111 centuries of delay in one year.

Four metropolitan areas – Chicago, Miami, New York-Northeastern NJ and Portland, OR are used to illustrate the range of operating conditions, customers and potential

opportunities for short line and regional railroads operating “inside the belt” of metropolitan areas. There are great differences among the railroads in terms of the miles operated, the number and types of customers served and products carried, as well as serving yards and Class I interchanges.

To understand the context within which short line and regional railroads will be operating in the future, the study addresses freight growth, economic and population forecasts out to 2035 and 2050, shifts in global conditions – including population, the global economy, energy and consumption patterns, climate and environmental change and other factors – that will likely impact on freight transportation in the United States and metropolitan areas.

We find that the tonnage of freight moved in the United States is forecast to double between 2005 and 2035, from 16 billion tons to 31.4 billion tons. It is projected that 80 percent of that freight by tonnage and 94 percent by value will be moved by truck. Trade with Canada is up. Oil imports and expanding trade with Mexico and Latin America have resulted in major increases in trade through Gulf Coast ports and across the U.S.-Mexico border. International container cargo coming primarily from Asia and Europe grew from 8 million units in 1980 to 40 million units by 2000 and is expected to explode to 110 million units by 2020. This is placing enormous pressure on West Coast and East Coast ports and the highway and rail distribution systems in between.

One of the characteristics of the changing economy is that freight traffic grew at a faster rate than the economy. For example, between 1999 and 2004, container traffic increased 44 percent while U.S. Gross Domestic Product (GDP) in constant dollars increased 13 percent. The U.S. GDP is expected to grow, on average, almost 3 percent per year between now and 2035, resulting in even greater demand for freight transportation. This growth in demand will be driven by a population that is expected to increase from 300 million people in 2006 to 380 million in 2035, and almost 420 million by 2050.

There is a distinct growth pattern that resembles a continuation of the regional shifts that have occurred over the last 50 years. The South and the West show the greatest increases in population out through 2030. States, such as Alabama, Kentucky, Louisiana and Mississippi will experience only moderate levels of population growth, while Florida will gain almost an 80 percent increase in population. Texas, North Carolina and Georgia are also forecast to see significant increases in their population. While Virginia, Maryland, Tennessee, Delaware, South Carolina and Arkansas will all see appreciable population gains.

In the West, two states are the big gainers in terms of population increases, Nevada and Arizona. In fact, most states in the West will see significant increases in their population. In the Northeast, growth on a percentage basis will be slower than the rapidly growing South and West. However, in absolute numbers some metropolitan areas will grow quite substantially. For example, while New York only grows about two and one half percent between 2000 and 2030, its population will increase by almost one half million. If that growth rate continues out to 2050, then there would be another half a million added to New York by then. Furthermore, it seems likely that most of the growth in New York will actually occur in close proximity to New York City. If that is combined with the forecast growth in New Jersey and Connecticut, most of which will most likely occur close to New York City, then, while the percentage increases may not look great, the end result will continue to be the dominance of New York as the largest metropolitan area in the country, by at least an order of magnitude.

Unless there are some catastrophic events that occur, the trend in the U.S., and the world, is for increasing numbers of people in the urban areas and fewer in the rural parts of the countries. These trends will do nothing but exacerbate congestion and freight transportation issues in metropolitan areas, as well as across the country.

Without major capacity investments, by 2020, 29 percent of urban National Highway System routes will be congested or exceed capacity for much of the day and 42 percent of National Highway System routes will be congested during peak periods. Urban Interstate highways, the portion of the National Highway System that carries the most freight trucks, are and will continue to be the most traveled segments. The percentage of urban Interstate sections carrying more than 10,000 trucks per day will increase from 27 percent in 1998 to 69 percent in 2020. It is estimated that approximately 53 percent of urban Interstate mileage will be congested in 2020 as compared to about 20 percent today. These statistics suggest that, as congestion increases in the coming decades, the speed and reliability of truck freight transportation will deteriorate and costs to shippers and receivers may rise.

The question becomes how to develop solutions to these congestion problems. It is clear that the many programs that have been implemented over the last decades have not resolved the congestion problem and that if the population forecasts and forecast freight volumes materialize, there are no easy options for mitigating the ensuing congestion that will negatively impact the economy, the environment and social fabric of the metropolitan areas and the country as a whole.

In assessing the potential role that short line and regional railroads might play in reducing truck congestion in metropolitan areas going forward, reviews of the current transportation planning models, policies and operations and management tools clearly indicates that MPOs, Federal and State planning agencies do not have the data, models or planning processes in place to derive rigorous means for informing policy and decision makers about possible alternative means of moving freight into, out of and through metropolitan areas.

There are a number of possible ways to locate distribution and collection facilities “inside the belt” of metropolitan areas so as to address congestion issues and provide cost-effective freight service within these areas. In addition, there are options such as off-peak pick-up and delivery to production and consumption facilities, peak pricing and tolling, truck-only lanes, etc. We focused on those options that are either freight rail linked, or could be done in conjunction with freight rail. These options include: Freight

Villages/Integrated Logistics Centers; City Logistics; Pooled Shipping; The Logistics Campus; Transload/Transflow/Team Tracks; Shared Rights of Way; and some creative Operating Strategies. These options could easily be worked in combination with demand management options such as off-peak pick-up and delivery to production and consumption facilities, peak pricing and tolling, truck-only lanes, etc.

These possible land use and rail operating and management options could play important roles in reducing truck traffic in metropolitan areas. However, there is no evidence that such options are currently being actively considered in addressing metropolitan area congestion issues, at least in conjunction with short line, regional and Class I railroads that service those metropolitan areas with significant truck congestion issues.

The report recommends that a meta-architecture be developed for modeling freight transportation in the United States that allows a logical and integrated data flow from the National level all the way through to the operations and management level within metropolitan areas. It is suggested this meta-architecture and the processes for involving not only the assorted public agencies and officials currently concerned with transportation planning in the United States, but also those from the private sector, be built around recommendations contained in *Transportation for Tomorrow* and modifications to the Metropolitan Transportation Plan process.

Four metropolitan areas are identified that may provide good base-case pilot project sites for testing, at least the modifications in the MTP process with explicit short line/regional and Class I railroad participation in evaluating possible rail-oriented options in solving metropolitan freight congestion issues. The possible pilot project sites include: Chicago-Northwestern Indiana and Dallas-Fort Worth for the large metropolitan areas. These two areas provide contrasts in population growth, while each has extensive destination traffic, as well as through traffic traversing the metropolitan area. For the smaller metropolitan areas – Portland-Vancouver (OR-WA) and Providence-Pawtucket-New Haven-Meriden-Bridgeport-Milford – similarly provide contrasts in population growth rates, while both have significant levels of destination traffic.

Chapter 1: Introduction

Project Purpose

The purpose of this project is to investigate the potential role of short line railroads in the U.S. to perform intermodal terminal operations and distribute/pick-up containers/trailers in metropolitan areas. Included in this project is an investigation of the potential for short line railroads to serve industrial parks and/or freight villages. This research report reviews the literature on short line operations in the U.S., their current role in originating and distributing rail freight traffic and their capacity to take on intermodal terminal operations and functions. Further, we examine transload/transflow operations vis-à-vis short line railroads, as well as the viability of industrial park/freight villages as short line served entities.

The research included discussions with knowledgeable officials at The American Short Line and Regional Railroad Association, FHWA and existing short line operators regarding their current situation, plans and constraints. In addition, discussions were held with senior officials in Class I railroads, senior members of industrial real estate organizations, academics and senior consultants in the transportation industry. These comments, suggestions and recommendations have been incorporated in this report, as noted in the body of the report and citations.

In addition, the report frames some options available to enhance these types of operations on short line railroads. It identifies potential candidate short line railroads for pilot projects to test these options. Finally, beyond this report, the research culminates in proposals for funding the pilot projects by external agencies.

Freight Transportation: Its Role in the Economy and Everyday Life

Transportation is an integral part of our daily lives. It is one of the primary means whereby people, commerce and employment are connected and bound together. Not only does it play this role in our economic activities, but it also connects and binds our social activities. The interaction between our economic and social activities often plays itself out in very complicated ways that frequently lead to transportation problems, such as congestion, accidents and increased costs to all the parties involved. We will return to this interplay later in this report.

Freight transportation has a dominant influence in our economy. Starting with the transportation of various components, raw materials, etc. that have to be assembled from the different corners of the world through to the final delivery of finished goods, food stuffs and materials to the end consumer, freight transportation plays an important role in every link of the supply chain. With the advent of internet shopping and the delivery of goods to our door, the importance of freight transportation has increased (Crainic and Laporte, 1997; Crainic, 1999; Valsaraj, 2008).

One measure of the vitality of the U.S. economy is to look at the amount of goods transported by freight. In 2002, in the U.S., 53 million tons of goods valued at more than $36 billion (2002 dollars) were transported each day. The freight volumes are projected by the Freight Analysis Framework (FAF) to increase by 92% by 2035. The national expenditure on freight transportation in the United States is estimated to be 5% of Gross Domestic Product (GDP). The value of freight moved on the U.S. transportation system is increasing faster than tons transported, even when calculated in 2002 prices. The FAF 2007 provisional estimate and 2035 forecast expect the value of shipments to increase between 3.1 percent and 3.5 percent per year while tonnage is predicted to grow between 2.0 percent and 2.1 percent per year – going from slightly over $13.2 billion in 2002 to almost $41.9 billion in 2035 (2002 dollars) (FHWA, 2008).

Not surprisingly, transportation costs constitute a significant part of the price of finished goods. For example, a Canadian study finds 13% of primary industry expenditures and 11% of secondary industry expenditures are for transportation (Owoc, 1993). One measure of the performance of the nation's freight transportation system is total logistics cost. Total logistics cost is the cost of managing, moving, and storing goods. The major components of total logistics cost are administration (e.g., management, insurance), transportation (e.g., by truck, rail, air, and water), and inventory carrying costs. In the U.S., logistics costs rose through the 1960s and 1970s to a high of about 16 percent in 1980, then declined through the 1980s and 1990s. Total logistics costs in 2003 were estimated to be about 8 percent of U.S. GDP (FHWA. 2005). These costs are just those associated with the actual transport of goods. The numbers become larger when the capital costs of infrastructure are included, although it is not easy to sort them out completely since railroad capital costs are embedded in their rates, while trucking, barge and air freight rates capture some of their capital costs, they do not capture the full costs of highways, waterway infrastructure and airport and air traffic control systems. Nevertheless, it is clear that freight transportation is a major component of the U.S. economy.

The freight transportation industry is complex. There are multiple firms and agents, often with conflicting objectives and motives that interact in attempts to maximize or minimize some particular set of objectives. In addition, transportation infrastructure requires huge capital investments, and frequently has significant implementation delays. Further, there is stiff competition among the different players in the freight industry. Often, there is a strong correlation between their decisions, although independently taken. Finally, the industry has to adapt and evolve quickly in response to social, economic and demographic changes (Crainic, 1999; Valsaraj, 2008).

It has been said that meeting America's surface transportation needs for the future will require a strategy that goes beyond just "more of the same." It will require a multi-modal approach, which preserves what has been built to date, improves system performance, and adds substantial capacity to highways, transit, freight rail, intercity passenger rail, and better connections to ports, airports, and border crossings (AASHTO, 2007a).

Further, meeting America’s surface transportation needs will also require solutions that go beyond transportation improvements and include policies addressing land use, energy, global climate change, the environment, and community quality of life (AASHTO, 2007a).

Thus, it is imperative to develop and implement accurate tools for planning, operation and control in the freight industry, and its various components, so as to improve the cost-effectiveness and efficiency of the economy in the U.S. and mitigate negative environmental consequences. To do this, as we will argue later in the report, it is necessary to address the freight transportation industry as a component of the transportation system within the U.S., and to view the various components within that system – and its environment – as linked and interacting in ways not currently captured by any planning, decision-making or policy mechanisms employed today. Thus, if we truly want to understand the potential role of short lines in helping to alleviate congestion in metropolitan areas, as well as be partners in the operation and service of terminals and origin and destination facilities “inside the belt” of metropolitan areas, we must place our analyses and recommendations within this greater context.

Chapter 2: Short Lines in the U.S.

The purpose of this chapter is to provide a brief overview of the role of short line railroads in the United States. In addition, we discuss the general character of short line operations, customers and revenue base. In the U.S. there is a precise revenue-based definition of categories of U.S. railroads found in the regulations of the Surface Transportation Board (STB). The STB's accounting regulations group rail carriers into three classes for purposes of accounting and reporting (49 CFR Part 1201 Subpart A) (the following information is drawn from the American Short Line and Regional Railroad Association website, Annual Report and Marketing Brochure; http://www.aslrra.org.):

Class I: Carriers with annual carrier operating revenues of $346.8 million* or more
Class II: Carriers with annual carrier operating revenues of less than $346.8 million* but in excess of $40 million*
Class III: Carriers with annual carrier operating revenues of $40 million* or less, and all switching and terminal companies regardless of operating revenues.
Generally, Class III carriers are referred to as short lines, and Class II carriers are referred to as regional railroads.

*These threshold figures are adjusted annually for inflation using the base year of 1991.

In addition, two other categories of freight railroads are generally described in the U.S.:

- Regional railroads are line-haul railroads operating at least 350 miles of road and/or earning revenue between $40 million and the Class I revenue threshold ($346.8 million).

- Short line railroads fall into two categories:

    - Local railroads are line-haul railroads below the Regional criteria, plus switching and terminal railroads.

    - Switching & Terminal railroads are railroads that are either jointly owned by two railroads for the purpose of transferring cars between railroads or operate solely within a facility or group of facilities.

A small number of regional and short line railroads are publicly owned:

- Florida East Coast Railway and Rail America (wholly-owned subsidiaries of Fortress Investment Group) – **FIG,**
- Genesee & Wyoming Inc. – **GWR,** and
- Providence & Worcester Railroad – **PWX.**

There are approximately 550 short line and regional railroads in North America today. Short lines take many forms. Some operate as privately owned companies, while others are publicly owned or grouped under holding companies – as noted above. There are some short lines controlled by government, and others that are subsidiaries of larger corporations.

Type of Ownership*	Number of Railroads	% of Total Short Line & Regional Railroads
Shipper	72	13.2%
Government	29	5.3%
Class I	18	3.3%
Private & Other	426	78.2%
All Types	545	**100.0%**

***Ownership Definitions:**
Shipper: Owners ship at least 50% ot the railroad's carloads
Government: Railroad is a government entity or majority-owned by a government entity
Class I: Owners include one or more Class I railroads
Private & Other: Railroad is not owned by one of the entities listed above (e.g., owned by a holding company, private entrepreneur or non-Class I railroad).

The current structure of the short line and regional railroad industry is shown in the following table.

Type of Railroad	Number of Railroads	Miles Operated*	Employees
Local Line Haul	309	21,855	5,102
Regional	31	17,073	7,807
Switching & Terminal	205	7,546	6,779
U.S. Total	**545**	**46,474**	**19,688**

*Includes Trackage Rights
Definitions:
Local Line Haul: Railroad is less than 350 miles and has revenues less than $40 million and primarily hauls freight over main or branch line tracks.
Regional: Railroad is at least 350 miles and/or has revenues between$40 million and the Class I threshold ($346.8 million).
Switching & Terminal: Railroad primarily provides switching and/or terminal services within certain switching limits.

Short line and regional railroads operate approximately one-third of the U.S. freight rail network and serve customers in 49 states (only Nevada does not have a short line or regional railroad providing service within its boundaries).
Short lines haul a vast array of commodities, including: intermodal trailers and containers, coal, farm products, primary metals, metallic ores, paper, chemicals, lumber, food, building products (including stone, clay, and glass), and minerals. In total, short lines transport 11 million cars each year. Together Class II and III railroads interchange 25% of rail freight traffic on Class I railroads.

Today, non-Class I railroads own, maintain, and operate 29% of the rail mileage in the United States, an amount equal to over 40,000 miles of track. Short lines employ 11% of all railroad workers and generate 8% of all rail freight revenue.

As we will argue later in this report, as the rail network nears capacity in some areas of the country, small railroads can help bypass congested areas to keep freight moving. The United States' short line and regional railroad infrastructure is an underutilized asset that offers opportunities for future growth.

Each year, short line and regional railroads haul enough carloads to divert 26 million trucks from the nation's highways. It is estimated this reduction in highway traffic lowers pavement damage costs by $1.2 billion annually. Again, as we will argue later in this report, freight rail service, in general, and short lines in particular offer significant opportunities to help mitigate congestion in metropolitan areas, reduce environmental degradation and capital infrastructure requirements for highways.

Brief History of Short Line and Regional Railroads in the U.S.

The establishment of the first commercial railroad in the U.S. – the Granite Railway located near Quincy, MA – to haul granite blocks from a quarry to the Neponset River for transshipment to Boston via barge was the first short line railroad in this country. In fact, all the initial railroads in the U.S. were short lines that were financed and built within the communities they served to move people and freight in local commerce. These early railroads quickly began to evolve as industry and commerce developed. The local projects began to interconnect, creating longer routes and improving the economies of the areas they served. By the 1860s, these consolidations created regional systems serving increasingly wider areas. But, not all railroads were destined to become part of a through route or a growing system (Lewis, 2007).

In the second half of the nineteenth century, and again in the middle of the twentieth century, federal, state, and local governments were involved in large-scale subsidizing and promoting of railroad infrastructure for economic development purposes. In the 1800s, public financial involvement in railroads focused on their expansion to develop the West. In the 1960s, 1970s, and early 1980s, public financial assistance aimed to preserve rail freight services, and restructure the then oversized national rail network (Walter, et al., 1993).

The genesis of the contemporary short line and regional railroad industry in the United States resides in a set of Congressional actions taken in the early '70s and '80s to deal with the rapidly deteriorating financial and operating conditions of the railroad industry. While the causes of this deterioration had been in place over the course of many years, it was the bankruptcy of several railroad companies and near bankruptcy of the remainder of the industry that led to the passage of landmark Federal legislation in 1970,1973, 1976, 1980 and 1981. This legislation, the Rail Passenger Service Act, 3R Act, 4R Act, Staggers Act and NERSA (Northeast Rail Services Act), brought about the separation of rail passenger service from freight rail service (through the creation of the National Railroad Passenger Corporation – AMTRAK), the consolidation of several bankrupt railroads into the Consolidated Rail Corporation (Conrail) serving much of the Northeast and Midwest sections of the U.S. and eventually, the spinning-off of very significant numbers of operating freight lines by Conrail and other carriers, either through abandonment or sale (For more detailed discussions of various railroad regulations prior to 1983, see Keeler, 1983; for a discussion of the Staggers Act, see Meyer, 1999; see USRA, 1986, for a discussion of NERSA).

In the years leading to 1973, the freight railroad system of the U.S. was collapsing. Even after the government-funded Amtrak took over intercity passenger service in 1971, railroad companies continued to lose money due to extensive government regulations, competition from other transportation modes, and other factors. In mid-1973, under Judge John P. Fullam, the bankrupt Penn Central threatened to end all operations by the end of the year if they did not receive government aid by October 1. At that time it would liquidate and cease operating completely, immediately threatening freight and passenger traffic in the United States. Fullam kept the Penn Central Company operating into 1974. On January 2, 1974, after threatening a veto, President Nixon signed the Regional Rail Reorganization Act of 1973 into law. The 3R Act, as it was called, provided interim funding to the bankrupt railroads and defined a new Consolidated Rail Corporation (Conrail) under the AAR's plan (Wikipedia, 2008).

The 3R Act also formed the United States Railway Association, another government corporation, taking over the powers of the Interstate Commerce Commission with respect to allowing the bankrupt railroads to abandon unprofitable lines. Under the 3R Act, the USRA was to create a Final System Plan to decide which lines should be included in the new Consolidated Rail Corporation. Unlike most railroad consolidations, only the designated lines were to be taken over. Other lines would be sold to Amtrak, various state governments, transportation agencies, and solvent railroads. The few remaining lines were to remain with the old companies along with all previously abandoned lines, many stations, and all non-rail related properties, thus converting most of the old companies into solvent property holding companies. The plan was unveiled July 26, 1975, consisting of lines from Penn Central and six other companies—the Ann Arbor Railroad (bankrupt 1973), Erie Lackawanna Railway (1972), Lehigh Valley Railroad (1970), Reading Company (1971), Central Railroad of New Jersey (1967) and Lehigh and Hudson River Railway (1972). Controlled railroads and jointly owned railroads such as Pennsylvania-Reading Seashore Lines were also included. It was approved by Congress on November 9, and on February 5, 1976, President Ford signed the Railroad Revitalization and Regulatory Reform Act of 1976 (known as the 4R Act), which included this Final System Plan, into law (Wikipedia, 2008). Some contemporary short lines were created through these sales to state governments and transportation agencies.

Although Conrail's government-funded rebuilding of the heavily run-down railroad infrastructure and rolling stock it inherited from its six bankrupt predecessors succeeded by the end of the 1970s in improving the physical condition of tracks, locomotives, and freight cars, the fundamental economic regulatory issues remained, and Conrail continued to post losses of as much as $1 million a day. Conrail management, recognizing the need for more regulatory freedoms to address the economic issues, was among the parties lobbying for what became the Staggers Act of 1980, which significantly loosened the Interstate Commerce Commission's (ICC) rigid economic control of the rail industry. This allowed Conrail and other carriers the opportunity to become profitable and strengthen their finances.

The Staggers Act allowed the setting of rates that would recover capital and operating cost (fully allocated cost recovery) by each and every route mile the railroad operated. There would be no cross-subsidization of costs between route-miles (i.e., rates on profitable route segments were not set higher to subsidize routes where rates were set at intermodal parity, yet still did recover fully allocated costs). Finally where current and/or future traffic projections showed that profitable volumes of traffic would not return, the railroads were allowed to abandon those routes, shippers and passengers to other modes of transportation. With the Staggers Act, the railroads, including Conrail, were freed from the requirement to operate services with open-ended losses for the public convenience and necessity for those who simply chose rail services as their mode of transportation (Wikipedia, 2008).

Despite the passage of the Staggers Act, Conrail continued to lose massive sums of money. In 1981, Congress once again reacted with support by passing the Northeast Rail Service Act (NERSA). There were many provisions within this Act that were critical to Conrail becoming profitable, e.g., the elimination of the requirement for Conrail to provide rail commuter service in the Northeast Corridor, an expedited line abandonment and line sale process and elimination of the Congressionally mandated “life-time” employment of organized railroad labor employees (See Leslie, 1995, for more about the mandated labor requirements contained in the 3 R Act).

Of particular importance to the development of the present-day short line and regional railroad industry was the expedited line abandonment and line sale process contained within NERSA. Notwithstanding the provisions of the Staggers Act, mentioned above, the ICC maintained its lengthy and burdensome review process for applications for line abandonment. Because of exigency of staunching Conrail’s continued operating losses, NERSA set forth a simplified, and time delimited, process for approving line abandonments for those lines shown to be unprofitable. To assist shippers and communities threatened with such line abandonments, NERSA also required such lines be offered for sale to interested, and qualified, parties. Again, this sale process was time delimited and set parameters under which such sales could take place.

The net result of these provisions is that Conrail filed for abandonment, and subsequent sale, a large number of branch lines and clusters of branch lines. The vast majority of these branch lines and clusters were sold to entrepreneurs. These newly created short lines continued to provide rail service to the customers and communities that had faced loss of such service as a result of potential abandonment. As this program became demonstrably successful, it led to the interest of other Class I railroads to enter into such line sales to help them improve their own profitability. The pressures to allow other Class Is to engage in such line sales, led to a dramatic shift in ICC practices.

The other major railroads quickly began to market unproductive branch lines to short line operators and the small railroad industry began an unprecedented rebirth. Over the ensuing years thousands of miles of track have been saved from abandonment. The impact on hundreds of communities has been the maintenance and advancement of their economies through continued, competitive freight rail service to their industries, many of which were plants operated by large national companies that could have relocated/closed such facilities as a result of threatened abandonments. As noted above, today these short lines and regional railroads number 545 and operate 29% of the rail mileage in the United States.

As mentioned above, short lines and regional railroads operate in 49 states. It is estimated they contribute over $86 million in taxes to state and local economies. Frequently, they are the only cost-effective shipping option for their customers. In many states, these carriers play a significant role in the transportation networks. Illustrative of these impacts, a 2003 study by the Washington Department of Transportation of a single 372-mile railroad stated that among the benefits provided to the public were lower costs for shippers and reduced damage to roadways, as well as direct economic benefits in the form of wages and benefits for railroad employees and rail-dependent industries. The estimate of these annual public benefits ranged from $12.9 million to $23.9 million to the State (ASLRRA, 2007).

Similarly, a Kansas Department of Transportation study found short lines in the western two-thirds of the state saved the state $49.5 million annually in highway maintenance and related costs. In Iowa, short line railroads operate over 1,400 miles to track and move over 40 percent of all Iowa grain moved by rail. Iowa farmers served by these railroads saved over 10 cents/bushel in transportation costs (ASLRRA, 2007).

Thus, as Class I railroads continue to spin off branch lines, we can expect the short line and regional railroad make-up will continually change, and will play an increasingly important role in state and local economies. This is likely to be the case “inside the belt” of metropolitan areas as well, although the number of branch lines within these metropolitan areas still operated by Class Is represent a much smaller set of “opportunities” for short line and regional railroad operators.

Chapter 3: Metropolitan Areas with Short Lines

The purpose of this chapter is to briefly describe short line operations in some U.S. metropolitan areas, their numbers, locations in the metropolitan areas and connections with Class I freight railroads. Included in this description are the types of customers, types of freight hauled, interchanges with Class Is, serving yards, etc. This is the backdrop against which any suggestions and recommendations regarding possible roles for short lines in relieving freight congestion in metropolitan areas must take place.

Short Line Operations in Metropolitan Areas

The focus here is on short lines and regional railroads that are currently operating in metropolitan areas that have been identified by FHWA as having significant truck freight bottleneck issues (FHWA, 2004). Depending upon the methodology used, the year of analysis and whether more than trucks are considered, there are over 20 such metropolitan areas in the U.S. (See Table 3.1). In this analysis, only metropolitan areas having three or more interchange bottlenecks, totaling more than 1 million hours of annual delay, are considered. There are other metro areas that exceed the 1 million hour delay mark, and there are areas that are close to that mark. For purposes of this study, we focus only on areas with multiple bottlenecks as these are less likely to yield to traditional interchange or roadway improvements. It is worth noting that in 2004, these metropolitan bottlenecks resulted in almost 100 million hours of delay for truck-hauled freight – that is the equivalent of over 4 million days of delay or more than 11 thousand years, i.e., more than 111 centuries of delay in one year.

As discussed later in this report, congestion is likely to increase not only in these particular metropolitan areas, but others as well. This will occur as a result of significant population growth over the next 20 to 30 years, as well as the likely increase in vehicular traffic (both automobiles and trucks). (Chapter 6 discusses estimated population growth in the U.S. and metropolitan areas, while Chapter 7 discusses in more detail the highway congestion issue in the U.S.)

TABLE 3.1: Metro Areas with Three or More Highway Interchange Bottlenecks for Trucks, 2004

CITY	FREEWAY	LOCATION	ANNUAL HRS DELAY
Atlanta	I-285	I-285 @ I-85 Interchange (“Spaghetti Junction”)	1,641,200
	I-285	I-285 @ I-75 Interchange	1,497,300
	I-20	I-20 @ I-285 Interchange	1,359,400
	I-75	I-75 south of I-85 Interchange	1,288,800

	I-20	I-20 @ Fulton Street	1,172,700
Baltimore	I-695	I-695 between I-70 & I-95	616,800
	I-95	I-95 between I-895 & SR 43	525,100
	I-83	I-83 @ I-695 Interchange	496,200
	I-695	I-695 @ I-70 Interchange	473,100
Boston	I-93	I-93 @ I-95 Interchange	1,280,100
	I-93	Columbia Rd @ I-93	1,081,800
	I-95	Worcester Rd @ I-95	1,041,800
Chicago-Northwestern Indiana	I-90	I-90/94 @ I-290 Interchange ("Circle Interchange")	1,544,900
	I-94	I-94 (Dan Ryan) @ I-90 Skyway Split (Southside)	1,512,900
	I-80	I-80/I-94 Split (Southside)	1,343,600
	I-55	Pulaski Road @ I-55	1,300,400
	I-290	I-290 @ I-355	1,246,200
	I-55	I-55 (Stevenson Expwy) @ I-294 Interchange)	1,001,600
	I-57	I-57 @ 112th Street	733,800
	I-90	I-90 @ I-94 Interchange ("Edens Interchange")	596,300
	I-355	I-355 @ I-55	523,100
	I-55	I-55 from Naperville to Weber	405,900
	I-80	I-80 @ I-294 Interchange	380,700
	I-355	Roosevelt Rd @ I-355	229,100
	I-55	I-55 @ I-294	180,100
	I-80	I-80 @ I-294 Interchange	91,700
	I-290	I-290 (Eisenhower Expwy) between Exits 17b @ 23a	59,400

Cincinnati (OH-KY)	I-75 I-75 I-275 SR 562 I-71 US 50 I-75	I-75 @ I-74 Interchange I-75 @ I-275 Interchange I-275 between I-74 & SR 126 SR 562 @ I-75 Interchange I-71 @ I-75 Interchange US 50 @ I-75 Interchange I-75 from Ohio River Bridge to I-71 Interchange	1,128,900 662,900 504,700 244,900 229,900 177,300 70,900
Columbus	SR 315 I-270 I-71 I-70	SR 315 @ I-70 Interchange I-270 @ I-70 Interchange (West) I-71 @ I70 Interchange I-70 @ US 23 Interchange	1,097,600 1,077,800 968,800 839,100
Dallas-Fort Worth	US 75 SR 360 I-35 I-35 I-820 US 75	US 75 @ Lemmon Ave SR 183 @ SR 360 I-35W @ SR 121 Interchange I-35E @ I-30 Interchange {“Mixmaster”) SR 121 @ I-820 US 75 to SR 190F	511,600 268,900 267,100 217,100 174,500 21,100
Denver	I-70 I-25 I-225	I-70 @ I-25 Interchange (“Mousetrap”) US 87 @ US 36 I-225 @ US 87 Interchange	859,200 614,100 193,700
Detroit	I-94 I-96 I-75 I-696 I-75	I-94 @ I-75 Interchange I-96 @ Jct I-275 7 Mile Rd @ I-75 I-696 @ Jct I-75 I-75 @ Jct M-8	643,700 527,200 467,200 418,900 360,500

	I-75	I-75 @ I-696 Interchange	300,600
	M-39	M-39 @ M-5 Interchange	264,800
	M-39	M-39 @ Jct M-5	230,900
	I-96	I-96 @ I-275 Interchange	35,100
Houston	I-610	I-610 @ I-10 Interchange (West)	805,500
	I-45	I-45 @ I-610 Interchange	452,300
	I-45	I-45 (Gulf Freeway) @ US 59 Interchange	386,900
	US 59	US 59 @ SR 6 Interchange	328,600
	SR 288	SR 288 @ US 59	309,200
	SR 146	SR 146 @ La Porte Fwt	19,400
Las Vegas	US 95	US 95 @ I-15 Interchange (“Spaghetti Bowl”)	670,400
	I-15	I-15 between Tropicana & Flamingo	486,700
	I-15	I-15 @ I-215 Interchange (the “Fishbowl”)	403,200
Los Angeles-Riverside-San Bernardino	I-10	San Bernardino Fwy	1,522,800
	SR 134	SR 134 @ SR 2 Interchange	1,489,400
	I-710	Long Beach Fwy	1,380,300
	SR 60	SR 60 @ I-605 Interchange	1,314,200
	I-405	I-405 (San Diego Freeway) @ I-605 Interchange	1,245,500
	SR 91	San Gabriel River Fwy	1,194,300
	SR 91	SR 91 @ I-215 Interchange	1,067,600
	SR 60	I-710 @ Whittier Blvd	1,059,700
	SR 91	Orange Fwy	1,029,700
	SR 91	SR 91 @ I-215 Interchange	966,900

	US 57 I-110 I-5 US 101 I-405 I-5 I-105 I-215 I-10	US 57 @ US 91 I-110 @ Saulson Av I-5 (San Diego Fwy) @ I-405 Interchange ("El Toro") US 101 (Ventura Freeway) @ I-405 Interchange I-405 (San Diego Freeway) @ I-10 Interchange I-5 (Santa Ana Freeway) @ SR 22/SR 57 Interchange ("Orange Crush") I-105 @ US 107 Interchange I-215 (Pomona Fwy) @ SR 91 Interchange I-10 (Santa Monica Freeway) @ I-5 Interchange	946,900 910,000 887,600 855,600 784,300 726,400 702,100 653,800 445,500
Miami-Hialeah	I-95 I-95 I-595	I-95 @ I-595 Interchange I-95 @ Golden Glades Interchange Florida Turnpike @ I-595	1,011,400 508,800 426,100
Minneapolis-St. Paul	I-35 I-494 I-494 I-94 I-94 US 169 I-35 I-394	I-35W @ SR 62 Interchange I-494 @ I-35W Interchange I-494 @ I-394 Interchange I-94 @ I-35E Interchange ("Spaghetti Bowl") I-94 @ I-35W Interchange US 169 @ I-394 Interchange I-35E @ TH 36 Interchange I-394 @ TH 100	815,600 508,800 329,500 230,300 217,700 177,100 146,500 64,000

	SR 100	Interchange SR 100 @ I-394 Interchange	48,900
New York-Northeastern NJ	I-908 I-278 I-278 I-678 Garden State Pkwy I-495 I-95 I-95 I-278 I-495 I-287 I-907 I-80 I-908 I-95	Southern State Pkwy @ Exit 25A I-278 @ Exit 36 I-278 (Staten Island Expwy) before Verrazano Br I-678 @ SR 27 Interchange (JFK) GSPW @ @ I-78 I-495 (Long Island Expwy) @ Exit 33 I-95 @ I-87 Interchange I-95 @ SR 9A (Westside Hwy) I-278 (BQE) @ I-495 Interchange I-495 (Long Island Expwy) @ Grand Ave. I-287 @ SR 24 FDR Drive south of Triborough Br I-80 @ GSPW Northern State Pkwy @ Exit 36A I-95 @SR 3	699,800 654,600 593,400 526,300 509,800 491,600 461,800 445,200 422,500 390,600 370,100 307,400 293,600 288,900 235,800
Philadelphia (PA-NJ)	I-76 US 202 I-95 I-95 I-95 US 202 I-76	I-76 @ Girard Av Darby Paoli Rd @ US 202 US 1 @ I-95 Interchange I-95 @ Chestnut St I-95 @ I-476 Interchange US 202 @ US 422 I-76 @ Walnut Lane	982,600 950,600 643,900 553,900 437,200 301,300 278,500
Phoenix	I-17	I-17 (Black Canyon Highway) @ I-10 Interchange (“The Stack”) to Cactus Road	1,608,500

	Loop 202 I-10 I-10 I-10 US 60 Loop 101	Loop 202, Dobson to I-10 I-10 @ SR 51/SR 202 Interchange ("Mini-Stack") I-10 @ I-17 Interchange West (the "Stack") I-10 @ I-17 Interchange West (the "Stack") US 60 (Superstition Fwy): Loop 101 to I-10 Loop 101 Aqua Fria: 67th Av to I-17	1,055,700 1,038,000 982,600 448,000 439,000 329,000
Portland-Vancouver (OR-WA)	I-5 I-84 I-205 I-26	I-5: Interstate Bridge & bridge influence area I-84 @ US 30 Interchange I-205 @ Powell Blvd Sunset Highway @ Murray Blvd	644,200 503,500 496,200 229,600
Providence-Pawtucket-New Haven-Meriden-Bridgeport-Milford	I-91 I-95 I-95 I-95	I-91 @ US 1 Interchange I-95 @ US 7 Interchange I-95 @ I-195 Interchange I-95 @ Route 4 Interchange	550,100 506,000 455,300 292,300
San Antonio	I-10 I-35 I-35 Loop 410	I-10 @ I-410 Loop North Interchange I-35 @ Loop 410 Interchange I-35 @ Loop 410 Interchange Loop 410 @ US 281 Interchange	418,300 338,600 235,300 62,400
San Diego	I-5 I-15 I-8	I-5 @ SR 56 Interchange I-15 @ SR 78 Interchange (Escondido) Mission Valley Fwy	635,100 566,200 489,800

	I-805	I-805 @ I-15 Interchange	464,500
San Francisco-Oakland-San Jose	I-80 I-880 US 101 US 101 US 101 I-280 I-580 I-880 I-238 SR 80 I-680	I-80 @ Central St I-880 @ I-238 US 101 @ I-280 Interchange US 101 @ I-880 Interchange US 101 @ SR 92 Interchange I-280 @ US 1 Interchange I-580 MP 17-19 I-880 @ SR 237 Interchange I-238 @ I-550 SR 80 @ US 101 Interchange I-680 @ US 13	1,196,700 1,106,700 673,400 669,000 663,800 460,500 398,300 262,700 363,600 228,800 159,500
Seattle	I-5 I-5 I-5 I-405 SR 16 SR 520	SR 167 SB @ 15th St. in Auburn Interchange I-5 NB @ SR 526 in Everett I-5 @ I-90 Interchange I-405 in Downtown Bellevue SR 16 @ Sprague Ave SR 520 Floating Bridge	638,900 457,200 387,300 324,700 95,500 76,200
Washington (DC-MD-VA)	I-95 I-495 I-66 I-66 I-95 I-64 I-295	I-495 @ I-95 Interchange (MD) I-495 @ I-270 Interchange I-66 @ I-495 (Capitol Beltway) Interchange Centreville Rd @ I-66 I-95 – Woodrow Wilson Bridge I-64 @ I-264 Interchange Balti/Wash Pkwy:	1,020,100 884,100 588,500 563,500 364,100 274,700 211,000

	I-295	I-495 @ I-95 to Powder Mill Rd Balt/Wash Pkwy @ I-495/I-95 Interchange	178,900
	I-66	I-66 @ US 29 Interchange (E. Falls Church)	34,500
Source: FHWA, 2006			99,153,500

These truck bottlenecks represent impedance to the movement of freight into, out of and through metropolitan areas. Our focus in this report is on what roles short lines and regional railroads can play in addressing this issue. Thus, we limit ourselves to considering those areas in the U.S. that have been identified as freight bottlenecks (the focus on truck freight rests on the fact that truck freight represents the primary means of moving freight in this country and is expected to increase its share of the freight market in the coming years (National Surface Transportation Policy and Revenue Study Commission. 2007)). The central question addressed in this report is whether there is a role that short lines and regional railroads can cost-effectively play in reducing some of these congestion impacts in the metropolitan areas they serve.

Short line or regional railroads do not serve all the metropolitan areas listed in Table 3.1. Table 3.2 identifies those metropolitan areas that have one or more short line or regional railroads operating within or proximate to them.

Table 3.2: Metropolitan Areas with Short Line & Regional Railroads

Metropolitan Area	Serving Railroads
Atlanta	Fulton County Railway, LLC Georgia Northeastern Railroad Co., Inc.
Baltimore	Patapsco & Back Rivers Railroad
Boston	Fore River Transportation Corporation
Chicago	Belt Railway Company of Chicago Central Illinois Railroad Company, Inc. Chicago, Ft. Wayne & Eastern Railroad Chicago Port Railroad Company Chicago Rail Link, LLC Chicago South Shore & South Bend Railroad Indiana Harbor Belt Railroad Co. The Indiana Rail Road Company Iowa, Chicago & Eastern Railroad Corp. Lake Michigan and Indiana Railroad Co. Manufacturers' Junction Railway, LLC South Chicago & Indiana Harbor Railway
Cincinnati	Central Railroad of Indiana Cincinnati Railway Co. Indiana & Ohio Railway Company

Columbus	Columbus & Ohio River Rail Road Co.
Dallas-Fort Worth	Dallas, Garland & Northeastern Railroad Fort Worth & Western Railroad
Denver	Denver Rock Island Railroad
Detroit	Detroit Connecting Railroad Co.
Houston	Galveston Railroad, L.P.
Los Angeles-Riverside-San Bernardino	Pacific Harbor Line Pacific Harbor Line
Miami	Florida East Coast Railway
Minneapolis-St. Paul	Minnesota Commercial Railway Co. Progressive Rail Inc.
New York-Northeastern NJ	East Jersey Railroad and Terminal Co. New York & Atlantic Railway New York New Jersey Rail LLC New York, Susquehanna & Western Railway NYCT Express Rail Port Jersey Railroad Co.
Philadelphia	East Penn Railroad LLC Philadelphia Belt Line Railroad Co., The SMS Rail Lines Upper Merion & Plymouth Railroad Co.
Portland-Vancouver (OR-WA)	Portland & Western Railroad Company
Providence-Pawtucket-New Haven-Meriden-Bridgeport-Milford	Providence & Worcester Railroad Co.
San Antonio	Alamo Gulf Coast Railroad Hondo Railway, LLC
San Diego	Carrizo Gorge Railway, Inc. San Diego & Imperial Valley Railroad
San Francisco-Oakland-San Jose	California Northern Railroad Napa Valley Railroad Co. Northwestern Pacific Railroad Company Richmond Pacific Railroad Co. San Francisco Bay Railroad Santa Cruz, Big Trees & Pacific Railway Co.
Seattle	Ballard Terminal Railroad Co., LLC Meeker Southern Railroad Tacoma Rail
Source: ASLRRA, 2008	

To further focus our study, we identify those metropolitan areas that have short line or regional railroads serving "within the belt," either directly or with serving rights. In addition, the short line or regional railroads are not just switching carriers basically serving one or more industries within a single industrial park or small geographically constrained area. Table 3.3 lists those cities and carriers.

Table 3.3: Metropolitan Areas with Short Line & Regional Railroads "Inside the Belt"	
Metropolitan Area	**Serving Railroads**
Chicago	Belt Railway Company of Chicago Central Illinois Railroad Company, Inc. Chicago, Ft. Wayne & Eastern Railroad Chicago Port Railroad Company Chicago Rail Link, LLC Chicago SouthShore & South Bend Railroad Indiana Harbor Belt Railroad Co. The Indiana Rail Road Company Iowa, Chicago & Eastern Railroad Corp. Lake Michigan and Indiana Railroad Co. Manufacturers' Junction Railway, LLC South Chicago & Indiana Harbor Railway
Dallas-Fort Worth	Dallas, Garland & Northeastern Railroad Fort Worth & Western Railroad
Denver	Denver Rock Island Railroad
Miami	Florida East Coast Railway
Minneapolis-St. Paul	Minnesota Commercial Railway Co. Progressive Rail Inc.
New York-Northeastern NJ	East Jersey Railroad and Terminal Co. New York & Atlantic Railway New York New Jersey Rail LLC New York, Susquehanna & Western Railway NYCT Express Rail Port Jersey Railroad Co.
Portland-Vancouver (OR-WA)	Portland & Western Railroad Company
Providence-Pawtucket-New Haven-Meriden-Bridgeport-Milford	Providence & Worcester Railroad Co.
Seattle	Ballard Terminal Railroad Co., LLC Meeker Southern Railroad Tacoma Rail

To illustrate the character of short line and regional carriers, we further focus on four metropolitan areas – Chicago, Miami, New York-Northeastern NJ and Portland, OR. These four areas provide a range of operating conditions, customers and potential opportunities. As will be seen, there are great differences among the railroads in terms of the miles operated, the number and types of customers served and products carried, as well as serving yards and Class I interchanges.

Chicago

Of the short line and regional carriers that provide service to/in Chicago, there are essentially four that have operations clearly "within the belt" and serving multiple industries, either directly or through some form of rights. These are the Belt Railway Company of Chicago, Chicago Rail Link, Chicago SouthShore and South Bend and Indiana Harbor Belt Railroad Company.

Belt Railway Company of Chicago (BRC)

The Belt Railway is the largest intermediate switching terminal railroad in the United States. The BRC employs approximately 520 people. It has 28 miles of mainline route with more than 300 miles of switching tracks. This allows it to interchange with every railroad serving the Chicago rail hub.

The Clearing Yard is located on the boundary between Chicago and Bedford Park, Illinois, just south of Chicago Midway International Airport. It is one of the largest hump classification facilities in the United States. Some 5.5 miles in length and covering 786 acres (3.2 km²), the yard supports more than 250 miles (400 km) of track. It has six main subdivisions: arrival, classification, and departure yards, in both eastbound and westbound directions.

At the heart of the yard is the wicket-shaped tower that straddles the hump and from which are controlled the switches and retarders of both east- and westbound classification yards to either side of it. Using computer controls, the hump tower dispatches more than 8,400 rail cars per day. Operating around the clock, employees can classify between 40 and 50 miles of consists daily.

The BRC is owned by several railroad operating companies: Burlington Northern Santa Fe, Canadian National, Canadian Pacific, CSX Transportation, Norfolk Southern and Union Pacific. In addition, there are several railroads that connect with BRC: Chicago Rail Link, Chicago Short Line, Chicago SouthShore and South Bend, Elgin, Joliet and Eastern Railway, Indiana Harbor Belt Railway, I & M Rail Link, Manufacturers' Junction Railway Company, Wisconsin Central Transportation Corporation and Wisconsin & Southern Railroad.

Chicago is the largest hub of the U.S. railroad industry, thus, very few transcon rail cars travel without coming through Chicago. Owner lines, as well as several other railroads, bring trains to the Belt Railway to be separated, classified, and re-blocked for cross-country departure.

The Belt Railway directly serves approximately 70 industries. It also offers industrial and intermodal facility development opportunities.

As would be expected, the BRC handles most commodity types carried by rail, either in cars or intermodal containers or trailers. As mentioned above, it interchanges with all the owner roads, plus nine non-owner roads. Clearly, a significant portion of its daily operations relate to separating, classifying and reblocking cars for cross-country departures. Nevertheless, it also has significant daily switching operations providing service to local industries situated "inside the belt." As with any freight rail operations within metropolitan areas that have significant commuter and passenger rail service, the BRC has to work around those operations where necessary.

Commodities handled for local industries include paper products, steel, lumber, chemicals, food products, metals, petroleum products, etc. These commodities move in the usual mix of car types for such products (http://www.beltrailway.com/index.html; and http://en.wikipedia.org/wiki/Belt_Railway_of_Chicago).

Chicago Rail Link (CRL)

Chicago Rail Link ("CRL") provides switching and terminal service over 72 miles of trackage in Chicago. It has a diverse customer base covering about 15 industries. CRL also provides customized intermediate switching services through the Chicago Terminal complex. Commodities handled include, plastics, lumber, metal, agricultural and food grade products, etc. (http://www.omnitrax.com/rail_crl.aspx). CRL is operated and managed by OmniTRAX, Inc., a transportation management company based in Denver. OmniTRAX manages companies in the United States and Canada.

CRL has interchange points with 14 railroads, including the major Class I carriers that reach Chicago.

In addition to serving the Illinois International Port, CRL is the contract switching operator for Union Pacific at its Canal Street and IMX Intermodal Facilities and CSXI at the Bedford Park Intermodal Facility.

With a 1,500 car storage capacity, CRL also provides storage and repair services to railcar owners operating within the Chicago metropolitan area.

Similar to the BRC, CRL has to work around commuter operations as necessary to service its customers.

Chicago SouthShore & South Bend Railroad (CSS&SB)

Chicago SouthShore and South Bend Railroad (CSS&SB) operates from Chicago east to South Bend, IN, and south to Kingsbury, IN. It has a customer base of approximately 30 industries, with a mixture of commodities, including chemicals, coal, grain and manufactured products, paper, pig iron and roofing materials, with a concentration in steel, roofing materials and coal. It is an affiliate of Anacostia & Pacific Company, Inc., a transportation development and consulting firm based in Chicago.

It operates approximately 180 system miles of track, of which 75 miles are joint operations with Northern Indiana Commuter Transportation District and about 80 miles are jointly used with other freight railroads.

CSS&SB directly interchanges with seven carriers in and around the Chicago metropolitan area. It has interchange arrangements with eight other carriers through operational agreements with carriers such as the BRC, IHB and CRL. This total of 15 carriers includes all the Class I railroads reaching Chicago.

CSS&SB has several transload facilities in the Chicago area, including both port and rail/truck transfer operations. These transloading operations include bulk materials, as well as miscellaneous finished goods (http://www.anacostia.com/css/css.html).

Indiana Harbor Belt Railroad Company (IHB)

The Indiana Harbor Belt Railroad (IHB) is a switching carrier with 54 miles of mainline track (24 miles of which are double main track) and 266 miles of additional yard and siding track. The IHB main line circles Chicago from near O'Hare to Northwest Indiana and roughly parallels Interstate 294 (Tri-state Expressway) and I-80/94. Its primary yard, Blue Island (a 44 class track hump yard) at Riverdale, IL lies in approximately the center of the railroad. Other major yards includes Gibson (in Hammond, IN) which only classifies cars of new autos and Michigan Avenue Yard (in East Chicago) which serves the extensive steel plants, which account for IHB's primary business. From East Chicago, the IHB operates east for an additional 16 miles on trackage rights to access Burns Harbor, IN and Portage, IN, which includes Indiana's International Port. From Argo Yard, the IHB operates west on trackage rights "inside the belt."

The IHB provides a wide variety of services, including industrial switching with 160 customers, generating 170,000 carloads of business annually. The IHB interchanges daily with 16 other rail carriers in Chicago. A growing fleet of approximately 1,400 freight cars is geared predominately to the steel industry. The industrial traffic base includes 4 of the 5 largest steel producers in the U.S. and a large aluminum processor, oil refineries, corn millers, grain elevators, chemical plants, warehouses, lumber transloading, and bulk transfer operations.

IHB's industrial traffic consists of 38% primary metals, 12% chemicals & petroleum products, 11% food products, 8% scrap iron, 7% coal & coke, 6% whole grain, as well as a variety of other products including lumber, paper, and aggregates. The IHB also operates as an intermediate switch carrier between the 12 trunk-line railroads for traffic interchanged between them in Chicago, generating an additional 475,000 revenue cars (http://www.ihbrr.com/; http://en.wikipedia.org/wiki/Indiana_Harbor_Belt_Railroad).

Miami

In contrast to Chicago, in Miami there is only one regional/short line railroad that serves the metropolitan area, the Florida East Coast Railway.

Florida East Coast Railway (FEC)

The Florida East Coast Railway (FEC) operates 351 miles of mainline track along the east coast of Florida. FEC interchanges with two Class I carriers, NS and CSXT. FEC is owned by RailAmerica, Inc., an owner and operator of over 40 regional and short line railroads in the U.S. and Canada. RailAmerica is headquartered in Jacksonville, FL.

FEC moves major carload commodities of aggregate, automobiles, lumber, farm products, food and kindred, machinery, pulp and paper, petroleum products, and stone, clay and glass.

The FEC operations are dominated by intermodal trains and unit rock (limestone) trains. The intermodal traffic includes interline shipments off CSX and Norfork Southern, participation in EMP container service operated by UP and Norfork Southern, UPS piggback trailers, trailers going to the WalMart distribution center at Ft. Pierce, and import containers through the ports of Miami, Port Everglades (Ft. Lauderdale)[the principal source of imports], Port of Palm Beach/Lake Worth Inlet, and Port Canaveral [minor, of no real consequence]. In addition, FEC offers "Hurricane Service." This provides trucking companies the opportunity of having their trailers piggybacked out of Jacksonville to save the expensive cost of back-hauling empty trailers. The rock trains come out of the FEC yard at Medley, just west of Hialeah in the "Lake Belt" area of Dade and Broward Counties principally for materials dealers Titan and Rinker.

The FEC also hauls normal manifest freight to and from points along its right of way. These cars are hauled on whatever train is going that way, so intermodal and rock trains routinely have manifest cars in their consists. Additionally, the FEC currently transports Tropicana Products' "Juice Train" cars to and from the company's processing facility just west of Fort Pierce, Florida on the "K Line."

FEC freight trains operate on precise schedules. Trains are not held for missed connections or late loadings. Most of the trains are paired so that they leave simultaneously from their starting points and meet halfway through the run and swap crews.

The FEC has 133 pound-per-yard (66 kg/m) continuous-welded rail attached to concrete ties, which sits on a high quality granite roadbed throughout its system. The entire railroad is controlled by centralized traffic control with constant radio communication. Because the railroad has only minor grades, it takes very little horsepower to pull very long trains at speed.

FEC serves five (5) intermodal terminals. It also provides a drayage leg in its portfolio of services to intermodal customers. Intermodal traffic is a dominant part of FEC business. FEC interchanges with CSX and NS at Jacksonville bringing intermodal business into Florida. Southeast Florida is a major export/import arena for goods and services. FEC moves over 300,000 intermodal units per year.

FEC Highway Services is the drayage arm of the FEC Railway. FEC and FEC Highway Services feature 5 ramp terminals, equipment pool capacity, a quality contractor base, dedicated customer service representatives, and load-tracking capabilities (http://www.railamerica.com/ShippingServices/RailServices/FECR.aspx; http://en.wikipedia.org/wiki/Florida_East_Coast_Railway).

New York-Northeastern NJ

While there are several short line railroads operating in the New York-Northeastern NJ metropolitan area, there are only two that meet the criteria identified above. These are the New York and Atlantic Railway and the New York, Susquehanna & Western Railway.

New York & Atlantic Railway (NYA)

New York & Atlantic Railway operates freight trains on lines owned by Long Island Rail Road. It is an affiliate of Anacostia & Pacific Company, Inc., a transportation development and consulting firm based in Chicago. The railway serves a diverse customer base and shares track with the densest passenger system in the United States. As would be expected, NYA must manage its operations around commuter operations of the Long Island Rail Road.
The NYA is a short line railroad formed in 1997 to provide freight service over the tracks of the Long Island Rail Road, a public commuter rail agency that decided to privatize its freight operations. NY&A operates exclusively on Long Island, New York and is connected to the mainland via the Hell Gate Bridge and a car float (the New York New Jersey Railroad) from Brooklyn to New Jersey.

NYA operates 269 route miles serving approximately 70 customers in Brooklyn, Queens and communities on Long Island. Lumber, building products, scrap metal, construction & demolition debris, food, beer, gravel, propane, chemicals, structural steel, plastics and recyclable cardboard/paper are NYA's main traffic. Occasionally, NYA transports utility poles and electrical transformers to the LIPA facility in Hicksville, which has its own spurs. NYA also moves municipal solid waste in sealed containers on COFC trains. Some NYA customers are located off-line, and make use of NYA's team tracks to receive or ship products. Team tracks are located in Bay Ridge, Hicksville, Huntington, Greenlawn, St. James, Islip, Richmond Hill, Maspeth, Speonk, Medford, Yaphank, Southold and elsewhere on the Long Island Rail Road lines that NYA serves. Most of NYA's customers have their own spurs, making the use of team tracks unnecessary. Some other occasional products shipped to Long Island via the NYA are bentonite and rock salt. The LIRR and the NYCTA both receive new passenger equipment via the NYA, and ship out old, retired equipment for scrapping by way of the NYA. It has 20,000 annual carloadings.

NYA has transload facilities in Brooklyn, Queens, Farmingdale, Hicksville, Speonk and Yaphank. It interchanges with CP, CSXT, NS, NYNJR and P&W (http://www.anacostia.com/nya/nya.html; http://en.wikipedia.org/wiki/New_York_and_Atlantic_Railway).

New York, Susquehanna & Western Railway (NYSW)

The New York, Susquehanna & Western Railway (NYSW) reaches into the outer edges of New York-Northeastern NJ metro area. It is owned by the Delaware and Otsego Corporation, a railway holding company based in Cooperstown, NY. The NYSW, also known as the Susie-Q, or simply the Susquehanna, is a Class III freight railway operating over 500 miles (800 km) of track in the northeastern states of New York, Pennsylvania and New Jersey and is 286,000 pound gross weight capable on all lines.

In Northeastern NJ, NYSW has operations into Paterson, Passaic Junction, Little Ferry, North Bergen, Marion and Croxton, among other stations.

NYSW serves over 85 customers. After losing its intermodal traffic in the late 1990s to CSX and Norfolk Southern (as a result of the Conrail breakup), NYSW continues to transport a wide range of commodities such as commercial waste, plastics, lumber, food products, paper products, motor vehicles, chemicals, aggregates, and metals in New Jersey and Pennsylvania.

The NYSW has connections with three Class I railroads: CPR, CSXT and NS. It also serves several Bulk Transfer / Distribution facilities for lumber, plastics, liquid and dry food products, chemicals, and motor vehicles, two of which are located proximate to truck bottlenecks in the New York metro area (http://www.nysw.com/; http://en.wikipedia.org/wiki/New_York,_Susquehanna_and_Western_Railway).

Portland

The Portland, OR-Vancouver, WA area has several short line or regional carriers operating within the general vicinity of Portland. But, there is only one regional carrier that actually operates "within the belt" of Portland. This is the Portland & Western Railroad Company.

Portland & Western Railroad Company (P&W)

Portland & Western Railroad (P&W) operates a 520-mile regional system, providing service to more than 135 customers. The P&W s a wholly-owned subsidiary of short line and regional railroad holding company Genesee & Wyoming, Inc. G & W owns and operates short line and regional freight railroads in the United States, Canada, Australia and the Netherlands and owns a minority interest in a railroad in Bolivia. G & W is headquartered in Greenwich, CT (http://www.gwrr.com/about_us). The P&W includes a subsidiary, the Willamette and Pacific Railroad (http://www.gwrr.com/operations/railroads/north_america/portland_western_railroad_inc).

P&W's tracks lie entirely within Oregon, extending from Astoria to Portland along the Columbia River, from Portland to Eugene through the Willamette Valley, and along several spurs through the Northern Oregon Coast Range.

P&W has a diverse traffic base based on carload commodities. The major sources of traffic are woodchips, paper, agricultural goods, and aggregates. P&W has over 135 customers. Its major customers are: Georgia Pacific, Stimpson/Forrestex, Cascade Steel Rolling Mills, and Hampton Lumber Sales. P & W handles over 90,000 carloads annually.

P&W works with the Union Pacific and BNSF for Class I service to other parts of the country. It has interchanges with four short lines serving other parts of Oregon. Two of these represent significant traffic generators for the P&W.

The first is the Port of Tillamook Bay Railroad (POTB), which interchanges with P&W solely. This line carries a significant number of carloads, primarily lumber, from Tillamook, Oregon, over the coast range via 100 miles of winding mountain railway. The POTB line was severely damaged by a major storm in 2007, and is out of service indefinitely.

The other is the Central Oregon and Pacific Railroad (CORP), a subsidiary of G & W's competitor holding company, RailAmerica. Although CORP and P&W cross each other in Eugene, Oregon, operating agreements with Union Pacific prevented the two railroads from interchanging traffic directly. Congestion problems experienced by UP in 2004 resulted in a new agreement allowing direct interchange, creating a new traffic flow on P&W. Today, P&W handles a great deal of log traffic from a log import-export firm on its lines in Rainier, Oregon, across the entire system to an interchange with CORP at Eugene.

P&W operates between 20 and 30 trains per day over its system. Its main yard, shops complex, and dispatcher are all located at Albany. Additional crew bases are in St. Helens, Oregon, Tigard, Oregon, McMinnville, Oregon, and Eugene, Oregon.

In 2007-2008, the P&W line between Beaverton and Wilsonville, Oregon was purchased by Washington County, Oregon and TriMet. It subsequently upgraded for use by commuter trains to be operated under the Westside Express Service, or WES, operating moniker.

Upgrades to the route included a new roadbed, ballast, ties and rail to accommodate passenger train speeds of 60 MPH and freight train speeds of 40 MPH, Centralized Traffic Control signaling, Automatic Train Stop at control points, new sidings, station platforms at the end points along with in Tigard, Oregon and Tualatin, Oregon, as well as a station in the Progress/Washington Square area near the Beaverton/Tigard city line, and a maintenance shop located in Wilsonville (staffed by TriMet employees). P&W is responsible for train operations, including staffing the trains with an Engineer and Conductor, dispatching, and maintenance. TriMet has a Manager to oversee the service and will handle basic maintenance of the fleet.

The service had been expected to launch as early as August 2008 but due to delays by the car manufacturer, Colorado Railcar, the actual start of service date was February 2, 2009. Four Colorado Railcar DMUs will be used, three of which are powered vehicles and can move on their own, and a fourth vehicle which is a trailer to be towed behind one of the three powered cars (http://en.wikipedia.org/wiki/Portland_and_Western_Railroad).

These four metropolitan areas, and the short line and regional railroads operating “within the belt,” are illustrative of the differences between carriers, their customer bases and the environments within which they operate. It should be no surprise that with over 500 short line and regional railroads in the U.S., there would be substantial variation in their profiles. However, with the exception of the FEC, most of the short lines and regional railroads in the U.S., and in the congested metropolitan areas, handle a preponderant amount of manifest, or commodity-based carload traffic. As we look at possible roles that short line and regional railroads might play in reducing truck congestion issues in metropolitan areas, it is clear there will be no “one-size” fits all solution. It will be paramount to consider the “market” within each of the metropolitan areas, i.e., the customer mix that exists, or could exist, “within the belt,” the existing rail and yard infrastructure, as well as the opportunities for expanding or modifying same, Class I interchange agreements and business models, etc.

In short, potential roles for the short line and regional railroads operating “within the belt” in terms of addressing truck traffic congestion will vary with the railroad, the metropolitan area, the customers and the potential Class I partners.

Chapter 4: Forecast Freight Traffic Growth in the United States

The tonnage of freight moved in the United States is forecast to double between 2005 and 2035, from 16 billion tons to 31.4 billion tons. It is projected that 80 percent of that freight by tonnage and 94 percent by value will be moved by truck. Trade with Canada is up. Oil imports and expanding trade with Mexico and Latin America have resulted in major increases in trade through Gulf Coast ports and across the U.S.-Mexico border. International container cargo coming primarily from Asia and Europe grew from 8 million units in 1980 to 40 million units by 2000 and is expected to explode to 110 million units by 2020. This is placing enormous pressure on West Coast and East Coast ports and the highway and rail distribution systems in between (AASHTO, 2007a).

In this chapter we briefly describe the historic freight traffic trends in the U.S., followed by a discussion of the current forecast for freight traffic growth out through 2035. We place these discussions in the context of the current economic downturn and suggest caveats for the estimated growth based upon potential global shifts in economic, population, energy, environmental and other factors that may impact freight traffic in the U.S. and elsewhere in the world.

Historic Freight Traffic Growth in the U.S

Our focus here is on what has happened to freight traffic in the U.S., post-World War II. More specifically, what has happened since the birth of the Interstate Highway System, which led to far easier transport of goods and people across the United States. When the Interstate System began construction in the late 1950s, there were 65 million vehicles in the U.S. creating 600 billion vehicle miles of travel (VMT). Vehicle ownership had just begun to increase and long-distance trucking was in its infancy. Fifty years later, there are over 240 million vehicles in the U.S. and 3 trillion VMT on a highway system that has grown only 15 percent in those fifty years (AASHTO, 2007a).

There have been major changes in the transportation environment over that period of time. For example, we have moved from basic interstate commerce (farm to market, urban/rural) to national and global commerce connections. This has corresponded with a movement from “old geography” (pre-sunbelt) to a new geography of dispersed regional growth. Likewise, we have moved from a limited truck use for freight to just-in-time logistics of large combination vehicles. At the beginning of the interstate system, there was uncongested new capacity. Today there is need for congestion management (discussed more fully in Chapter 7). At the same time, there has been an evolution from use of civil engineering standards for highway design to a search for intelligent transportation systems and solutions (AASHTO, 2007a).

In looking at the evolution of freight transportation in the United States in the Post-War years, there are several different measures available for assessing the amount of freight moved/handled by the various transportation modes. The most common measures include value, tons and ton-miles. In addition, estimates for these metrics have been made by different organizations, with differing degrees of comprehensiveness and completeness. Regardless of the measures chosen, what is clear is that freight traffic has grown enormously over the years, and more importantly, trucks have become the primary mover of freight nationally.

The ton-mile metric is the primary physical measure of freight transportation output, as it addresses both weight and distances covered in freight handling. As Dennis (2007) states, national estimates of ton-miles have been developed by various organizations over the years. These estimates have differed in coverage and reliability. The U.S. Bureau of Transportation Statistics (BTS) has worked to improve basic measures of transportation activity, including ton-miles. Various BTS estimates for air, truck, rail, water, and pipelines are used for the following tables.[1]

Table 4.1 clearly shows the overall increase in the ton-miles of freight traffic in the United States post-war. This increase parallels the growth in population and the economy during that period. What is also clear is the dramatic increase in both truck and air freight. The former corresponding to the development of the Interstate Highway System, beginning in 1955. The latter corresponding to changes in the underlying economy of the Unites States as it shifted more into a service-based economy and away from an agricultural and extractive industry economy. Also evident is the increase and then decrease in the roles that both domestic water and pipeline transportation have played in the movement of freight and commodities. However, ton-mile data do not portray clearly the dramatic shifts that have occurred over that period of time with regard to modal share.

Table 4.1: U.S. Ton-Miles of Freight – 1960 – 2006
(Millions)

	1960	1970	1980	1990	1995	2000	2005	2006
TOTAL U.S. ton-miles of freight	U	2,206,713	3,404,015	3,621,943	4,104,235	4,328,642	4,574,701	4,637,513
Air	553	2,709	4,840	10,420	12,720	15,810	15,741	15,357
Truck	285,000	412,000	629,675	848,779	1,034,041	1,192,825	1,291,515	1,294,492
Railroad	572,309	764,809	932,000	1,064,408	1,317,010	1,546,319	1,733,777	1,852,833
Domestic water transportation	U	596,195	921,835	833,544	807,728	645,799	591,276	561,629
Pipeline	229.000	431,000	915,666	864,792	932,737	927,889	942,392	913,202
Oil & Oil Products	U	U	588,000	584,100	601,100	577,000	607,500	584,700
Natural Gas	U	U	327,666	280,692	331,637	350,889	334,892	328,502

NOTES: BTS is developing more comprehensive and reliable estimates of ton-miles for the air, truck, rail, water, and pipeline modes than are presented in table 1-46a. These improved estimates are not comparable to data in table 1-46a. Improved estimates for 1960-1989, which will allow more comprehensive and reliable data for the entire period from 1960 to present, are still under development and will be reported when they are completed.

Numbers may not add to totals due to rounding.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, special tabulation.

While not providing an historical picture of the change in modal share of freight handled in the U.S., Table 4.2 does dramatically illustrate the role trucking plays in the

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[1] Fuller coverage is achieved by combining reported data from established sources, estimates from surveys, and calculations based on certain assumptions. For more information on the improved approach, including discussion of data sources and methods used, visit the BTS web site at www.bts.gov, and use the search engine to find improved estimates of ton-miles.

movement of freight in this country. As is evident, trucking is responsible almost 70 percent of the freight by value, 60 percent by tons and over 34 percent on the ton-miles. Rail trails a distant second in terms of tons and ton-miles and ranks behind air, water and pipeline with regard to value.

Table 4.3 indicates this disparity between modes is not new. As the value of shipments has increased over time, changes have occurred in the national pattern of mode selection. The rising need for quicker deliveries of high-value products on time-definite schedules has led to the rapid growth in the value of air shipments, which as measured in the 2002 CFS grew by 90 percent from $141 billion in 1993 to $264 billion in 2002 in inflation-adjusted 2000 dollars. During this same period, the value of parcel, postal, and courier shipments, which are transported predominately by air and truck, grew 75 percent from $563 billion to $986 billion (U.S. DOT, 2006a).

Table 4.2: Commercial Freight Activity in The U.S. by Mode: 2002

(Based on Composite Estimates)1

	Modal estimates			Relative shares (percent)		
Transportation mode	Value (billion $)	Tons (million)	Ton–miles (billion)	Value	Tons	Ton-miles
All modes[1]	13,052	19,487	4,409	100.0	100.0	100.0
Single modes	11,599	18,894	4,073	88.9	97.0	92.4
Truck[2]	9,075	11,712	1,515	69.5	60.1	34.4
Rail	392	1,979	1,372	3.0	10.2	31.1
Water	673	1,668	485	5.2	8.6	11.0
Air (incl. truck and air)	563	6	13	4.3	—	0.3
Pipeline[3]	896	3,529	688	6.9	18.1	15.6
Multiple modes	1,121	229	233	8.6	1.2	5.3
Parcel, postal, or courier	1,022	27	21	7.8	0.1	0.5
Truck and rail	77	52	50	0.6	0.3	1.1
Other multiple modes[4]	22	150	162	0.20	0.8	3.7
Unknown modes	331	365	103	2.5	1.9	2.3

Key: — Represents measurement less than one-tenth of one percent
1 These composite estimates include Commodity Flow Survey (CFS) data and out-of-scope shipments for sectors that are not included in the CFS, such as imports, logging, construction, retail, services, publishing, municipal solid waste, and household and business moves. They also include estimates of in-scope shipments for sectors that are covered in CFS, including some sectors that may have been underestimated due to small sample size, such as exports, intermodal, and petroleum products. These composite estimates serve as the 2002 benchmark data for the FHWA Freight Analysis Framework II.
2 "Truck" as a single mode includes shipments that were made by private truck only, for-hire truck only, or a combination of private and for-hire truck.
3 Estimates for pipeline include shipments of crude petroleum.
4 Other multiple modes include combinations of truck and water, rail and water, and other combinations.

SOURCE: U.S. DOT, 2006a. U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics and U.S. Department of Commerce, U.S. Census Bureau, 2002 Commodity Flow Survey, United States Data, December 2004. The composite estimates were developed through a cooperative effort by the Bureau of Transportation Statistics and the Federal Highway Administration.

Table 4.3: Commodity Flow Survey Shipments by Transportation Mode: 1993 and 2002

(CFS Data Only)

Transportation mode	Value (billion inflation-adjusted 2000 $) 1993	2002	Percent change	Tons (millions) 1993	2002	Percent change	Ton–miles (billions) 1993	2002	Percent change
All modes	5,862	8,382	43.0	9,688	11,668	20.4	2,421	3,138	29.6
Single modes	4,953	7,037	42.1	8,923	11,087	24.2	2,138	2,868	34.2
Truck[1]	4,414	6,224	41.0	6,385	7,843	22.8	869	1,256	44.5
Rail	246	310	26.1	1,540	1,874	21.6	942	1,262	34.0
Water	64	89	38.3	504	681	35.2	271	283	4.2
Air (incl. truck and air)	141	264	88.0	—	4	NA	5	6	20.5
Pipeline[2]	88	149	69.4	484	685	41.4	S	S	NA
Multiple modes	662	1,077	62.6	223	217	–2.8	191	226	18.0
Parcel, postal, or courier	563	986	75.2	19	26	31.7	12	19	57.0
Truck and rail	82	S	S	39	43	10.9	39	46	17.5
Other multiple modes	12	21	S	165	148	S	S	161	S
Other and unknown modes	240	268	11.6	543	365	–32.8	92	44	–51.9

NOTE: The 2002 value data in this table are adjusted for inflation to allow comparison with the 1993 data. Also, these are CFS data only, therefore the numbers are different from those found in Table 4.2.

KEY: — Represents data cell equal to zero or less than 1 unit of measure.
S = Estimate does not meet publication standards because of high sampling variability or poor response quality.
NA = Not applicable.
1 "Truck" as a single mode includes shipments that were made by only private truck, only for-hire truck, or a combination of the two.
2 CFS estimates for pipeline exclude shipments of crude petroleum.
3 Other multiple modes include combination of truck and water, rail and water, and other combinations.

SOURCE: U.S. DOT, 2006a. U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics and U.S. Department of Commerce, U.S. Census Bureau, 2002 Commodity Flow Survey, U.S. Data, December 2004.

Not surprisingly, heavy, low-value commodities are mostly transported at lower unit costs by rail and water modes. According to composite estimates, rail shipments were valued at $198 per ton on average compared to $401 per ton for water and $775 per ton for truck in 2002. Multimodal combination shipments were valued on average at approximately $4,892 per ton, while air-truck shipments averaged more than $88,618 per ton. The variation in the modal averages is a reflection of the wide variation in the range of commodities moved by each of the modes. For example, trucks haul goods ranging from gravel and crushed stones, coal, and grain to electronic equipment, refrigerated perishables, pharmaceuticals, and gasoline. Rail similarly hauls freight ranging from low valued coal and other bulk commodities to higher valued products such as automobiles, petroleum and chemical products, etc. (U.S. DOT, 2006a).

According to composite estimates, trucking, as a single mode, was used most frequently, accounting for an estimated 70 percent of the total value, 60 percent of the weight, and 34 percent of the ton-miles.[2] In 2002, the trucking industry, both for-hire and private own-use, transported over $9 trillion worth of shipments, weighing over 11

[2] The relative modal shares of ton-miles depend on how "multi-modal" shipments are measured. Rail moves a slightly larger share when intermodal truck-rail shipments are counted in its totals.

billion tons and generating about 1.5 trillion ton-miles. Measured by ton-miles, trucking was followed by rail at 31 percent, pipeline at 15 percent, and water with 11 percent. Trucking's modal share by ton-miles has grown as manufacturing and services, rather than bulk commodity producing sectors such as agriculture and mining, have increased their combined share of the nation's economic activities. Manufactured goods tend to be higher in value per ton than farming and mining products, such as grain and coal (U.S. DOT, 2006a).

In Table 4.4 we see the uptick in higher valued goods being transported between 1993 and 2002. The heavier, lower-valued goods show, at most, slight increases as percentages of the freight moved, and in some cases are decreasing. As indicated above, the higher-valued commodities and products tend to move frequently by truck and/or air, although certain high-valued products are carried by rail.

One of the characteristics of the changing economy is that freight traffic grew at a faster rate than the economy. For example, between 1999 and 2004, container traffic increased 44 percent while U.S. Gross Domestic Product (GDP) in constant dollars increased 13 percent. Furthermore, in addition to moving larger volumes of freight, the transportation system is moving goods over greater distances. During the past decade, domestic tons transported increased by slightly more than 20 percent while ton-miles rose by almost 30 percent. This increase in the weighted average distance of shipments may have been caused by the growth in East Coast demand for Asian products that are reshipped through the West Coast, the increase in agricultural exports, and the shift by Midwestern power plants from local sources to Powder River Basin coal (FHWA, 2008).

The movement of freight in the United States occurs on 985,000 miles of Federal-aid highways, 141,000 miles of railroads, 11,000 miles of inland waterways and 1.6 million miles of pipelines. Figure 4.1 shows where these flows are concentrated on highway, rail, and inland waterway networks (FHWA, 2008).

As noted previously, most of the nation's freight transportation network was developed before 1960 to provide national connectivity, move goods from farm to market and from fort to port, and serve industrial and population centers concentrated in the Northeast and the Midwest. The growth of population and manufacturing in the South and along the West Coast (see Chapter 6), the restructuring of the economy from heavy industries to services, and the explosion of international trade are placing new demands on the freight system. Accordingly, ports, airports, and border crossings now handle huge volumes of traffic. Today's railroads and steamship companies accommodate an enormous number of containers that would have been a technological novelty five decades ago. Trucks serve new inland distribution centers beyond the urban fringe, and air carriers deliver parcels anywhere in the country overnight. The freight system must serve an economy that is increasingly decentralized and organized around just-in-time delivery (FHWA, 2008).

Table 4.4: Freight Shipments by Two-Digit Commodity: 1993, 1997 and 2002

SCTG	Commodity description	Value, tons, and ton-miles 1993	1997	2002 (P)	Percentage of total 1993	1997	2002(P)
	Ranked by 2002 value	**Value (billion current dollars)**					
	CFS total	**5,846**	**6,944**	**8,483**	**100.0**	**100.0**	**100.0**
35	Electronic, electrical, and office equipment	515	870	948	8.8	12.5	11.2
43	Mixed freight (1)	207	230	858	3.5	3.3	10.1
36	Motorized and other vehicles (including parts)	498	571	736	8.5	8.2	8.7
34	Machinery	385	417	509	6.6	6.0	6.0
30	Textiles, leather, and articles of textiles or leather	449	379	507	7.7	5.5	6.0
21	Pharmaceutical products	163	224	427	2.8	3.2	5.0
40	Miscellaneous manufactured products	233	4 1	405	4.0	6.1	4.8
7	Other prepared foodstuffs, fats, and oils	347	346	362	5.9	5.0	4.3
24	Plastics and rubber	236	279	343	4.0	4.0	4.0
32	Base metal in primary or semi-finished forms and in finished basic shapes	145	286	254	2.5	4.1	3.0
	Ranked by 2002 tonnage	**Weight (millions tons)**					
	CFS total	**9,688**	**11,090**	**11,573**	**100.0**	**100.0**	**100.0**
12	Gravel and crushed stone	977	1,815	1,775	10.1	16.4	15.3
15	Coal	1,130	1,217	1,255	11.7	11.0	10.8
31	Nonmetallic mineral products	817	910	910	8.4	8.2	7.9
17	Gasoline and aviation turbine fuel	912	963	840	9.4	8.7	7.3
2	Cereal grains	440	490	579	4.5	4.4	5.0
18	Fuel oils	448	482	508	4.6	4.3	4.4
20	Basic chemicals	246	296	497	2.5	2.7	4.3
11	Natural sands	405	443	466	4.2	4.0	4.0
7	Other prepared foodstuffs and fats and oils	372	397	463	3.8	3.6	4.0
19	Coal and petroleum products, n.e.c.	524	475	431	5.4	4.3	3.7
	Ranked by 2002 ton-miles	**Ton-miles (billions)**					
	CFS total	**2,421**	**2,661**	**3,204**	**100.0**	**100.0**	**100.0**
15	Coal	488	542	562	20.1	20.4	17.6
2	Cereal grains	202	201	264	8.3	7.5	8.2
20	Basic chemicals	109	137	174	4.5	5.1	5.4
7	Other prepared foodstuffs and fats and oils	127	124	171	5.2	4.7	5.3
17	Gasoline and aviation turbine fuel	102	137	130	4.2	5.1	4.1
3	Other agricultural products	74	81	122	3.1	3.0	3.8
32	Base metal in primary or semifinished forms and in finished basic shapes	70	117	122	2.9	4.4	3.8

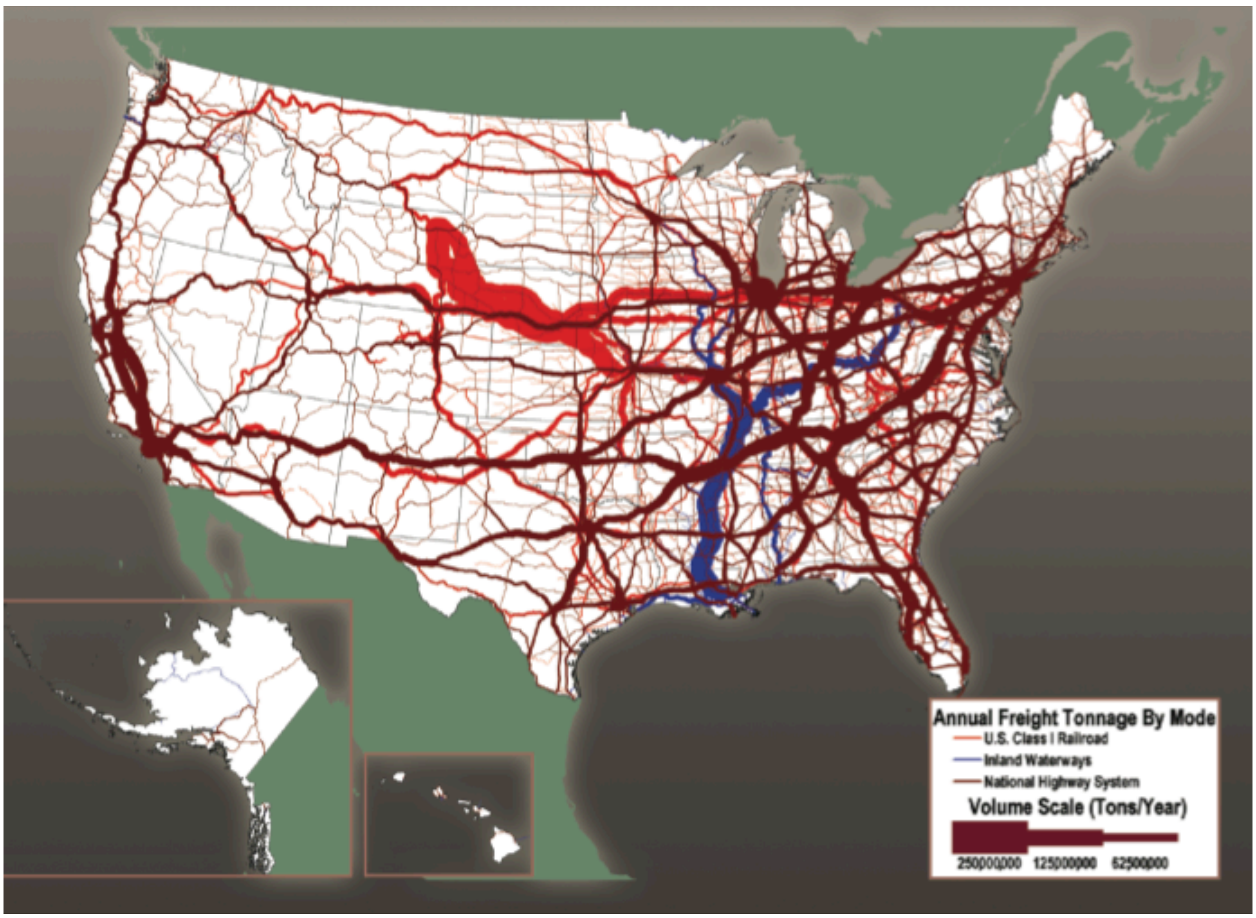
31	Nonmetallic mineral products	86	91	120	3.5	3.4	3.8
26	Wood products	98	97	114	4.0	3.6	3.6
18	Fuel oils	59	51	109	2.5	1.9	3.4

KEY: SCTG = Standard Classification of Transported Goods; P = preliminary.
(1) Mixed freight shipments include: supplies and food for restaurants and fast food chains, items (including food) for grocery and convenience stores, hardware or plumbing supplies (not elsewhere classified), office supplies, and miscellaneous.

NOTE: The CFS totals in this table differ from other BTS data because they do not include additions to account for the out of scope missing pieces and some in-scope segments that are underrepresented in the CFS, such as waterborne and pipeline shipments.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based on data from the 1993, 1997, and preliminary 2002 Commodity Flow Survey, January 2004.

Figure 4.1: Tonnage on Highways, Railroads and Inland Waterways: 2002



SOURCE: FHWA, 2008. **Highways:** U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007. **Rail:** Based on Surface Transportation Board, Annual Carload Waybill Sample and rail freight flow assignments done by Oak Ridge National Laboratory. **Inland Waterways:** U.S. Army Corps of Engineers (USACE), Annual Vessel Operating Activity and Lock Performance Monitoring System data, as processed for USACE by the Tennessee Valley Authority; and USACE, Institute for Water Resources, Waterborne Foreign Trade Data. Water flow assignments were done by the Oak Ridge National Laboratory

Not surprisingly, the existing and anticipated volumes of freight, by type, moved determine the pressures on the transportation system. For example, the transportation of high-value, time-sensitive goods requires different routes, facilities, and services than does the movement of low-value bulk commodities (Table 4.5). Transportation facilities and services that handle bulk products tend to be specialized and seldom overlap with facilities and services for high-value, time-sensitive products. As shown in Figure 4.2, maritime facilities that serve bulk shipments are concentrated at Gulf Coast and Middle Atlantic ports while facilities that handle high-value, time-sensitive shipments are located at ports and airports in major cities and at several border crossings (Figure 4.3). There are a few ports that handle both high-value, containerized goods and bulk products. They use separate docks because different handling equipment is required (FHWA, 2008).

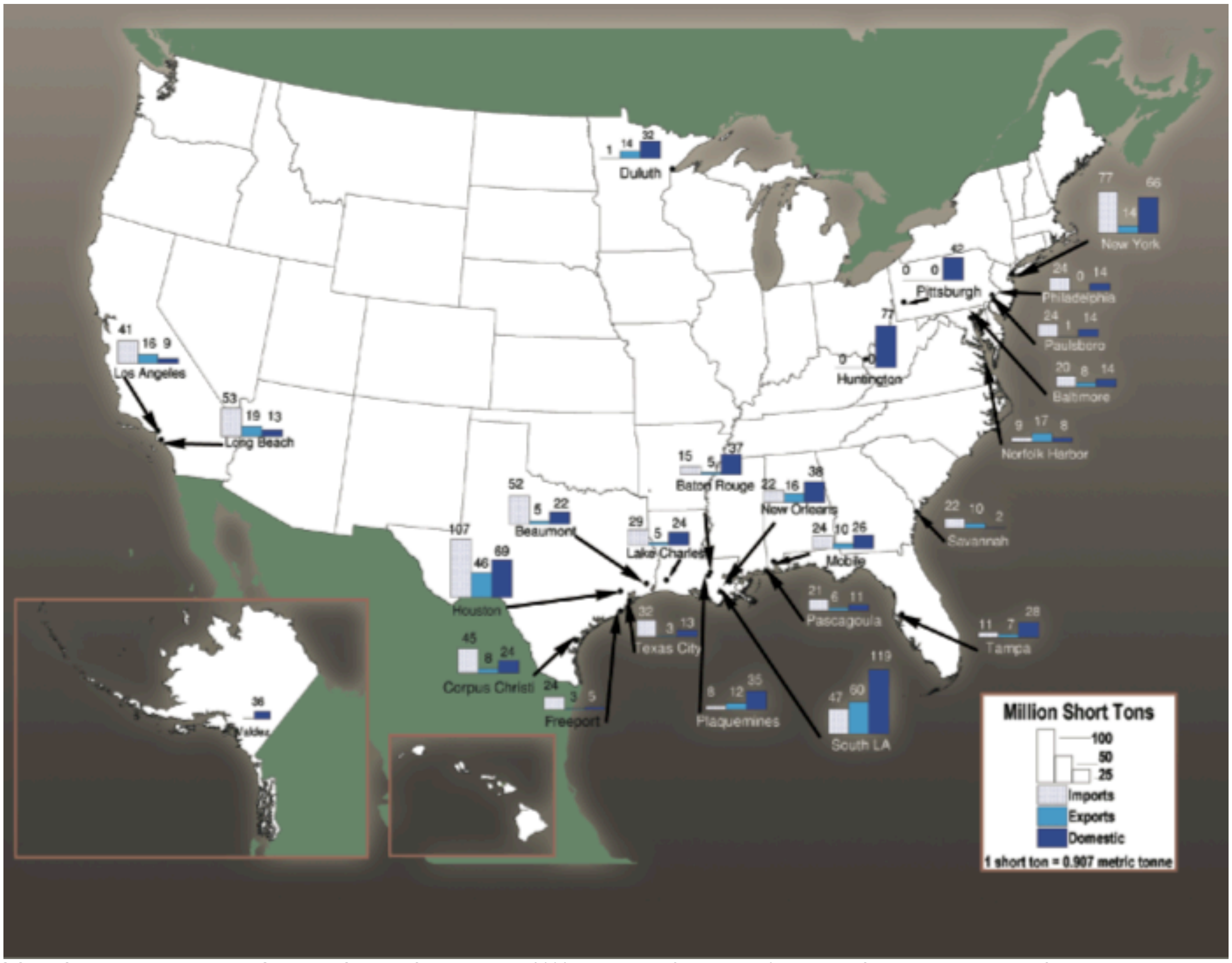
Table 4.5: The Spectrum of Freight Moved in 2002

	High Value Time Sensitive	Bulk
Top 5 Commodity Classes	Machinery Electronics Mixed freight Motorized vehicles Textiles and leather	Natural Gas Gravel Cereal grains Crude petroleum Coal
Share of Total Tons	30%	70%
Share of Total Value	85%	15%
Key Performance Variables	Reliability Speed Flexibility	Reliability Cost
Share of Tons by Domestic Mode	88% Truck 7% Rail 5% All Other	51% Truck 12% Rail 32% Pipeline 5% Water <1% Air and Intermodal
Share of Value by Domestic Mode	83% Truck 10% Intermodal 3% Rail 4% All Other	36% Truck 5% Rail 53% Pipeline 4% Water 2% Air and Intermodal

SOURCE: FHWA, 2008. U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007.

The transportation system was stressed during most of the twentieth century by the growth in bulk shipments. For example, there were railcar shortages during grain harvests and port capacity limitations during the coal export boom. While many of the past stresses were relieved by the deregulation of transportation carriers and changes in the economy, it is likely the continued growth of bulk movement and new economic conditions may create new stresses (FHWA, 2008).

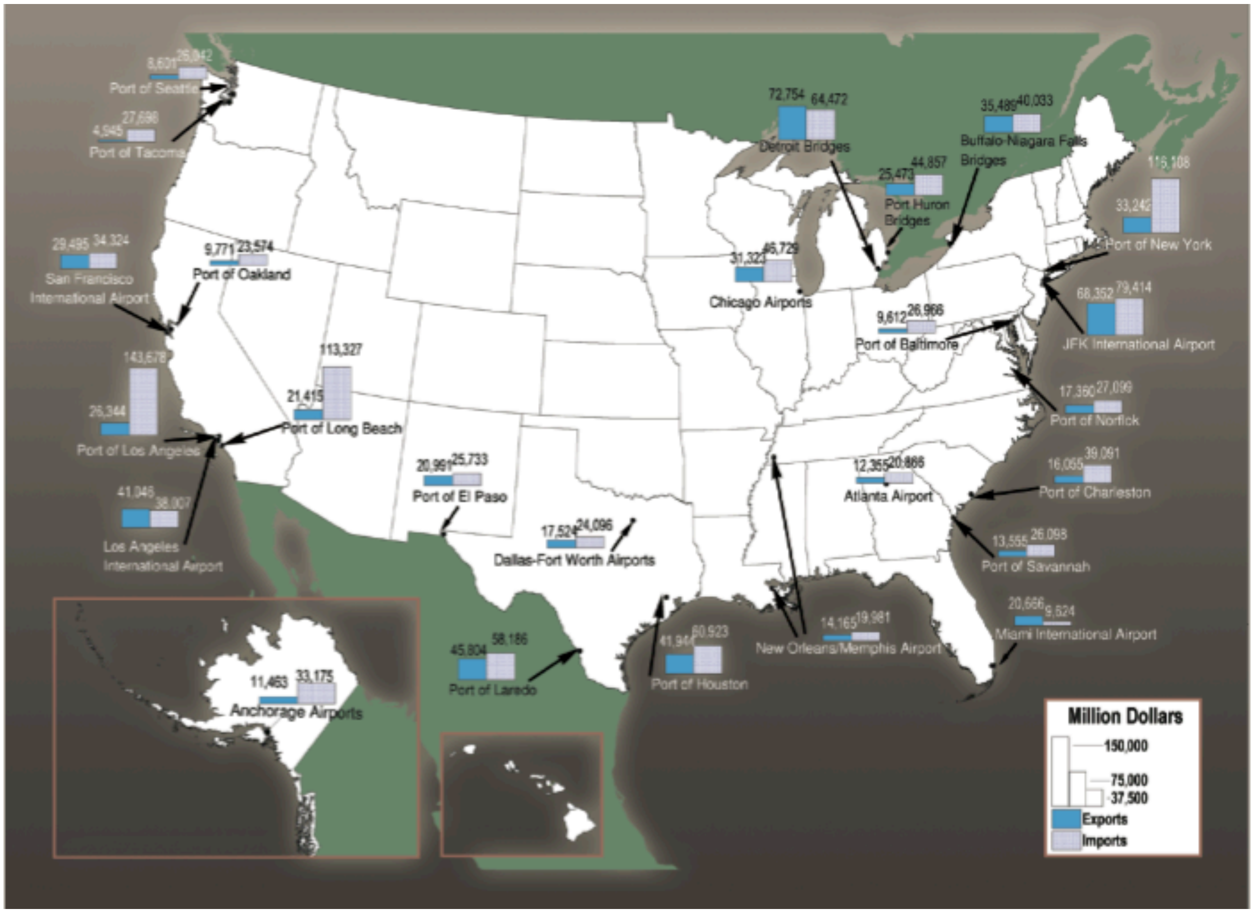
Figure 4.2: Top Water Ports by Tonnage: 2006



SOURCE: FHWA, 2008. U.S. Army Corps of Engineers, *2006 Waterborne Commerce of the United States, Part 5, National Summaries* (New Orleans, LA: 2007), table 5-2.

In the twenty-first century economy there is an emphasis on high-value, time-sensitive goods in the freight mix. The value of goods moved is forecast to grow in constant dollars by over 190 percent between 2002 and 2035, which is nearly twice the growth rate forecast for tonnage. The cost of holding inventory in warehouses or in transit increases as the value of goods transported grows. Thus, many industries shifted to just-in-time (JIT) delivery systems to minimize inventory costs and maximize responsiveness to rapidly changing markets. JIT systems depend on fast and reliable transportation. According to Hermans, companies judged to be best in class for supply chain management have 40 percent higher profitability and 25 percent higher sales growth than those considered median class (Hermans, 2006). However, as discussed in Chapter 9, dramatic increase in fuel costs may be shifting company strategies with regard to forward warehousing, sourcing closer to points of manufacturing and distribution, etc. While these changes do not portend less concern for fast and reliable transportation, they do suggest possible shifts in trading patterns, and hence transport patterns and operations (Bentz, Simchi-Levi and Gosier, 2008; Rubin and Tal, 2008).

Figure 4.3: Top 25 Foreign-Trade Gateways by Value: 2006



SOURCE: FHWA, 2008. U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics 2007*(Washington, DC: 2007).

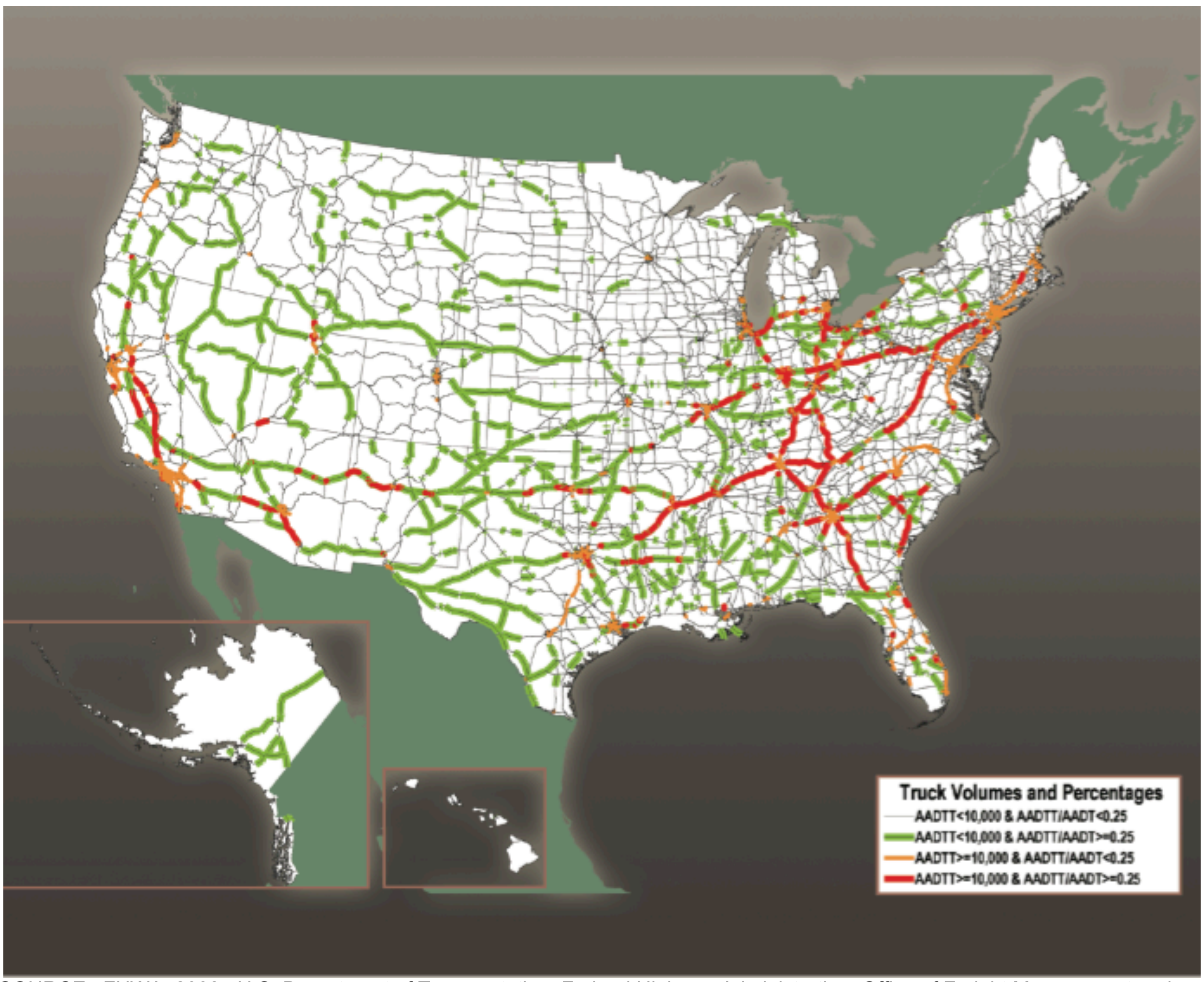
Notes: Data for all air gateways include a low level of small user-free airports located in the same region. Data for courier operations are included in the airport totals for JFK International Airport, New Orleans, Los Angeles, Chicago, Miami, and Anchorage. The New Orleans/Memphis Airports include all of Louis Armstrong International air cargo and the Federal Express portion of Memphis, which are not separated in the reporting system.

JIT delivery systems contribute to an increase in transportation activity per ton-mile and thus capacity requirements per ton. For many products, just-in-time logistical systems require more vehicles hauling smaller payloads to meet market demands. This shift to more vehicles carrying less per vehicle has contributed to the 71 percent growth in the number of trucks used in for-hire transportation and the 115 percent increase in their vehicle miles of travel over the last 20 years of the twentieth century (FHWA, 2008).

The anticipated growth in demand for high-value, time-sensitive goods is driving the forecast growth of trucking, both for truck-only service and for truck portions of intermodal service. As a consequence, trucks are becoming a significant portion of traffic on an increasing number of highways. In addition, typical freight-hauling vehicles are more than twice as long as passenger vehicles. They take up even more space when differences in operating characteristics and motorists’ reactions to trucks are taken into account. Not surprisingly, trucks have become a dominant part of the traffic stream when they represent every fourth vehicle on the road. Trucks accounted for at least 25 percent of average daily traffic on almost 31,000 miles of the National Highway

System (NHS) in 2002 and are expected to account for that share of traffic on 37,000 miles in 2035 (Figures 4.4 and 4.5). Most freight moving by truck uses the Interstate System. As seen in Table 4.6, while all vehicle miles of travel are divided about equally among Interstate highways, the balance of the NHS, and other public roads, the Interstate System carries one-half of truck travel and three-fourths of travel by freight-hauling trucks serving places at least 50 miles apart (FHWA, 2008).

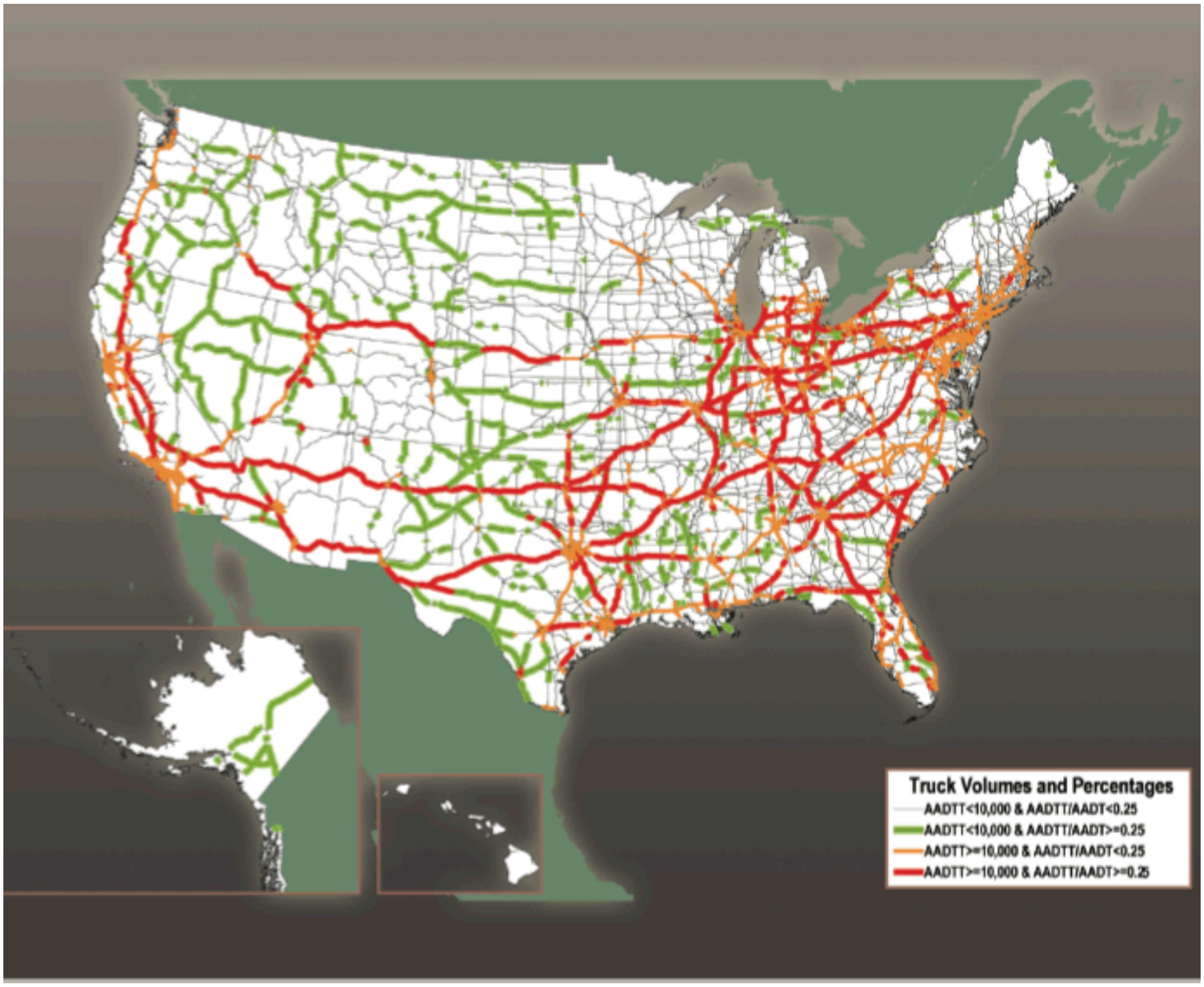
Figure 4.4: Major Truck Routes on the National Highway System: 2002



SOURCE: FHWA, 2008. U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007.

Notes: AADTT is average annual daily truck traffic and includes all freight-hauling and other trucks with six or more tires. AADT is average annual daily traffic and includes all motor vehicles.

Figure 4.5: **Major Truck Routes on the National Highway System: 2035**



SOURCE: FHWA, 2008. U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007.

Notes: AADTT is average annual daily truck traffic and includes all freight-hauling and other trucks with six or more tires. AADT is average annual daily traffic and includes all motor vehicles.

Notwithstanding the relatively dispersed character of the major truck routes in the U.S., there are a small number of corridors that carry the largest freight flows. These corridors shown in Figure 4.6, highlight segments of the transportation network carrying more than 50 million tons per year, include (FHWA, 2008):

- Highway segments carrying at least 8,500 trucks per day, this is the number needed to move 50 million tons per year at 16 tons per truck.
- Additional highway segments and parallel rail lines that together carry at least 8,500 truck, trailer-on-flatcar, and container-on-flatcar payloads of typically high-value, time-sensitive cargo at 16 tons per payload.
- Rail lines and waterways carrying 50 million tons of bulk cargo annually.

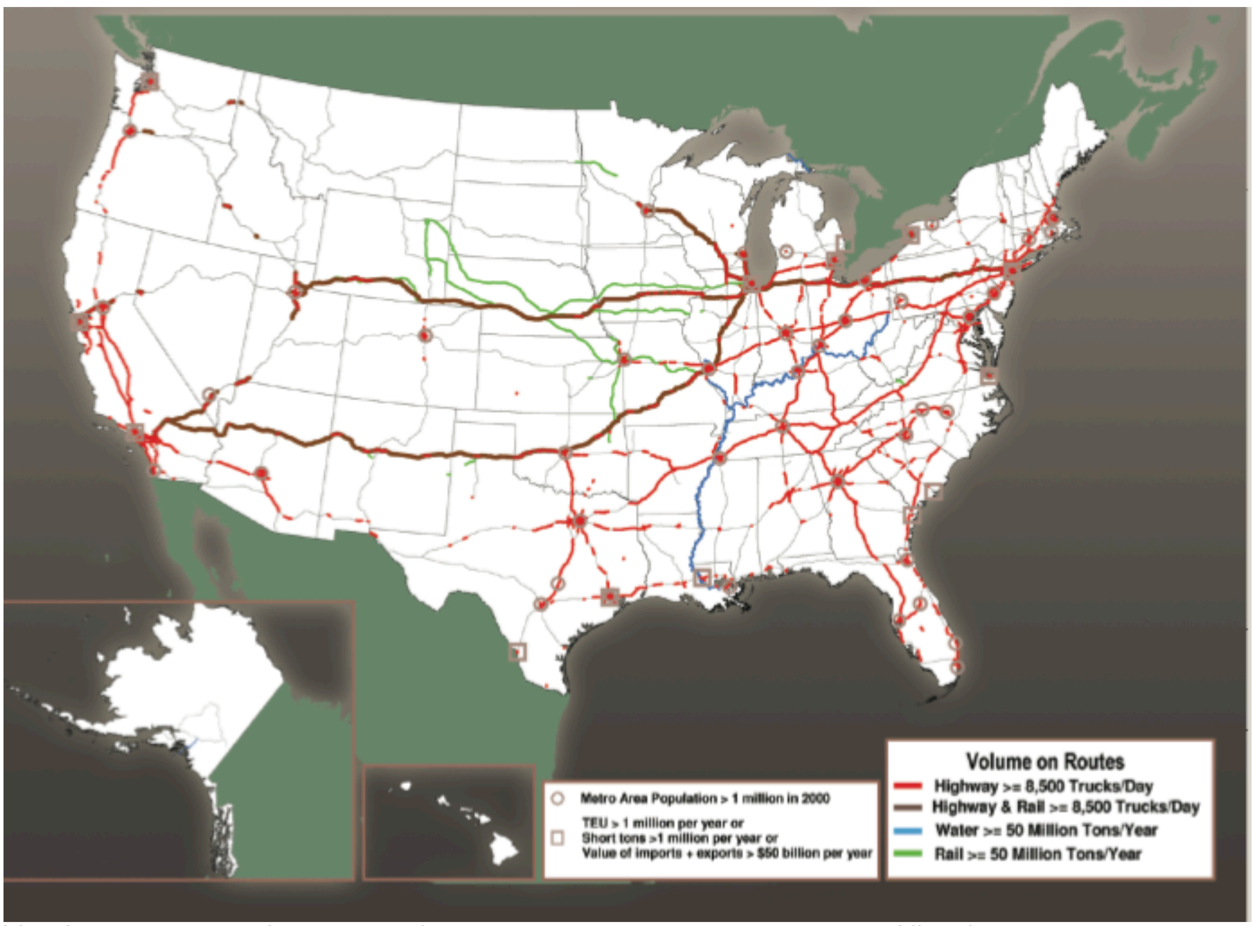
Table 4.6: Share of Vehicle Miles of Travel by Highway System

	Interstate Highway (Percent)	Balance of National Highway System (Percent)	Other Highways (Percent)
All vehicles	35	30	35
All trucks	49	26	25
Freight-hauling trucks serving places at least 50 miles apart	75	20	6

Note: Numbers do not add to 100 due to rounding.

SOURCE: FHWA, 2008. U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007.

Figure 4.6: Components of Major Freight Corridors

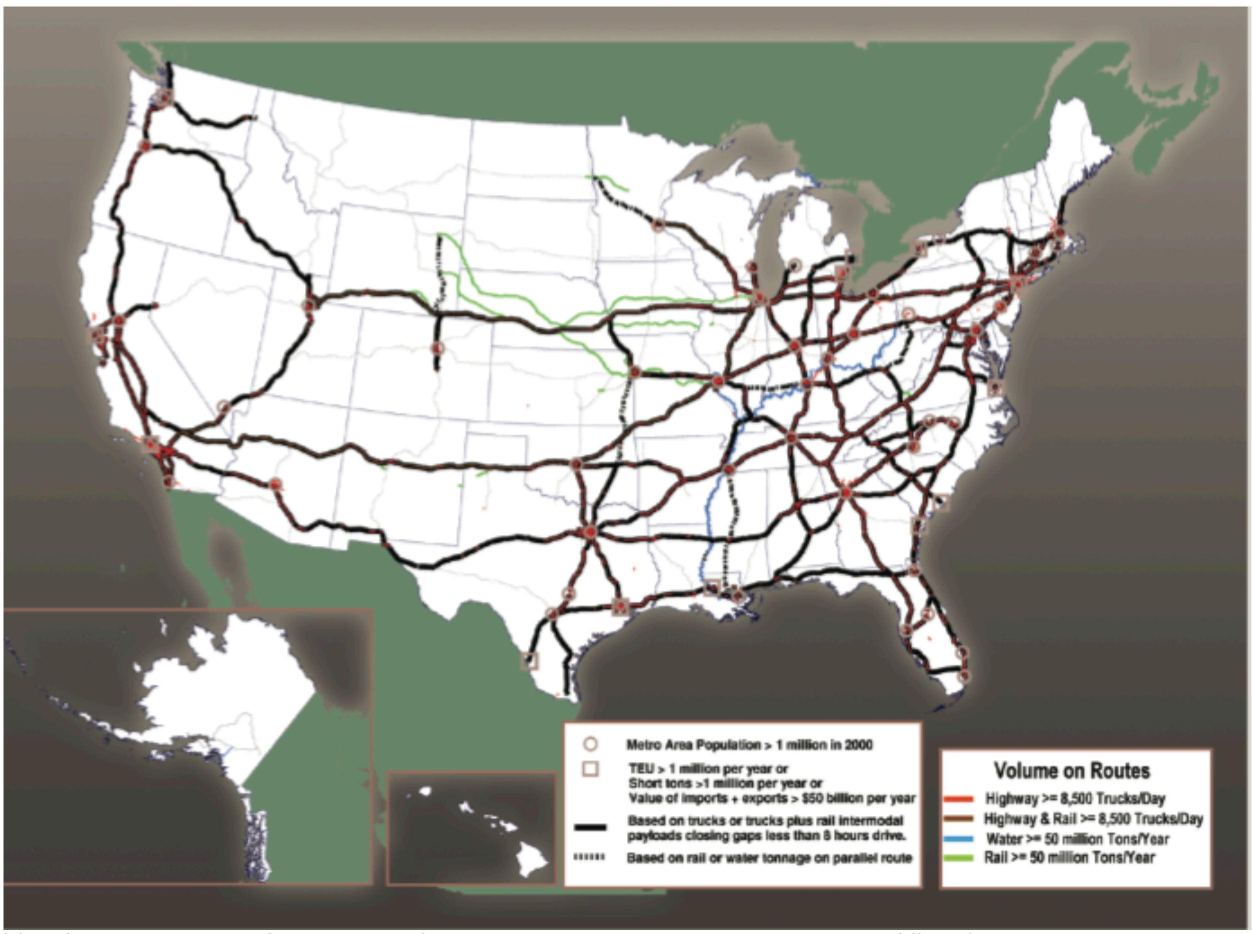


SOURCE: FHWA, 2008. U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, 2008.

Notes: Highway & Rail is daily truck payload equivalents based on annual average daily truck traffic plus average daily intermodal service on parallel railroads. Average daily intermodal service is the annual tonnage moved by container-on-flatcar and trailer-on flatcar service divided by 365 days per year and 16 tons per average truck payload.

Figure 4.7 illustrates the major freight corridors identified by FHWA. These corridors were developed by connecting gaps that are less than 440 miles between highway segments shown in Figure 4.6 (the distance a truck can travel in 8 hours at 55 miles per hour). In addition, routes were added that parallel bulk cargo rail lines and waterways. These corridors include approximately 26,000 miles of highway, plus an additional 1,500 miles of bulk cargo rail and waterway routes measured along the nearest parallel highway. Of these 27,500 route miles of corridors, over 95 percent are accounted for by Interstate highways. The total mileage is about 60 percent of the length of the Interstate System, and less than 17 percent of the National Network designated for conventional combination trucks (FHWA, 2008).

Figure 4.7: Major Freight Corridors



SOURCE: FHWA, 2008. U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, 2008.

Notes: Highway & Rail is daily truck payload equivalents based on annual average daily truck traffic plus average daily intermodal service on parallel railroads. Average daily intermodal service is the annual tonnage moved by container-on-flatcar and trailer-on-flatcar service divided by 365 days per year and 16 tons per average truck payload.

It is this transportation system that will have to carry the brunt of the freight traffic that is likely to be generated over the next 30 to 40 years. We now turn to look at the forecast freight traffic growth out through 2035.

Forecast Freight Traffic Growth in the U.S.

As is clear from preceding comments, the Nation's 114 million households, 7.6 million business establishments, and 88,000 government units are part of an enormous economy that requires the movement of freight. The U.S. GDP is expected to grow, on average, almost 3 percent per year between now and 2035, resulting in even greater demand for freight transportation. This growth in demand will be driven by a population that is expected to increase from 300 million people in 2006 to 380 million in 2035, and almost 420 million by 2050 (see more on population growth in Chapter 6).

As seen above (Tables 4.2 and 4.3), and as reflected in Table 4.7, the U.S. transportation system moved, on average, 53 million tons of freight worth $36 billion each day in 2002. The Freight Analysis Framework (FAF) forecasts that tons transported will almost double by 2035, with international shipments growing somewhat faster than domestic shipments. The provisional estimate of tons moved in 2007 is consistent with annual growth rates in the FAF forecast for all modes except water, which declined slightly, and air and intermodal, which grew at faster rates (FHWA, 2009).

As reflected in Table 4.3 (above) and Table 4.8, below, the value of freight moved on the U.S. transportation system is increasing faster than tons transported, even when calculated in 2002 prices. The FAF 2007 provisional estimate and 2035 forecast expect the value of shipments to increase between 3.1 percent and 3.5 percent per year while tonnage is predicted to grow between 2.0 percent and 2.1 percent per year (FHWA, 2009).

By 2035, long-haul truck traffic between places at least 50 miles apart is expected to increase dramatically on Interstate highways and other arterials throughout the nation. These trucks are expected to travel 600 million miles per day (see Figure 4.8, below). It is no surprise that the number of NHS miles carrying large volumes and high percentages of trucks is forecast to increase dramatically by 2035. The number of segments of the NHS with more than 10,000 trucks per day, and where at least every fourth vehicle is a truck, is forecast to exceed 14,000 miles. This represents an increase of almost 230 percent from 2002 (FHWA, 2009).

Finally, international trade has grown rapidly and has placed pressure on the domestic transportation network and on all modes. Trucks are the most common mode used to move imports and exports between international gateways and inland locations (FHWA, 2009). Table 4.9 shows the export and import values and volumes for 2002 and 2035.

All of these forecasts were made prior to the global economic meltdown in the past 18 months, thus, there may be some downward pressures on the volumes (tons and value) over the next few years. However, without taking into account the various factors discussed in Chapter 9 – that could significantly alter freight traffic volumes and flows within the U.S. and globally – there are indications that an economic recovery will lead to a resumption of consumption of consumer goods, etc. that fuel freight transportation demand and growth. This growth will have significant impacts on highway and rail congestion in the future. This is the subject of Chapters 7 and 8.

Table 4.7: Weight of Shipments by Transportation Mode: 2002, 2007 and 2035

Millions of tons

	2002				2007				2035			
	Total	Dom	Exp	Imp	Total	Dom	Exp	Imp	Total	Dom	Exp	Imp
Total	19,328	17,670	525	1,133	21,225	19,268	619	1,338	37,210	33,666	1,112	2,432
Truck	11,539	11,336	106	97	12,896	12,691	107	97	(R) 22,813	(R) 22,230	262	320
Rail	1,879	1,769	32	78	2,030	1,872	65	92	3,525	3,292	57	176
Water	701	595	62	44	689	575	57	57	1,041	874	114	54
Air, air & truck	11	3	3	5	14	4	4	6	61	10	13	38
Intermodal1	1,292	196	317	780	1,505	191	379	935	2,598	334	660	1,604
Pipeline and unknown2	3,905	3,772	4	130	4,091	3,934	6	151	7,172	6,926	5	240

1 Intermodal includes U.S. Postal Service and courier shipments and all intermodal combinations, except air and truck. Intermodal also includes oceangoing exports and imports that move between ports and interior domestic locations by modes other than water.
2 Pipeline and unknown shipments are combined because data on region-to-region flows by pipeline are statistically uncertain.
3 Data do not include imports and exports that pass through the United States from a foreign origin to a foreign destination by any mode.

SOURCES: FHWA, 2009. Data for 2002 and 2035: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007. Data for 2007**:** U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, 2007 provisional estimates, 2008.

Table 4.8: Value of Shipments by Transportation Mode: 2002, 2007 and 2035

Billions of 2002 dollars

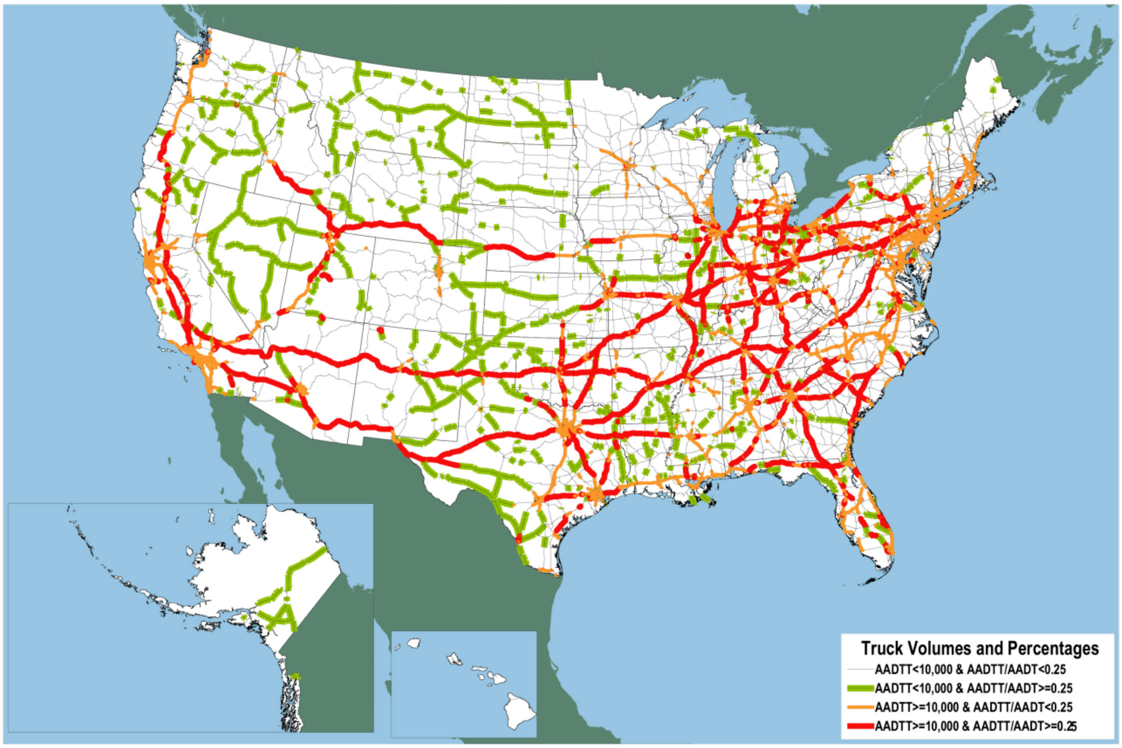
	2002				2007				2035			
	Total	Dom	Exp	Imp	Total	Dom	Exp	Imp	Total	Dom	Exp	Imp
Total	13,228	11,083	778	1,367	14,869	12,363	904	1,603	41,867	21,590	3,392	8,884
Truck	8,856	8,447	201	208	9,764	9,266	235	264	23,767	21,653	806	1,306
Rail	382	288	26	68	416	303	36	78	702	483	63	156
Water	103	76	13	13	51	37	8	7	151	103	31	18
Air, air & truck	771	162	269	340	1,022	235	354	434	5,925	721	1,548	3,655
Intermodal1	1,967	983	268	716	1,935	870	270	795	8,966	4,315	943	3,708
Pipeline and unknown2	1,149	1,127	1	22	1,680	1,652	1	26	2,357	2,315	1	41

1 Intermodal includes U.S. Postal Service and courier shipments and all intermodal combinations, except air and truck. Intermodal also includes oceangoing exports and imports that move between ports and interior domestic locations by modes other than water.
2 Pipeline and unknown shipments are combined because data on region-to-region flows by pipeline are statistically uncertain.
3 Data do not include imports and exports that pass through the United States from a foreign origin to a foreign destination by any mode.

SOURCES: FHWA, 2009. Data for 2002 and 2035: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007. Data for 2007**:** U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, 2007 provisional estimates, 2008.

Figure 4.8: Major Truck Routes on NHS: 2035

Major Truck Routes on the National Highway System: 2035



Note: AADTT is average annual daily truck traffic and includes all freight-hauling and other trucks with six or more tires. AADT is average annual daily traffic and includes all motor vehicles.
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007.

SOURCE: FHWA, 2009

Table 4.9: Domestic Mode of Exports and Imports by Tonnage and Value: 2002 and 2035(R)

	Tons (millions)		Value ($ billions)	
	2002	2035	2002	2035
Total	1,658	3,544	2,145	12,277
Truck(1)	797	2,116	1,198	6,193
Rail	200	397	114	(R)275
Water	106	168	26	49
Air, Air & Truck(2)	9	54	614	5,242
Intermodal(3)	22	50	52	281
Pipeline & Unknown (4)	524	760	141	238

Key: R = revised.
(1) Excludes truck moves to and from airports.
(2) Includes trucks to and from airports.
(3) Includes intermodal U.S. Postal Service and courier shipments and all intermodal combinations, except air and truck. In this table, oceangoing exports and imports that move between ports and domestic locations by single modes are classified by the domestic mode rather than intermodal.
(4) Pipeline and unknown shipments are combined because data on region-to-region flows by pipeline are statistically uncertain.
Note: Numbers may not add to totals due to rounding.

SOURCE: FHWA, 2009. U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007.

Chapter 5: Forecast Freight Rail Traffic Growth in the United States

In the previous chapter, the dramatic increases in freight traffic in the U.S. are highlighted, particularly the ascendancy to trucking as the major mode for moving freight in this country, post-1960 (see Table 4.1). In this chapter we briefly consider the rail-side of freight transportation. First, the historic trends of rail freight in the U.S. are portrayed to illustrate how it has evolved from a major force in the expansion and development of the U.S. economy into an important player today, but by no means the "economic elephant in the room."

Historic Rail Freight Traffic Trends in the United States

In many ways, while freight transportation in the U.S. began to shift dramatically in terms of volumes and modal market share following the introduction of the Interstate Highway System in the late 1950s (as illustrated in Table 4.1), from the standpoint of the freight rail industry, post-1980 is perhaps a more relevant demarcation of the beginning of the modern freight railroad system. Pre-Staggers, the railroad industry was fundamentally in the going-out-of-business business. A quick capsule review of the railroad industry illustrates the shift in its fortunes over time.

The U.S. railroad industry started in Maryland in 1827. By 1850, more than 9000 miles of railroad were in operation and were providing the means for previously inaccessible parts of the country to be developed; for mineral, timber and agricultural products to find their way to market; and to link together the various parts of the nation (AAR, 2009b).

By 1917, when the federal government took control of the rail industry during World War I, the 1,500 U.S. railroads operated around 254,000 miles and employed 1.8 million people — more than any other industry. Rail mileage had already peaked (in 1916), however, and rail employment would soon (in 1920). The Great Depression devastated railroads. Rail industry revenues fell by 50 percent from 1928 to 1933. By 1937, more than 70,000 miles of railroad were in receivership, representing around 30 percent of all rail miles (AAR, 2009b).

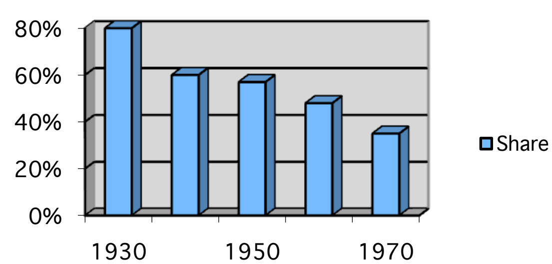
At the beginning of World War II, most railroads were in financial trouble. War-related traffic surged and brought a temporary reprieve to the railroads. But by 1949 rail traffic had fallen 28 percent from its 1944 level. The post-war drop in passenger revenue was even larger. Railroads were losing huge amounts of money on passenger operations, but government agencies often refused to allow railroads to discontinue passenger service (AAR, 2009b).

Throughout the 1950s and 1960s, the rapid growth of truck and barge competition (aided by tens of billions of dollars in federal funding for construction of the interstate highway and inland waterway systems) and huge losses in passenger operations led to more railroad bankruptcies, service abandonments, and deferred maintenance. By 1970 the railroads were on the verge of bankruptcy. Excessive regulations, intense competition from trucks and barges, and changing shipping patterns drove railroads to the brink of ruin. The Rail Passenger Service Act of 1970 created Amtrak and relieved freight railroads of most of the huge losses (then approaching $200 million per year, or around $850 million in today's dollars) incurred in passenger service, but conditions continued to deteriorate on the freight side (AAR, 2009b).

During the 1970s, most major railroads in the Northeast, including the giant Penn Central and several major Midwestern railroads, went bankrupt. These bankrupt railroads accounted for more than 21 percent of the nation's rail mileage. Between 1970 and 1979, the rail industry's return on investment never exceeded 2.9 percent and averaged 2.0 percent. The average rate of return had been falling for decades: it was 4.1 percent in the 1940s, 3.7 percent in the 1950s, and 2.8 percent in the 1960s. Not surprisingly, the railroads lacked the funds to properly maintain their tracks. By 1976, more than 47,000 miles of track had to be operated under slow orders because of unsafe conditions. Railroads had billions of dollars in deferred maintenance, and the term "standing derailment" — when stationary railcars simply fell off poorly maintained track — was often heard (AAR, 2009b).

By 1978, the rail share of intercity freight had fallen to 35 percent, down from 75 percent in the 1920s (see Figure 5.1). Despite record traffic in 1979, the rail industry's rate of return on investment rose only to 2.9 percent (AAR, 2009b).

Figure 5.1: Railroad Share of Intercity Ton-Miles

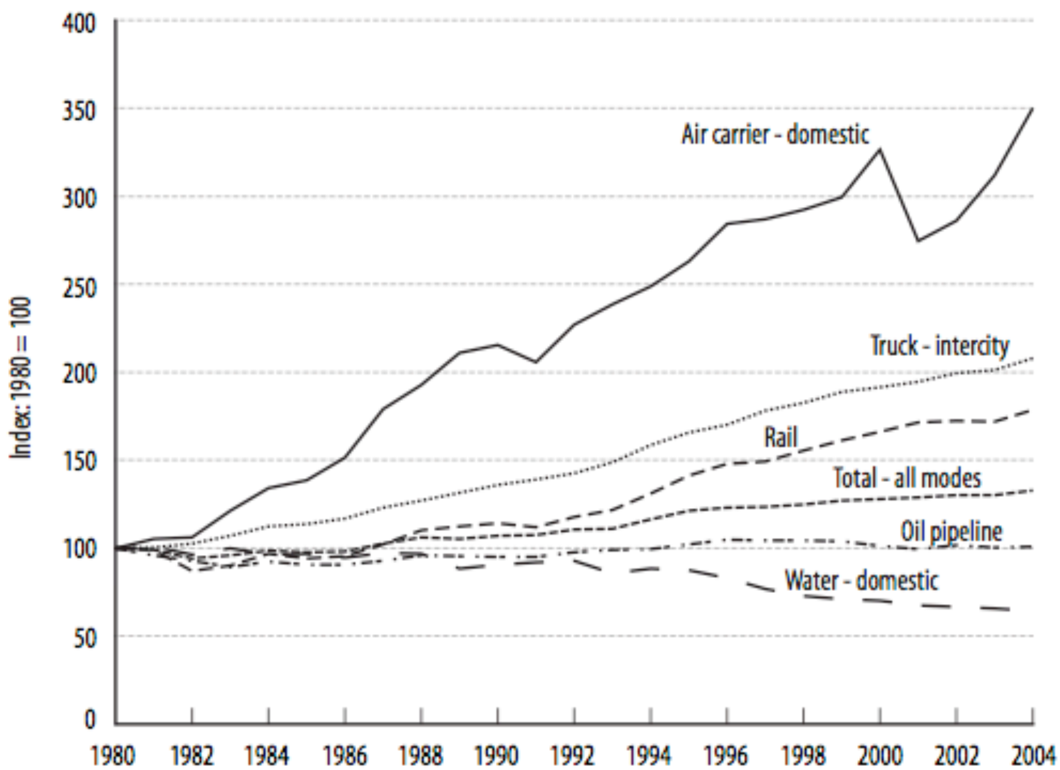


SOURCE: AAR, 2009.

The Staggers Rail Act was passed in 1980. This provided a more balanced regulatory environment for railroads, consistent with other deregulation that was occurring during that same time period for the trucking and airline industries. Since 1980, the average inflation-adjusted rail rates (as measured by revenue per ton-mile) are down 54 percent. Freight railroads have invested more than $410 billion back into their operations from 1980 through 2007. The freight train accident rate has fallen more than 70 percent, while the employee injury rate has been reduced more than 80 percent. Rail productivity gains since Staggers have been among the highest of all U.S. industries, with overall freight railroad productivity rising over 160 percent from 1980 to 2007. This compares with just 15 percent in the comparable pre-Stagger period (AAR, 2009b).

After decades of steady decline (see Figure 5.1), rail market share (measured in ton-miles) has been trending slowly upward since Staggers (see Figure 5.2). It is currently around 43 percent. Thus, freight railroads are stronger financially. Return on net investment rose to 4.4 percent in the 1980s, 7.0 percent in the 1990s and 7.7 percent from 2000 to 2007. However, even in recent years when the railroads have had record traffic and earnings, the industry's profitability has remained in the bottom half among all industries (AAR, 2009b).

Figure 5.2: Growth in U.S. Domestic Freight Ton-Miles by Mode: 1980 – 2004



SOURCE: U.S. Department of Transportation, 2006. Research and Innovative Technology Administration, Bureau of Transportation Statistics. *Freight in America*. January, 2006: U.S. DOT.

In 2007, Class I railroads in the United States transported their second highest originating tonnage ever, 2.26 billion tons. This level of tonnage reflects steady growth in rail traffic since 1998. Coal accounted for almost 44 percent of the rail tonnage in 2007, followed by chemicals and related products with 9.2 percent, and farm products at 7.8 percent and non-metallic products with 7.1 percent. By revenue, coal accounted for 21 percent ($11.4 billion) of the Class I rail industry-wide gross revenues ($54.6 billion), followed by miscellaneous mixed shipments (mostly intermodal) with 14.4 percent, and chemicals and related products with 12.6 percent (AAR, 2009a).

U.S. freight trains are carrying more loads and traveling farther than in 1980. In 2004, for example, the average freight train carried over 3,100 tons of freight. By comparison, the average trainload in 1980 was about 2,200 tons. While the average load per train rose, the average cargo weight per rail car dropped from 67 tons in 1980 to 62 tons in 2007, reflecting the higher growth rate of lighter freight that is typical of intermodal shipments. During this same timeframe, the freight trains traveled more miles on average. The average length of haul was 913 miles per ton in 2007, up from 616 miles per ton in 1980. Since 1980, the length of haul has grown at an average annual rate of about 1.6 percent per year. Railroads improved on their operational efficiency as they carried more loads farther. Net ton-miles per train-hour, one measure of industry efficiency, increased 49 percent from 40,400 in 1980 to 60,300 in 2003 (US DOT, 2006a).

U.S. freight railroads serve almost every economic sector in the nation. They handle goods that include manufacturing, mining, wholesale, and retail trade. They move not only bulk commodities but also time-sensitive goods. According to composite estimates, rail as a single mode carried about 3 percent of the nation's freight shipments, measured by value, and 10 percent of the weight, hauling over long distances everything from coal to vegetables, lumber to orange juice, and finished automobiles and parts to grain (see Table 4.2). Rail accounted for 31 percent of the estimated total ton-miles, despite having a more spatially concentrated network than the highway system and in spite of declines in miles of rail roadway operated due to rail abandonment and industry consolidation. Rail's shares of overall shipment value and weight primarily reflect the fact that low value-per-ton primary raw materials account for the bulk of rail shipments. Coal and chemicals alone accounted for over half (53 percent) of the rail tonnage in 2007 (AAR, 2009a). Rail's share of ton-miles reflects the high weight and the longer length of haul of the products moved by rail (US DOT, 2006a). For example, in 2002, coal was shipped an average of 671 miles per ton, cereal grain averaged 841 miles per ton, and fertilizers about 747 miles per ton (see Table 5.1).

Table 5.1: U.S. Rail Total Carload and Intermodal Commodity Shipments: 2002

SCTG Code	Description	Tons (thousands)	Ton-Miles (millions)	Miles per Ton
15	Coal	849,060	569,552	671
42	Mixed freight	136,962	193,270	1,411
2	Cereal grains	127,365	107,159	841
12	Gravel and crushed stone	105,124	22,858	217
20	Basic chemicals	84,332	69,556	825
26	Wood products	66,446	71,331	1,074
14	Metallic ores and concentrates	65,570	12,979	198
32	Base metal in primary or semi finished forms and in finished basic shapes	57,131	37,075	649
13	Nonmetallic minerals n.e.c.	55,928	29,165	521
41	Waste and scrap	55,719	27,165	488
27	Pulp, newsprint, paper,	53,782	52,283	972

	and paperboard			
7	Other prepared foodstuffs and fats and oils	53,415	52,071	975
36	Motorized and other vehicles (including parts)	50,672	42,232	833
19	Coal and petroleum products, n.e.c.	47,675	32,859	689
22	Fertilizers	45,130	33,701	747
31	Nonmetallic mineral products	37,549	18,464	492
24	Plastics and rubber	37,360	34,804	932
4	Animal feed and products of animal origin, n.e.c.	35,012	26,620	760
3	Other agricultural products	28,952	28,804	995
6	Milled grain products and preparations, and bakery products	22,058	16,876	765
11	Natural sands	17,848	7,443	417
23	Chemical products and preparations, n.e.c.	17,763	14,483	815
8	Alcoholic beverages	6,914	7,903	1,143
25	Logs and other wood in the rough	6,766	2,393	354
33	Articles of base metal	6,740	7,626	1,132
37	Transportation equipment, n.e.c.	4,589	2,167	472
18	Fuel oils	2,267	1,891	834
17	Gasoline and aviation turbine fuel	2,222	776	349
34	Machinery	2,130	2,584	1,213
28	Paper or paperboard articles	1,805	2,103	1,165
35	Electronic and other electrical equipment and components and office equipment	1,589	2,214	1,393
5	Meat, fish, seafood, and their preparations	1,246	2,340	1,878
16	Crude petroleum	1,121	391	349
39	Furniture, mattresses and mattress supports, lamps, lighting fittings, and...	869	1,389	1,599
40	Miscellaneous manufactured products	830	1,051	1,266
10	Monumental or building stone	634	323	509
29	Printed products	560	700	1,250
30	Textiles, leather, and articles of textiles or leather	455	718	1,579
21	Pharmaceutical products	155	227	1,464
38	Precision instruments and apparatus	71	130	1,834

9	Tobacco products	11	22	2,059
99	Commodity unknown	18	22	1,223

SOURCE: U.S. DOT, 2006.
NOTE: SCTG = Standard Classification of Transported Goods.

Coal (mainly destined for utilities or export) was the top originated rail commodity in 2006, followed by nonmetallic minerals (mainly crushed stone, phosphate rock, and sand); farm products (mostly grain); chemicals; mixed freight (mainly intermodal traffic); food products; metallic ores (mostly iron ore); primary metal products (mostly iron and steel); petroleum products, and stone, clay, glass and concrete products (mostly cement and ground nonmetallic minerals). Waste and scrap materials and lumber & wood products round out the top 12 originated commodities (AAR, 2009c).

Some of the largest rail freight flows by tonnage are coal shipments originating in the Powder River Basin in Wyoming (54.8 percent) and from West Virginia (12.8 percent) and Kentucky (8.3 percent), with Pennsylvania, Montana, Virginia and Colorado generating 4.5, 3.7, 3.6 and 2.8 percent of the U.S. total respectively. These are vital economic flows because the vast majority of coal shipments are to coal-fired power plants for generating electricity. In 2006, the top three states accounted for more than three-quarters (75.9 percent) of the total tonnage of coal originations. In 2006, the leading states by tons terminated included Illinois, Texas, Missouri, Ohio, Georgia and Wisconsin – accounting for over 40 percent of the U.S. total tons of coal received (AAR, 2009c).

In terms of the flows of the other major rail commodities, we find the usual suspects for originating/terminating traffic by commodity groups. For example, nonmetallic minerals predominantly originated in Florida and Texas (22.8 and 16.0 percent respectively), while Florida and Texas were also the two biggest receivers (27.5 and 23.0 percent respectively), in short, both being net receivers of nonmetallic minerals, while at the same time being the largest generators of them. Farm products largely originated in four states (Illinois, 12.2 percent, North Dakota, 12.1 percent, Nebraska, 11.7 percent and Minnesota, 10.7 percent), with healthy shipments originating in the other Midwestern and upper Midwestern states. Interestingly, over 30 percent of the terminating farm products occur in just two states – Washington and Texas. More generally, this pattern prevails across commodity groups, two to four states originate the greater percentage of a given commodity group and two to four states will terminate a significant percentage of a particular commodity group (AAR, 2009c).

According to Rail Waybill data, the classic intermodal rail and truck combination moved shipments weighing 173 million tons in 2002. This increase was 47 percent over the 118 million tons moved in 1993. If it is assumed that these goods would have otherwise been carried by only trucks in 50,000 lb payloads, then the intermodal traffic handled by rail in 2002 essentially removed 6.9 million large truck trips from our highways for a major part of the distance traveled by these shipments (US DOT, 2006a). In 2004, intermodal rail-truck service handled about 11 million trailers and containers. In 2003, for the first time ever, intermodal freight surpassed coal in terms of revenue for U.S. Class I railroads, accounting for about 23 percent of Class I carriers gross revenue. In 2004, nearly three-quarters (74 percent) of the rail-truck intermodal traffic was in containers. Trailers accounted for the remainder. The rapid growth in use of containers for transportation of U.S.-international merchandise trade is the primary factor behind the rising trend in U.S. rail-truck intermodal shipments with imports accounting for the majority of this intermodal activity (US DOT, 2006a).

Class I freight rail car-miles reached over 35 billion in 2003, up from 29 billion in 1980. Also, the average miles traveled annually per rail car more than tripled from 25,000 to 76,000, since 1980. Rail hauls bulk commodities, such as grain and coal, over long distances as well as time-sensitive commodities, such as automobiles and parts, to domestic markets and to industrial plants in the United States and in Canada and Mexico, our top trading partners. Refrigerated rail cars are used to transport perishable produce on tight schedules. The intermodal segment of the rail industry moves a wide assortment of goods from imported seasonal toys to lawn mowers, bicycles and computers.

Finally over the past two decades as the rail industry has consolidated, the mileage of railroads operated by the remaining Class I railroads sharply declined from 165,000 miles in 1980 to about 94,400 miles in 2007 (AAR, 2007a). Despite the reduction in rail line stemming from the consolidation and mergers, from 1980 to 2007, rail employee productivity rose 428 percent, locomotive productivity rose 124 percent, the productivity of each mile of track rose 225 percent, and fuel efficiency rose 85 percent. In each case, railroad productivity improvements in the post-Staggers era have been far higher (usually two to three times higher) than in the comparable pre-Staggers period (AAR, 2009d).

Forecast Rail Freight Traffic in the United States

The demand for freight rail services is projected to increase 69 percent based on (2000) tons and 84 percent based on (2000) ton-miles by 2035 (see Tables 4.7 and 4.8 for projections). However, the rail market share is expected to decline as a percentage of all shipments falling slightly from 14 to 13 percent of all freight tonnage. (These estimates vary depending upon the baseline data bases used and assumptions made with regard to traffic mix; however, the directionality of the estimates are consistent.) The rail market is shrinking in part because of structural changes in the economy. The growth of services, the need for smaller, more high-value movements, and the declining importance of commodities within the larger economy are expected to slightly reduce rail's share of overall freight movements – i.e., among rail-served commodities, rail retains its current market share, but these commodities are not forecast to grow as rapidly as the commodities that are predominantly handled by truck or air today (AASHTO, 2007b).

Intermodal shipments are the most rapidly growing railroad product. They are growing at 3.8 percent a year and are expected to become the second-largest volume of rail business. Intermodal has been the great success story for the Class I railroads. With international trade booming, this hybrid mode efficiently moves goods from the coasts and transports it quickly throughout the nation. Approximately 60 percent of the unit volume and the great majority of recent international growth involved marine containers, particularly bearing imported products from Asia (AASHTO, 2007b).

However, growth in one area of rail service increasingly squeezes service from another market segment, particularly with the significant reductions in trackage that have occurred since 1980. Rail service basically divides into three categories: bulk, general merchandise, and intermodal. The railroads are using operational efficiencies to increase capacity. In so doing, however, there may be negative consequences for some shippers. Among other actions the railroads are taking, they are dropping less profitable services and increasing capacity by reducing or eliminating shorter hauls for longer trains and longer hauls. They are also using longer and heavier trains. Because long coal and intermodal trains can be operated more efficiently (i.e., they can be longer, and in the case of coal, heavier) they may squeeze out the smaller, more specialized general merchandise shipments. Those require more handling in yards to consolidate and to disperse. That raises the costs of operations and makes them less attractive to carriers (AASHTO, 2007b).

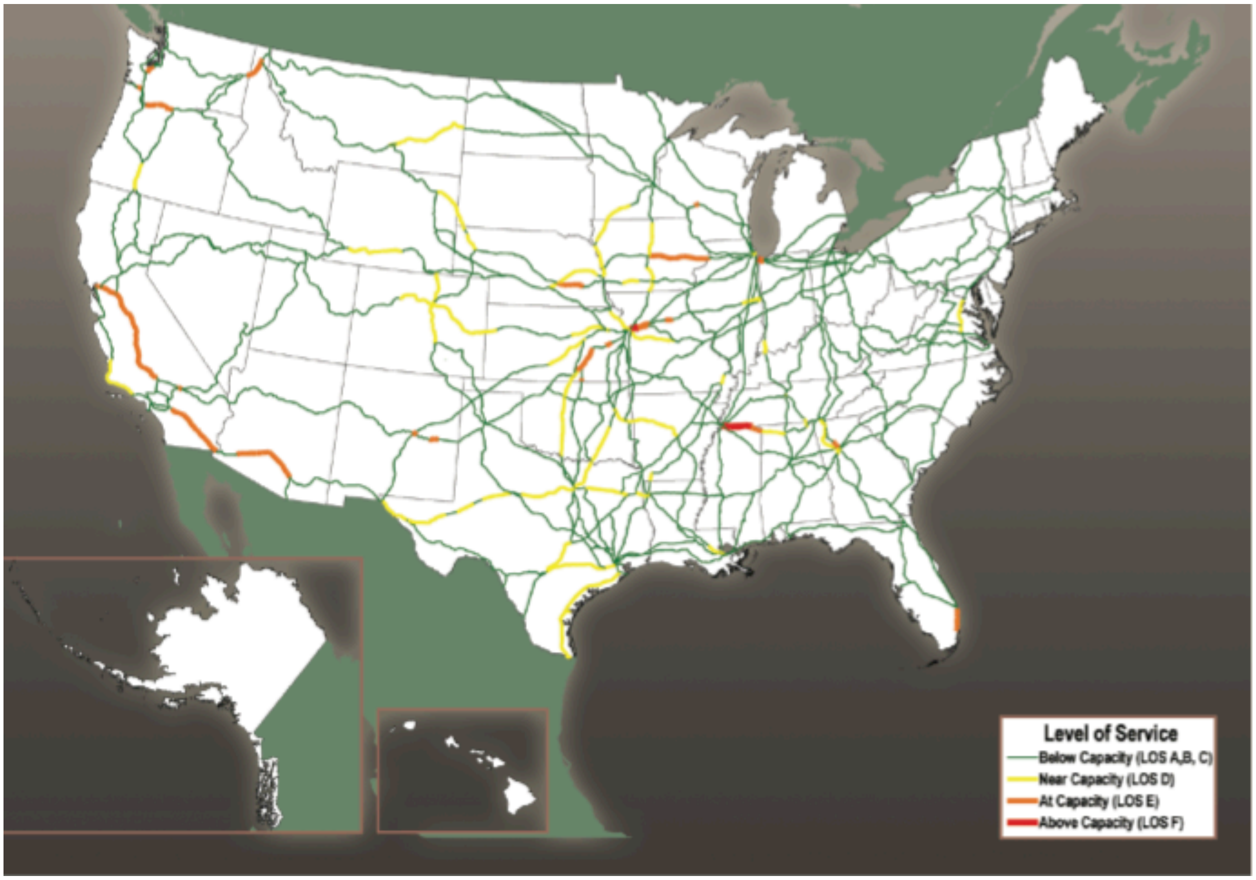
This situation will become greatly exacerbated with the forecast growth in rail freight traffic. Keep in mind, there is no assumption here that rail will gain market share, yet there are increasing pressures to move trucks off the highway and on to rail for environmental and congestion reasons. Should those forces lead to greater levels of freight rail traffic, the situation will become much severe. Figure 5.3 illustrates the current rail network and train volumes, with the concomitant chokepoints. Figure 5.4 illustrates what will happen to the rail network, assuming its current capacity, with 2035 volumes flowing across it. Clearly, there will be major levels of congestion and stoppages.

Congestion on the mainline railroad network is forecast to spread significantly by 2035 (Figures 5.3 and 5.4). Using volume-to-capacity comparisons similar to highway calculations, the AAR reports that rail lines experiencing unstable flows and service break-down conditions will increase from 108 miles today to almost 16,000 miles (30 percent of the network) in 2035 if current capacity is not increased. Rail routes that have moderate to very limited capacity to accommodate maintenance without serious service disruptions and to recover quickly from incidents will increase from 6,413 miles today to over 12,000 miles in 2035, affecting 25 percent of the network (ASSHTO, 2007b).

The picture for short-line and regional railroads is less clear. Very few statistics are collected on this segment of the industry. Some of these railroads provide links between port facilities and Class 1 railroads, while others serve small communities and shippers in rural areas (see Chapter 3 for descriptions of short line and regional railroads, and some of their operating characteristics).

Unlike with highways, there is no national planning process that allows the magnitude of rail congestion to be measured. Because “what gets measured, gets managed” there is no systematic national management of the nation’s rail congestion needs. It is clear from the preceding discussions that the individual Class I railroads run their companies

Figure 5.3: Current Train Volumes Compared to Current Capacity

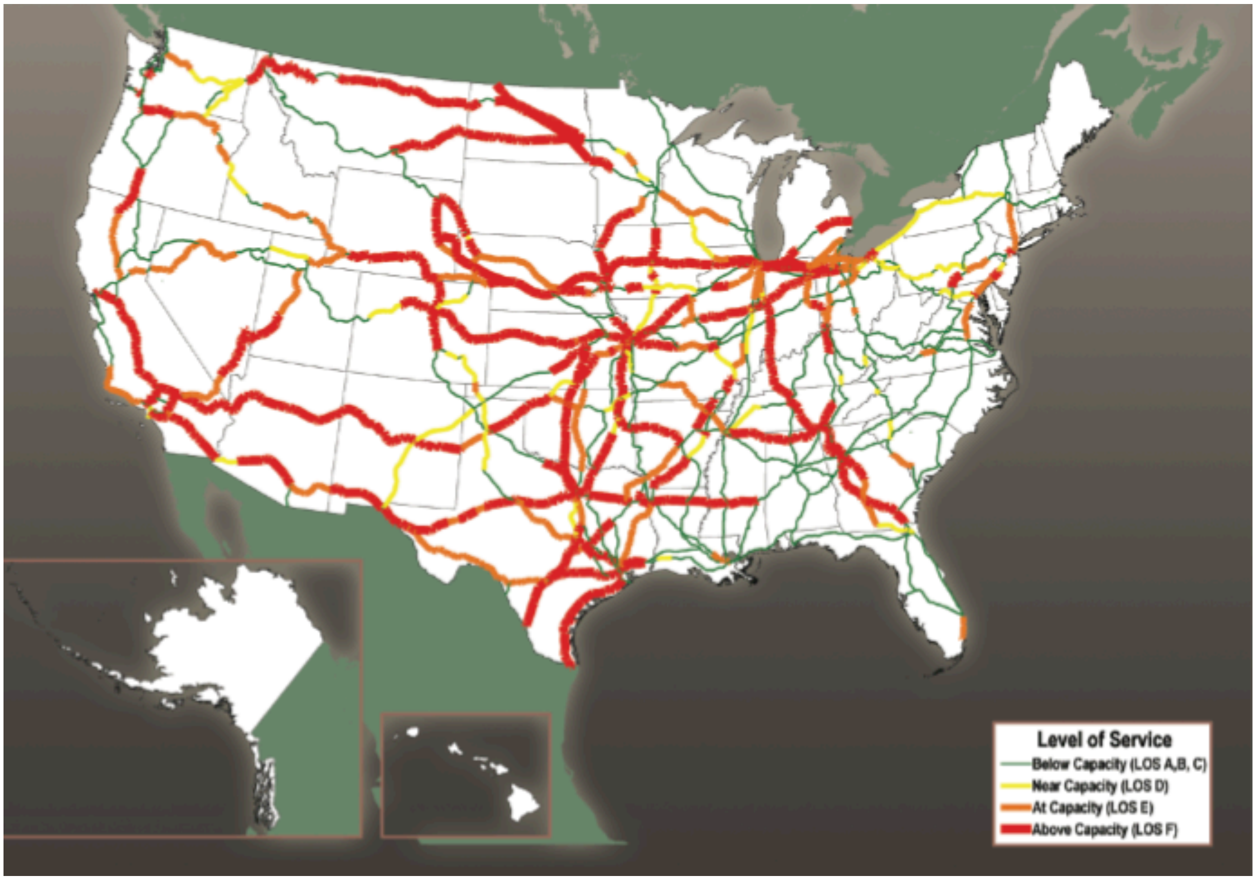


SOURCE: U.S. DOT, 2008. Association of American Railroads, National Rail Infrastructure Capacity and Investment Study prepared by Cambridge Systematics, Inc. (Washington, DC: September 2007), figure 4.4, page 4-10.
Note: Level of Service (LOS) A through F approximates the conditions described in Transportation Research Board, *Highway Capacity Manual 2000*.

efficiently and they make investments that meet the criteria of their business plans. However, from the perspective of the performance of the national freight transportation system, there is no baseline for service, no standards for operations and no true measure of what type of system and service the country needs. As a result, various states are struggling to deal with the national problem piecemeal, at their local or regional level (AASHTO, 2007b).

We return to this theme in Chapters 8, 10 and 11 where we look more closely at rail congestion, transportation infrastructure planning and large-scale transportation network models.

Figure 5.4: Train Volumes in 2035 Compared to Current Capacity



SOURCE: U.S. DOT, 2008: Association of American Railroads, National Rail Infrastructure Capacity and Investment Study prepared by Cambridge Systematics, Inc. (Washington, DC: September 2007), figure 45.4, page 5-5.
Note: Level of Service (LOS) A through F approximates the conditions described in Transportation Research Board, *Highway Capacity Manual 2000*.

Chapter 6: Forecast Population Growth in the United States

In this chapter we look at population trends in the United States during the 20th Century, with a focus on the shift toward significant concentrations of population in the metropolitan centers of the country. This is followed with an overview of forecast population growth out through 2050 for the U.S., as a whole, as well as in the metropolitan areas. As noted in Chapter 3, and discussed in more detail in Chapter 7, impedance to freight transportation in the U.S. is predominantly a metropolitan area phenomenon. Thus, as we look to the future and the movement of freight within this country, we need to consider where the population concentrations are most likely to be found and when these are forecast to manifest themselves.

20th Century Population Growth in the United States

The United States population more than tripled, growing from 76 million people in 1900 to 281 million people in 2000 (see Figure 6.1). From the start of the century until the breakup of the Soviet Union in 1991, the United States ranked as the fourth most populous country in the world, and since 1991 as the world's third most populous country. The net addition of more than 200 million people to the U.S. population over the course of the 20th century represents more than the current population of every country in the world, except China, India, and Indonesia (Hobbs and Stoops, 2002).

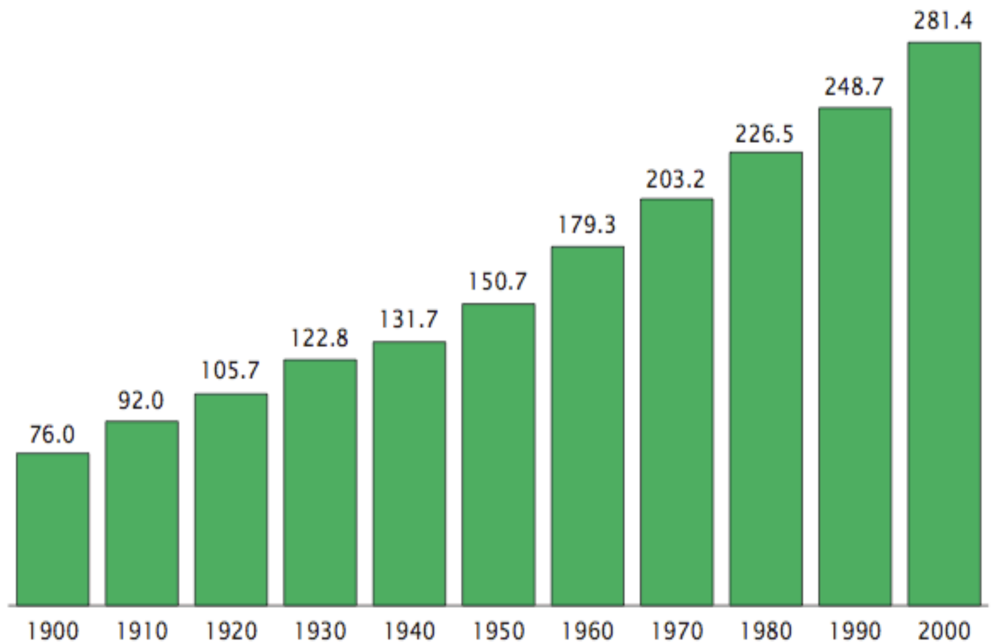
Many social and demographic factors contributed to the huge growth of the U.S. population in the 20th century. One factor was declining mortality. As public sanitation, personal hygiene, and scientific and medical technology improved, life expectancy improved. Average life expectancy at birth increased by about 30 years over the course of the 20th century, from about 47 years in 1900 to about 77 years in 2000. Infants, in particular, benefited from 20th century advances in health and medicine. The infant mortality rate decreased sharply over the century, from a rate well in excess of 100 per 1,000 births at the start of the century, to a rate less than 10 per 1,000 births by the century's end (Hobbs and Stoops, 2002).

All four regions of the United States grew considerably in the 20th century, however, the South and the West experienced the largest increases in population, 76 million and 59 million, respectively. Combined, these two regions increased by 471 percent during the century, compared with the combined increase of 149 percent for the Northeast and Midwest. Between 1900 and 2000, the combined increase of 135 million people in the South and the West represented 66 percent of the U.S. population increase of 205 million people (Hobbs and Stoops, 2002).

One of the most significant demographic trends of the 20th century has been the regional shift of population. There has been a steady shifting of the population west and south. In 1900, the majority (62 percent) of the population lived in either the Northeast or the Midwest (Hobbs and Stoops, 2002). This combined proportion declined each decade during the century. By 1980, the majority (52 percent) of the country's population resided in either the South or the West. This trend continued to the end of the century, with the combined South and West regional populations representing 58 percent of the total population of the United States in 2000 (see Figure 6.2).

Figure 6.1: Total U.S. Population: 1900 to 2000

(Millions)

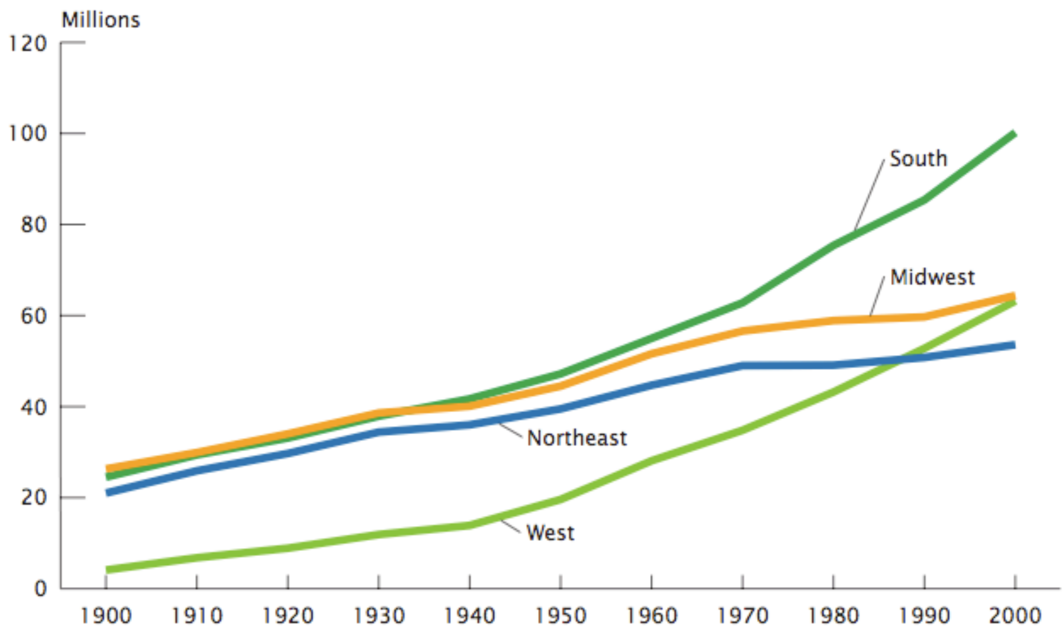


Source: Hobbs and Stoops, 2002

As seen in Figure 6.3, more than one-third of the U.S. population lived in the South in 2000, and about one-third (between 31 to 36 percent) lived in this region over the entire century. For most of the century, the Northeast represented about one-fourth of the U.S. (ranging between 24 to 28 percent during the period 1900 to 1970), but its share declined every decade since 1910, to about one-fifth of the U.S. population in 2000. The Midwest's share of the country's total population declined every decade throughout the century, and its percentage-point decline was even more than the Northeast's. The Midwest's share fell by 12 percentage points, from more than one-third (35 percent) of the total population in 1900 to just under one-fourth (23 percent) in 2000. In contrast, the West represented just 5 percent of the country's population in 1900, but its share increased every decade of the century and reached 22 percent in 2000. As a result of the changing regional distribution of population over the course of the century, the West, Midwest, and Northeast each represented similar fractions (around one-fifth) of the total U.S. population in 2000 (Hobbs and Stoops, 2002).

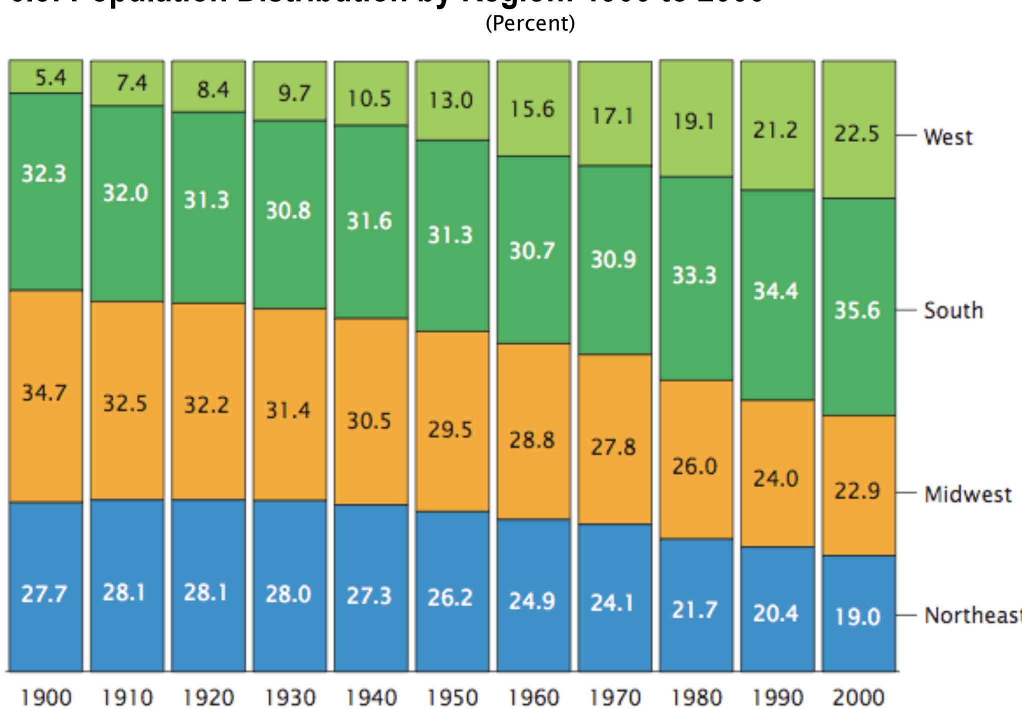
The population of the West grew faster than the other three regions of the country in every decade of the 20th century (see Figure 6.4). In fact, with the exception of the 1930s, the rate of growth in the West was at least double the rate of the other regions for the decades from 1900 to 1960. While the Midwest (until 1930), and the South (since 1940) had the largest populations among the regions, and the West grew the

Figure 6.2: Total Population by Region: 1900 to 2000



Source: Hobbs and Stoops, 2002

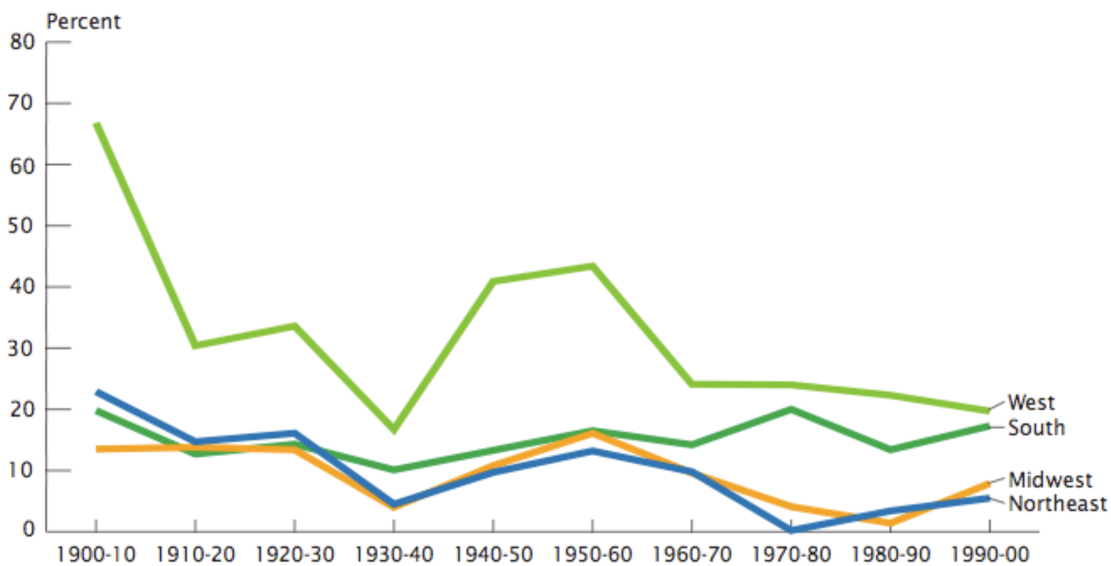
Figure 6.3: Population Distribution by Region: 1900 to 2000



Source: Hobbs and Stoops, 2002

fastest each decade, the population density of the Northeast far exceeded the densities of the other regions from 1900 to 2000 (see Figure 6.5). The West's land area, with nearly half of the total U.S. land area, had the fewest people per square mile of all regions. Nevada's population grew faster (4,620 percent) than the population of any other state, from 1900 to 2000. Arizona ranked second, increasing 4,074 percent. Western states had 9 of the 10 fastest-growing states during this period, while Florida ranked third, with an increase of 2,924 percent (Hobbs and Stoops, 2002).

Figure 6.4: Percent Change in Population per Decade by Region: 1900 to 2000

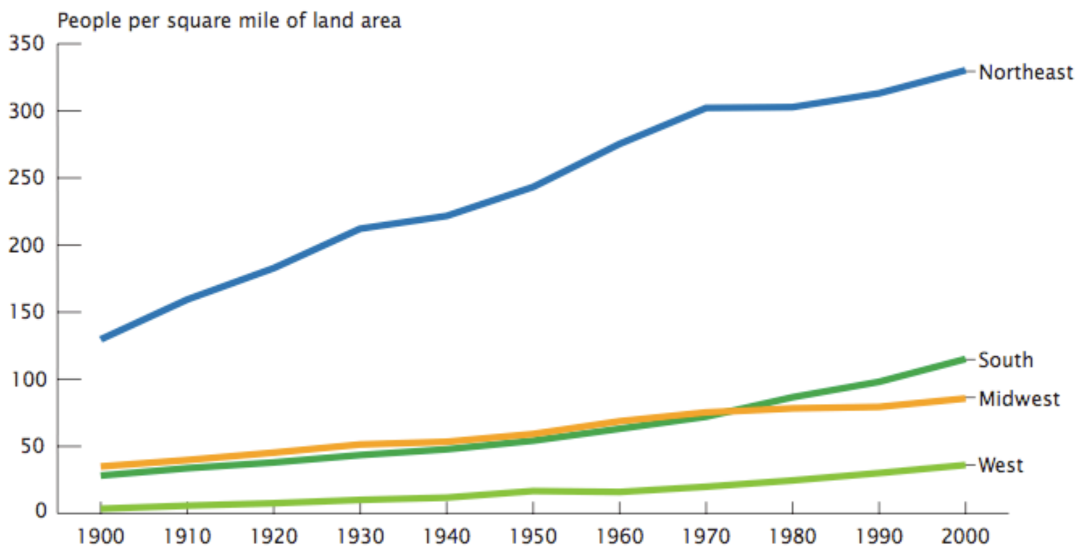


Source: Hobbs and Stoops, 2002

Comparing population change in the first and second halves of the century, California grew fastest in the first part and Nevada in the second half. Nevada, Arizona, and Florida ranked among the five fastest-growing states in both periods. In addition, California, New Mexico, and Washington ranked among the ten fastest-growing states for each 50-year period. Meanwhile, Iowa was the only state to appear among the five slowest-growing states in population for both halves of the century, while Nebraska and Mississippi were among the ten slowest-growing states. In that same period, the population of 11 western states, Florida, and Texas at least doubled in size during both 50-year periods (Hobbs and Stoops, 2002).

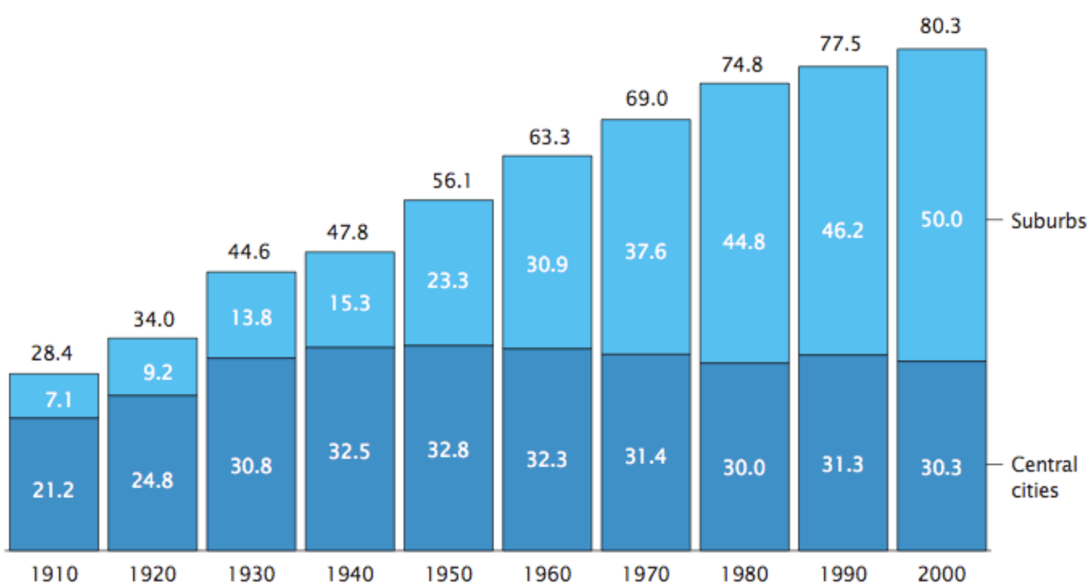
By 1950, the U.S. population had become predominantly metropolitan for the first time, with the metropolitan population exceeding the nonmetropolitan population by 18.3 million people. By 2000, the metropolitan population (226 million) was four times the size of the non-metropolitan population (55 million). Figure 6.6 illustrates that, over the course of the century, metropolitan areas accounted for a growing proportion of the U.S. population. In 1910, for example, 28 percent of the total population lived in metropolitan areas, but by 1950, more than half of the U.S. population lived in metropolitan areas. In 2000, the metropolitan population represented 80 percent of the U.S. resident total of 281.4 million people (Hobbs and Stoops, 2002).

Figure 6.5: Population Density by Region: 1900 to 2000



Source: Hobbs and Stoops, 2002

Figure 6.6: Percent of Total Population Living in Metropolitan Areas and in Their Central Cities and Suburbs: 1910 to 2000



Source: Hobbs and Stoops, 2002

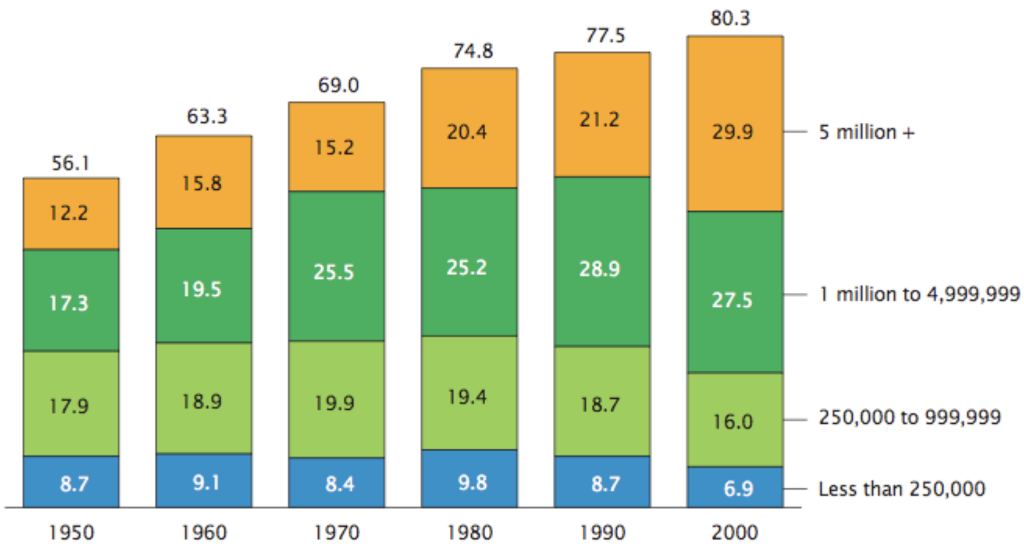
The highest percentage increase in metropolitan population growth occurred from 1920 to 1930, when metropolitan areas grew by 52 percent. The lowest percentage growth occurred from 1980 to 1990, when metropolitan areas grew by 14 percent. Metropolitan areas include two parts: central cities and suburbs. From 1960 to 2000, suburbs accounted for most of the growth of metropolitan areas. From 1910 to 1960, the population of central cities accounted for a larger proportion of the total population than the population living in suburbs. For example, in 1910, 21 percent of the total U.S. population lived in central cities, while only 7 percent of the population lived in suburbs (Hobbs and Stoops, 2002).

From 1910 to 1930, both central cities and suburbs grew rapidly. In the 1930s, growth continued at a slower pace. From 1940 onward, suburbs accounted for more population growth than central cities and, by 1960, the proportion of the total U.S. population living in the suburbs (31 percent) was almost equal to the proportion of the population living in the central cities (32 percent). From 1940 to 2000, the proportion of the population living in central cities remained relatively stable, while the suburbs continued to grow substantially. By 2000, half of the entire U.S. population lived in the suburbs of metropolitan areas (Hobbs and Stoops, 2002).

Most of the metropolitan population lives in relatively large concentrations (see Figure 6.7). In 1950, only 14 metropolitan areas had populations of at least 1 million people, which constituted less than a third (29 percent) of the total U.S. population. By 2000, 50 metropolitan areas had populations of at least 1 million people, which accounted for over half (57 percent) of the total U.S. population. From 1950 to 2000, the population living in metropolitan areas of at least 1 million people increased by 117.1 million and accounted for 83 percent of the total metropolitan growth and 90 percent of the total U.S. population growth. It is important to note that the growth of the different size categories of metropolitan areas is directly affected by the addition of new metropolitan areas, the movement of existing metropolitan areas into larger size categories due to population increase, and the territorial growth of metropolitan areas due to changing metropolitan boundaries, which often adds counties to existing metropolitan areas (Hobbs and Stoops, 2002).

Perusing Table 6.1, we can see that between 1950 and 2000, the share of the population living in metropolitan areas with 1 million to 5 million people and with 5 million or more people increased greatly (by 10.2 and 17.7 percentage points, respectively), while the share of the population living in the other two size categories stayed within a narrow range. Although the share of the population living in metropolitan areas of 250,000 up to 1 million, and less than 250,000 increased in two decades during the 50-year period, a smaller share of the U.S. population lived in these areas in 2000 than in 1950. Since 1950, the ten largest metropolitan areas have always had populations of 1 million or more. In 1950, Cleveland, Ohio, the 10th largest metropolitan area had nearly 1.5 million people. By 2000, the 10th largest metropolitan area, Houston-Galveston- Brazoria, Texas, had a population of 4.7 million (Hobbs and Stoops, 2002).

Figure 6.7: Percent of Total Population Living in Metropolitan Areas by Size of Metropolitan Area Population: 1950 to 2000



Source: Hobbs and Stoops, 2002

New York and Chicago were the only metropolitan areas with populations of 5 million or more in 1950. Their combined population in 1950 (18.4 million) accounted for 12.2 percent of the total U.S. population. But, by 2000, they had been joined by 7 other metropolitan areas, creating a combined population of 84.1 million, or 29.9 percent of the U.S. total, in short, nearly 1 in 3 Americans lived in a metropolitan area with 5 million or more residents (Hobbs and Stoops, 2002).

Metropolitan population density levels remained higher than nonmetropolitan density (see Figure 6.8) since 1950, when metropolitan areas were first defined. From 1950 to 2000, the density of metropolitan areas ranged from 299 to 407 people per square mile, and the density of nonmetropolitan territory ranged from 19 to 24 people per square mile. While the density of nonmetropolitan areas remained relatively stable from 1950 to 2000, the density of metropolitan areas fluctuated. The metropolitan population density peaked in the last half of the century, in 1950. It then declined steadily from 1950 to 1980, driven primarily by the steep decline in the population of central cities. As Figure 6.8 shows, the density of central cities was substantially higher than the density of suburban and nonmetropolitan areas throughout the second half of the century, although it declined in every decade during this period, from a peak of 7,517 people per square mile in 1950 to a low of 2,716 people per square mile in 2000 (Hobbs and Stoops, 2002).

Table 6.1: Ten Most Populous Metropolitan Areas: 1950 to 2000

Year and area	Region	Population
1950		
New York, N.Y.-Northeastern New Jersey SMA	Northeast	12,911,994
Chicago, Ill. SMA	Midwest	5,495,364
Los Angeles, Calif. SMA	West	4,367,911
Philadelphia, Pa. SMA	Northeast	3,671,048
Detroit, Mich. SMA	Midwest	3,016,197
Boston, Mass. SMA	Northeast	2,369,986
San Francisco-Oakland, Calif. SMA	West	2,240,767
Pittsburgh, Pa. SMA	Northeast	2,213,236
St. Louis, Mo. SMA	Midwest	1,681,281
Cleveland, Ohio SMA	Midwest	1,465,511
1960		
New York, N.Y.-Northeastern New Jersey SCA	Northeast	14,759,429
Chicago, Ill.-Northwestern Indiana SCA	Midwest	6,794,461
Los Angeles-Long Beach, Calif. SMSA	West	6,742,696
Philadelphia, Pa.-N.J. SMSA	Northeast	4,342,897
Detroit, Mich. SMSA	Midwest	3,762,360
San Francisco-Oakland, Calif. SMSA	West	2,783,359
Boston, Mass. SMSA	Northeast	2,589,301
Pittsburgh, Pa. SMSA	Northeast	2,405,435
St. Louis, Mo.-Ill. SMSA	Midwest	2,060,103
Washington, D.C.-Md.-Va. SMSA	South	2,001,897
1970		
New York, N.Y.-Northeastern New Jersey SCA	Northeast	16,178,700
Chicago, Ill.-Northwestern Indiana SCA	Midwest	7,612,314
Los Angeles-Long Beach, Calif. SMSA	West	7,032,075
Philadelphia, Pa.-N.J. SMSA	Northeast	4,817,914
Detroit, Mich. SMSA	Midwest	4,199,931
San Francisco-Oakland, Calif. SMSA	West	3,109,519
Washington, D.C.-Md.-Va. SMSA	South	2,861,123
Boston, Mass. SMSA	Northeast	2,753,700
Pittsburgh, Pa. SMSA	Northeast	2,401,245
St. Louis, Mo.-Ill. SMSA	Midwest	2,363,017
1980		
New York-Newark-Jersey City, N.Y.- N.J.-Conn. SCSA	Northeast	16,121,297
Los Angeles-Long Beach-Anaheim, Calif. SCSA	West	11,497,568
Chicago-Gary-Kenosha, Ill.-Ind.-Wis. SCSA	Midwest	7,869,542
Philadelphia-Wilmington-Trenton, Pa.-Del.-N.J.-Md. SCSA [1]	Northeast	5,547,902
San Francisco-Oakland-San Jose, Calif. SCSA	West	5,179,784
Detroit-Ann Arbor, Mich.SCSA	Midwest	4,618,161
Boston-Lawrence-Lowell, Mass.-N.H. SCSA	Northeast	3,448,122
Houston-Galveston, Tex. SCSA	South	3,101,293
Washington, D.C.-Md.-Va. SMSA	South	3,060,922
Dallas-Fort Worth, Tex. SMSA	South	2,974,805
1990		
New York-Northern New Jersey-Long Island, NY-NJ-CT CMSA	Northeast	18,087,251
Los Angeles-Anaheim-Riverside, CA CMSA	West	14,531,529
Chicago-Gary-Lake County, IL-IN-WI CMSA	Midwest	8,065,633
San Francisco-Oakland-San Jose, CA CMSA	West	6,253,311
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD CMSA [1]	Northeast	5,899,345
Detroit-Ann Arbor, MI CMSA	Midwest	4,665,236
Boston-Lawrence-Salem, MA-NH CMSA	Northeast	4,171,643
Washington, DC-MD-VA MSA	South	3,923,574
Dallas-Fort Worth, TX CMSA	South	3,885,415
Houston-Galveston-Brazoria, TX CMSA	South	3,711,043
2000		
New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	Northeast	21,199,865
Los Angeles-Riverside-Orange County, CA CMSA	West	16,373,645
Chicago-Gary-Kenosha, IL-IN-WI CMSA	Midwest	9,157,540
Washington-Baltimore, DC-MD-VA-WV CMSA	South	7,608,070
San Francisco-Oakland-San Jose, CA CMSA	West	7,039,362
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA [1]	Northeast	6,188,463
Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA	Northeast	5,819,100
Detroit-Ann Arbor-Flint, MI CMSA	Midwest	5,456,428
Dallas-Fort Worth, TX CMSA	South	5,221,801
Houston-Galveston-Brazoria, TX CMSA	South	4,669,571

[1] A small portion of the Philadelphia SCSA (1980) and CMSA (1990 and 2000) includes population in states of the South region (Delaware and Maryland).

Source: Hobbs and Stoops, 2002

The decline of central city populations was partly offset by the movement of population into the suburbs. The density of suburban areas steadily increased from 1950 to 1970. However, this increase had little effect on the overall density of metropolitan areas. To some extent, this phenomenon reflects the addition of land area (usually relatively lower density suburban counties) to metropolitan areas as a whole with each passing census.

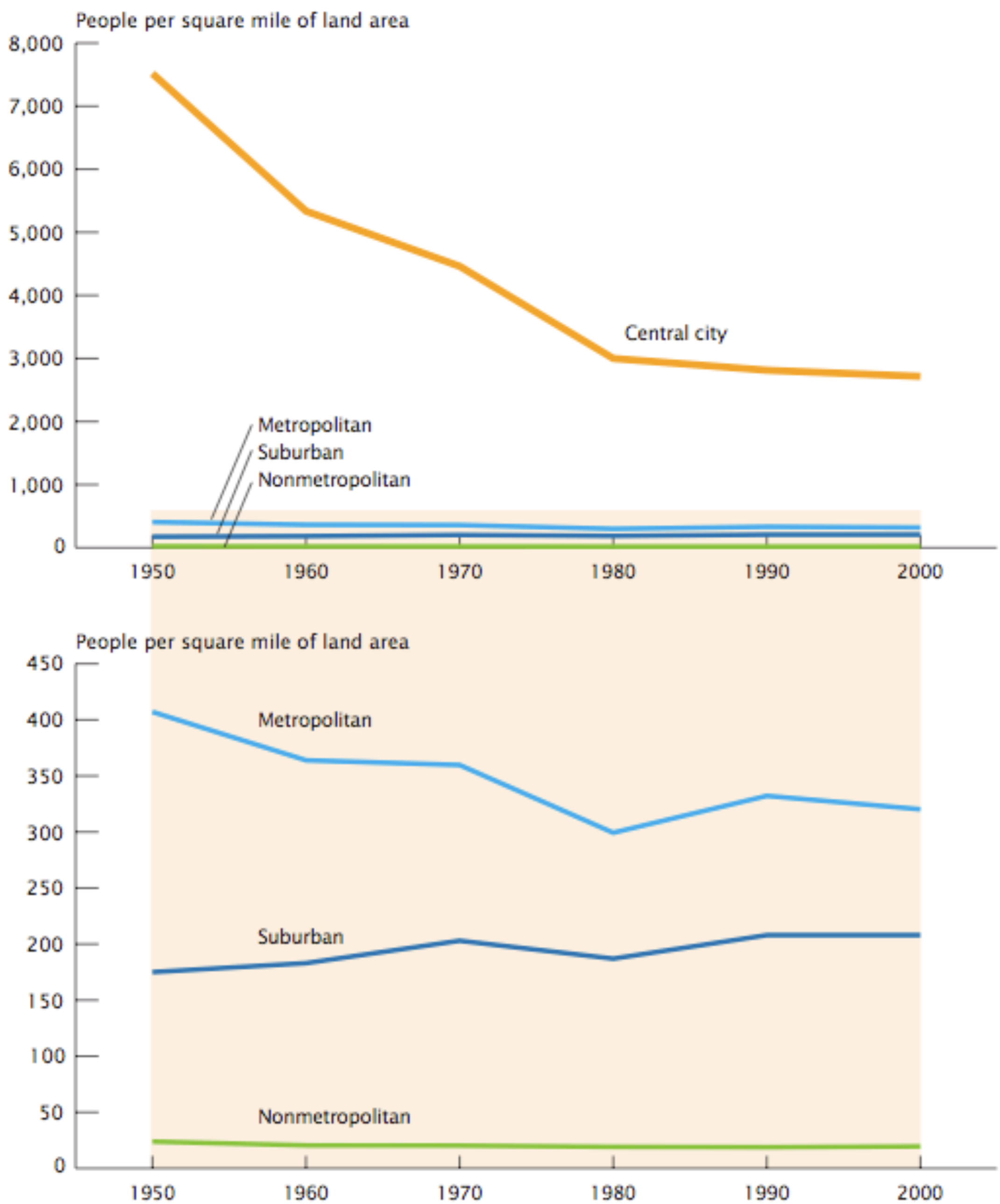
Increased land area, coupled with population declines of many central cities, resulted in an overall decline in metropolitan density between 1950 and 2000 (Hobbs and Stoops, 2002).

In the 1980s, metropolitan area density increased slightly, then decreased slightly in the 1990s. Similarly, the density of the suburban areas increased slightly from 1980 to 1990, then leveled off from 1990 to 2000. Although the density of central cities continued to decline in both the 1980s and 1990s, the rate of the decline slowed considerably during this period (Figure 6.8). Nevertheless, as seen in Figure 6.9, the percentage of people living in metropolitan areas increased in every decade for every region. In 1910, more than half of the Northeast's population, about a quarter of the Midwest's and the West's, and about a tenth of the South's population was metropolitan. By 2000, at least three quarters of the populations in the Northeast, the South, and the West were metropolitan and nearly three quarters (73.8 percent) of the population in the Midwest lived in metropolitan areas (Hobbs and Stoops, 2002).

Despite the significant growth of metropolitan areas in the United States, the percentage of the population living in the ten largest cities grew steadily in the first three decades of the 20th century, but declined appreciably over the next seven decades. The percentage of the population living in the ten largest cities peaked in 1930 (15.5 percent) and fell every decade thereafter, reaching its lowest point in 2000 (8.5 percent, see Figure 6.10). The growth of the ten largest cities from 1900 to 1930 and their subsequent decline as a proportion of the U.S. population mirrors the growth and decline of the total central city population in the United States in the 20th century. During the first part of the century, immigrants as well as natives poured into the cities. In the second half of the century, the growth of cities slowed and in some cases even declined as the proportion of the population living in the suburbs increased (Hobbs and Stoops, 2002).

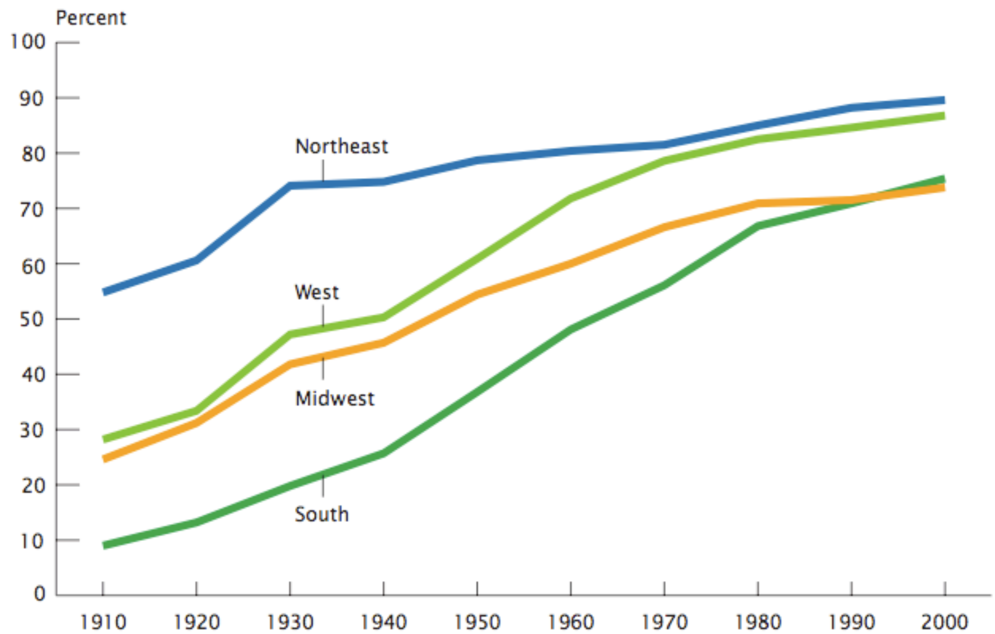
Over the last half of the century, the growth and change in the ten largest cities reflected the growth of the U.S. population in the Sunbelt. During this period, St. Louis, Boston, Baltimore, Cleveland, and Washington, DC, dropped out of the ten largest cities. They were either replaced by cities in Texas (Houston, Dallas, and San Antonio) or in the West (Phoenix and San Diego). None of the cities that fell from the list of The 10 largest ever reached 1 million population, while all the cities that replaced them passed the 1 million mark. In 2000, for the first time in U.S. history, a city (Detroit) declined from a population above 1 million to a population below 1 million. Throughout the century, New York's population far exceeded the population of any other city, ranging from 3.4 million to 8.0 million. From 1900 to 2000, its population was always at least double the population of the second largest city (Hobbs and Stoops, 2002).

Figure 6.8: Population Density by Metropolitan Area Status: 1950 to 2000



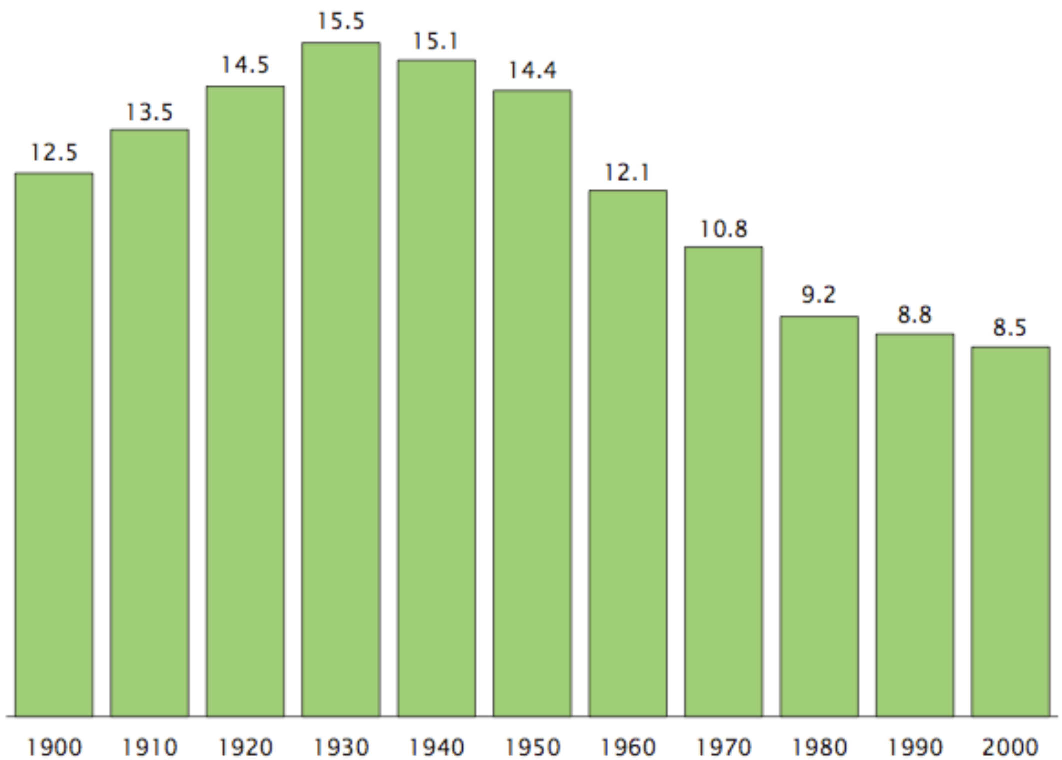
Source: Hobbs and Stoops, 2002

Figure 6.9: Percent of Population Living in Metropolitan Areas by Region: 1910 to 2000



Source: Hobbs and Stoops, 2002

Figure 6.10: Percent of Total Population Living in the Ten Largest Cities: 1900 to 2000



Source: Hobbs and Stoops, 2002

Forecast Population Growth in the United States

Population forecasts for the United States do not provide the same level of granularity on a metropolitan basis as the estimates discussed above. However, for the years out to 2030, there are projections by state and region. These are shown in Tables 6.2 and 6.3. Tables 6.4 through 6.7 provide percentage changes for the period 2000 to 2030. For the period out to 2050, the current available population forecasts are for total population, as well as by age, sex, race, and Hispanic origin. Table 6.8 shows the total population estimates for 2040 and 2050.

What one sees in viewing Tables 6.2 through 6.7 is a distinct growth pattern that resembles a continuation of the regional shifts describe above. The South and the West show the greatest increases in population out through 2030, although there are some states that fair less well in those two regions, for example, West Virginia will experience an absolute decrease in population. The District of Columbia, which is a special case in many respects, will also experience an absolute decline in population. States, such as Alabama, Kentucky, Louisiana and Mississippi will experience only moderate levels of population growth, while Florida will gain almost an 80 percent increase in population. Texas, North Carolina and Georgia are also forecast to see significant increases in their population. While Virginia, Maryland, Tennessee, Delaware, South Carolina and Arkansas will all see appreciable population gains.

Table 6.2: Interim Projections: Total Population for Regions, Divisions and States: 2000 to 2030

Region, Division, and State	Census April 1, 2000	Projections July 1, 2005	Projections July 1, 2010	Projections July 1, 2015	Projections July 1, 2020	Projections July 1, 2025	Projections July 1, 2030
United States	**281,421,906**	**295,507,134**	**308,935,581**	**322,365,787**	**335,804,546**	**349,439,199**	**363,584,435**
Northeast	**53,594,378**	**54,802,949**	**55,785,179**	**56,565,669**	**57,135,437**	**57,470,313**	**57,671,068**
New England	13,922,517	14,372,985	14,738,789	15,052,263	15,309,528	13,922,517	14,372,985
Maine	1,274,923	1,318,557	1,357,134	1,388,878	1,408,665	1,274,923	1,318,557
New Hampshire	1,235,786	1,314,821	1,385,560	1,456,679	1,524,751	1,235,786	1,314,821
Vermont	608,827	630,979	652,512	673,169	690,686	608,827	630,979
Massachusetts	6,349,097	6,518,868	6,649,441	6,758,580	6,855,546	6,349,097	6,518,868
Rhode Island	1,048,319	1,086,575	1,116,652	1,139,543	1,154,230	1,048,319	1,086,575
Connecticut	3,405,565	3,503,185	3,577,490	3,635,414	3,675,650	3,405,565	3,503,185
Middle Atlantic	39,671,861	40,429,964	41,046,390	41,513,406	41,825,909	39,671,861	40,429,964
New York	18,976,457	19,258,082	19,443,672	19,546,699	19,576,920	18,976,457	19,258,082
New Jersey	8,414,350	8,745,279	9,018,231	9,255,769	9,461,635	8,414,350	8,745,279
Pennsylvania	12,281,054	12,426,603	12,584,487	12,710,938	12,787,354	12,281,054	12,426,603
Midwest	**64,392,776**	**66,005,033**	**67,391,433**	**68,569,609**	**69,455,175**	**70,041,457**	**70,497,298**
East North Central	45,155,037	46,188,274	47,041,323	47,732,177	48,208,733	48,469,671	48,638,464
Ohio	11,353,140	11,477,557	11,576,181	11,635,446	11,644,058	11,605,738	11,550,528
Indiana	6,080,485	6,249,617	6,392,139	6,517,631	6,627,008	6,721,322	6,810,108
Illinois	12,419,293	12,699,336	12,916,894	13,097,218	13,236,720	13,340,507	13,432,892
Michigan	9,938,444	10,207,421	10,428,683	10,599,122	10,695,993	10,713,730	10,694,172
Wisconsin	5,363,675	5,554,343	5,727,426	5,882,760	6,004,954	6,088,374	6,150,764
West North Central	19,237,739	19,816,759	20,350,110	20,837,432	21,246,442	21,571,786	21,858,834
Minnesota	4,919,479	5,174,743	5,420,636	5,668,211	5,900,769	6,108,787	6,306,130
Iowa	2,926,324	2,973,700	3,009,907	3,026,380	3,020,496	2,993,222	2,955,172
Missouri	5,595,211	5,765,166	5,922,078	6,069,556	6,199,882	6,315,366	6,430,173
North Dakota	642,200	635,468	636,623	635,133	630,112	620,777	606,566
South Dakota	754,844	771,803	786,399	796,954	801,939	801,845	800,462
Nebraska	1,711,263	1,744,370	1,768,997	1,788,508	1,802,678	1,812,787	1,820,247
Kansas	2,688,418	2,751,509	2,805,470	2,852,690	2,890,566	2,919,002	2,940,084
South	**100,236,820**	**106,916,476**	**113,583,614**	**120,440,208**	**127,570,819**	**135,160,886**	**143,269,337**
South Atlantic	51,769,160	55,737,197	59,791,781	64,019,354	68,442,026	73,129,056	78,093,216
Delaware	783,600	836,687	884,342	927,400	963,209	990,694	1,012,658
Maryland	5,296,486	5,600,563	5,904,970	6,208,392	6,497,626	6,762,732	7,022,251
District of Columbia	572,059	551,136	529,785	506,323	480,540	455,108	433,414
Virginia	7,078,515	7,552,581	8,010,245	8,466,864	8,917,395	9,364,304	9,825,019
West Virginia	1,808,344	1,818,887	1,829,141	1,822,758	1,801,112	1,766,435	1,719,959
North Carolina	8,049,313	8,702,410	9,345,823	10,010,770	10,709,289	11,449,153	12,227,739
South Carolina	4,012,012	4,239,310	4,446,704	4,642,137	4,822,577	4,989,550	5,148,569
Georgia	8,186,453	8,925,796	9,589,080	10,230,578	10,843,753	11,438,622	12,017,838
Florida	15,982,378	17,509,827	19,251,691	21,204,132	23,406,525	25,912,458	28,685,769
East South Central	17,022,810	17,571,539	18,063,711	18,530,725	18,978,828	19,432,299	19,902,285
Kentucky	4,041,769	4,163,360	4,265,117	4,351,188	4,424,431	4,489,662	4,554,998
Tennessee	5,689,283	5,965,317	6,230,852	6,502,017	6,780,670	7,073,125	7,380,634
Alabama	4,447,100	4,527,166	4,596,330	4,663,111	4,728,915	4,800,092	4,874,243
Mississippi	2,844,658	2,915,696	2,971,412	3,014,409	3,044,812	3,069,420	3,092,410
West South Central	31,444,850	33,607,740	35,728,122	37,890,129	40,149,965	42,599,531	45,273,836
Arkansas	2,673,400	2,777,007	2,875,039	2,968,913	3,060,219	3,151,005	3,240,208
Louisiana	4,468,976	4,534,310	4,612,679	4,673,721	4,719,160	4,762,398	4,802,633
Oklahoma	3,450,654	3,521,379	3,591,516	3,661,694	3,735,690	3,820,994	3,913,251
Texas	20,851,820	22,775,044	24,648,888	26,585,801	28,634,896	30,865,134	33,317,744

West	**63,197,932**	**67,782,676**	**72,175,355**	**76,790,301**	**81,643,115**	**86,766,543**	**92,146,732**
Mountain	18,172,295	20,005,440	21,740,479	23,585,039	25,557,049	27,668,947	29,909,432
Montana	902,195	933,005	968,598	999,489	1,022,735	1,037,387	1,044,898
Idaho	1,293,953	1,407,060	1,517,291	1,630,045	1,741,333	1,852,627	1,969,624
Wyoming	493,782	507,268	519,886	528,005	530,948	529,031	522,979
Colorado	4,301,261	4,617,962	4,831,554	5,049,493	5,278,867	5,522,803	5,792,357
New Mexico	1,819,046	1,902,057	1,980,225	2,041,539	2,084,341	2,106,584	2,099,708
Arizona	5,130,632	5,868,004	6,637,381	7,495,238	8,456,448	9,531,537	10,712,397
Utah	2,233,169	2,417,998	2,595,013	2,783,040	2,990,094	3,225,680	3,485,367
Nevada	1,998,257	2,352,086	2,690,531	3,058,190	3,452,283	3,863,298	4,282,102
Pacific	45,025,637	47,777,236	50,434,876	53,205,262	56,086,066	59,097,596	62,237,300
Washington	5,894,121	6,204,632	6,541,963	6,950,610	7,432,136	7,996,400	8,624,801
Oregon	3,421,399	3,596,083	3,790,996	4,012,924	4,260,393	4,536,418	4,833,918
California	33,871,648	36,038,859	38,067,134	40,123,232	42,206,743	44,305,177	46,444,861
Alaska	626,932	661,110	694,109	732,544	774,421	820,881	867,674
Hawaii	1,211,537	1,276,552	1,340,674	1,385,952	1,412,373	1,438,720	1,466,046

SOURCE: U.S. Census Bureau, 2005. Population Division, Interim State Population Projections, 2005. Internet Release Date: April 21, 2005

In the West, two states are the big gainers in terms of population increases, Nevada and Arizona – a clear continuation of the trends discussed above. In fact, most states in the West will see significant increases in their population, with only Wyoming having an increase that is more on par with states in the Midwest. Montana and New Mexico are also two states that, while experiencing growth, will not obtain the explosive change of the other western states.

Table 6.3: Interim Projections: Change in Total Population for Regions, Divisions and States: 2000 to 2030

Region, Division, and State	Numeric Change 2000-2010	Numeric Change 2010-2020	Numeric Change 2020-2030	Numeric Change 2000-2030	Percent Change 2000-2010	Percent Change 2010-2020	Percent Change 2020-2030	Percent Change 2000-2030
United States	**27,513,675**	**26,868,965**	**27,779,889**	**82,162,529**	**9.8**	**8.7**	**8.3**	**29.2**
Northeast	**2,190,801**	**1,350,258**	**535,631**	**4,076,690**	**4.1**	**2,4**	**0.9**	**7.6**
New England	816,272	570,739	313,487	1,700,498	5.9	3.9	2.0	12.2
Maine	82,211	51,531	2,432	136,174	6.4	3.8	0.2	10.7
New Hampshire	149,774	139,191	121,720	410,685	12.1	10.0	8.0	33.2
Vermont	43,685	38,174	21,181	103,040	7.2	5.9	3.1	16.9
Massachusetts	300,344	206,105	156,463	662,912	4.7	3.1	2.3	10.4
Rhode Island	68,333	37,578	-1,289	104,622	6.5	3.4	-0.1	10.0
Connecticut	171,925	98,160	12,980	283,065	5.0	2.7	0.4	8.3
Middle Atlantic	1,374,529	779,519	222,144	2,376,192	3.5	1.9	0.5	6.0
New York	467,215	133,248	-99,491	500,972	2.5	0.7	-0.5	2.6
New Jersey	603,881	443,404	340,805	1,388,090	7.2	4.9	3.6	16.5
Pennsylvania	303,433	202,867	-19,170	487,130	2.5	1.6	-0.1	4.0
Midwest	**2,998,657**	**2,063,742**	**1,042,123**	**6,104,522**	**4.7**	**3.1**	**1.5**	**9.5**
East North Central	1,886,286	1,167,410	429,731	3,483,427	4.2	2.5	0.9	7.7
Ohio	223,041	67,877	-93,530	197,388	2.0	0.6	-0.8	1.7
Indiana	311,654	234,869	183,100	729,623	5.1	3.7	2.8	12.0
Illinois	497,601	319,826	196,172	1,013,599	4.0	2.5	1.5	8.2
Michigan	490,239	267,310	-1,821	755,728	4.9	2.6	0.0	7.6
Wisconsin	363,751	277,528	145,810	787,089	6.8	4.8	2.4	14.7
West North Central	1,112,371	896,332	612,392	2,621,095	5.8	4.4	2.9	13.6
Minnesota	501,157	480,133	405,361	1,386,651	10.2	8.9	6.9	28.2
Iowa	83,583	10,589	-65,324	28,848	2.9	0.4	-2.2	1.0
Missouri	326,867	277,804	230,291	834,962	5.8	4.7	3.7	14.9
North Dakota	-5,577	-6,511	-23,546	-35,634	-0.9	-1.0	-3.7	-5.5
South Dakota	31,555	15,540	-1,477	45,618	4.2	2.0	-0.2	6.0

Nebraska	57,734	33,681	17,569	108,984	3.4	1.9	1.0	6.4
Kansas	117,052	85,096	49,518	251,666	4.4	3.0	1.7	9.4
South	**13,346,794**	**13,987,205**	**15,698,518**	**43,032,517**	**13.3**	**12.3**	**12.3**	**42.9**
South Atlantic	8,022,621	8,650,245	9,651,190	26,324,056	15.5	14.5	14.1	50.8
Delaware	100,742	78,867	49,449	229,058	12.9	8.9	5.1	29.2
Maryland	608,484	592,656	524,625	1,725,765	11.5	10.0	8.1	32.6
District of Columbia	-42,274	-49,245	-47,126	-138,645	-7.4	-9.3	-9.8	-24.2
Virginia	931,730	907,150	907,624	2,746,504	13.2	11.3	10.2	38.8
West Virginia	20,797	-28,029	-81,153	-88,385	1.2	-1.5	-4.5	-4.9
North Carolina	1,296,510	1,363,466	1,518,450	4,178,426	16.1	14.6	14.2	51.9
South Carolina	434,692	375,873	325,992	1,136,557	10.8	8.5	6.8	28.3
Georgia	1,402,627	1,254,673	1,174,085	3,831,385	17.1	13.1	10.8	46.8
Florida	3,269,313	4,154,834	5,279,244	12,703,391	20.5	21.6	22.6	79.5
East South Central	1,040,901	915,117	923,457	2,879,475	6.1	5.1	4.9	16.9
Kentucky	223,348	159,314	130,567	513,229	5.5	3.7	3.0	12.7
Tennessee	541,569	549,818	599,964	1,691,351	9.5	8.8	8.8	29.7
Alabama	149,230	132,585	145,328	427,143	3.4	2.9	3.1	9.6
Mississippi	126,754	73,400	47,598	247,752	4.5	2.5	1.6	8.7
West South Central	4,283,272	4,421,843	5,123,871	13,828,986	13.6	12.4	12.8	44.0
Arkansas	201,639	185,180	179,989	566,808	7.5	6.4	5.9	21.2
Louisiana	143,703	106,481	83,473	333,657	3.2	2.3	1.8	7.5
Oklahoma	140,862	144,174	177,561	462,597	4.1	4.0	4.8	13.4
Texas	3,797,068	3,986,008	4,682,848	12,465,924	18.2	16.2	16.4	59.8
West	**8,977,423**	**9,467,760**	**10,503,617**	**28,948,800**	**14.2**	**13.1**	**12.9**	**45.8**
Mountain	3,568,184	3,816,570	4,352,383	11,737,137	19.6	17.6	17.0	64.6
Montana	66,403	54,137	22,163	142,703	7.4	5.6	2.2	15.8
Idaho	223,338	224,042	228,291	675,671	17.3	14.8	13.1	52.2
Wyoming	26,104	11,062	-7,969	29,197	5.3	2.1	-1.5	5.9
Colorado	530,293	447,313	513,490	1,491,096	12.3	9.3	9.7	34.7
New Mexico	161,179	104,116	15,367	280,662	8.9	5.3	0.7	15.4
Arizona	1,506,749	1,819,067	2,255,949	5,581,765	29.4	27.4	26.7	108.8
Utah	361,844	395,081	495,273	1,252,198	16.2	15.2	16.6	56.1
Nevada	692,274	761,752	829,819	2,283,845	34.6	28.3	24.0	114.3
Pacific	5,409,239	5,651,190	6,151,234	17,211,663	12.0	11.2	11.0	38.2
Washington	647,842	890,173	1,192,665	2,730,680	11.0	13.6	16.0	46.3
Oregon	369,597	469,397	573,525	1,412,519	10.8	12.4	13.5	41.3
California	4,195,486	4,139,609	4,238,118	12,573,213	12.4	10.9	10.0	37.1
Alaska	67,177	80,312	93,253	240,742	10.7	11.6	12.0	38.4
Hawaii	129,137	71,699	53,673	254,509	10.7	5.3	3.8	21.0

SOURCE: U.S. Census Bureau, 2005. Population Division, Interim State Population Projections, 2005. Internet Release Date: April 21, 2005

In the Northeast, the state exhibiting the greatest percentage increase is New Hampshire, while New York will see a much smaller percentage increase in population. However, the population bases of the two states are significantly different, with New Hampshire starting from about 1.25 million people in 2000 and New York starting from almost 19 million people in 2000. Thus, while New York only grows about two and one half percent between 2000 and 2030, its population will increase by almost one half million. If that growth rate continues out to 2050, then there would be another half a million added to New York by then. That is the equivalent of adding a little more than two and one half Washington, D.C.s to the state between 2000 and 2050. Furthermore, it seems likely that most of the growth in New York will actually occur in close proximity to New York City. If that is combined with the forecast growth in New Jersey and Connecticut, most of which will most likely occur close to New York City, then, while the percentage increases may not look great, the end result will continue to be the dominance of New York as the largest metropolitan area in the country, by at least an order of magnitude.

Table 6.4: Interim Projections: Percent Change in Population by Region – 2000 to 2030	
Region	
United States	29.2 Percent
Northeast	7.6 Percent
Midwest	9.5 Percent
South	42.9 Percent
West	45.8 Percent

SOURCE: U.S. Census Bureau, Population Division, Interim State Population Projections, 2005

Table 6.5: Interim Projections: Percent Distribution of Population Growth by Region – 2000 to 2030	
Region	
Northeast	5.0 Percent
Midwest	7.4 Percent
South	52.4 Percent
West	35.2 Percent

SOURCE: U.S. Census Bureau, Population Division, Interim State Population Projections, 2005

Table 6.6: Interim Projections: Percent Distribution of Population by Region – 2000 to 2030

Region	2000	2005	2010	2015	2020	2025	2030
U.S.	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Northeast	19.0	18.5	18.1	17.5	17.0	16.4	15.9
Midwest	22.9	22.3	21.8	21.3	20.7	20.0	19.4
South	35.6	36.2	36.8	37.4	38.0	38.7	39.4
West	22.5	22.9	23.4	23.8	24.3	24.8	25.3

SOURCE: U.S. Census Bureau, Population Division, Interim State Population Projections, 2005

Table 6.7: Interim Projections: Percent Change in Population by Region – 2000 to 2030

Region	2000-05	2005-10	2010-15	2015-20	2020-25	2025-30
West	7.3	6.5	6.4	6.3	6.3	6.2
South	6.7	6.2	6.0	5.9	5.9	6.0
Midwest	2.5	2.1	1.7	1.3	0.8	0.7
Northeast	2.3	1.8	1.4	1.0	0.6	0.3

SOURCE: U.S. Census Bureau, Population Division, Interim State Population Projections, 2005

Modest growth will be the essential characteristic of population change in the Midwest, with the exception of Minnesota that will show increases comparable to some of the southern and western states. Missouri, Wisconsin and Indiana will also experience moderate growth rates, but the remainder of the states will see slower growth rates – with North Dakota experiencing actual decline.

It is our expectation, at this juncture, that the patterns of growth in the metropolitan areas described above will continue throughout the period from 2000 to 2030. For example, it seems likely that most of the growth forecast for Minnesota will occur in the Minneapolis-St. Paul metropolitan area. Similarly, in Texas, we would expect to see much of the anticipated growth occurring in San Antonio, the Dallas-Forth Worth Metroplex, Houston and Austin. This is not to say there would not be gains in El Paso, Lubbock, etc., but rather those gains will not be sufficient to alter their relative positions in the metropolitan hierarchy in Texas. Thus, our expectation is that the metropolitan areas of today will be the areas attracting most of the population growth forecast for the respective states. There may be some shifts in these population trends because of climate and environmental issues discussed later. But, at present, the current prevailing growth patterns would seem likely to continue in this timeframe.

In Table 6.8 we see the total population projected for the United States will be close to 420 million by 2050. While there are many exogenous factors currently manifesting themselves that could alter these forecasts (see Chapter 9), at present it is not possible to know how these are likely to play out in the demographic mix of the world and the U.S. As discussed in Chapters 9, 10 and 11, our transportation policies, plans and models are going to have to become much sensitive to how these population and demographic shifts may take place. Unless there are some catastrophic events that occur (again, see Chapter 9), the trend in the U.S., and the world, is for increasing numbers of people in the urban areas and fewer in the rural parts of the countries. These trends will do nothing but exacerbate congestion and freight transportation issues. It is imperative that, at least in this country, we get out in front of these developmental issues so that more cost-effective transportation options are not foreclosed by in-place land use and infrastructure investments and residential patterns.

Table 6.8: Interim Projections Total Population – 2000 – 2050

	2000	2010	2020	2030	2040	2050
Total Population	281,421,906[a]	308,935,581[a]	335,804,546[a]	363,584,435[a]	391,946,000	419,854,000

SOURCE: U.S. Census Bureau, 2004, "U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin," <http://www.census.gov/ipc/www/usinterimproj/> Internet Release Date: March 18, 2004.

a Estimates drawn from Table 6.2: SOURCE: U.S. Census Bureau, 2005. Population Division, Interim State Population Projections, 2005. Internet Release Date: April 21, 2005

Chapter 7: Highway Congestion in the United States

The purpose of this chapter is to briefly describe the problem of highway congestion in the U.S., types of solutions that have been adopted/recommended and typical results of those solutions. In addition, we discuss in more detail the current congestion issues in metropolitan areas and the possible congestion issues for those areas based upon current forecast population growth.

The Highway Congestion Phenomenon

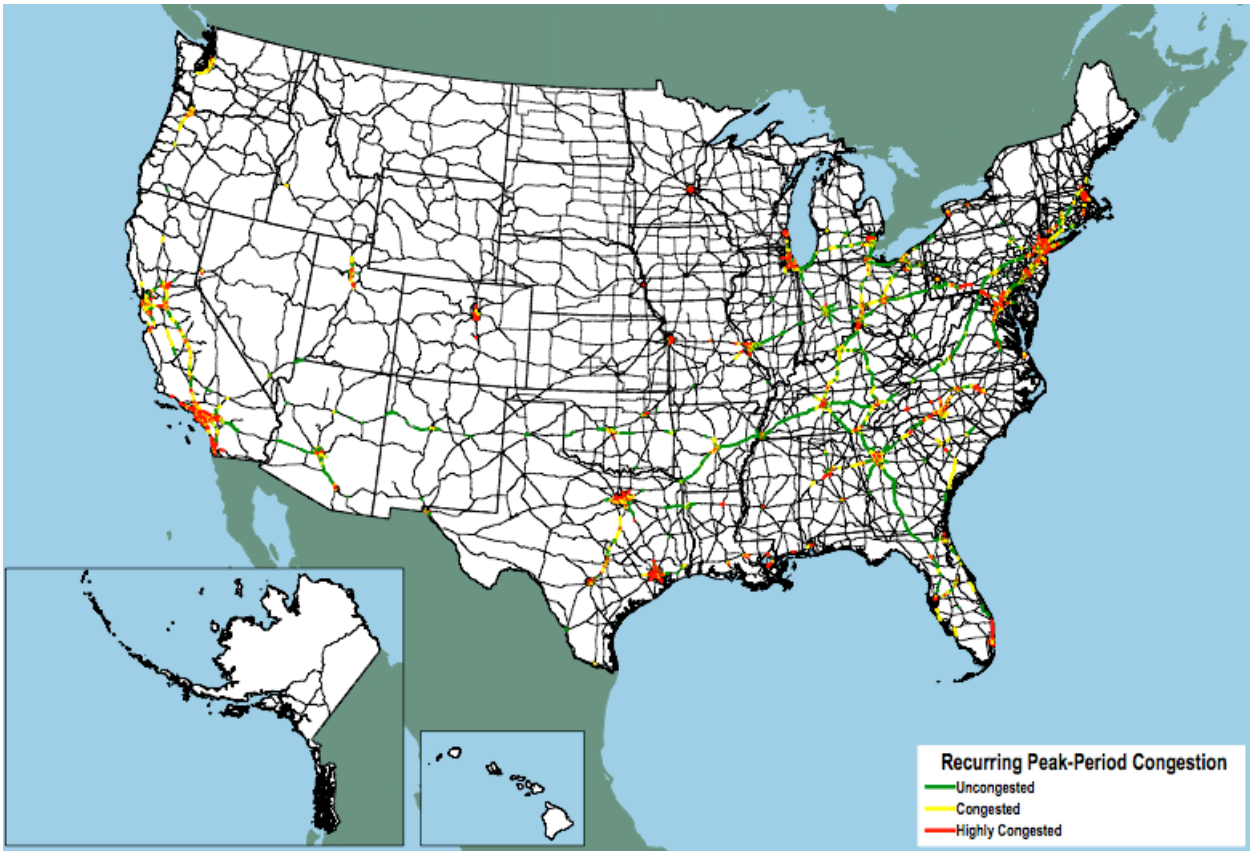
As recently summarized by the Congressional Research Service, congestion on the nation's road and railroad networks, at seaports and airports, and on some major transit systems is a significant problem for many transportation users, especially commuters, freight shippers, and carriers. Some observers argue congestion has already reached crisis proportions. Other commentators are less worried. They believe congestion is a minor impediment to mobility, the by-product of prosperity and accessibility in economically vibrant places, or the unfortunate consequence of over reliance on cars and trucks that causes more important problems such as air pollution and urban sprawl. However, trends underlying the demand for freight and passenger travel — population and economic growth, the urban and regional distribution of homes and businesses, and international trade — suggest that pressures on the transportation system are likely to grow substantially over the next 30 years (Mallett, 2007).

It has been argued that the nation is entering the early stages of a freight transportation capacity crisis. The last several decades have witnessed steady growth in the demand for freight transportation in the United States, driven by economic expansion and global trade. But freight transportation capacity, especially highway capacity, is expanding too slowly to keep up with demand, and the freight productivity improvements gained though investment in the Interstate highway system and economic deregulation of the freight transportation industry in the 1980s are showing diminishing returns. The effects of growing demand and limited capacity are felt as congestion, upward pressure on freight transportation prices, and less reliable trip times as freight carriers struggle to meet delivery windows (FHWA, 2005).

Freight congestion problems are most apparent at bottlenecks on highways: specific physical locations on highways that routinely experience recurring congestion and traffic backups because traffic volumes exceed highway capacity. Bottlenecks are estimated to account for about 40 percent of vehicle hours of delay. The balance—about 60 percent of delay is estimated to be caused by nonrecurring congestion, the result of transitory events such as construction work zones, crashes, breakdowns, extreme weather conditions, and suboptimal traffic controls (FHWA, 2005).

Not surprisingly, and as suggested in Chapter 4, recurring congestion caused by volumes of passenger vehicles and trucks that exceed capacity on roadways during peak periods is concentrated primarily in major metropolitan areas. In 2002, peak-period congestion resulted in traffic slowing below posted speed limits on more than 10,600 miles of the NHS and created stop-and-go conditions on an additional 6,700 miles in 2002. Interstate commerce is most affected on congested segments that carry at least 10,000 trucks per day, including 3,300 miles with slowed traffic and an additional 3,000 miles with stop-and-go conditions. Congested highways carrying a large number of trucks substantially impede interstate commerce, and trucks on those segments contribute significantly to congestion. Recurring congestion slows or stops traffic on over 6,300 miles of the NHS that carry more than 10,000 trucks per day (FHWA, 2008). Figure 7.1 portrays these conditions for 2002.

Figure 7.1: Peak-Period Congestion on High-Volume Truck Portions of the NHS: 2002

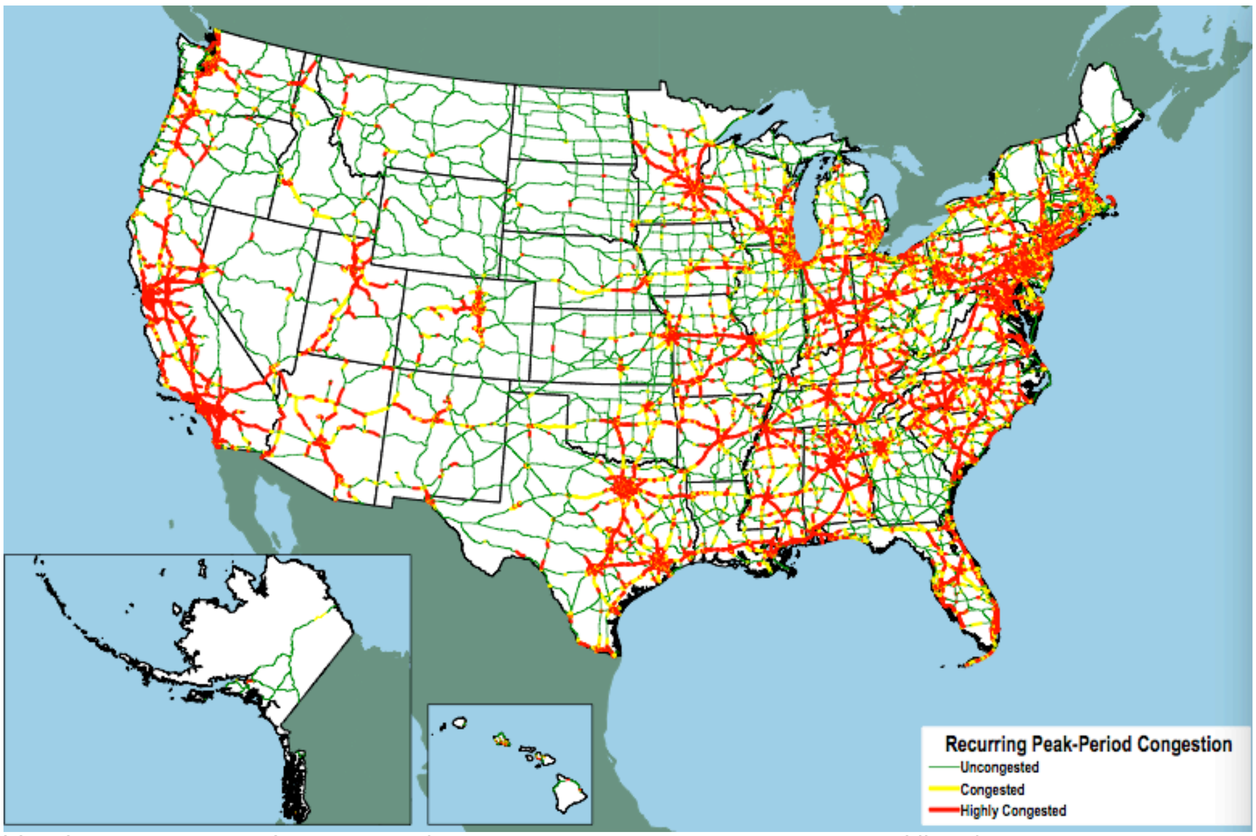


SOURCE: FHWA, 2008: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007.

Note: High-volume truck portions of the National Highway System carry more than 10,000 trucks per day, including freight-hauling long-distance trucks, freight-hauling local trucks, and other trucks with six or more tires. Highly congested segments are stop-and-go conditions with volume/service flow ratios greater than 0.95. Congested segments have reduced traffic speeds with volume/service flow ratios between 0.75 and 0.95.

Assuming no changes in network capacity, increases in truck and passenger vehicle traffic are forecast to expand recurring, peak- period congestion to 40 percent of the NHS in 2035 compared with 11 percent in 2002. This will slow traffic on nearly 20,000 miles of the NHS and create stop-and-go conditions on an additional 45,000 miles. The number of NHS miles with recurring congestion and a large number of trucks is forecast to increase four fold between 2002 and 2035. On highways carrying more than 10,000 trucks per day, recurring congestion will slow traffic on more than 4,800 miles and create stop-and-go conditions on an additional 23,300 miles (FHWA, 2008). Figure 7.2 illustrates these conditions for 2035.

Figure 7.2: Peak-Period Congestion on the NHS: 2035



SOURCE: FHWA, 2008. U. S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information, Highway Performance Monitoring System, and Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2007.

Note: Highly congested segments are stop-and-go conditions with volume/service flow ratios greater than 0.95. Congested segments have reduced traffic speeds with volume/service flow ratios between 0.75 and 0.95.

Bottlenecks on highways that serve high volumes of trucks are "freight bottlenecks." They are found on highways serving major international gateways like the Ports of Los Angeles and Long Beach, at major domestic freight hubs like Chicago, and in major urban areas where transcontinental freight lanes intersect congested urban freight routes. Freight bottlenecks are a problem today because they delay large numbers of truck freight shipments. Trucking is heavily exposed to congestion because it is the dominant freight transportation mode. According to the 2002 Commodity Flow Survey, trucks carried 67 percent of domestic shipments by tons, 74 percent by value, and 40 percent by ton-miles. Thus, delays will become increasingly problematic in the future as the U.S. economy grows and generates more demand for truck freight shipments. If the U.S. economy grows at a conservative annual rate of 2.5 to 3 percent over the next 20 years, domestic freight tonnage will almost double and the volume of freight moving through the largest international gateways may triple or quadruple. Without new strategies to increase capacity, congestion at freight bottlenecks on highways may impose an unacceptably high cost on the nation's economy and productivity (FHWA, 2005).

Trucking will be more exposed to congestion in the future. FHWA projects that between 1998 and 2020 domestic freight volumes will grow by more than 65 percent, increasing from 13.5 billion tons to 22.5 billion tons. Trucks are expected to move over 75 percent more tons in 2020, capturing a somewhat larger share of total freight tonnage than currently. To carry this freight, truck VMT is expected to grow at a rate of more than three percent annually over the same period (FHWA, 2005).

Without major capacity investments, FHWA estimates that by 2020, 29 percent of urban National Highway System routes will be congested or exceed capacity for much of the day and 42 percent of National Highway System routes will be congested during peak periods. By comparison, only 10 percent of the urban National Highway System routes were congested in 1998 (FHWA, 2005).

Urban Interstate highways, the portion of the National Highway System that carries the most freight trucks, are and will continue to be the most traveled segments. Urban Interstate highways, the portion of the National Highway System that carries the most freight trucks, are and will continue to be the most traveled segments. FHWA estimates that the percentage of urban Interstate sections carrying more than 10,000 trucks per day will increase from 27 percent in 1998 to 69 percent in 2020. They further estimate that approximately 53 percent of urban Interstate mileage will be congested in 2020 as compared to about 20 percent today. These statistics suggest that, as congestion increases in the coming decades, the speed and reliability of truck freight transportation will deteriorate and costs to shippers and receivers may rise (FHWA, 2005).

Although transportation congestion continues to grow and intensify, the problem is geographically concentrated in major metropolitan areas, at international trade gateways, and on some intercity trade routes. Because of this geographical transportation congestion, most places and people in America are not directly affected by transportation congestion. Consequently, Federal transportation policy has continued to treat this as a state or local issue, best addressed at that level. For example, in recent federal law, Congress, for the most part, has allowed states and localities to decide the relative importance of congestion mitigation vis-a-vis other transportation priorities. This has been accompanied by a sizeable boost in funding for public transit and a more moderate boost in funding for traffic reduction measures as part of a patchwork of relatively modest federally directed congestion programs (Mallett, 2007).

It seems likely that surface transportation congestion will be a major issue that will come before Congress as it considers reauthorization of the Safe, Accountable, Flexible, Efficient Transportation Act – A Legacy for Users (SAFETEA), P.L. 109-59, set to expire on September 30, 2009. Whether this will become part of the new Administration’s major infrastructure reinvestment program or dealt with in some other legislative manner, remains to be seen. Nevertheless, congestion mitigation in some form will probably be part of any legislative initiative regarding infrastructure in the forthcoming

Congressional deliberations.

As Mallett notes, Congress may decide to continue with funding flexibility in its reauthorization of the surface transportation programs. In this scenario, states and localities that suffer major transportation congestion would be free to devote federal and local resources to congestion mitigation if they wish. Likewise, congestion-free locales would be able to focus on other transportation-related problems, such as connectivity, system access, safety, and economic development. Alternatively, the Administration and Congress may want to more clearly establish congestion abatement as a national policy objective, given its economic development impact, and take a less flexible and, in other ways, more aggressive approach to congestion mitigation. Regardless of the approach chosen, at least three basic elements need to be considered: (1) the overall level of transportation spending, (2) the prioritization of transportation spending, and (3) congestion pricing and other alternative ways to ration transportation resources with limited government spending (Mallett, 2007).

While we will argue in this report the country needs to promulgate a national transportation policy and program – the first since the Eisenhower Administration's Interstate Highway System – it is useful to briefly consider the advantages and disadvantages of specific transportation congestion remedies. Thus, a discussion of the three basic types of congestion remedies proposed by engineers and planners follows. These include: adding new capacity, operating the existing capacity more efficiently, and managing demand.

Transportation Congestion: Concepts, Measures and Trends

Transportation congestion exists when demand for a transportation facility or vehicle is greater than its capacity and the excess demand causes a significant drop in service quality, such as speed, cost and comfort, depending upon the mode and specific situation. For example, when too many drivers compete for road space this usually results in a significant drop in traffic speed, as well as higher vehicle operating costs and, with bumper-to-bumper, stop-and-go conditions, an increase in driver stress. From the perspective of multi-modal freight shipments, the possibility exists for congestion not only within each mode, but also in the connection between modes. Poor or overstretched intermodal connections are another part of the transportation system that can damage service quality. In addition, inefficient intermodal connections may cause problems within a mode as unexpected delays interfere with other shipments farther down the line. For example, a delayed ship-to-truck transfer in a major metropolitan area may result in the truck traveling during peak-period traffic (Mallett, 2007).

In an ideal world, transportation congestion would be defined and measured from the perspective of the end user – the recipient of a freight shipment. Congestion would then be measured by the extent to which excess demand slows or otherwise harms a freight shipment from the origin to the destination (Giglio, 2005). Unfortunately, we do not live in an ideal world. With the exception of those situations where there is an integrated logistics supply-line that tracks each shipment from origin to destination, it is difficult to measure trips from origin to destination in a large scale and meaningful way. Thus, measures of congestion typically focus on service problems within a mode. Further, within each mode, many congestion measures are limited to a specific transportation facility. This is particularly true in highway transportation. For example, highway engineers typically refer to speed or level of service (LOS) on a particular road segment. Sometimes, measurements on these segments are aggregated to develop a systemwide measure of highway congestion (Mallett, 2007). As we saw in the table we constructed using FHWA data (Table 3.1), to identify metropolitan areas with significant truck bottlenecks, the data are based upon specific interchange or other chokepoints on the roadway network.

Mode-specific and facility-specific measures of congestion are not wholly satisfactory indicators of capacity problems in transportation service because they fail to measure aggregate impacts across the whole system. However, some transportation experts argue that the focus on facility congestion instead of the effect of congestion on freight trips overstates its importance. They suggest that the impact of freight bottlenecks may not be as bad as is generally believed if seen from the perspective of the entire supply chain (Mallett, 2007).

Another criticism of transportation-based congestion measures is that they ignore the land-use context within which travel is taking place. In short, they measure mobility, not accessibility (Mallett, 2007). In addition, such measures do not account for the environmental impacts of such congestion in the corridors in which they occur. Unfortunately, national data do not exist that would allow us to examine the effects of congestion on accessibility as opposed to mobility. Nor are there the means to examine the effects of congestion on freight shipments from end-to-end, including the efficiency of intermodal connections. The transportation congestion measures discussed in the literature, including those we reference in this report, are both facility- and modally-based. Several measures of congestion, particularly freight rail (as we discuss separately) are gross indicators of capacity utilization using aggregate measures across the whole system. Further, no measures of intermodal terminal congestion per se exist. For a more detailed summary and critique of congestion measures, see the CRS report (Mallett, 2007). However, the measures of congestion used in this report represent the best available information today using publicly available data.

Regardless of the limitation in measurements and congestion data, it is generally agreed that urban road traffic congestion has intensified and become more widespread during the past quarter century. For example, for the period 1982 through 2005, TTI data indicate that total travel delay has increased over five-fold and delay per peak-period traveler has tripled -- Table 7.1 (Shrank and Lomax, 2007). On average, delay increases with city size, but delay in small urban areas (population >500,000) has grown more quickly during this time period. Delay is five times larger overall, but six times higher in regions with fewer than 1 million people. Further, the morning and evening peak periods have lengthened and a greater share of roadways are congested (Shrank and Lomax, 2007).

Despite becoming more widespread, road traffic congestion is still heavily concentrated in a few of America’s largest urban places. For example, the ten largest urban areas by population account for 60% of total delay, although accounting for only about 25% of the U.S. population. The top 20 urban areas account for 80% of the total and only 35% of the population (Mallett, 2007).

Congested Metropolitan Areas

In a recent report focusing on mobility and congestion in urban areas in the U.S., it is clear that congestion is a problem in America's 437 urban areas and it is getting worse in regions of all sizes. For almost all urban areas that were intensively studied, and for urban America as a whole, there was more delay, more wasted fuel and higher congestion cost in 2005 than in 2004. The conclusion of this report is that congestion is worse in urban areas of all sizes.

The data show congestion caused urban Americans to travel 4.2 billion hours more and to purchase an extra 2.9 billion gallons of fuel for a congestion cost of $78 billion (Table 7.1). This was an increase of 220 million hours, 140 million gallons and $5 billion from 2004. As the authors state, "**THE** solution to this problem is really to consider implementing **ALL** the solutions." One of the lessons they draw from more than 20 years of mobility studies is that congestion relief is not just a matter of highway and transit agencies building big projects. Those are important. But so are actions by businesses, shippers, manufacturers and employers, as well as commuters, shoppers, and travelers for all reasons. In their words, it takes agencies, businesses and commuters taking actions jointly and individually to achieve congestion relief (Shrank and Lomax, 2007).

What are some of the causes of congestion in metropolitan areas? First, the 100 largest metropolitan regions contribute 70 percent of the gross domestic product and have 69 percent of the jobs (Global Insight, 2007). It is not surprising that congestion exists in large areas given the number of people and the amount of freight moving in many directions over the course of two peak periods of two or three hours each. So the first cause of congestion is many people and lots of freight moving at the same time (Shrank and Lomax, 2007).

The second cause is the slow growth in supply—both roads and public transportation—in the last 20 years. Congestion has increased even though there are more roads and more transit service. Urban road traffic congestion has increased because motor vehicle travel has grown rapidly, outstripping the existing road capacity and efforts to add new capacity and improve throughput with operational treatments. Travel by public transportation riders has increased 30 percent in the 85 urban areas studied in the TTI report. Nevertheless, overall travel has increased 105 percent in big metro regions while road capacity on freeways and major streets has grown by only 45 percent (Shrank and Lomax, 2007). In short, there are too many people, too many trips over too short of a time period on a system that is too small (FHWA, 2006; FTA, 2007).

Table 7.1: Major Findings for 2007 –
The Important Numbers for The 437 U.S. Urban Areas

(Note: Improved methodology and more urban areas than 2005 Report)				
Measures of…	**1982**	**1995**	**2004**	**2005**
… Individual Traveler Congestion				
Annual delay per peak traveler (hours)	14	31	37	38
Travel Time Index	1.09	1.19	1.25	1.26
“Wasted" fuel per peak traveler (gallons)	9	21	25	26
Congestion Cost (constant 2005 dollars)	$260	$570	$680	$710
Urban areas with 40+ hours of delay per peak traveler	1	11	28	28
… The Nation’s Congestion Problem				
Travel delay (billion hours)	0.8	2.5	4.0	4.2
“Wasted” fuel (billion gallons)	0.5	1.7	2.7	2.9
Congestion cost (billions of 2005 dollars	$14.9	$45.4	$73.1	) $78.2
… Travel Needs Served				
Daily travel on major roads (billion vehicle-miles)	1.67	2.79	3.62	3.73
Annual public transportation travel (billion person-miles)	35.0	36.4	44.7	45.1
… Expansion Needed to Keep Today’s Congestion Level				
Lane-miles of freeways and major streets added every year	19,233	17,254	15,677	16,203
Daily public transportation riders added every year (million)	14.5	14.9	16.0	16.5
… The Effect of Some Solutions				
Travel delay saved by				
Operational treatments (million hours)	N/A	N/A	270	292
Public transportation (million hours)	255	396	543	541
Congestion costs saved by				
Operational treatments (billions of 2005 dollars)	N/A	N/A	$5.0	$5.4
Public transportation (billions of 2005 dollars)	$4.9	$7.4	$10.1	$10.2

N/A – No Estimate Available. Pre-2000 data do not include effect of operational strategies.
Travel Time Index (TTI) – The ratio of travel time in the peak period to travel time at free-flow conditions. A Travel Time Index of 1.35 indicates a 20-minute free-flow trip takes 27 minutes in the peak.
Delay per Peak Traveler – The extra time spent traveling at congested speeds rather than free-flow speeds divided by the number of persons making a trip during the peak period.
Wasted Fuel – Extra fuel consumed during congested travel.
Vehicle-miles – Total of all vehicle travel (10 vehicles traveling 9 miles is 90 vehicle-miles).
Expansion Needed – Either lane-miles or daily riders to keep pace with travel growth (and maintain congestion).

Source: Schrank and Lomax, 2007.

Motor vehicle travel has grown rapidly for a number of reasons, including substantial growth in population, jobs, and national income; increased vehicle availability; and growth in metropolitan areas, particularly the suburbs. Between 1980 and 2000, the

United States added 55 million people (a 24% increase), 38 million jobs (a 38% increase), 64 million motor vehicles (a 40% increase), and gross domestic product (GDP) grew by 90% in real terms (U.S. Bureau of the Census, 2006; USDOT, 2006; U.S. Bureau of Economic Analysis). Both population and job growth have been concentrated in metropolitan areas, most especially in low-density suburban rings that are difficult to serve with public transit. A metropolitan suburb-to-suburb commute is today, by far, the most common type of commute. As result, most people drive alone to work — 76% in 2000, up from 64% in 1980. Over the same period, the share of commuters using transit hovered around 5% (Pisarski, 2006). There has been a recent uptick in transit usage nationwide as the price of fuel escalated to the $4.00/gallon range. It remains to be seen whether this increase in transit usage will continue with the more recent drop in fuel prices. We return to this subject in Chapter 10.

These trends have been enhanced by an increase in the number, and widespread availability, of motor vehicles. The number of personal motor vehicles (cars, sport-utility vehicles, pickups, and minivans) per licensed driver passed 1.0 some years ago and continues to climb. In 2005, the average number of personal motor vehicles per driver was 1.16. That same year, only about 8% of households were without a vehicle (U.S. Census Bureau and U.S. Department of Housing and Urban Development, 2006). The low price of gasoline has also contributed to enhancing the attractiveness of motor vehicles as a transportation option. For about 20 years beginning in the mid-1980s, the pump price of gasoline was below $2.00 per gallon (in 2006 dollars) in real terms, lower than at any time since 1918 (American Petroleum Institute, 2007). As noted above, the real price of gasoline has escalated dramatically in the past year, with a concomitant change in automobile travel.

Not surprisingly, many of these same factors — population and income growth — in conjunction with economic complexity and globalization have led to more demand for commercial truck transportation. Since 1980, truck traffic has grown slightly faster than passenger traffic. Although a lot of truck mileage is made on long intercity trips, about half of truck VMT is made in urban areas, contributing significantly to urban traffic congestion, particularly near urban-based industrial facilities, ports, and border crossings (FHWA, 2006).

It is expected that many of the same factors generating vehicle travel and congestion will continue growing. As discussed in Chapter 6, the Census Bureau expects the population to reach almost 364 million by 2030, an increase of about 20% from 2006 (U.S. Census Bureau, 2006). Two-thirds of this population growth, and with it a significant portion of new road traffic, is expected to occur in just seven states: Florida, California, Texas, Arizona, North Carolina, Georgia, and Virginia. Over the same period, the CBO projects that GDP will increase by about 70% (in real terms) (Congressional Budget Office, 2005). The annual growth rate of state-based future VMT is projected to be 1.92%, with rural VMT growing somewhat faster than urban areas (2.15% average annual versus 1.79%) (FHWA, 2007a, and FTA, 2007). Similarly, The Freight Analysis Framework projects that freight tonnage by truck will double between 2002 and 2035 (FHWA, 2007a).

A third factor causing trips to be delayed is events that are irregular, but frequent. Crashes, vehicle breakdowns, improperly timed traffic signals, special events and weather are factors that cause a variety of traffic congestion problems. The effects of these events are made worse by the increasing travel volumes. The solutions to each of these problems are different and are usually a combination of policies, practices, equipment and facilities (Shrank and Lomax, 2007).

According to recent research, about 40% of urban road traffic congestion is caused by capacity problems and another 5% is caused by poor signal timing. About 55% of congestion is the result of a temporary loss of capacity, with incidents (crashes, disabled vehicles, etc.) accounting for 25%, weather 15%, work zones 10% and other events 5% (Cambridge Systematics and Texas Transportation Institute, 2005).

As is evident from the above comments, the supply of solutions is not being implemented at a rate anywhere near the rate of travel demand growth. This is because there is not a single congestion problem. There are several problems and therefore several solutions.

Transportation Congestion Remedies

It is no surprise many potential solutions for congestion have been proposed by transportation engineers and planners. It is beyond the scope of this report to evaluate or describe all of these remedies, but it is worthwhile to characterize some of the major solutions to provide a context for our recommendations regarding potential roles for short line and regional railroads for addressing some of the metropolitan congestion problems. It is possible to classify the many different remedies into three classes: adding new capacity; operating the existing capacity more efficiently; and managing demand.

Building New Capacity

Frequently, when the discussion of adding capacity is raised it is done so in terms of new roadways and/or new transit facilities, vehicles, routes, etc. While adding new freight rail capacity may help in reducing truck volumes, and thus congestion in urban areas, this has not been a primary focus over the last decade or so since congestion became an increasing issue. (We discuss rail congestion and capacity issues subsequently – Chapter 8.)

One approach to reducing congestion is to build new roads or expand existing ones. Those who argue for road building point to the fact that since completion of the interstate system, road construction has generally lagged behind the growth in motor vehicle travel. Further, they argue that lack of capacity is the major contributor to road congestion in some places (Mallett, 2007). There is some evidence to support this argument, for example, the TTI analyses found that adding road capacity slowed the growth in travel delay (Shrank and Lomax, 2007). Adding new roadway capacity can range from major new freeways to bottleneck reduction projects, to much smaller projects, such as widening arterial roads and improving street connectivity (Mallett, 2007).

There is little disagreement that highway travel has grown more than highway capacity during the past few decades. However, there is major disagreement about whether new road capacity, absent toll pricing, can solve congestion because of the problem of induced demand. Other concerns about major road expansions include the costs of labor and raw materials, right-of-way acquisition in heavily developed urban areas and social and environmental disruptions. The cost of raw materials has increased dramatically in the past few years (partly due to the rapid escalation in transportation costs of these materials and partially as the result of rapidly increasing world-wide demand for steel, cement, asphalt, etc.). In addition, the amount of time it takes to plan, design and build major new facilities has dramatically increased – TTI estimates anywhere from 10 to 15 years for major improvements (Shrank and Lomax, 2007). Thus, it is argued by some experts that once congestion has developed it is very hard for an area to build its way out of the problem because of the time it takes to add new capacity, notwithstanding the innovative ways that complex projects have been recently completed using mixed design-build strategies (Mallett, 2007; Shrank and Lomax, 2007).

It has also been argued that road congestion is a problem because other viable means of transportation are not widely available. The hypothesis here is that new or expanded public transportation service is a major solution to urban road traffic congestion. Some of the evidence used to buttress this case comes from TTI's analyses which show that if public transportation service was discontinued and the riders traveled in private vehicles in the 437 urban areas studied, there would be an additional 541 million hours of delay and 340 million more gallons of fuel consumed in 2005, one-third more than a decade ago. The value of the delay and fuel that would be consumed if there were no public transportation service would be an additional $10.2 billion in congestion costs, a 13 percent increase over current levels in the 437 urban areas studied (Shrank and Lomax, 2007).

A variant on building more capacity is to relieve the chokepoints through solutions that range from quick and cheap to the complex, lengthy and expensive. For example, in Minneapolis, about 250 miles of freeway shoulder are used to allow buses to bypass stop-and-go traffic. This saves time and provides a much more reliable time schedule for public transportation riders. The routes that use the shoulders had a 9.2 percent ridership increase over a two-year period when the overall system ridership decreased 6.5 percent. This result demonstrates the favorable passenger reaction to improved speed and reliability attributes (Shrank and Lomax, 2007).

Improving Productivity of Existing Capacity

Another way to get more productivity out of the existing systems at relatively low costs is to more efficiently operate roads and public transportation. Some of these changes can be accelerated by information technology, some are the result of design changes and some are the result of more aggressive operating practices.

Shrank and Lomax highlight (see Table 7.2) the benefits of four operational treatments that, if deployed to all 437 urban areas in the U.S., could yield significant benefits in terms of hours and dollars saved (not included in these calculations are the benefits derived from reduced emissions of noxious pollutants). What is particularly appealing about these types of solutions is that they are relatively inexpensive and can be enacted much more quickly than significant roadway or public transportation expansions (Shrank and Lomax, 2007).

Table 7.2: Operational Improvement Summary for All 437 Urban Areas

Operations Treatment	Delay Reduction from Current Projects		Possible Delay Reduction if Implemented on All Roads (Million Hours)
	Hours Saved (Million)	Dollars Saved ($ Million)	
Ramp Metering (25)	38.6	733	106.2
Incident Management (272)	129.5	2,493	222.6
Signal Coordination (437)	21.0	451	55.5
Access Management (437)	68.2	1,376	180.2
TOTAL	257	5,053	565

SOURCE: Shrank and Lomax, 2007.

Note: This analysis uses nationally consistent data and relatively simple estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of information obtained from source databases.

Note: This operational treatment benefit summary does not include high-occupancy vehicle lanes.

These four treatments may be summarized as follows (Shrank and Lomax, 2007):

- Freeway Entrance Ramp Metering:

  Entrance ramp meters regulate the flow of traffic on freeway ramps using traffic signals similar to those at street interchanges. They are designed to create more spacing between entering vehicles so those vehicles do not collide or disrupt mainline traffic flow.

- Freeway Incident Management Programs

  Freeway Service Patrol, Highway Angel, Highway Helper, The Minutemen and Motorist Assistance Program are all names that have been given to operations that remove crashed and disabled vehicles from freeway lanes and shoulders. They work in conjunction with surveillance cameras, cell phone incident report call-in programs and other mechanisms to remove these disruptions, decrease delay and fuel consumption and improve the reliability of the system.

- Traffic Signal Coordination Programs

  Traffic signal timing can be a significant source of delay on the major street system. Much of this delay is the result of managing the flow of intersecting traffic, but some of the delay can be reduced if the traffic arrives at the intersection when the signal is green instead of red. This remedy is difficult to implement successfully in complex urban environments and when traffic volumes are very high. In these situations, coordinating the signals does not work as well due to the long lines of cars already waiting to get through the intersection in both directions.

- Traffic Access Management Programs

Providing smooth traffic flow and reducing collisions are the goals of a variety of individual treatments that make up a statewide or municipal access management program. Typical treatments include:

- Combining driveways to minimize the disruptions to street traffic flow
- Increasing the spacing between intersections
- Median turn lanes or turn restrictions
- Acceleration and deceleration lanes
- Development regulations that help reduce the potential collision and conflict points

Such programs are a combination of design standards, public sector regulations and private sector development actions.

Managing Demand

The use of the transportation network by travelers can be modified to accommodate more demand and reduce congestion. Examples would be using the telephone or internet for certain trips, traveling in off-peak hours and using public transportation and carpools. In addition, projects that use tolls or pricing incentives can be tailored to meet transportation needs and also address social and economic equity concerns (Shrank and Lomax, 2007).

Any of these changes will affect the way that travelers, employers and shippers conduct their lives and business. The impacts of these may not be inconsequential. The key will be to provide better conditions and more travel options primarily for work commutes, but there are also opportunities to change trips for shopping, school, health care and a variety of other activities (Shrank and Lomax, 2007).

Commuter trips comprise slightly less than 20 percent of all vehicular trips in the average urban area. However, they generally cluster around the most congested peak periods and are from the same origin to the same destination at the same time of day. These factors make commute trips by carpooling, vanpooling, public transit, bicycling and walking more viable options. Furthermore, alternative work arrangements, which could include flexible work hours, compressed work weeks and teleworking represent other options for shifting trips out of the peak periods. For more detailed discussion of these options, see *Still Stuck in Traffic* (Downs, 2004).

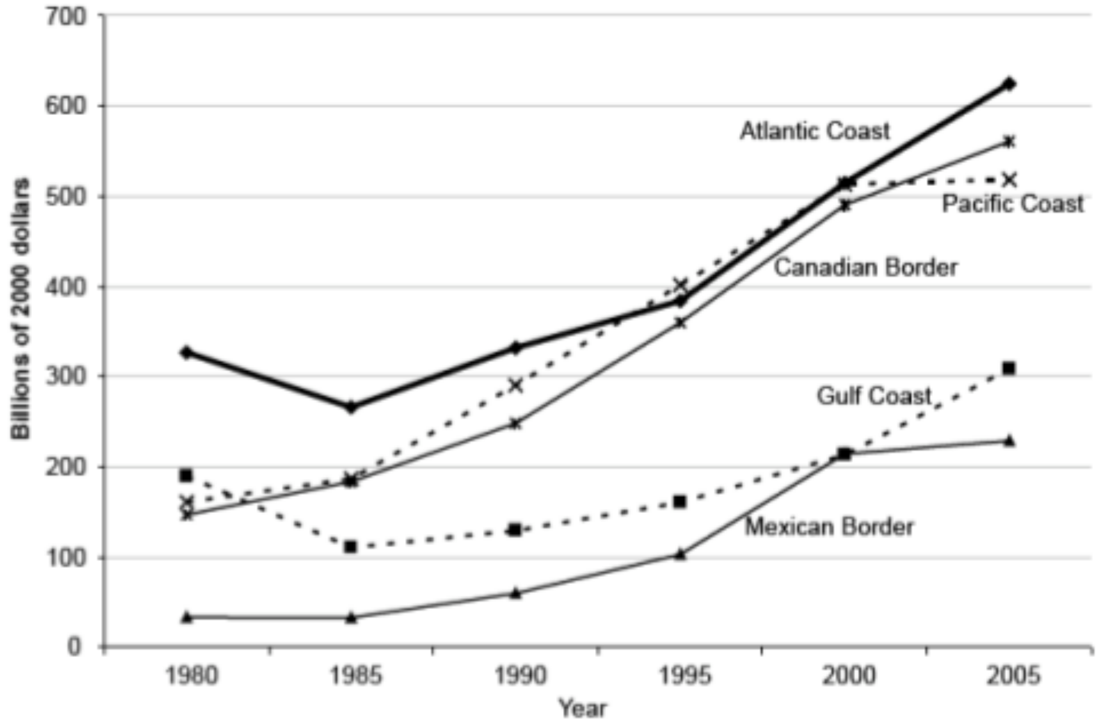
The goal of all of these programs is to move trips to uncongested times, routes or modes so that there is less congestion during peak hours and so that more trips can be handled on the current system. Getting more trips out of the existing system is analogous to increasing production in a manufacturing plant. If the current buses, cars and trains can carry more people to the places they want to go, there are benefits to society and the economy. At the same time, the role of phones, computers and the internet cannot be overlooked in examining the future role of commute options. New technologies are being used along with changes in business practices to encourage employers to allow jobs to be done from home or remote locations. These new technologies and practices might allow workers to avoid their commute a few days each month, or travel to their jobsites after a few hours of work at home in the morning, or some other variation on work days and hours (Shrank and Lomax, 2007).

Congestion at International Gateways

While not the focus of this report, it is important to recognize another significant impediment to freight movement into and out of this country – bottlenecks at foreign trade gateways. Rapid growth in international trade over the past decade has placed enormous pressure on land border crossings, certain ajrports and water ports, and the road and rail infrastructure that supports them. As shown in Figure 7.3, between 1980 and 2005, using inflation-adjusted dollars, international merchandise trade increased by more than 160% (American Highway Users Alliance, American Automobile Association and TRIP, 2005). This growth, in value terms, has been particularly rapid on the Mexican and Canadian borders and the Pacific Coast. Although, in terms of total dollar value, the Atlantic Coast continues to handle the most trade. There is every expectation these trends are likely to continue as globalization of production and consumption continues – FHWA expects foreign trade tonnage to more than double between 2002 and 2035 (FHWA, 2007a). In Chapter 10, we discuss some counter trends that may lead to a lower and slower growth rate of foreign trade.

Citing several studies, Mallett notes that numerous studies have found delay and unreliable travel times at certain heavily used crossings. At land crossings, congestion is caused by three main factors: inadequate transportation infrastructure to handle the volume of cars and trucks; import and security processing; and general urban road traffic congestion. There is also evidence that border delay and reliability problems have more to do with institutional and staff issues than infrastructure issues – although this may be crossing-specific. Likewise, delays at water ports may be the result of inadequate road and rail infrastructure, general road congestion and customs and security requirements. Certainly, one of the biggest challenges at international gateways since 9/11 has been balancing passenger and freight mobility with heightened security (Mallett, 2007).

Figure 7.3: U.S. Merchandise Trade by Region: 1980 — 2005



SOURCE: Mallett, 2007: U.S. Department of Transportation, Federal Highway Administration, *Freight Facts and Figures 2006*. Washington, DC, 2007.

Freight rail may have a significant role to play in helping reduce some of these forms of congestion, for example, run-through trains from Canada and Mexico, or direct ship-to-rail transfer in ports. However, those issues are beyond the scope of this report.

The Current Federal Response to Addressing Congestion

Finally, given that congestion, while a local issue, has implications for regional and national economic well-being, it is worth briefly looking at how the federal government proposes to be involved in addressing the phenomenon. The U.S. DOT has proposed to focus on the following six areas of emphasis (U.S. DOT, 2006b).

"Relieve urban congestion. The Department will seek to enter *Urban Partnership Agreements* with model cities, pursuant to which the cities and Department will commit to the following actions:

- Implementing a broad congestion pricing or variable toll demonstration;
- Creating or expanding express bus services, which will benefit from free flow traffic conditions;
- Securing agreements from major area employers to establish or expand telecommuting and flex scheduling programs; and
- Expediting completion of the most significant highway capacity projects currently underway that hold the greatest potential for reducing congestion and bottlenecks.

To the maximum extent possible, the Department will commit discretionary resources and expertise to support the above actions, including potentially Small Starts funds, Open Roads Pilot Program funds (if appropriated in FY '07), and Value Pricing Pilot Program funds. The Department will work to expedite completion of capacity projects through: i) inclusion of such projects on the Executive Order on Environmental Stewardship and Transportation Infrastructure Project Reviews; and ii) providing tolling flexibility, private activity bond borrowing authority, and TIFIA program credit assistance, if necessary."

"Unleash private sector investment resources. The Department will work to reduce or remove barriers to private sector investment in the construction, ownership, and operation of transportation infrastructure by:

- Developing an organized effort to encourage states to enact legislation enabling them to enter into infrastructure agreements with the private sector;

- Overcoming institutional resistance to reform through education, demonstrations and relationship building with state agencies and private investors/developers; and

- Utilizing existing Federal program authorities, including the major surface transportation legislation signed by President Bush last August, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), to encourage formation of public-private partnerships."

"Promote operational and technological improvements. The Department will work to advance low-cost operational and technological improvements that increase information dissemination and incident response capabilities by:

- Encouraging states to utilize their Federal-aid formula funds to improve operational performance, including providing better real-time traffic information to all system users;
- Emphasizing congestion reducing technologies in the implementation of the Intelligent Transportation Systems program; and
- Promoting best practices and identifying private sector partnering and financing opportunities to improve incident and intersection management (e.g., formation of roving response teams, enactment of quick clearance and "move it" laws, and deployment of adaptive intersections)."

"Establish a "Corridors of the Future" competition. The Department will accelerate the development of multi-state, multi-use transportation corridors by:

- Running a competition to select 3-5 major growth corridors in need of long-term investment;
- Convening a multi-state process to advance project development and seek alternative financial opportunities; and
- Fast-tracking major congestion reducing corridor projects that received funding in SAFETEA-LU."

"Target major freight bottlenecks and expand freight policy outreach. The Department will address congestion in the nation's freight system by:

- Transforming DOT's existing Gateway Team in Southern California into a larger Intermodal Hot Spot Team to convene the region's diverse freight stakeholder community to forge consensus on immediate and longer term transportation solutions;
- Engaging shippers from the retail, manufacturing, agricultural and technology sectors, as well as freight carriers and logistics firms, through a series of "CEO Summits," structured around the Department's National Freight Policy Framework; and
- Establishing a senior-level DHS-DOT border congestion team to prioritize operational and infrastructure improvements at the nation's most congested border crossings."

"Accelerate major aviation capacity projects and provide a future funding framework. The Department will address congestion in the aviation system by:

- Designing and deploying the Next Generation Air Transportation System – a modernized aviation system with greater capacity and less congestion;
- Improving efficiency and reducing delays at New York City's LaGuardia Airport. In the short-term this will involve replacing the current High Density Rule. In the longer-term, it will include a redesign of the region's airspace and the use of market-based tools to manage congestion at our most crowded airports;
- Giving priority treatment and agency resources to projects that enhance aviation system capacity; and
- Streamlining environmental reviews for aviation capacity projects."

What is most notable, from this author's perspective, is that, in 2006, with the exception of the mention of freight carriers and logistics firms in the proposed "CEO Summits," the Intermodal Hot Spot Team for Southern California and a senior-level DHS-DOT border congestion team, there is no explicit emphasis on addressing freight congestion or looking at the possibilities of rail as a means of reducing congestion across the nation. In short, there remains, in this U.S. DOT proposed set of activities, a noticeable failure to look at the transportation in the United States as a system that sits within a larger economic, social and environmental system.

By 2008, there is a noticeable shift in the federal response to freight congestion in the United States. Thus, we see in *Freight Story 2008* explicit recognition of the economic costs of congestion to the consumer and ultimately the national economy. In this study the various components of the freight transportation system are explicitly discussed in terms of capacity constraints and congestion, albeit on a mode-by-mode basis, with some recognition given to the interactions between different components of the freight system (FHWA, 2008).

As this report points out, the freight transportation challenge differs from that of urban commuting and other passenger travel in several ways:

> “• Freight moves long distances through localities and responds to distant economic demands. The majority of passenger travel occurs between local origins and destinations. Freight movement often creates local problems with no local benefits.
> • Freight movements fluctuate more quickly and in greater relative amounts than passenger travel. While both passenger travel and freight respond to long-term demographic change, freight responds more quickly to short-term economic fluctuations. Fluctuations can be national or local. The addition or loss of just one major business can dramatically change the level of local freight activity.
> • Freight movement is heterogeneous compared to passenger travel. Patterns of passenger travel tend to be very similar across metropolitan areas and among large economic and social strata. The freight transportation demands of farms, steel mills, and clothing boutiques differ radically from one another. Solutions aimed at average conditions are less likely to work because the freight demands of economic sectors vary so widely.
> • Improvements targeted at freight demand are needed as freight accounts for a larger share of the transportation system. Improvements targeted at general traffic or passenger travel are less likely to aid the flow of freight as an incidental by-product.”

Local public action is difficult to pull together because freight traffic, and the benefits of serving that traffic, rarely stay within a single political jurisdiction. One-half of the weight and two-thirds of the value of all freight movements cross a state or international boundary. While federal legislation established metropolitan planning organizations (MPOs) to coordinate transportation planning and investment across state and local lines within urban areas, freight corridors extend well beyond even the largest metropolitan regions and usually involve several states. To address these issues, creative and ad hoc arrangements are often required through pooled fund studies and multistate coalitions to plan and invest in freight corridors that span regions and even the continent. However, there are few institutional arrangements that coordinate this activity (FHWA, 2008).

The growing needs of freight transportation bring into focus conflicts between interstate and local interests. Many communities do not want the noise and other aspects of trucks and trains that pass through them with little benefit to the locality. But those through movements of freight can have a huge impact on national freight movement and regional economies (see the recent Jim Lehrer PBS Special on Freight Rail Bottlenecks, and the subsequent WWTT story on local concerns over the recent acquisition of the EJ & E by the Canadian National that has shifted a significant volume of through rail freight through communities, such as Barrington, IL).

Beyond the challenges of intergovernmental coordination, there are other issues involving the relationships between public and private sectors that arise. Almost all carriers and many freight facilities are privately owned. The private sector owns $985 billion in transportation equipment plus $558 billion in transportation structures. In comparison, public agencies own $486 billion in transportation equipment plus $2.4 trillion in highways. Freight railroad facilities and services are owned almost entirely by the private sector, while trucks, which are owned by the private sector, operate over public highways. Likewise, air cargo services owned by the private sector operate in public airways and mostly at public airports. Privately owned ships operate over public waterways and at both public and private port facilities. Most pipelines are privately owned but significantly controlled by public regulation (FHWA, 2008).

In the public sector, essentially, all truck routes are owned by state or local governments. Airports and harbors are typically owned by public authorities. Air and water navigation are usually handled at the federal level, and safety is regulated by all levels of government. As a consequence of this mixed ownership and management, most solutions to freight problems require joint action by both public and private sectors. Financial, planning, and other institutional mechanisms for developing and implementing joint efforts have been limited. This inhibits effective measures to improve the performance and minimize the public costs of the freight transportation system (FHWA, 2008).

Recently, freight has moved to the forefront of many debates and plans concerning transportation. The various stakeholders have increasingly expressed concerns that piecemeal improvements to the freight transportation system are not enough. The freight challenges outlined above require a wide range of activities by the private sector and all levels of government. These may be organized formally or informally to pursue common objectives.

Additional evidence of this interest in addressing freight transportation on a national level is found in the National Surface Transportation Policy and Revenue Study Commission support for the creation and funding of a national freight transportation program to implement needed infrastructure improvements. This program proposes to bring together local, state and federal interests to “provide public investment in crucial, high-cost transportation infrastructure,” especially on networks that carry large volumes of freight. In addition, public-private projects that have the potential to facilitate international trade, relieve congestion, or enable “green” intermodal facilities would be included in this program (U.S. DOT, 2008).

Further, a TRB sponsored Freight Transportation Industry Roundtable was convened of individuals from transportation providers, shippers, state agencies, port authorities, and the U.S. DOT. The Roundtable developed an initial Framework for a National Freight Policy to identify freight activities and focus those activities toward common objectives (Table 7.3). This has led to the identification of lead parties/agencies for various elements of the Framework (U.S. DOT, 2008). What is not clear at this juncture, from the available printed and online materials, is how the freight rail component of the transportation system will be integrated into this evolving effort. If one looks at the website and searches for rail, there are very few hits and those do not appear to be addressing the kinds of issues identified above, and those discussed more fully in Chapter 8.

Finally, in looking at the proposed Corridors of the Future program, it is obvious the focus is on highways, with six existing and one future Interstate being identified on the map (see Figure 7.4). Thus, the message coming from the federal level is a bit mixed about how the role of freight rail is expected to be integrated into the development of national transportation policies and programs that recognize that the transportation system of the United States is part of an economic, social and environmental system that spans not only the U.S., but the globe, with a complex set of feedback loops that must be understood and addressed in planning and development going forward. We will return to this theme in Chapters 10 and 11.

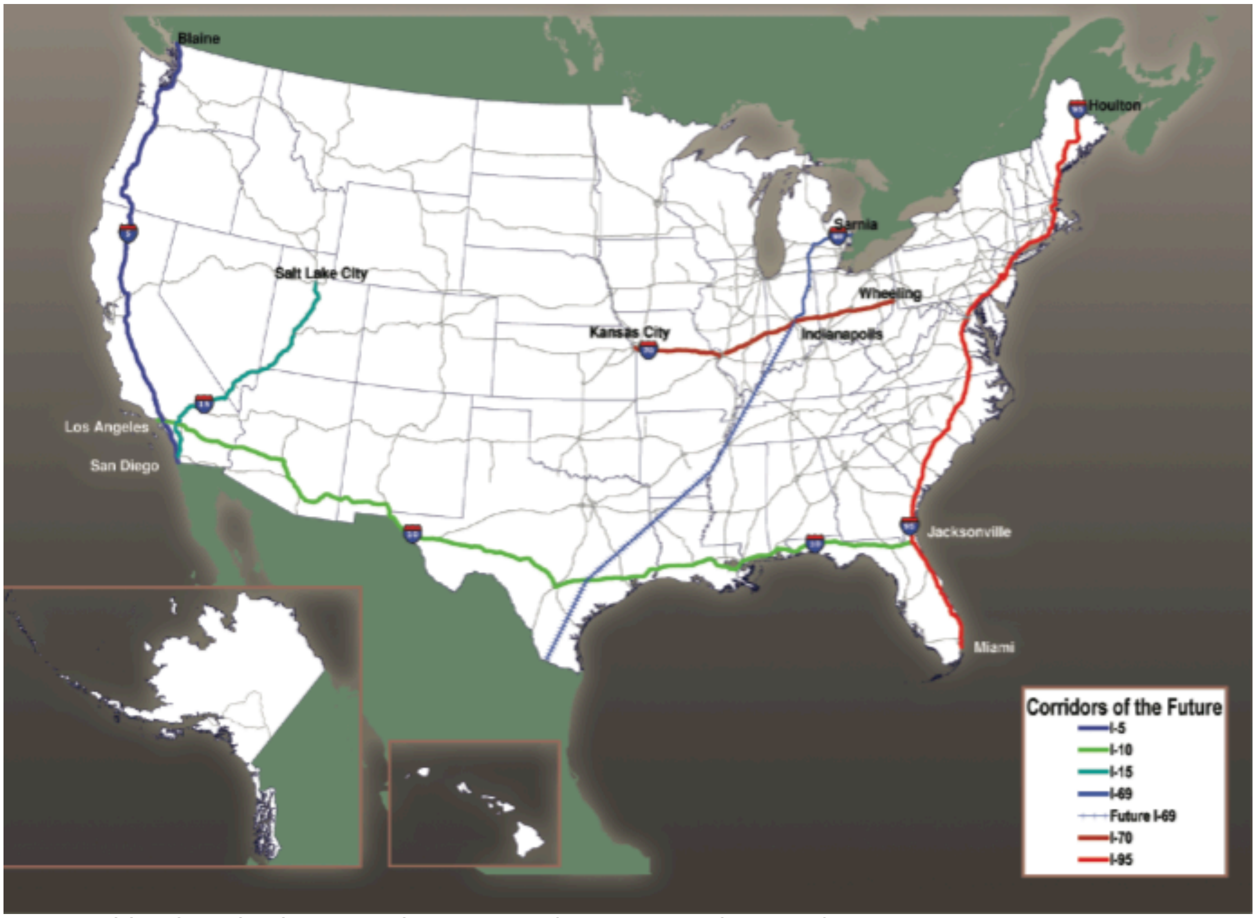
Table 7.3: Framework for a National Freight Policy

Vision: The United States freight transportation system will ensure the efficient, reliable, safe and secure movement of goods and support the nation's economic growth while improving environmental quality.

Objectives	Strategies
Improve the operations of the existing freight transportation system.	Improve management and operations of existing facilities. Maintain and preserve existing infrastructure. Explore opportunities for privatization. Ensure the availability of a skilled labor pool sufficient to meet transportation needs.
Add physical capacity to the freight transportation system in places where investment makes economic sense.	Provide physical access to interstate commerce. Facilitate regionally-based solutions for nationally significant freight corridors and major gateways. Utilize and promote new/expanded financing tools to incentivize private sector investment in transportation projects.
Better align all costs and benefits among parties affected by the freight system to improve productivity.	Utilize public sector pricing tools. Utilize private sector pricing tools. Spend public revenues raised from transportation on transportation. Explore opportunities for public-private partnerships and/or privatization. Track progress of performance measured at system and program levels. Ensure benefit-cost analysis and informed decision making are enacted at system and program levels.
Reduce or remove statutory, regulatory, and institutional barriers to improved freight trans-portation performance.	Identify/inventory potential statutory, regulatory, and institutional changes. Provide pilot projects with temporary relief from unnecessarily restrictive regulations and/or processes. Encourage regionally-based intermodal gateway responses. Actively engage and support the establishment of international standards to facilitate freight movement.
Proactively identify and address emerging transportation needs.	Develop data and analytical capacity for making future investment decisions. Conduct freight-related research and development. Maintain dialogue between and among public and private sector freight stakeholders. Make public sector institutional arrangements more responsive. Make the public sector transportation system and investments more accountable and performance oriented. Establish the federal role in freight transportation.
Maximize the safety and security of the freight transportation system.	Pursue activities that improve safety of the freight transportation system. Manage public exposure to hazardous materials. Ensure a balanced approach to security and efficiency in all freight initiatives. Preserve redundant capacity for security and reliability.
Mitigate and better manage the environmental, health, energy, and community impacts of freight transportation.	Pursue pollution reduction technologies and operations. Pursue investments to mitigate environmental, health, and community transportation impacts. Promote adaptive reuse of brownfields and dredge material. Prevent introduction of or control invasive species. Pursue energy conservation strategies and alternative fuels in freight operations.

SOURCE: U.S. DOT, 2008. U.S. Department of Transportation, Freight Transportation Web site, available at www.freight.dot.gov/freight_framework.

Figure 7.4: Corridors of the Future



SOURCE: U.S. DOT, 2008. U.S. Department of Transportation, Corridors of the Future Program, available at www.corridors.dot.gov.

Chapter 8: Freight Rail Congestion in the United States

To begin our discussion on freight railroad congestion, we first consider a reason why we could see more traffic on freight railroads in the future. A major plus for freight railroads is that they are the most energy efficient choice for moving goods. Nationally, in 2007 one gallon of fuel moved one ton of freight by rail 436 miles. Moving more freight by rail is a straightforward way to meaningfully reduce both energy use and greenhouse gas emissions without harming our economy. Based on data from the American Association of State Highway and Transportation Officials if, for each one percent of long-haul freight that currently moves by truck were moved by rail instead, fuel savings would be approximately 111 million gallons per year and annual greenhouse gas emissions would fall by 1.2 million tons (NY DOT, 2009).

Obviously, as we have seen from the preceding chapter, moving more freight by rail would help cut highway congestion by taking trucks off the road, especially along key corridors. A single intermodal train can take up to 280 trucks off the highways. Other trains can take up to 500 trucks off our highways, depending on length and cargo. A freight train can move a ton of freight an average of 436 miles on a single gallon of fuel. That's close to four times as far as it could move by truck. Each ton-mile of freight moved by rail rather than highway reduces greenhouse gas emissions by two-thirds or more. Freight trains are three or more times more fuel-efficient than trucks. Thus, if only 10 percent of freight currently moved by highway switched to rail, national fuel savings would exceed one billion gallons of fuel a year and greenhouse gas emissions would fall by 12 million tons. By improving their fuel efficiency, freight railroads have, in effect, reduced their greenhouse gas emissions by 20 million tons every year since 1980 (AAR, 2009f). Clearly, railroads enhance mobility and reduce the costs of maintaining existing roads and the pressure to build costly new roads (NY DOT, 2009).

According to 2006 Environmental Protection Agency (EPA) data, nationally, freight railroads account for a small share of U.S. greenhouse gas (GHG) emissions. In 2006, total U.S. greenhouse gas emissions were 7,054 teragrams of carbon dioxide equivalents, with transportation accounting for 28 percent. Most transportation-related greenhouse gas emissions are due to fossil fuel consumption. Of the transportation sector's GHG emissions, trucking accounted for 20.8 percent of GHG emissions, while freight railroads produced only 2.6 percent (NY DOT, 2009).

The impact of this difference in GHG emissions is seen in what happened in the period 1990 to 2005. Although freight rail volume rose by 64 percent in this period, freight rail GHG emissions rose by only 29 percent (AAR, 2007b). More recently, freight railroads are reducing GHG emissions through the use of "Green Rail Yard" technology. A green rail yard is defined as any facility at a rail system node that has applied leading-edge technology to minimize environmental effects. Some examples of these technologies include the use of low- or no-emission mobile equipment, such as container lift cranes; on-site renewable energy generation equipment (solar, wind, etc.) to provide all or part of the yard's power consumption; and the use of Gen-Set or hybrid locomotives (NY DOT, 2009).

Because freight transportation demand is expected to rise sharply, future fuel savings and GHG reductions are expected to increase. For example, AASHTO projects that ton-miles for truck movements more than 500 miles long will increase from 1.40 trillion in 2000 to 2.13 trillion in 2020. If 10 percent of this truck traffic went by rail — perhaps via efficient intermodal movements involving both railroads and trucks — cumulative estimated GHG reductions from 2007 to 2020 would be 210 million tons (NY DOT, 2009). Such reductions would be a big step in slowing down the rate of climate change (see Chapter 9). More importantly, these estimates are based upon the over-the-road trucking and do not account for the enormous amount of fuel consumed and GHG emissions that occur when trucks are delayed in metropolitan congestion – recall from Table 3.1, in 2004, this delay amounted to over 111 centuries for just for 24 metropolitan areas that year. Thus, the more traffic that can be moved from truck to rail, the greater the improvement in reducing fuel consumption and GHG.

This brings us to the topic of freight rail congestion in the U.S. and its likely trajectory based upon the current forecasts for freight moved by rail over the next 50 years. It is important to keep in mind that forecasts for rail freight actually assume a decrease in the rail share, not an increase as many policy makers and others are arguing is necessary.

Rail Freight Operations in the United States Over the Last 50 Years

As discussed in Chapter 5, by 1917, when the federal government took control of the rail industry during World War I, the 1,500 U.S. railroads operated around 254,000 miles and employed 1.8 million people. The Great Depression devastated the railroads. By 1937, more than 70,000 miles of railroad were in receivership, representing around 30 percent of all rail miles (AAR, 2009b).

At the beginning of World War II, most railroads were in financial trouble. War-related traffic surged and brought a temporary reprieve to the railroads. But by 1949 rail traffic had fallen 28 percent from its 1944 level. The post-war drop in passenger revenue was even larger. Railroads were losing huge amounts of money on passenger operations, but government agencies often refused to allow railroads to discontinue passenger service (AAR, 2009b).

By the 1970 the railroads were on verge of bankruptcy. The Rail Passenger Service Act of 1970 created Amtrak and relieved freight railroads of most of the huge losses incurred in passenger service, but conditions continued to deteriorate on the freight side (AAR, 2009b).

During the 1970s, most major railroads in the Northeast, including the giant Penn Central and several major Midwestern railroads, went bankrupt. By 1976, more than 47,000 miles of track had to be operated under slow orders because of unsafe conditions. Railroads had billions of dollars in deferred maintenance (AAR, 2009b).

By 1978, the rail share of intercity freight had fallen to 35 percent, down from 75 percent in the 1920s. Finally, over the past two decades as the rail industry has consolidated, the mileage of railroads operated by the remaining Class I railroads sharply declined from 165,000 miles in 1980 to about 94,400 miles in 2007 (AAR, 2007a). Despite the reduction in rail lines stemming from the consolidation and mergers, from 1980 to 2007, rail employee productivity rose 428 percent, locomotive productivity rose 124 percent, the productivity of each mile of track rose 225 percent, and fuel efficiency rose 85 percent. In each case, railroad productivity improvements in the post-Staggers era have been far higher (usually two to three times higher) than in the comparable pre-Staggers period (AAR, 2009d).

By 2007, these productivity improvements generated 93 percent more ton-miles of freight in 2007 than carried in 1980, but they did so with 41 percent fewer miles of track, 64 percent fewer employees, 14 percent fewer locomotives, and just 4 percent more gallons of diesel fuel — and at rates that, on average, were 54 percent lower when adjusted for inflation. However, future rail productivity gains will require continued massive spending on infrastructure and equipment (including large amounts of new capacity) and innovative new technologies (AAR, 2009d).

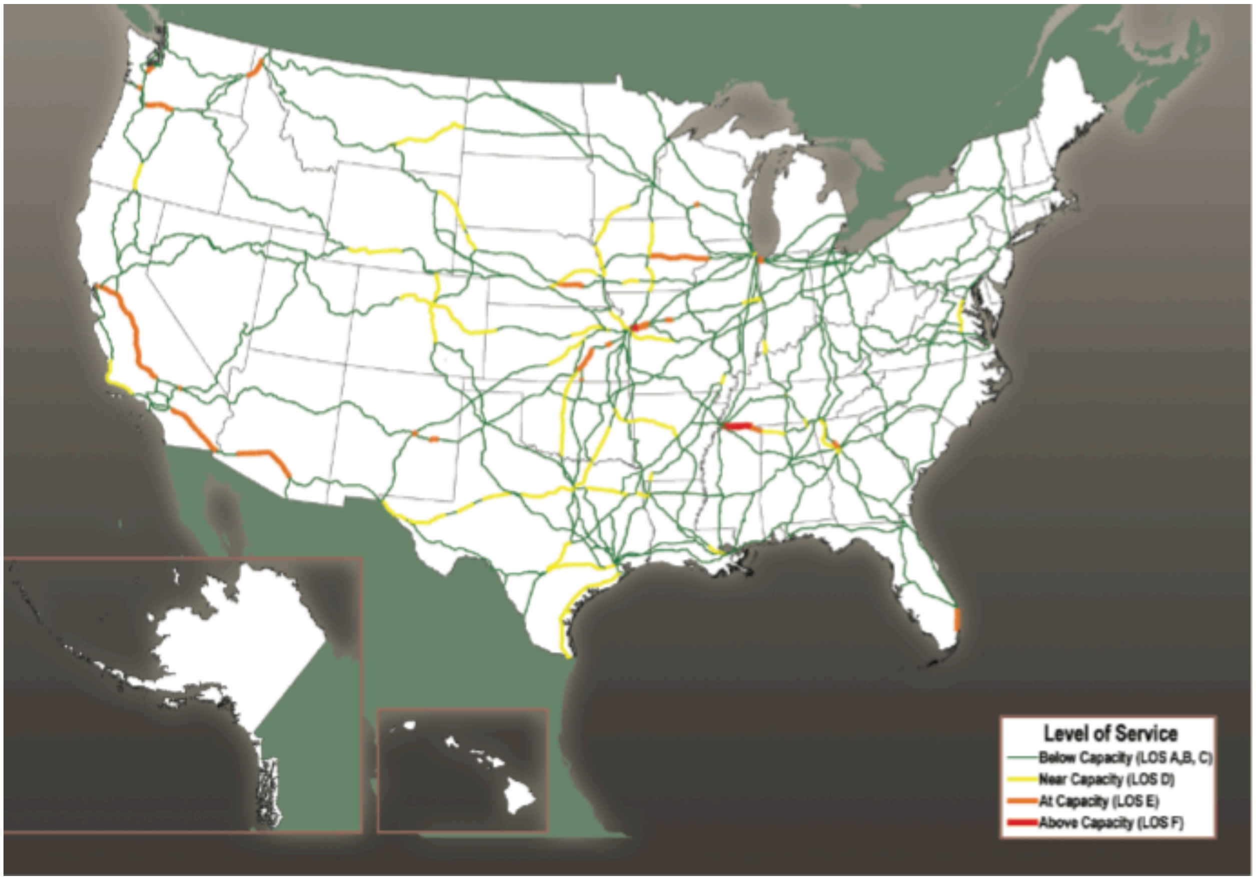
Current and Forecast Rail Operations in the United States

As described in Chapter 5, Class I freight railroads are experiencing significant growth in demand after decades of responding to a relatively stagnant market by reducing trackage by about 50 percent between 1960 and 2000. Trailer-on-flatcar and container-on-flatcar service, once a small market, is now a major source of traffic and revenue, with high speed intermodal trains vying for space on the network with slower trains carrying bulk commodities. Seasonal surges in freight demand and disruptions from incidents and maintenance activities add to congestion as volumes reach capacity on the reduced mainline railroad network. Class I railroads have responded with operational improvements and capital expenditures. In 2006, railroads invested $8.5 billion on renewal of existing roadway, structures, and equipment, and on expansion to serve additional traffic (AAR, 2007a). The results have been a relative stability, with steady improvements, in average speeds and terminal dwell times for each of the major railroads in 2007, 2008 and the first quarter 2009 (AAR, 2009e).

As reflected in Figure 8.1 (also found in Chapter 5 as Figure 5.3), these improvements in the freight rail network have yielded a system that does not experience significant capacity issues. As we discuss below, measures of freight rail congestion are challenging, but with some exceptions, present day needs are generally being met, as reflected in the continued improvements in average speeds and terminal dwell times. However, if one overlays the forecast for freight rail traffic in 2035 on the present-day network, we see very substantial congestion issues arising across most of the system (see Figure 8.2 — also found in Chapter 5 as Figure 5.4).

Today, Class I freight railroads are expanding intermodal freight service. They are carrying more trailers and domestic and international containers for motor carriers on long-haul moves. Motor carriers, such as United Parcel Service, are among the railroads' largest customers today. Rail intermodal traffic has been growing steadily and is now the largest source of revenue (although not the most profitable source) for several railroads. However, as noted in Chapter 5, growth in one area of rail service increasingly squeezes service from another market segment, particularly with the significant reductions in trackage that have occurred since 1980. This manifests itself in the limited capacity of the railroads to expand intermodal service quickly while maintaining carload and unit train (bulk) service is limited (FHWA, 2005).

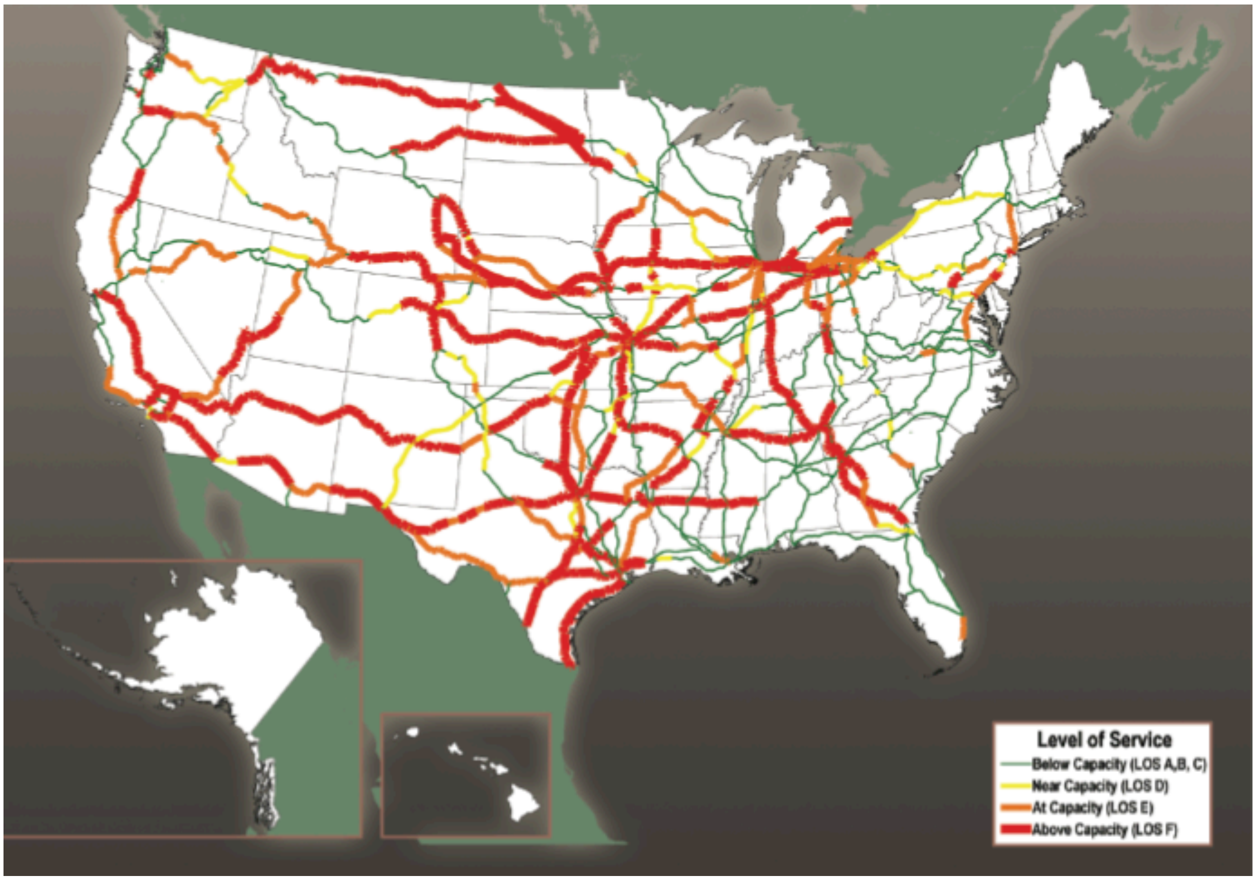
Figure 8.1: Current Train Volumes Compared to Current Capacity



SOURCE: U.S. DOT, 2008. Association of American Railroads, National Rail Infrastructure Capacity and Investment Study prepared by Cambridge Systematics, Inc. (Washington, DC: September 2007), figure 4.4, page 4-10.
Note: Level of Service (LOS) A through F approximates the conditions described in Transportation Research Board, *Highway Capacity Manual 2000*.

Aside from the significant reduction in rail infrastructure over the last two decades, the constraints on adding additional capacity rest more on the complexity of the network and the large capital expenditures required to address many components of that network. The rail network is made up of a system of mainlines, spurs, sidings, yards, intermodal terminals, and interchanges where the lines of different railroad companies come together. Additional complexity resides in the physical characteristics of the thousands of tunnels, bridges, and overpasses with different clearances, the number and type of highway-rail grade crossings, and the thousands of miles of track with different load-bearing capacity and parallel lines. As noted above, for the most part, this railroad infrastructure is owned and operated by private companies engaged in the transportation of freight. However, in some places, freight trains share space with passenger trains belonging to Amtrak and, in some urban areas, commuter rail operators (Mallett, 2007).

Figure 8.2: Train Volumes in 2035 Compared to Current Capacity



SOURCE: U.S. DOT, 2008: Association of American Railroads, National Rail Infrastructure Capacity and Investment Study prepared by Cambridge Systematics, Inc. (Washington, DC: September 2007), figure 45.4, page 5-5.
Note: Level of Service (LOS) A through F approximates the conditions described in Transportation Research Board, *Highway Capacity Manual 2000*.

All of these complexities tend to require that substantial sums of money, over extended periods of time, be expended to make system improvements. The challenge facing each of the Class I railroads is matching their investments against the likely duration of any given market – the capital intensity of Class I railroads is far greater than any other industry in the country (manufacturing industry average is approximately 3.7 percent compared with the freight rail industry of 17.8 percent). And, the typical physical-life of railroad infrastructure is around 50 years, whether it is equipment or rail lines, thus as L. Stanley Crane, former CEO of Conrail, once said, “how do I justify a 50-year investment in a five-year market?” (Crane, 1987).

In contrast to the way highway transportation works, decisions about accessing the rail system are controlled by each railroad, i.e., each railroad determines when a shipment will be transported and for what price. Thus, capacity problems tend to appear in a different form than they do on the highways and must be measured in different ways. Moreover, because the rail system is primarily private, the government has chosen not to collect and publicly disclose detailed data related to congestion. As a result, some indications of congestion problems are impressionistic and anecdotal (Mallett, 2007).

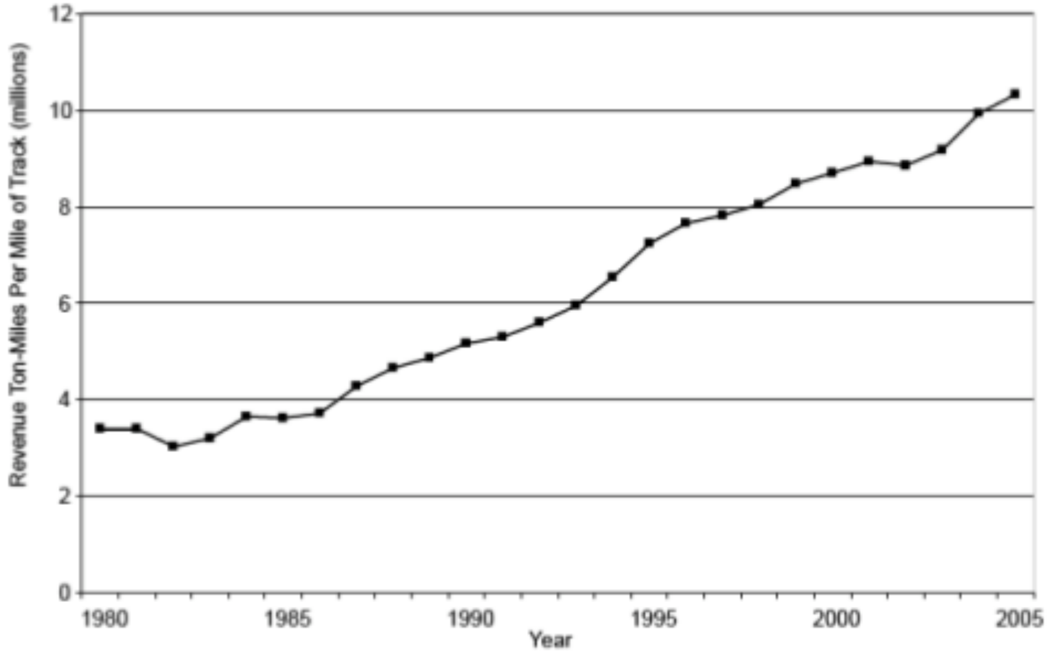
Having each railroad control access to the rail system would seemingly avoid the queuing seen on highways; however, in practice, delay and unreliability do tend to increase as the number of trains on the system reaches maximum capacity. This derives from the complexity of determining the timing and routing of trains with different dimensions, such as single- or double-stacked containers, carrying different commodities over long distances, and the rules that must be followed to ensure that trains do not collide, particularly in places that are not signal-controlled. In addition, tight schedules can be upset by incidents such as accidents, bad weather, and breakdowns and by interference with passenger trains that, by federal law, are supposed to have priority over freight trains (Mallett, 2007).

Up through 2005, the three publicly available measures of capacity utilization — traffic density, average freight speed, and freight rates — suggest a growing congestion problem in the industry. This is supported by anecdotal evidence of trip times and bottlenecks. Since rail deregulation in 1980, Class I rail freight ton-miles have increased 85%, from 919 billion to 1,696 billion, while miles of track have decreased 40%. AAR data for the period 1980 to 2005 show that traffic density, as measured by millions of revenue ton- miles per mile of track has increased from 3.4 in 1980 to 10.3 in 2005 – Figure 8.3 (AAR, 2006). Further, these data exclude demands placed on the system by intercity and commuter passenger rail operations – which are rising.

The average speed of freight moved by rail, measured by net ton-miles per train hour, grew substantially in the 1980s and into the early '90s. It began to decline through the mid-'90s, with a particularly significant decrease during the turbulent 1997-1998 period following the merger of the Union Pacific and Southern Pacific. It then picked back up and was increasing toward its earlier gains until the U.S. economy really began to see dramatic increases in imports, etc. around 2003, at which point it began to decline again (Figure 8.4). However, as noted above, in the period 2007 to date, average train speeds and terminal dwell times have been steadily improving (AAR, various dates).

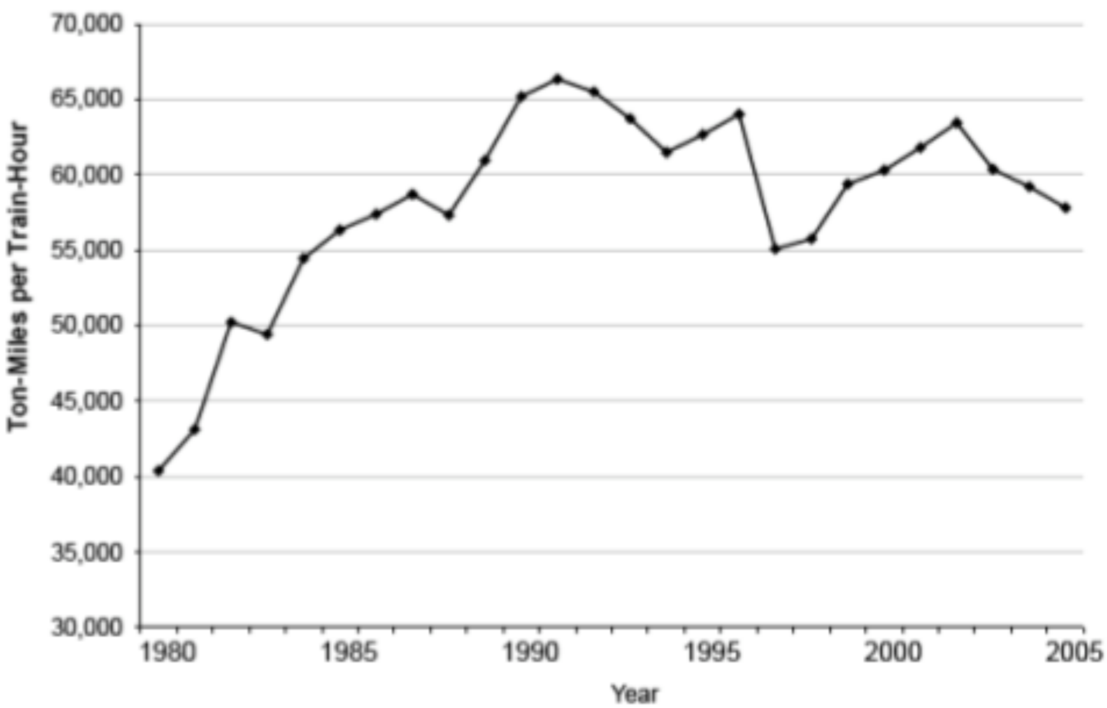
Finally, looking at freight rates, average freight rates, as measured by freight revenue per ton-mile, have declined substantially since 1980. However, beginning in 2001 the rate of decline slowed and in beginning in 2004, rates have increased (AAR, various dates). What is not clear, at this juncture, is whether this represents a new upward trend in rates (there is some evidence the railroads are pricing away certain types of business to improve their operational efficiencies); nor is it obvious whether these increases relate in any meaningful way to capacity problems in the industry.

Figure 8.3: Freight Rail Traffic Density: 1980 – 2005



SOURCE: AAR, *Railroad Facts*, various issues – beginning in October 2005, AAR began publishing individual railroad performance statistics, which are different from data previously reported.

Figure 8.4: Average Speed of Freight by Rail: 1980 – 2005



SOURCE: AAR, *Railroad Facts*, various issues – beginning in October 2005, AAR began publishing individual railroad performance statistics, which are different from data previously reported.

As previously described, when the Federal government rescinded economic regulation of the freight railroads in 1980, the freight railroads responded by reorganizing and downsizing to match the shrinking demand for freight-rail services through the 1980s. However, economic growth over the last decade absorbed much of the underutilized capacity of the railroads' deregulated and downsized system, and anecdotal evidence suggests that congestion is now increasing at major network choke points. FHWA, in 2005, identified four major freight-rail gateways and corridors thought to be most at risk because of congestion:

The **Chicago rail hub**, which is critically important for freight-rail traffic moving from Pacific ports to Midwest and East Coast markets, and Midwest exports moving to U.S. and global markets;

The **Mid-Atlantic rail network**, which connects the South and Southeast to the Washington D.C.-New York-Boston megalopolis;

The **Alameda Corridor East**, the second leg of the rail corridor connecting the Ports of Los Angeles and Long Beach to the transnational rail network; and

The **Pacific Northwest West Coast ("I-5") rail corridor**, which connects British Columbia, Washington State, and Oregon to the large Southern California markets (FHWA, 2005).

In addition to these four areas, AASHTO has identified four other locations where freight rail congestion is an issue: the Houston region; the Powder River Basin; the Kansas City Region; and the Atlanta region (Hunt, 2007). The congestion in the Chicago region is compounded by the lack of connectivity between the several different railroads serving the area whose route structures are focused on states east and west of the Mississippi River (see the Jim Lehrer PBS Special "PBS Examines Freight Rail Bottlenecks" for a graphic portrayal of this issue).

It is clear from Figure 8.2 that the current freight rail system in the U.S. cannot handle the freight forecast to materialize by 2035. Thus, new freight-rail capacity is needed to keep pace with the expected growth in the economy and relieve congestion at these major network choke points. However, creating this capacity will be a challenge for the railroads. The railroad industry today is stable, productive and competitive, with enough business and profit to operate, but it does not have the resources to replenish its infrastructure quickly or grow rapidly. Productivity and volume have gone up since deregulation of the railroads in 1980, and prices have gone down, as competitive pricing has forced rail revenues down – notwithstanding recent increases in rail rates (FHWA, 2005).

The "easy" productivity gains have already been made. Looking ahead, future gains in rail efficiencies productivity will have to come from things like improved signaling systems, improved braking systems, heavier car loadings (with concomitant increases in rail bed and bridge carrying capacity), more powerful locomotives, more efficient classification yards, and new bridges and tunnels. All of these require continued, massive re-investments in the rail networks (AAR, 2009d).

AASHTO, in its *Freight-Rail Bottom Line Report*, estimated that the railroads must invest $175 to $195 billion over the next 20 years to address the worst bottlenecks and keep pace with the growth of the economy. AASHTO estimated the freight railroads are capable of funding about $142 billion of that investment. This leaves a budget shortfall of up to $53 billion (or $2.65 billion annually). The surge in rail demand through 2007, made it possible for the railroads to raise their rates and increase earnings and profits. However, industry observers do not expect revenues to increase sufficiently to close the longer-term funding gap and ensure that the railroads can keep up with the demand generated by economic growth (Cambridge Systematics, 2003).

These estimates do not include line expansion costs on short line and regional railroads, nor do they include the cost of expanding tunnels, bridges and service facilities on short line and regional railroads. The tracks and bridges of much of the nation's short-line system are inadequate to handle the newer 286,000-pound and 315,000-pound railcars coming into service. The short-lines must upgrade the weight-bearing capacity of their tracks and bridges to handle these cars or risk losing a portion of their business. A study commissioned by the American Short Line and Regional Railroad Association estimated the cost of upgrading the nation's short line system to handle 286,000-pound railcars. The estimated cost was $6.9 billion. This estimate is consistent with the findings of the Railroad Shipper Transportation Advisory Council (White Paper III, April 2000), which was based on a 1999 survey by AASHTO. The council found a total capital need of $11.8 billion, of which $9.5 billion was unfunded. The council's estimate included redress of deferred maintenance and safety, speed, and weight improvements. In 2002, AASHTO estimated the costs for these short line and regional railroad improvements to be $11.8 billion (AASHTO, 2002).

Furthermore, these cost estimates assume the future demand for freight rail transportation will be met by using current technology and existing rail corridors. Finally, the analyses also assume there will be no major shifts in freight traffic among modes, and no significant changes in regulation or other factors that could change the demand for, or supply of, rail freight services.

Not included in any of these estimates or scenarios are the impacts of any proposed increases in commuter or high speed rail operations, which frequently share the same tracks and right-of-ways, and, by federal law, have priority over freight operations. These issues are already impacting operations in congested metropolitan areas, such as Chicago, but also have impacts outside of urban areas where high-density freight operations must make way for intercity rail passenger service.

These investment projections also assume the market will support rail freight prices sufficient to sustain long-term capital investments. If regulatory changes, or unfunded legislative mandates, reduce railroad earnings and productivity, investment and capacity expansion will be slower and the freight railroads will not be able to meet the forecast demand.

If the freight railroads cannot maintain their current share of national freight, then some rail freight will be shed to trucks on an already congested highway system. This will impose greater costs on state and local highway agencies, which must maintain roads; on highway users, who will experience increasingly congested roads; and on shippers, who will pay higher rates for truck service than they did for rail service (FHWA, 2005).

Chapter 9. Some Global Issues Affecting Rail Freight Traffic in the United States

In this chapter we look at some of the trends and technology shifts that are on the horizon and that may impact rail freight transportation demand and flows in the United States. We begin this discussion by first examining the character of the demand for freight transportation, and rail freight transportation in particular. Following this, we consider what is happening in the global economy and some of the implications these shifts may have for freight transportation.

Freight Transportation as Derived Demand

In general, the demand for transportation, both as a service and the facilities required to provide the service, is a derived demand. The construct of derived demand comes from economics. Demand is said to be *derived* where demand for one good or service occurs as a result of demand for another. This may result because the former is a part of production of the second. For example, demand for coal leads to derived demand for mining, as coal must be mined for coal to be consumed. Another good example is the demand for transport. The users of transport are very often consuming the service not because they benefit from the consumption directly (except in cases such as pleasure cruises), but because they wish to partake in other forms of consumption elsewhere. This is particularly the case for freight transportation. The only reason for the transportation of freight is because there is a demand for that which is being transported. It is derived from the interplay between producers and consumers and the significant distances that usually separate them. For example, for coal to be consumed, the coal must be transported from the mine to the consumer, usually coal-fired generating plants. Were there no demand for the materials (factors of production, consumer goods, etc.) transported, there would be no freight transportation.

Thus, as we consider freight transportation in the United States in the forthcoming years, say out through 2035 and beyond, we must look at what may cause shifts in this demand. There are currently trends emerging in a number of arenas, globally and domestically, which may significantly impact the demand for freight transportation in the United States, as well as the directional flows of such transportation. We now turn our consideration to some of those trends that are emerging and some of the changes in technology that may also affect the demand for freight transport.

The Shifting Global Economy: Implications for Freight Transportation

There are many shifts that are underway in the global and domestic economy that are likely to affect the demand for freight transportation in the this country, and elsewhere, between now and the period 2035 to 2050. Because of the capital intensive nature of freight transport, and relatively long lead times necessary for capacity enhancements to be installed (see Chapters 7 and 8), it is important to begin to consider how the likely changes in factors such as population growth, energy demand and supply, environmental and climate change, health and possible contagion, standards of living and consumption of food stuffs and consumer goods, etc. may alter the demand for freight transportation. We begin our discussion by looking at population growth since it determines to some great extent the demand for goods, services, etc.

Global Population Growth

As discussed in Chapter 6, the population growth forecast for the United States out to 2055 is expected to grow from over 295 million in 2005 to 419 million in 2050 – a 42% increase in population. This is a growth of 124 million people. The forecast for the world population is that it will grow by at least an additional 50% by 2040. However, this growth will be geographically concentrated, with decreases in population expected in Europe, Russia and Japan. For example, Japan will lose approximately 34 million people during this period – roughly 27% of its 2005 population. During this 45-year period, Russia will lose almost 34 million people, or almost 24% of its population by 2050. Western Europe will lose slightly over 14 million people (approximately 3.5%), and Eastern Europe will see a decrease of slightly less than 19 million people (almost a 17% decline), between now and 2050. Meanwhile, China, India and other emerging countries are expected to grow during this period. For example, China will grow its population by approximately 118 million in this same period, and India will increase its population by slightly more than 714 million – or +9% and +65% respectively. Both of these countries have large current populations – China has slightly more than 1.3 billion people and India almost 1.1 billion – so these growth rates will add to their dominant population bases, just changing their rank-order in terms of first and second. While to the south of the U.S., Brazil will experience growth on the order of almost 72 million and Mexico almost 42 million people – or 38% and slightly more than 39%, respectively. By 2030, developing countries could represent 85%-87% of the world population, compared to around 80% in 2005 (U.S. Census Bureau, 2008).

Just on the basis of population shifts contained in these forecast, one could argue there will be shifts in commerce and, thus, in the demand for freight transportation. As we will discuss shortly, some corresponding shifts in the economic status of various countries will likely reinforce shifts in the demand for commodities and consumer goods, as well as energy. So we now consider some possible economic scenarios that may affect the demand for freight transportation.

Global Economic Shifts

The global economic crisis of 2008 has demonstrated in no uncertain terms the dramatic shift in the character of national, continental and global economies. The highly coupled nature of the economies of the world, not just the so-called developed economies, but also those of emerging economies, has been amply illustrated with the very rapid, and devastating, collapse of banking systems throughout the world, the rapid deceleration of economic growth into full-fledged recessions in virtually every country that has been a participant in the flow of trade, currencies, financial instruments, etc. In a recent book, Paul Krugman has persuasively argued there were signals sent over the last decade or so by failures in Mexico, Brazil, Iceland, Japan, Thailand, Sweden, the United States and others of the highly interlinked character of the world's economies (Krugman, 2009). But, the strongest case he makes is how highly interconnected the global economy has become and how the economic well-being of diverse nations is tied to the overall economic well-being across the world.

As we look out to the years 2035 to 2050, history would suggest (as clearly portrayed by

Krugman), that we can expect several more financial collapses in various economies around the globe, and perhaps some that will spread well beyond any particular region or hemisphere (Krugman, 2009). Therefore, the following comments regarding the shifting global economic powers do not account for such perturbations, because we cannot predict just how and where such economic failures will occur. But, it does suggest that as we begin to develop planning models for addressing current and future transportation infrastructure investments, we need to find ways to build into such models scenario-testing for alternative economic futures in short-, intermediate- and long-term horizons.

There are various scenarios for the character and players in the global economic power structure over the next 40 to 50 years (see for example, Khanna, 2008a & b; Kupchan, 2002; Reid, 2004; Reisser, 2009; and Zakaria, 2008). Indeed, some see the current economic malaise as perhaps accelerating these shifts (see, for example, Kennedy, 2009). As noted above, over this time horizon, there will be substantial population shifts among various parts of the world. While there is not necessarily a direct tie between population growth and economic growth and influence, there are clearly more than coincidental relationships between those countries and parts of the world that will play significant roles in the world economy in the near-term as well as reaching out to 2035 and beyond.

Regardless of the particular scenario one might choose to adopt, it is clear there will be a shifting of economic growth centers and a concomitant shift in economic power. As Zakaria notes, we are currently witnessing the "The Rise of the Rest," in terms of economic growth, well-being and economic power (Zakaria, 2008). This is leading to significantly different market opportunities, sourcing and consumption patterns and, ultimately, different freight transportation demands and flows.

For example, China is a well known, and often cited, example of a rising economic power, not only in terms of its role as an exporting nation of much of the consumer goods for the world, but also as a rapidly burgeoning market in its own right. Illustrative of these characteristics, in recent years China has become the world's largest producer of coal, steel and cement. At the same time it has become the largest cell phone market in the world. It has become the primary source of supplying Wal-Mart's goods – to the tune of approximately $18 billion annually. At the same time, China's trade-to-GDP ratio is about 70 percent, which makes it one of the most open economies in the world – for example, Proctor & Gamble earns approximately $2.5 billion annually in China from the sale of products such as Head & Shoulders Shampoo, Pampers, etc. Again, as Zakaria notes, China has become the second-most-important country in the world (after the U.S.), adding a wholly new element to the international economic system (Zakaria, 2008).

Turning now to another country that has made dramatic shifts in its economy and role in the world economy, in the decade since 1997, India's economy has grown at the rate of 6.9 percent over the entire decade and 8.5 percent in the second half of it. In fact, over the past fifteen years, India has been the second fastest growing economy in the world, behind only China. As Zakaria notes, like China, India's sheer size – one billion people and apparently destined to increase by another 700 million or so over the next 30 years

– means that, once on the move, the country will cast a long shadow across the globe (Zakaria, 2008).

If one is to believe economic predictions, by 2040, India will be the world's third largest economy and by 2050, its per capita income will be twenty times its current level (Wilson and Purushothaman, 2003). Perhaps more importantly, India will continue to have a young population as the rest of the industrial world ages – i.e., India will have workers. Again, the current economic downturn is impacting India, as other countries, but if one looks at the private sector growth over the last several years, it has been very vibrant with growth rates of 15, 20 and 25 percent year after year. And, contrary to popular opinion, it is not based solely upon outsourcing services. Rather, if one looks at the industrial base companies, such as Reliance Industries or the auto-parts business, one sees dramatic revenue and profit growth. Today, India has more billionaires than any other Asian country, with most of them being self-made (Zakaria, 2008).

In terms of its GDP profile, India looks like no other developing country. In India the GDP is 50 percent services, 25 percent industrial and 25 percent agriculture. In a similar manner, the role of the consumer in India's growth is anomalous to the typical Asian scenario – in India the consumer is king. Personal consumption makes up 67 percent of GDP in India, much higher than in China (42 percent) or any other Asian country. The only country in the world where consumption is higher is the United States, at 70 percent. Another indicator of the shift in the Indian business outlook is that Indian companies are buying stakes in Western companies because they believe they can do a better job of managing them. For example, Indian investment in Britain in 2006 and 2007 was larger than British investment in India. Illustrative of this phenomenon is Tata Motors' recent acquisition of Jaguar from Ford Motor Company in England. While India certainly has many constraints on its path to becoming a global power, it will still make a powerful package, whether it is technically number two, three or four in the world (Zakaria, 2008).

In fact, if one considers, as a measure of economic power, the foreign exchange reserves and savings and corporate financing of I.P.O.'s, in 2007 the so-called BRIC countries (Brazil, Russia, India and China) accounted for 39 percent of the global volume – even after China is subtracted out. These are countries where it will be necessary for the U.S., Europe and China to place their economic bets in terms of productive assets. The other countries/regions that are likely to become global players include the European Union (notwithstanding its slow loss of population), Brazil and members of the South American common market (Mercosur), some of the members of the Gulf Cooperation Council in the Persian Gulf – think of the United Arab Emirates and Saudi Arabia – and some of the members of the Southeast Asian Nations (Asean), such as Vietnam, Malaysia and Thailand have all shown in recent years dramatic economic growth and the ability/willingness to play on the global economic field (Khanna, 2008a & b). In fact, the recent global economic malaise has dramatically demonstrated how all of these players are linked together in the flows of funds, goods and commodities.

Most recently, the G-20 meeting held in April 2009, provides ample evidence of the growing importance of developing countries in the calculus of economic power and influence (see, for example, Faiola, 2009). The trends/forecasts noted by both Khanna and Zakaria are coming to pass (Khanna, 2008a & b; Zakaria, 2008). Clearly, the world economic scene is shifting fairly dramatically and will continue to do so over the next several decades. Thus, there will be shifts in consumption and production over the next 20-40 years. How this will affect the U.S. remains an open question at the moment. However, one can expect that there will be shifts in the amount of intermodal traffic entering and leaving both east and west coast ports. We can also expect high levels of consumer, agricultural and manufactured products entering the U.S. from Mexico. Flows from the north, i.e., Canada may also increase. So, a potential challenge lies in planning and developing the requisite infrastructure to support the north/south freight flows, and perhaps commodity and volume changes in the east/west flows.

Energy Demand and Supply

The demand and supply of energy plays two very important roles in the freight transportation arena. First, freight transportation is a very significant consumer of all transportation energy used. We see, for example, that freight transportation accounts for 30-40 percent of all transportation energy consumed (Victoria Transport Policy Institute, 2008). Second, energy, in the form of coal, petroleum products and, now, biomass represents a significant amount of freight business for railroads, trucks and barges. As an example, for the Class I railroads in the U.S., the transport of energy materials represented almost 25 percent of the revenue generating traffic in 2007 (AAR, 2009a).

In terms of the transport of energy materials, the last year or so has brought into increasing relief the shifts that are occurring in the coal market in the U.S. For example, in 2007 there were more than 50 proposed coal-fired power plants in 20 states that were canceled or delayed. These delays or cancelations came about because of concerns regarding climate change issues, dramatically increasing construction costs and transportation problems (Pasternak, 2008).

In addition, because of the concerns about climate change, it has been estimated that coal power will cost more than nuclear power or natural gas power by 2030 if coal's CO_2 problem cannot be solved in more economical ways than currently envisioned. Beyond the environmental issues, there are serious transportation bottlenecks for coal. In fact, the bottlenecks are of sufficient magnitude as to entice some coal customers to look overseas for supplies. For example, Southern Co., the largest power supplier in the Southeast was importing 19 percent of its supply through East Coast ports from countries such as Columbia, Venezuela and Russia (Pasternak, 2008). Others, such as American Electric Power are acquiring coal mines to assure themselves of consistent supply. Thus, as of this writing, there are fairly significant shifts occurring on the global market for energy sources, and the transport thereof.

In 2004, Maxwell argued that over the next 25 years, i.e., out to 2030, a new world energy economy will arrive in three waves. He argues these are essentially three oil volume waves: a warning wave; the second wave occurring in 2009-2010 when non-OPEC producing nations reach their highest all-time output of crude, subsequently declining to become ever more dependent upon OPEC for incremental barrels of production. Finally, a third wave, breaking around 2020, or earlier, when OPEC's vast reserves are tapped at a maximum rate of production. After that oil volume should head down and keep falling. Whether this is the right time-table is, perhaps, open to question depending upon whether significant new reserves are found, but the essential point here is the interplay between the geological – the limits on oil supply – and the human – the tendencies toward greater consumption (Maxwell, 2004).

As Maxwell states, close to 40 percent of global energy consumption is based on petroleum. The oil-producing capacity-utilization rate is greater than 95 percent, which is considered an upper limit before the system is stressed. Part of the reason for this over-utilization rate is the lack of capital investment to lift capacity additions above the future demand growth – currently world demand increases about 2 percent annually, which requires an increase in new oil discoveries of about 7 to 8 percent annually. At present, approximately 70 percent of the oil consumed is coming from fields discovered 25 or more years ago, and many of these fields are advancing along their decline curves (Maxwell, 2004).

So, what about substituting natural gas for petroleum over this time period? If adequate supplies were available at a reasonable cost, this could be a partial solution to the increasing likelihood of a petroleum shortfall. However, there are problems within North America, similar to those for petroleum. There is some evidence the U.S. natural gas output has peaked, although there are natural gas fields that have not been exploited because of environmental concerns. In Canada, the situation is only marginally better – i.e., they can produce a bit more, but not enough to supply their own needs, let alone those in the U.S. Europe has some greater opportunity to move energy production from a petroleum base to a natural gas base. However, to do so requires obtaining new gas supplies from places such as Russia, Turkmenistan, Algeria and four or five countries in the Arab Middle East, or by liquid-natural gas tanker from Nigeria, Trinidad or the Gulf. All countries not currently noted for their stability. As is obvious, these incremental gas volumes would not come cheaply, quickly or without political risk. In terms of China and Southeast Asia, some major gas-production developments are starting up. But, the infrastructure to transport this gas and distribute it to local markets is not yet ready for use and it could be several years before that is the case. Finally, gas cannot easily or cheaply take over the role of oil as the major transportation fuel. So, natural gas can only stand in for some oil consumption over the next decade or so (Maxwell, 2004).

Finally, some would hope for the emergence of new technologies that would shatter the world caps on energy calculations. For example, it is well known that new equipment and methods allow the production of more oil from current fields and the exploitation of smaller fields at lower costs. However, no devices are known to be under development in oil industry labs that would dramatically alter the basic trend. In short, technology does not seem to be moving fast enough to significantly alter a rather grim future (Maxwell, 2004).

Obviously, aside from natural gas, there are some possibilities for substituting coal for petroleum as an energy source. Basically this option is quite circumscribed because the technology to burn coal cleanly is still under development (Ball, 2009). This is also the situation with nuclear power, although there is increasing enthusiasm for ramping-up nuclear powered energy generating facilities around the globe (Goering, 2009). Aside from these limitations, there would be many years that would pass before new plants and equipment could be brought on-line (we'll discuss new "breakthrough" technologies that might alter this scenario later). Thus, the U.S. will eventually turn to a massive national and international conservation effort. This will need to be launched with further development of coal and nuclear energy, along with imported liquid natural gas, tight-sand gas, coal-bed methane, gas-to-liquids conversion, tar sands and wind power, along with solar and biomass power (Maxwell, 2004). As has become clearly articulated in the popular press over the last two or more years, there is now a recognition, although not universally accepted, that the U.S. has to move toward "green" energy sources and away from petroleum- and coal-based fuels (Paternak, 2008).

The need for the U.S. to lead on this issue is clear when it is considered that the U.S. is the largest consumer of energy in the world. For example, in 2003, the U.S. alone accounted for 23 percent of the world's energy consumption – it consumed 40 percent more energy than it produced. The OECD nations (30 countries which include some of the largest economies, such as the U.S., Japan and Germany) consumed 60 percent of the world's primary energy consumption in 2003. At the same time energy consumption in China has increased dramatically. Right along with Russia, China, plus the U.S., are the leading consumers of energy on a global basis (in 2003, these three countries accounted for 41 percent of the world's energy consumption). They are also the world's leading producers of energy, with both the U.S. and China being net consumers – i.e., consuming more than they are producing (World Almanac Education Group, 2006).

Finally, there is evidence that higher energy prices are impacting transport costs as an unprecedented rate. This had led to the cost of moving goods as the largest barrier to global trade today. Exactly how much trade the soaring transport costs will divert from China (or anywhere else) depends ultimately on how important those costs are in the total cost structure for any given product. Goods that have high vale to freight carry implicitly small transport costs, while goods with low value to freight ratios carry significant transportation costs. A rather high percentage of Chinese exports to the U.S. fall into the latter category, e.g., furniture, apparel, footwear, metal manufacturing and industrial machinery are all typical Chinese exports. There is evidence that American importers are starting to do the math and are shifting some business from China to Mexico (Rubin and Tal, 2008). Thus, the cost of transportation energy will become one of the drivers in future sourcing and distribution patterns.

Climate Change

Climate change is extremely topical at the moment, there is seldom a day that passes without something being written or talked about in the various media venues regarding climate change (now the more *correct* term than global warming). We do not intend to discuss the pros and cons of the climate change in this report, although the evidence is persuasive about its extent and increasing role in the world, rather, we will proceed with a discussion about the implications that seem apparent as the world, and United States, grapple with how to reduce the impacts of climate change.

For example, to reduce emissions and boost energy security, the EU has set the target of producing 20 percent of its energy from renewable sources by 2020, including use of biofuels – transportation fuels derived from crops or plant waste, wood chips or wild grasses (Friedman, 2008). Without considering the possible ramifications for the biodiversity of the world, should the U.S. adopt such an approach, there would need to be significant shifts in the production, distribution and consumption of transportation fuels, including vehicular motive power, fuel production and distribution, etc. 2020 is not that far away – just over ten years. So, we need to begin now thinking through how such shifts might play themselves out in the transportation network in the United States.

First, considering the global implications, and more specifically the implications for the U.S., Friedman has made persuasive arguments, based upon irrefutable scientific evidence drawn from a large number of sources, that the U.S. has to lead in terms of altering not only our behaviors with regard to energy consumption, etc., but also the world's behavior. Citing John Holdron, he notes that "the most important conclusions about global climatic disruption – that it's real, that it's accelerating, that it's already doing significant harm, that human activities are responsible for most of it, that tipping points into really catastrophic disruption likely lurk along the "business as usual" trajectory, and there is much that could be done to reduce the danger at affordable cost if only we get started . . . are based on an immense edifice of painstaking studies published in the world's leading peer-reviewed scientific journals." What we see in the world today are dramatic shifts in economic development and progress such that many people (perhaps two to three billion) are living, or aspiring to do so, an American lifestyle. Growth is not negotiable. To tell people they can't grow is to tell them they have to remain poor forever. Thus, as he points out, Americans are in a position to use our resources and know-how to invent the renewable, clean power sources and energy efficient systems that can make growth greener and allow peoples around the world to attain and maintain an American middle-class lifestyle. There is evidence the current administration is stepping up to that challenge (Whitlock, 2009). Not coincidentally, by exhibiting this form of leadership, Friedman asserts the U.S. will benefit economically and regain its position of world leadership on many different levels (Friedman, 2008).

Thus, looking first at the current legislative and regulatory agenda in the U.S., it is reasonably clear there will be some form of legislative or regulatory action within the next year or so that will lead to limitations on emissions from utility and industrial emitters, as well as vehicular sources (mobile sources). While the specific forms these actions will take remains to be determined, there is little doubt that restrictions will come into being on many levels (see for example, Eilperin, 2009; Weisman and Hughes, 2009). What is important is how American companies adapt to these regulations and develop cost-effective, energy efficient products and production and distribution facilities. The trick is that you have to rethink every process, not just try to tweak old designs. There is ample evidence that this can be done from equipment such as locomotive engines, to wafer plants, to power utilities, servers, etc. (Friedman, 2008). Further, as we now see in the transportation sector, whether it is action to require increasing efficiency in terms of fuel consumption and/or decreasing CO_2 emission levels, reductions in congestion, or restrictions on vehicular movements, there are going to be climate-based imperatives for dramatically improving how people and freight are transported in the United States (Weisman and Hughes, 2009). Finally, we see in current legislative agendas, as well as the current Administration's stimulus proposals, significant opportunities to provide more efficient and environmentally sensitive transportation infrastructure and systems for both passengers and freight (Sperling and Gordon, 2008).

Aside from the regulatory impacts of climate change, over the next thirty years or so there will likely be some dramatic shifts in commodities being moved, both in terms of location, as well as volumes. For example, while coal is the current dominant energy source in the U.S., that role may be significantly altered as emission caps come into play and alternative energy sources are brought online. There is little doubt that coal will continue to be used as a generating energy source, but it will probably be at much lower volumes. From the standpoint of freight railroads, this could have a dramatic impact on their bottom line economics since many of the Class I carriers see as much as 20 percent of their revenue and contribution coming from line-haul coal operations (AAR, 2009a). This is mostly not the case for short lines and regional railroads, however, since the short lines and regional railroads largely depend upon healthy Class I connections, there may be possible negative consequences in terms of the need to alter rate structures on the remaining traffic to ensure continued profitable operations.

Another possible consequence for Class I carriers may be the need to dramatically alter their current coal operations in terms of end-customer locations. As coal demand in the U.S. declines, coal producers will look to other markets and need to transport their coal to those markets.

The implication here is not that we need to begin planning, necessarily, for such changes, but that we need to have planning models and processes that can account for dramatically altered conditions brought on by climate, economic and other global changes. We will discuss this argument further in Chapter 10.

Biodiversity and Contagion

Closely related to the topic of Climate Change is the issue of biodiversity change loss. As Speth has noted, "half the world's tropical and temperate forests are now gone. The rate of deforestation in the tropics continues at about an acre a second. About half the wetlands and a third of the mangroves are gone. An estimated 90 percent of the large predator fish are gone, and 75 percent of marine fisheries are now overfished or fished to capacity. Twenty percent of the corals are gone, and another 20 percent severely threatened. Species are disappearing at rates about a thousand times faster than normal. The planet has not seen such a spasm of extinction in sixty-five million years, since the dinosaurs disappeared. Over half the agricultural land in drier regions suffers from some degree of deterioration and desertification. Persistent toxic chemicals can now be found by the dozens in essentially each and every one of us" (Speth, 2008).

Furthermore, with the issue of biodiversity loss comes the threat of contagion. While one might ask how any of these topics have anything to do with addressing the problems of congestion and freight transportation in metropolitan areas, the simple fact is that we live in an open system in which all of these factors are players and changes in one arena may, or may not, redound to another. Highly illustrative of this situation is the recent incidence of the so-called Mexican Flu pandemic that rapidly sped from Mexico to places all over the world because of transportation – i.e., the movement of people from the original source of the disease to diverse parts of the world. While this particular situation largely involved passenger transportation, one only needs to look at the *USA Today* photograph of hundreds of trucks queued up to be inspected at the Mexican border by the FDA's mobile labs (Weise, 2009), to understand that the threat of contagion will impact the freight transportation industry in significant ways. History is replete with examples of the introduction of new species into areas as a result of being transported in ships – early-on – and now trucks, rail cars and aircraft. Thus, as we look out to 2050 or so, we need to take into consideration how changes in biodiversity and contagion may impact on freight transportation in the U.S. and metropolitan areas.

That the fear of contagion is upon us is exemplified by two recent headline articles (Brilliant, 2009; Garrett, 2009). Common to both of these articles is the theme that "we live in a globalized world filled with shared microbial threats that arise in one place, and are amplified somewhere else through human activities that aid and abet germs, and traverse vast geographic terrains in days, even hours – again, thanks to human activities and movements" (Garrett, 2009). What might the impact of such pandemics be in economic terms? Bank of Montreal Chief Economist, Sherry Cooper, estimates that a "mild" pandemic will lead to costs of 2 percent of global GDP, which in 2005 dollars was $1.1 trillion, through the loss of travel and trade, in addition to the health-care costs associated with such a pandemic (Brilliant, 2009). Thus, we no longer have the luxury of not incorporating such scenarios into our modeling, planning and decision-making processes.

The characteristics just described regarding climate change, biodiversity loss and contagion suggest that we are perhaps beginning to recognize these are deviation amplifying systems that require very different forms of analysis and intervention strategies (see Forrester, 1968-1975, for discussions of deviation amplifying systems). As such, future modeling efforts regarding transportation systems will need to take this into account both in terms of inputs into the models, as well as how outputs from the models (and subsequent policy decisions) impact such deviation amplifying systems.

Changing Global Patterns of Consumption

There are very significant global shifts occurring in consumption patterns of food stuffs, consumer goods such as electronics, energy, automobiles, factor inputs for manufacturing, etc. These shifts are not surprising when one considers that "it took all of human history to build the seven-trillion-dollar world economy of 1950; today economic activity grows by that amount every decade. At the current rates of growth, the world economy will double in size in a mere fourteen years" (Speth, 2008). The implications of this dramatic shift of economic well-being can be seen in the number of "Americans" popping-up all over the world in terms of consumption of housing, eating American-style fast food, buying American-style automobiles and creating American levels of garbage. For example, in the southern Chinese city of Shenzhen, a single Sam's Club sold roughly 1,100 air conditioners in one hot weekend in 2006 – that is probably more than most major outlets in the U.S. sold during a whole summer (Friedman, 2008). Or, as Economy noted in a 2007 article, "Chinese developers are laying more than 52,700 miles of new highways throughout the country. Some 14,000 new cars hit China's roads each day. . . . China's leaders plan to relocate 400 million people – equivalent to well over the entire population of the United States – to newly developed urban centers between 2000 and 2030. In the process, they will construct half of all the buildings expected to be constructed in the world during that period. This is a troubling prospect considering that Chinese buildings are not energy efficient – in fact, they are roughly two and one half times less so than those in Germany. Furthermore, newly urbanized Chinese, who use air conditioners, televisions, and refrigerators, consume about three and a half times more energy than do their rural counterparts" (Economy, 2007).

To understand how China is affecting the world of consumption, one only needs to look at shifts in the percentage of the world's commodities and products, from aluminum to washing machines that occurred in the period ranging 1993 to 2003 (see Table 9.1). As is evident, while China's proportion of the world's population showed a slight decline, with the exception of a couple of categories, there were increases in the commodities and products consumed, some of them rather significant (Cherry, 2004). Given the enormous amount of construction that occurred in China during that period, some fairly obvious materials saw significant increases, such as aluminum, coal, copper and finished steel. In addition, the shifts in eating patterns and consumer tastes and standards become evident in the increases in beef and veal, cellphone users, cotton (which may also be related to their increases in exports of clothing), fish, ice cream, microwaves and washing machines.

What is important to keep in mind in looking at these data is that Chinese per capita consumption rates do not come close to those of the U.S. Should they begin to consume at the same rate as Americans, for example in the food categories of meat, milk and eggs, by the year 2031, it has been estimated they would consume 1,352,000,000 tons of grain, far more than the 382,000,000 tons used in 2004. This would equal two thirds of the entire 2004 world grain harvest of just over 2,000,000,000 tons. Given the limited potential for further increasing the productivity of the world's existing cropland, the production of an additional 1,000,000,000 tons of grain for consumption in China would require the equivalent of converting a large part of Brazil's remaining rainforests to grain production (Brown, 2005).

If the Chinese were to consume the same ratio per person of steel as the U.S., China's aggregate steel use would jump from 258,000,000 tons in 2004 to 511,000,000 tons in 2031, more than the entire Western industrialized world's consumption in 2004. Regardless of what commodity or product we look at, if Chinese per capita consumption climbs to the equivalent of the current American per capita consumption, then we will encounter enormous shortfalls (Brown, 2005).

It is not just China where we see this dramatic upsurge of the middle class. We see the same pattern in India and elsewhere (Friedman, 2009; Khanna, 2008a & b; Zakaria, 2008). The middle class in poor countries is the fastest growing segment of the world's population. In 2008, there were protests in countries such as Indonesia, Mexico, Nigeria and others on the rapid increase in the costs of foodstuffs as mundane as soybeans, wheat flour for bread, etc. The demand for energy for domestic consumption (both residential and industrial) in Russia, Mexico and the OPEC countries could force those nations to reduce their crude exports by between two to three million barrels a day by the end of this decade. And certainly, Americans remain the world's greatest energy hogs by far (Friedman, 2008).

Table 9.1: Shifts in Chinese Consumption Rates of Commodities and Products

Category	World's %-age	World's %-age
People	'98: 21.1%	'03: 20.5%
Aluminum	'96: 10.3%	'03: 18.6%
Beef and Veal	'98: 9.8%	'03: 12.6%
Cellphone Users	'98: 7.5%	'03: 20.1%
Cigarettes	'98: 30.8%	'02: 34.8%
Coal	'98: 27.2%	'03: 31.0%
Computers	'98: 3.3%	'02: 6.1%
Copper	'98: 10.4%	'03: 19.7%
Cotton	'98: 22.2%	'03: 32.7%
Electricity	'98: 8.0%	'02: 10.2%
Fish	'93: 22.1%	'01: 32.3%
Hair-care Products	'99: 3.7%	'03: 3.9%
Ice Cream	'98: 14.1%	'03: 19.1%
Microwaves	'98: 7.9%	'02: 12.1%
Petroleum	'98: 5.5%	'03: 7.7%
Pork	'98: 48.8%	'03: 50.8%
Poultry	'98: 18.6%	'03: 19.2%
Rice	'98: 34.5%	'03: 34.5%
Soda	'98: 2.9%	'03: 3.9%
Soybeans	'98: 14.2%	'03: 19.6%
Steel (finished)	'98: 16.2%	'03: 26.9%
TVs	'98: 23.6%	'02: 23.2%
Vacuum Cleaners	'98: 1.3%	'02: 1.1%
Washing Machines	'98: 10.6%	'02: 18.0%

Source: Cherry, 2004

Thus, the pressures on the world's limited resources will begin to place limits on how economic development proceeds, but at the same time, the spread of economic development will alter the flow of goods and services in the world. For example, as noted previously, China is already competing with the U.S. for oil and metals on the world market.

Furthermore, research by the USDA's Economic Research Service shows that as incomes rise around the world, consumption patterns change in affected countries.

Income-initiated dietary changes in high-income nations are relatively small, while income-initiated changes in lower-income nations are relatively large. Not surprisingly, how a country's income is distributed has important implications for changes in a country's food purchases and trade. In short, increased incomes for large shares of population in lower income nations offer greater potential trade opportunities for producers of high-valued food products and the ingredients used to make those products (Regmi and Pompelli, 2002).

For example, as countries prospered, particularly in Asia, they have also expanded meat production and consumption (see Table 9.1, for example, with regard to China). The expansion of meat production leads to increased global demand for feed grains. Many countries turn to imports to meet their feed needs, for example, feed imports to China increased by almost 70 percent in value from 1992-2000, while imports to Mexico increased almost three times. The U.S. is a major feed grains supplier, but it must compete with other grain-rich countries in North and South America for export sales (Regmi and Pompelli, 2002). Part of the competitive equation is the transportation of these commodities to export locations on either coast, as well as through north and south ports of entry/exit. Our planning and decision models, as well as policies will have to account for these shifting global consumption and production patterns.

Conflict

Another topic, related to several of those discussed above, is that of conflict (war). Historically, wars between nations, tribes, groups, etc. occur when one or more parties believe they are being substantially deprived of their means of livelihood, survival, etc. There are, of course, wars fought over ethnic and religious matters, but frequently wars occur because there are dramatic disparities in the availability of food, or economic opportunity or fears about disease or drought, etc. Over the next 40 or so years, as outlined above, there are certainly possibilities that one or more of these conditions could prevail (Krepinevich, 2009). How such events would impact the transportation sector in the United States is unclear, but to the extent that the U.S. becomes involved in such conflicts, the transportation system may experience significant shocks through demands for mobilization, or disruptions in global distribution patterns, etc. Thus, our planning models and policies will need to bear this possibility in mind. We need only recall that in the last 40 years, the United States has found itself embroiled in conflicts in Europe, Africa, the Middle East and currently is assessing how a failing Asian country is likely to behave. And, only eight years ago, the U.S. experienced an attack on its own soil.

Some Technological Shifts on the Horizon

Finally, there are some interesting technological shifts on the horizon for nuclear power that could lead to changes in energy consumption and sourcing. Specifically, there are various types of reactors under development or in the early stages of being built and installed in different parts of the world that operate in a very different scale, and in some cases with different forms of fuel. For example, Toshiba is currently working on a "mininuke" that uses a bath of molten sodium to produce steam twice as hot as steam from water-cooled reactors. The 4S (short for **S**uper-**S**afe, **S**mall and **S**imple) can generate as much as 50 megawatts of power, easily enough to fire up a small factory, or to service an entire town that's located off the main power grid. Furthermore, the 4S can go 30 years without refueling, as opposed to typical reactors, which must be fed every 18 months. And it will be safer, because the reactor core is located deep underground, meaning it's well protected against a terrorist attack or earthquakes. (Miller, 2009).

An even more interesting nuclear generator is the Hyperion Power Module produced by Hyperion Power Generation. The Hyperion Power Module, a self-contained, self-regulating reactor, is designed to meet the need for moderately-sized power applications, either distributed or dedicated. The Hyperion Power Module was specifically designed for applications in remote areas where cost, safety and security are of concern. Generating nearly 70 megawatts of thermal energy and from 25 to 30 megawatts of electrical energy, the Power Module is the world's first small mobile reactor. About the size of a hot tub, this portable nuclear reactor could be buried in a small cement casing within the ground and provide maintenance-free power to 25,000 homes for 5-years (Webb, 2008).

Both of these nuclear generating plants represent potential means for creating electrical energy from non-organic materials that yield CO_2 and other noxious pollutants as they are burned. While neither of these particular devices may be the ultimate nuclear generating system, they certainly are on the near-term horizon and may offer viable alternatives to coal and petroleum-based fuels for generating electricity.

In summary, this chapter provides some insights into likely changes in the global economy out through 2050. As we go forward with developing planning models and decision tools that address the freight infrastructure in the U.S., it will be imperative these models and tools are designed to account for such shifts, both in terms of inputs, as well as outputs that will manifest themselves in policies, infrastructure investments and operations.

Chapter 10: Some Musings on Planning for Transportation Infrastructure Investment in the United States

In this chapter we briefly outline how planning and decisions are made in the United States regarding transportation infrastructure investment. This is not a detailed history of transportation planning in the U.S., those have been written elsewhere, rather the focus here is on how the current planning practices affect what gets built, when, where and how. And, what that means for the effectiveness of the transportation system in this country.

These comments then lead to recommended changes in the way transportation planning and decisions happen in the U.S. going forward. Again, much has been written recently on these topics, so our purpose here is to summarize the thinking on this subject and identify the implications for addressing freight transportation over the next 30 to 40 years.

Current Planning Practices for Transportation Infrastructure Investment in the United States

Perhaps the strongest indictment of the state of transportation planning and decision-making in this country has been leveled by the National Surface Transportation Policy and Revenue Study Commission in its 2007 report, *Transportation for Tomorrow* (National Surface Transportation Policy and Revenue Study Commission, 2007). The short version of this story is that their recommendation is to essentially scrap the current Federal programs, processes and requirements that address surface transportation in the United States.

How have we come to this place? In brief, we have arrived at our current state of affairs through essentially an ad hoc process of addressing narrowly defined problems – even when it was something like the Dwight D. Eisenhower National System of Interstate and Defense Highways – aka, the Interstate System. In large measure, most decisions regarding transportation have been made around specific modes, and specific problems associated with those modes at particular points in time. Perhaps the one exception is transportation safety wherein there is a Federal agency that addresses safety across all modes – although even in this arena there are mode-specific entities that address safety incidents and determine safety policy that is mode specific.

Unfortunately, this situation is not limited to the Federal level. It is found throughout all levels of government. So, while we have State DOTs today – formerly there were Highway Departments, Railroad Commissions, etc. – the focus still remains on the individual modes in those agencies. This structure devolves all the way down to the municipal level. Even when it became recognized that such modal agency structures were not capable of addressing transportation issues that cut across multiple jurisdictions and Metropolitan Planning Organizations (MPOs) were created to coordinate all surface transportation issues in their respective regions, we continue to find disjointed decisions that increasingly have an ad hoc character to them.
As Flanigan and Howard point out, historically, MPOs developed long-range plans with a 20 to 25 year horizon. These plans focused on the capital investments (highways, transit, bicycle, and pedestrian facilities) needed to satisfy the anticipated demand

within that time period. While these demands remain important and must be considered, the reality is that, in most metropolitan areas, this traditional approach is constrained by limited funding, environmental and quality of life considerations, and land use considerations. Furthermore, given the long lead times for the capital investments to be constructed, we find the public frustrated by the lack of mobility improvements within a shorter timeframe. Thus, it is time for metropolitan transportation planning to provide a mix of long-term capital investment and both long-term and near-term operational enhancements to the regional transportation system (Flanigan and Howard, 2008).

As noted in the aforementioned *Transportation for Tomorrow*, the absence of national investment priorities is illustrated by the long lists of highway and transit programs authorized in SAFETEA-LU. Many of these programs are heavily earmarked. These categorical programs address narrow issues, many with value, but with little or no overarching national interest. Thus, we find transit and certain highway programs deal with metropolitan mobility, but not in any comprehensive manner. Similarly, there are many highway programs that address freight investment needs, but again not in a way that targets potential multi-modal freight improvements that are in the national interests (National Surface Transportation Policy and Revenue Study Commission, 2007).

The Commission goes on to state that Federal programs should be restructured around functional areas (e.g., freight, metropolitan mobility, etc.) rather than around modes. Clearly, this alignment would be more effective if the State and local programs were similarly oriented. The Commission's belief is that State and local transportation agencies might be "moved" to make such a shift were there such a shift at the Federal level. However, there are significant institutional barriers to making the shift to a true multimodal focus on the State and local levels. These barriers would need to be overcome (National Surface Transportation Policy and Revenue Study Commission, 2007).

One observation that might be made here is that the definition of functional areas needs to be carefully considered. For example, using the two functional areas identified by the Commission as an illustration, freight and metropolitan mobility are not independent of one another, as demonstrated in many of the chapters above. In fact, the focus on surface transportation neglects the role of air transportation and its interaction with surface transportation, both from the passenger and freight sides. In addition, the call for an enhanced focus on high-speed intercity rail passenger service needs to be matched with a clear understanding of the interlinkages between rail freight and rail passenger facilities and services. Indeed, highly successful high-speed rail services are quite likely to generate their own vehicular congestion issues around the passenger terminals in the metropolitan areas – one only needs to have traveled on high-speed passenger trains in Europe and Japan to realize that the trip to and from the train station can be as lengthy, and significantly more arduous, than the trip between Paris and Lyon, for example.
There is no national plan for surface transportation, let alone all transportation, in this country. Over the years, there have been several national transportation policy statements issued, including ones addressed to freight. But there has never been,

since the Interstate Highway System plan, a national plan to construct a system of facilities. In fact, there was no national plan for maintaining the Interstate System. In short, there has never been an overarching national strategic transportation plan with specific improvement, maintenance and performance plans developed in the history of this country. There currently are no nationally designated facilities or plans for the public transit, freight rail or passenger rail modes. And, while the NHS was designated in 1993, there is no national plan for maintaining the condition and performance of the NHS (National Surface Transportation Policy and Revenue Study Commission, 2007).

The Commission argues that surface transportation programs cannot fully contribute to economic growth, international competitiveness or other national goals without a national investment strategy. It believes that such an investment strategy can provide the basis for allocating funds among States and metropolitan areas to maximize the return on the Federal investment, and achieve the greatest overall improvement in surface transportation conditions and performance (National Surface Transportation Policy and Revenue Study Commission, 2007). Clearly, to develop this national transportation investment strategy, there needs to be in place a national transportation plan with identified facilities, performance standards and maintenance plans.

Up to this point, we have focused on transportation planning on the governmental level, with a particular emphasis on the Federal role. Now we briefly turn to the private sector side, and in particular, the freight rail part of the transportation equation. It practically goes without saying that freight railroads in this country do not plan in terms of the national transportation system, except perhaps in the sense of anticipating what their competitors might do (truck, other rail and barge – air freight is not considered a competitor to rail freight), and what their transportation business partners (short line and regional railroads, trucks and to some extent interline relationship with Class I railroads) might do as competitive pressures unfold and economic conditions shift. In fact, there are legal restrictions in place (Anti-Trust, etc.) that limit such conversations and planning.

However, within these constraints, Class I railroads actively plan for their infrastructure and equipment needs, along with the requisite investment plans to bring those plans to fruition. In this context, Class I railroads are mindful of what is happening with their customers and the world economy. The planning process within each of the Class I railroads is rigorous and brings to bear customer inputs, economic trend data, assessments of technological change, etc. There are serious analyses associated with determining the return on investments associated with any infrastructure or equipment purchases. The typical time horizon today for most Class I railroads in their planning cycle is five years, although some are looking out ten years. It is probably fair to say that within Class I railroads today, there is an understanding and recognition of the necessity for determine how any given investment will impact on the long-term (meaning five to ten year horizon) performance of the company. This level of understanding is certainly now found down through the level of front-line managers. However, these are private sector firms that must earn their cost of capital (something which Class I railroads have not had a good history of accomplishing) and provide competitive returns to their shareholders. Thus, their focus is necessarily upon their “franchise” and any perceived threats to that franchise. Given that there are seven Class I freight railroads operating in the United States, the result is seven different sets of decisions about infrastructure and equipment investment, none of which specifically address a national plan for rail infrastructure.

Now, consider that there are over 500 short line and regional railroads in the United States. It is the case, that for most of these operators, their first and foremost concern is managing their daily operations to ensure their customers’ needs are met for that particular day. With the exception of those short line and regional railroads that are part of a larger enterprise, e.g., Genesee & Wyoming, Anacostia & Pacific, RailAmerica, etc., there is no formal long-term planning process, and certainly none that even considers the national freight transportation picture. Again, each of these operators focuses on taking care of their customers and trying to identify new business opportunities that will provide them with near-term revenue benefits.

So, what we have here is basically an ad hoc system for piecing together a nationwide transportation system, whether we look at it from public or private sector perspectives. It is, therefore, no surprise that we find a pattern of suboptimal infrastructure investments that are frequently mode specific and driven by agency, State and local agendas, as well as the business priorities of the private sector parties. There is no overall national transportation system perspective by any of the parties involved.

We now turn to some thoughts about how to move forward from this place in terms of planning, building and maintaining a transportation infrastructure that is based upon national needs and goals, not only for transportation, but also with regard to the environment, economic development, etc. The following section explores some ideas germane to addressing this issue.

Some Thoughts on Future Planning for Transportation Infrastructure Investment in the United States

As is clear from the preceding discussion, the United States has no national transportation planning process that cuts across modal lines and addresses national priorities, and provides a plan for facilities, performance standards and management and maintenance. Following are some thoughts and recommendations posited with a focus on freight transportation in this country to alter this situation going forward.

“The nation’s economy depends on the collective action of all stakeholders to maintain and enhance the freight transportation system within the context of safety and environmental concerns. Bold ideas have moved freight forward in the past, such as the domestic canals and railroads of the nineteenth century, the Panama Canal at the beginning of the twentieth century, containerization and the Interstate highway system starting at mid-century, and the establishment of nationwide, overnight delivery services in the last half of the twentieth century. Few would claim to see the next big idea with clarity, but most would agree that creative solutions, both large and small, are needed to keep goods moving and to meet the needs of the economy and the nation” (FHWA, 2008).

In terms of creative solutions, the Commission's proposal to start with a "clean slate" in terms of the national surface transportation programs so as to allow for radical program reforms, probably falls in the realm of a "big idea." Essentially, the proposal is to replace the roughly 110 or so separate SAFETEA-LU surface transportation programs covering highway, transit and railroads with ten new Federal surface transportation programs – see Figure 10.1 (National Surface Transportation Policy and Revenue Study Commission, 2007).

Figure 10.1: Proposed Federal Surface Transportation Program

1. Rebuilding America: A National Asset Management Program;
2. Freight Transportation: A Program to Enhance U.S. Global Competitiveness;
3. Congestion Relief: A Program to Improve Metropolitan Mobility;
4. Saving Lives: A National Safe Mobility Program;
5. Connecting America: A National Access Program for Smaller Cities and Rural Areas;
6. Intercity Passenger Rail: A Program to Serve High-Growth Corridors by Rail;
7. Environmental Stewardship: A Transportation Investment Program to Support a Healthy Environment;
8. Energy Security: A Programt to Accelerate the Development of Environmentally-Friendly Replacement Fuels;
9. Federal Lands: A Program for Providing Public Access.
10. Research, Development and Technology: A Coherent Transportation Research Program for the Nation.

SOURCE: National Surface Transportation and Revenue Study Commission, 2007.

An important element in this proposal is that most programs would be explicitly charged with the development of national plans (within the specific program area) to accomplish key national program goals (National Surface Transportation Policy and Revenue Study Commission, 2007). On the face of it, this represents a significant departure from prior Federal programmatic directions.

Further, the Commission recommends creating an independent National Surface Transportation Commission (NASTRAC) to oversee development of a national strategic plan for transportation investment and to recommend appropriate revenue adjustments to the Congress to implement that plan. Finally, the Commission explicitly recognizes the need for cross-program coordination and states that USDOT needs to take an active role in consolidating the separate plans into a national strategic plan. For example, the

Commission states "Federal policy should comprehensively support freight mitigation efforts not only through the proposed Federal freight program, but also through eligibility in the Metropolitan Mobility, Connecting America, Intercity Passenger Rail, Environmental Stewardship, and other programs. There should be broad eligibility across programs for activities that support the aims of each respective program, toward achieving the vision of the most efficient and sustainable transportation system possible" (National Surface Transportation Policy and Revenue Study Commission, 2007).

In addition, to facilitate this cross-coordination, among the programs, the Commission recognizes the importance of robust State and metropolitan planning to ensure a national transportation is achieved. To that end, on-going funding, as a percentage of the total authorized Federal funding for the national transportation program, is recommended to support the State and metropolitan planning efforts. And, as pertains to freight transportation, there is recognition that the Intercity Passenger Rail program needs to be explicitly linked with the Metropolitan Mobility, Connecting America, Freight Transportation and Safe Mobility Plans (National Surface Transportation Policy and Revenue Study Commission, 2007). This represents a significant departure from recent studies, e.g., AASHTO (2002, 2007a & b), wherein, even though multiple modes are discussed, the analyses, data, forecasts and proposed investments do not address the cross-mode impacts, nor how the calls for moving more freight off trucks and on to rail, or more passengers out of automobiles and into public transit, or moving people off airplanes and into high-speed intercity passenger rail will impact on the investment forecasts, service capabilities, etc. of freight rail, for example.

Thus, we have in *Transportation for Tomorrow* a bold call to change our way of "doing business" in this country with regard to transportation planning and investment. While one might quibble about some of the specifics, e.g., the focus on surface versus all transportation, there is a persuasive case made by the authors, along with fairly specific recommendations about processes and ways to implement this proposal. Additionally, the array of authors and participants in the Commission represent a broad cross-section of the "players" in the transportation game, thus presenting an important supporting constituency for moving this along. Certainly, this is a propitious time to bring forth such a shift. There appears to be broad recognition among public leaders that continuation of the practices and policies of the past will not lead us to an improved situation in the United States. As has been said in other contexts, "to continue past behaviors and expect different outcomes is the definition of organizational insanity." As the evidence in the earlier chapters attests, it is not sustainable for the United States, or the world for that matter, to continue our past behaviors. It is in our national interests to recognize that freight transportation, mobility, etc. are national concerns that directly impact on our future competitiveness in the global economy as well as upon the way of life in this country.

Whether it is the specific proposals contained in *Transportation for Tomorrow* or some variant thereof, it is clear that we need to begin the process of developing a national transportation plan. With or without a NASTRAC, the USDOT could begin addressing freight transportation as a national issue, whether sponsored by FHWA or the Secretary's office, by bringing together a team comprised of representatives from the Federal, State, metropolitan and local agencies, as well as representatives from the private sector to undertake the development of a national freight transportation plan. One might question whether private sector participants would willingly enter into such an endeavor that smacks of having government "in their business." However, there are very smart CEOs and Boards that recognize the continuation of current behavior is not sustainable for their enterprise, let alone their industries. As Marshall (2007) has said in another context, "get a couple of creative CEOs together to address the problem and the others will follow." If, for example, the CEO of a Class I freight railroad and the CEO of a national freight trucking company would place one of their senior people (say the VP of Strategic Planning or someone in a similar capacity – perhaps on the rail side, the VP of Intermodal), with full corporate support for the national freight transportation planning effort, on such a group, combined with the expertise from the Federal, State, metropolitan and local levels, it is the author's opinion that in a reasonably short period of time a creative national freight transportation plan could be developed with clear investment, performance and maintenance priorities for both public and private sectors. In the case of the latter, this would lay out where private sector investment would be supported as part of the national freight transportation system and to the extent such investments had public benefits, there would be public monies available via public-private partnerships to create those transportation assets. It would then be up to the respective private sector enterprises to determine whether it was in their business interest to join in such partnerships.

In closing, there is one segment of transportation community that has not been addressed in the preceding comments, viz., the academic institutions – both teaching and research. While this is not the place to lay out the assorted roles academia could and should play in preparing students for being active participants in the decision processes as they enter their working careers, it is sufficient to point out that interdisciplinary/cross-disciplinary education and research is at the heart of preparing future participants and leaders to make more informed decisions about not only their lifestyles, but also how their roles in business, government or elsewhere will be conducted in light of the interconnectedness of transportation, energy, environment, economics and social and personal well-being.

More specifically with regard to university-based transportation-related research, there has been work done on a variety of the issues discussed above. In terms of looking at large-scale transportation network issues, there is a body of work that may help inform future efforts on developing a national freight transportation plan. That is the topic of the next chapter.

Chapter 11: A Role for Large-Scale Network Modeling in Addressing Infrastructure Investment in the U.S.

The purpose of this chapter is to suggest some ways in which large-scale network modeling can play an important role going forward in transportation planning and infrastructure investment. As we have seen in the preceding chapters, the United States is facing mammoth levels of increased freight traffic in the coming years, along with the need for enormous investments in infrastructure to handle this increased freight with efficiency and cost-effectiveness. It is clear that continuing with the forms of planning and decisions for investment in infrastructure that have prevailed over the last several years will not be adequate going forward.

As stated by the National Surface Transportation Policy and Revenue Study Commission, "The surface transportation system of the United States is at a crossroads. The future of our Nation's well-being, vitality and global economic leadership is at stake. We must take significant, decisive action now to create and sustain the pre-eminent surface transportation system in the world." (National Surface Transportation Policy and Revenue Study Commission, 2007.)

"The American people can no longer tolerate more 'business as usual' in the surface transportation arena. . . . Concern for the infrastructure goes beyond the tangible pieces of infrastructure that can be plotted on a map. Although [the] engineering perspective was effective in the early days of building our rail, highway, transit and port systems, it focuses on only the infrastructure side of a complex and sophisticated network essential to moving people and goods reliably and efficiently. By updating our focus to include the performance that this system provides, we can identify current and future failures that will come, for example, with insufficient capacity, inadequate intermodal linkages and poor system operation." (National Surface Transportation Policy and Revenue Study Commission, 2007.)

Thus, in addition to new policies and financing mechanisms, we need tools that take into account the complexity of the surface transportation system and provide a rigorous analytical means of investigating various scenarios and possible paths for addressing those scenarios. One possible class of those tools is that of large-scale network modeling. In our following remarks, we review the current state of network modeling and then discuss some possible direction for utilizing large-scale network modeling.

Large-scale Network Models in Transportation

Before characterizing the current state of large-scale networks models, we begin with laying out what we see as some of the salient attributes of the transportation network in the United States. At the highest level of abstraction, the transportation systems of the United States sit within an environment comprised of interdependent components normally identified as being an economic system (one that is global, national, regional and local), a social system, a political system (also global, national regional and local), a built environment and a natural one (that is clearly evidencing its global character, as well as its local aspects). The transportation system has two interacting subsystems: a passenger transportation system and a freight transportation system. Within these two subsystems, there are shared components and those that are wholly owned and usually not shared, although sometimes that may occur. Each of these subsystems has interactions with the environment, both as systems themselves and as the transportation system as a whole.

Suffice it to say, there are no large-scale models that address this whole system and its environment. Further, in general, these environmental components are usually treated as exogenous variables or inputs in large-scale models – if they are included at all. Yet, as we have seen in Chapter 9, all of these components have enormous impacts on the transportation system and vice versa. Bearing these comments in mind, in the following comments, we briefly describe how the current large-scale models may be characterized and some of the current directions and limitations in such modeling efforts.

Frequently, when freight transportation is examined or discussed the distinction is made between producers that own or operate their own transportation fleet (the carriers for their own freight), and "for hire" carriers, which perform transportation services for various shippers. Crainic suggests that from a planning and operations point of view, a more interesting and practical classification differentiates between: (1) long-haul transportation and vehicle routing and distribution problems; (2) the multimodal transportation system of a region, irrespective of its dimensions, and the transportation services of a particular carrier; (3) consolidation transportation where one vehicle or convoy may serve to move freight for different customers with possibly different initial origins and final destinations, and door-to-door transportation operations customized for a particular customer (Crainic, 2002).

Further, most freight transportation planning issues are multicommodity in nature. Typically, several distinct commodities must be moved.   Even in those cases when the transportation system is dedicated to only one commodity, the traffic between different origin and destination points must be accounted for individually. Both conditions must be satisfied most of the time (Crainic, 2002).

Thus, transportation systems are complex organizations that involve a great deal of human and material resources with intricate relationships and tradeoffs among the various decisions and management policies affecting their different components. Crainic (2002) has defined three planning levels to classify these management policies:

1. *Strategic* (long-term) planning. At the firm level this typically involves the highest level of management and requires large capital investments over long-term horizons. Strategic decisions determine general development policies and broadly shape the operating strategies of the system. Included in such decisions would be the design of the physical network and its evolution, the location of major facilities (e.g., terminals), the acquisition of major resources such as motive power units and the definition of broad service and tariff policies.

At the international, national and regional level, strategic planning encompasses the transportation networks or services of several carriers simultaneously. National or regional transportation departments, consultants, international shippers and forwarders engage in this type of activity. In the United States, such strategic planning at a national or regional level, with concomitant commitments regarding capital and facilities tends to be more modally specific, and, with regard to rail freight, done at the firm level. To the extent that State DOTs engage in such strategic planning behavior, it seldom transcends state borders. For those MPOs encompassing multi-state jurisdictions, such strategic planning remains limited to their respective designated metropolitan planning areas. As noted previously, the United States has never truly engaged in national transportation planning, and has devolved strategic planning to the State and MPO levels and to some extent, local municipality level.

2. *Tactical* (medium-term) planning. At this level the focus is on determining an efficient allocation and utilization of resources to achieve the best possible performance of the whole system over a medium-term horizon. Typical tactical decisions in the private sector include the *design of the service network*, which may include addressing determining the routes and types of service to operate, service schedules, vehicle and traffic routing, repositioning of the fleet for use in the next planning period, etc.

   In the public sector, particularly with regard to transit operations, typical tactical decisions would include the *design of the service network*, which may include addressing determining the routes and types of service to operate, service schedules, vehicle and traffic routing, repositioning of the fleet for use in the next planning period, etc. For non-transit operations, e.g., highways, tactical decisions could include the design and development of congestion management strategies such as, freeway entrance ramp metering, freeway incident management programs, traffic signal coordination programs and traffic access management programs – as discussed in Chapter 7.

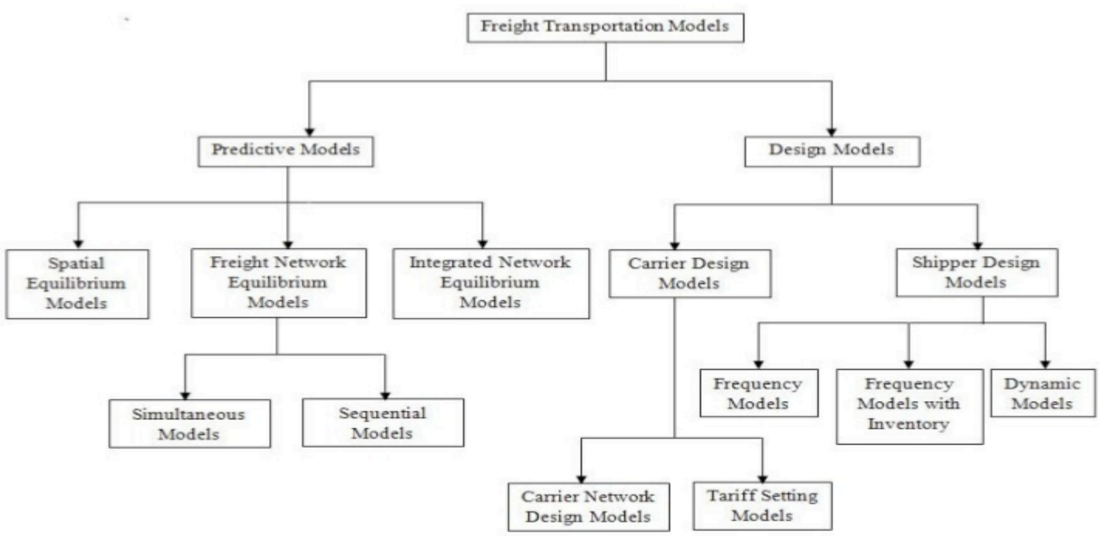
3. *Operational* (short-term) planning. This is the type of planning performed by local management, yardmasters and dispatchers, for example, in a highly dynamic environment where time is a critical element and detailed information about vehicles, facilities and activities is essential. Some important operational decisions might include the implementation and adjustment of schedules for services, crews and maintenance activities; routing and dispatching vehicles and crews; and dynamic allocation of scarce resources.

   In the public sector, operational planning might include monitoring and adjusting – on a daily basis – such programs as freeway ramp metering, freeway incident management, traffic signal coordination programs and traffic access management programs, as well as similar decisions to those outlined above.

This hierarchical classification scheme highlights how data flow among decision-making levels. Clearly, there are differences in scope, data and complexity among the various planning issues. Crainic (2002) argues these differences prevent the formulation of a unique model for the planning of freight transportation systems, as well as requiring different model formulations to address specific problems at particular levels of decision making.

However, before characterizing the types of models found at the different levels of planning, it is useful to briefly consider an alternative framework for classifying freight transportation models. In a recent Master's thesis, Valsaraj offers another taxonomy of these models. In this instance such models may be broadly classified in two classes: predictive models or design models, depending upon the objective of the model. Predictive models are those that seek to accurately predict the flow on a network for a given value of the model parameters. Whereas the objective of a design model is to compute optimal design parameters to maximize the utility of the resources for the network's owners/operators. Clearly, a good predictive model must lie at the heart of a design model because the design model is evaluating the utility for different combinations of parameters before deciding on an optimal value (Valsaraj, 2008). Figure 11.1 illustrates this taxonomy.

Figure 11.1 Taxonomy of Freight Transportation Models



Source: Valsaraj, 2008.

As is evident in Figure 11.1, under Predictive Models there are three classes of models: Spatial Equilibrium Models, Freight Network Equilibrium Models and Integrated Network Equilibrium Models. We can further divide Freight Equilibrium Models into two sub-classes – Simultaneous Models and Sequential Models. While in the case of Design Models, there are two sub-classes: Carrier Design Models and Shipper Design Models, each of which has its own subset of models (Valsaraj, 2008). As will be discussed shortly, the three planning level characterizations described above (due to Crainic, 2002) is contained within Design Models, although as we described it, we moved beyond the shipper and carrier framework to include certain types of public sector planning decisions.

Beginning with the Predictive Models, the three classes of sub-models are based upon the interactions between agents that are being modeled. For example, in Spatial Equilibrium Models, the focus is on the interaction between producer, consumer and shipper. These models have been used to compute interregional freight flows, where the behavior of the producers and consumers are usually described by elastic, but deterministic supply and demand functions (Valsaraj, 2008).

In contrast, the Freight Network Equilibrium Model only captures the interaction between the shipper and carrier. As seen in Figure 11.1, these models can be further classified into sequential and simultaneous models. Basically, a sequential model has the shipper deciding the flow of freight that will be routed through specific carriers. In the second stage, the demand estimated in the first stage – i.e., the shipper generated freight flows – is then routed through the carrier's sub-network to minimize the cost of transportation. In contrast, in the simultaneous model, the shipper and carrier make their decisions at the same time, responding to each other's decisions to attain an equilibrium. Not surprisingly, the sequential models are more computationally tractable, while the simultaneous models are more realistic (Valsaraj, 2008).

It is only with the Integrated Network Equilibrium Models that the interactions between producer, consumer, shipper and carrier are captured. Basically, an integrated model combines both demand and supply models to capture the interactions between the four agents. So, a spatial price equilibrium model is used to capture the interactions between producers, consumers and shippers to create commodity flows. The interactions between shippers and carriers, and the actual transportation process, are captured using freight equilibrium models. Profit maximizing behavior of the carriers is then captured using another model, for example, a Cournot-Nash model (Valsaraj, 2008).

Turning now to Design Models, the issue at hand is for the decision maker to determine the optimum asset pool, under its control, that is required to maximize profit. The assumption here is that shippers and carriers are two independent sets of decision makers. This leads to the classification of Shipper Design Models and Carrier design Models. In either case, the models can be further classified into strategic (long-term), tactical (medium-term) and operational (short-term) decisions – see our earlier discussion on these three types of planning level decisions.

Table 11.1 illustrates examples of the three levels of decisions (strategic, tactical and operational) that might confront a public sector actor (say an MPO), a carrier and a shipper. As described earlier, these three levels of decision making tend to be modeled quite separately with little to no interaction between models, data sets, etc. In fact, the reality of the world is that, for successful public sector actors, carriers and shippers, there is continuous interaction between the three planning and decision levels.

Table 11.1: Illustrative Public Sector, Carrier and Shipper Decisions			
Decision Type	**Public Sector**	**Carrier**	**Shipper**
Strategic	Freight corridors	Set of origin & destination locations Size of fleet	Warehouse location Warehouse capacity
Tactical	Chokepoint mitigation	Tariff Setting	Carriers to be chosen
Operational	Ramp metering	Routing of trucks	Goods storage & routing

SOURCE: Adapted from Valsaraj, 2008.

Clearly, as is evident from the preceding discussion and the many possible approaches to modeling freight transportation networks (as well as the extant literature), large-scale transportation network modeling is a complex undertaking that cannot be adequately reviewed in the context of this report. Thus, we limit our discussion to a brief summary of two modeling frameworks that illustrate the issues in constructing large-scale transportation network models as related to national freight flows and those impacting metropolitan areas.

Adopting the Crainic (2002) classification, the first type of model we consider are those at the strategic system analysis and planning level. These models attempt to simultaneously address broad international, national and regional movements of several commodities through the transportation networks and services of several carriers. The main questions addressed at this level relate to the evolution of a given transportation system and its response to various modifications in its environment. Those might include changes to existing infrastructure, construction of new facilities, evolution of the "local" or international socio-economic environment that result in changes to the patterns and volumes of production, consumption and trade, as well as variations in energy prices, changes to labor conditions, new environment-motivated policies and legislation. In addition, there are such factors as carrier mergers and the introduction of new technologies, etc. In short, many of the types of issues that were briefly discussed in Chapter 9.

Strategic (long-term) Planning Models

Predicting multicommodity freight flows over a multimodal network is an important component of transportation science. It has attracted significant amounts of interest in recent years. However, as Crainic (2002) notes, the study of freight flows at the regional and national level levels has not reached the maturity of that found on the passenger transportation side where the prediction of car and transit flows over multimodal networks has been extensively studied and several of the research results have been transferred to practice.

If one were to define/describe a "complete" strategic planning tool, it would identify and represent the fundamental components of a transportation system – demand, supply, performance measures and decision criteria – and their interactions. Such a tool would yield product flow volumes and associated performance measures defined on a network representation of the transportation system. The aim of this tool would be to provide a sufficiently good simulation of the global behavior of the system to both offer a correct representation of the current situation and serve as an adequate analysis tool for planned or forecast scenarios and policies. Furthermore, it has to be tractable and produce easily accessible results. Finally, if we were to adopt the previous arguments regarding the interaction between the passenger and freight transportation systems, such a tool would also capture those interactions in such a manner as to allow for analyzing various scenarios and policies to identify concomitant (and potentially conflicting) impacts upon each other. As Crainic (2002) has stated, this constitutes an extremely broad scope. He believes it is unreasonable to expect a single formulation, mathematical, or otherwise, or single procedure that could encompass all relevant elements, address all important issues and fulfill all goals. It is certainly the case that there is no such tool available today, and based upon the extant literature, most, if not all, authors would agree with Crainic.

Thus, what is found in the literature, and practice, today is a set of models and procedures that will be considered by an agency, or practitioner, to represent a strategic planning tool. So, in addition to data manipulation (e.g., collection, merging, updating, validation, etc.) and results analysis tools (e.g., cost-benefit, environmental impacts, energy consumption policies, etc.), the main components of strategic planning tools are: (1) *Supply modeling* which characterizes the transportation modes, infrastructure, carriers, services and lines; vehicles and convoys; terminals and intermodal facilities; capacities and congestion; economic, service and performance measures and criteria. (2) *Demand modeling* that captures product definitions, identifies producers, shippers and intermediaries and represents production, consumption and zone-to-zone (region-to-region) distribution volumes, as well as mode choices; in addition, the relationships of demand and mode choice to performance of economic policies are addressed in the modeling process. (3) *Assignment* of multi-product flows (from the demand model) to the multi-mode network (the supply representation). Such a procedure simulates the behavior of the transportation system. The output from simulation forms the basis for analyses that are specified under the strategic plan. So, such a simulation has to be precise in reproducing the current situation and general enough to produce robust analyses of future scenarios based on forecast data (Crainic, 2002).

The demand modeling and assignment components of such strategic planning tools represent critical elements in the creation of outputs upon which impact analyses and, ultimately, investment decisions are to be made. Reviews of the literature associated with these modeling efforts suggest serious challenges from a data acquisition standpoint, levels of aggregation/disaggregation, computational ease in terms of number of paths and nodes, as well as working with forecast data and addressing such issues as congestion, etc., see for example Crainic's (2002) summary of these issues.

Illustrating some of these is a modeling framework developed by Guelat, Florian and Crainic (1990). In this model, shippers and carriers are <u>not</u> considered as distinct actors in the decisions made in shipping freight. Moreover, it is assumed the shipper's behavior is reflected in the origin to destination matrices, and in the specification of the corresponding mode choice. The demand for each product for all origin-destination pairs is exogenous and is specified by a set of O-D matrices. In addition, the mode choice for each product is exogenous and is indicated by defining for each O-D matrix a subset of modes allowed for transporting the corresponding demand. Further, vehicle and convoy traffic on the links (and transfers) of the network is deduced from the assigned product flows. These deduced flows are then used to evaluate congestion conditions and compute costs in the network. Finally, capacities are considered through congestion or penalty functions (Crainic, 2002).

This model and algorithm are embedded in the STAN interactive-graphic system. This system allows for the utilization of a large number of tools to input, display, analyze, modify and output data; specify the network and assignment models; analyze flows, costs and commodity routings and paths. Mode choice and demand models can be implemented using matrix-based computing tools and a network calculator can be used to combine network data to utilize various performance and analysis models. This system has been implemented on various computer platforms, in several countries, around the world (Crainic, 2002).

This model illustrates some of the strengths and weaknesses of strategic planning tools currently in use and available for the freight transportation sector. In terms of strengths, models of this type allow for detailed representations of transportation infrastructure, facilities and services at the regional and national level, as well as the simultaneous assignment of multiple products on multiple modes. Through the use of congestion or penalty functions, the model captures the competition of products for the service capacity available. This can be very helpful when considering alternative scenarios of network capacity expansion. In addition, the model is flexible enough to represent the transportation infrastructure of only one carrier, if necessary. And, as mentioned above, it can be run on a variety of computer platforms. Finally, from a pragmatic perspective, the formulation allows for the solution of large-size network problems in reasonable amounts of computational time (Crainic, 2002).

The principle weakness of these types of models lies in the data. Recall, the demand data are exogenous, as are the mode choice data. These data are specified by a set of O-D matrices. Further, vehicle and convey traffic on the links is deduced from the assigned product flows, which are generated through the O-D matrices. Herein lies the problem. These exogenous data are likely to be generated from input/output models of the economy, or perhaps (albeit more rarely) spatial price equilibrium models, or national freight flow statistics, or perhaps observed demand or the scaling of past observed demand, etc. In any case, we are talking about aggregated data for aggregated geographic zones or regions. For the purposes of the particular study at hand, these data may be disaggregated in some manner, using a variety of possible decision rules. But, at the end of the day, they remain aggregated data that are not shipper/carrier/consignee specific, nor commodity specific, and may well be the result of ad hoc estimation procedures. Furthermore, they generally are mode-blind estimates, i.e., production, consumption, import and export estimates and, perhaps, sectorial surveys are not tied or connected with any modes of transport. These are not new concerns, but when one begins to consider the arguments presented earlier regarding the need to address the complexity of the surface transportation system – one that includes land use, environmental and other issues – then the character of these exogenous inputs into this model framework becomes a concern. Further, after the model has done all the assignment to the network and the various outputs are generated, we are still talking about aggregate data at the Destination end of the process. As we will see shortly in our discussion about forecasting metropolitan area freight transportation travel, this is a significant shortcoming. Finally, because of the periodicity of data collection for input/output models, spatial price equilibrium models, national freight flow statistics, or observed demand or the scaling of past observed demand, etc., the exogenous input data may be quite stale and not reflective of the dynamic changes occurring in the freight transportation globally, nationally and regionally, let alone within metropolitan areas.

One final comment on weaknesses in these model formulations; in general, these are optimization models that seek to achieve a system optimum with total cost minimized over the set of flow volumes. Such models are usually static models that achieve the cost minimization for a set of flows generated on the state of the network at generation time and they are not responsive to assignment results. In fact, transportation networks are anything but static and the likelihood of ever achieving a minimized total cost of any set of flow volumes is close to epsilon. Dynamic and stochastic model formulations help alleviate some of this weakness, but when one considers the overall character of the system within which the transportation system operates, it is not an unreasonable question to ask whether adopting optimizing models as a means of representing the transportation network is the correct starting point in developing rigorous planning tools for addressing policy, investment and management decisions regarding transportation at the regional and national levels.

We will return to further discuss some of these issues at the end of this chapter. But, before doing so, we consider another modeling and planning arena, and one closely associated with the impetus for this report – viz., forecasting and planning for freight transportation into, out of and within metropolitan areas. Keep in mind, that some form of modeling, as described above, generally provides the data inputs for metropolitan level analyses and modeling efforts. Different metropolitan areas utilize various approaches to metropolitan freight forecasting, although most of them use some variant of the four-step process (to be discussed below) as their planning and forecasting platform. Further, while there has been an increasing interest by MPOs to model freight and commercial traffic, as recently as 2006 only about 55 percent of all MPOs had a procedure currently in place. A recent NCHRP synthesis report (Kuzmyak, 2008) provides a good overview of the current state-of-the-art, with a focus on the highway practice. Further, there are two manuals designed to assist MPOs in addressing metropolitan freight forecasting, as well as a guidebook on metropolitan freight forecasting, plus two guidebooks that have been developed for managing metropolitan congestion, an obviously related issue (Beagan, Fischer and Kuppam, 2007; Cohen, et al., 1996; Flanigan and Howard, 2008; Mason, Grant, Messenger, Bauer and Smith, 2007; NCHRP, 1997). The issues characterized in these documents are germane to our discussion and are briefly summarized in the following section.

Metropolitan Freight Forecasting

The heightened interest in understanding freight activity and attempting to better integrate it into all levels of transportation planning is the result of both external and internal factors. Externally, pressure to consider freight in transportation planning appeared in the early 1990s with passage of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and the 1990 Clean Air Act Amendments (CAAA). ISTEA (and its successors TEA-21 and SAFTEA-LU) stressed the importance of planning for the “total trip.” This led to a greater emphasis being placed on balance and connectivity in the transportation system. Not inconsequentially, ISTEA also matched major new funding for transportation with new requirements for monitoring the condition and performance of the transportation system and making upkeep and preservation of the existing system a first priority when identifying system financial needs (Kuzmyak, 2008).

Air quality also created a clear motivation for including freight in transportation plans and programs. The 1990 CAAA establish stringent new standards for ambient air quality that affected many U.S. metropolitan areas. Further, its “transportation conformity” provision required transportation plans and programs to conform to an agreed-on timetable for achieving the national standards, as set forth in the state implementation plan. However, off-road freight modes such as rail, water, and air did not fall under the provision for transportation conformity, meaning that MPOs were not responsible for their emission contributions. But, trucks were included in their regional mobile source air quality budgets. Diesel power in many of these trucks contributes substantially to nitrogen oxide (NO_x) and particulate emissions, at levels far beyond their proportion in the regional traffic stream (Kuzmyak, 2008).

Clearly, metropolitan areas have other important internally generated reasons to be more active and thorough in their treatment of freight. For example, trucks are at the core of numerous metropolitan transportation planning concerns, for example:

- Truck volumes on crowded regional roadways are visibly contributing to traffic congestion, delay and breakdowns;
- A high percentage of the fatal crashes in metropolitan areas involve heavy trucks;
- Heavy, diesel-powered trucks are significant contributors in the emissions of regulated pollutants, such as nitrogen oxide (NO_x) and fine particulate matter (PM-2.5);
- Noise impacts; and
- Accelerated wear of pavements and intensified stress on bridges (Kuzmyak, 2008).

In attempting to address these issues with appropriate mitigation strategies, MPOs find they need better information and tools to assess the performance and effectiveness of such strategies as:

- Air quality mitigation/emission reduction strategies aimed at heavy-duty vehicles (HDVs);

- Channeling truck flows onto or away from specific facilities, such as discouraging through trucks from a metropolitan area's radial freeways and arterials;

- Tolls and congestion pricing measures;

- The ability to conduct freight movement, facility location, or access studies in relation to the local economy, future development plans, or changes in market conditions; and

- Projecting the volume of trucks on key facilities in relation to congestion, safety, noise, rates of wear, and so forth (Kuzmyak, 2008).

The economic sustainability of metropolitan areas is another major driver in MPOs interests because:

- Freight access and efficiency are tied to current and business location decisions, thus regional economic health relies on efficient and reliable access to manufacturing, suppliers, ports, terminals, warehouses and customers inside and outside the metropolitan region (Kuzmyak, 2008).

Notwithstanding the motivations and interest in developing models for freight activity in metropolitan areas, the challenges to developing effective models are many. Chief among these difficulties are selecting the right paradigm for modeling freight behavior and generating appropriate data to create reliable models. Most transportation planners and planning agencies in metropolitan areas have historically focused on analyzing person travel. Almost every such person travel study has used an application of some variation on the four-step modeling process. Given that framework, it has been a natural tendency to try to incorporate freight into the same behavioral paradigm. However, even if one adopted a very constrained definition of freight as truck travel in metropolitan models, trucks and other commercial vehicles operate much differently than the passenger vehicles with which they share the roads (Kuzmyak, 2008).

The reasons for not lumping freight traffic into the same paradigm as person travel are many. In a 2005 report, Donnelly cites the following reasons for separating out freight travel from personal travel modeling efforts:

- "Major changes in technology and markets, which have a direct bearing on freight demand, occur in much shorter cycles than the 20-year horizon often used in highway and transit planning.
- Many of the key factors influencing the growth in freight are not included in the

socioeconomic forecasting done by states and MPOs. Among these are changes in markets attributable to globalization of trade and continued competitive growth in intermodal rail, which are trends beyond the ability of most urban areas to analyze and forecast.

- Freight distribution patterns are decidedly different from those for person travel. Although people may organize their travel around tours, rather than independent trips, the tour is still anchored around a primary purpose (e.g., shopping or travel to work).

- Freight movements, in contrast, are influenced by multiple "agents," which often do not share the same goals or information. They include shippers, consumers, carriers, and intermediaries (distribution centers, warehouses, intermodal terminals, freight forwarders, customs brokers, breakbulk facilities, and third-party logistics firms).

- Many goods found in retail stores are now delivered from distribution centers, rather than their manufacturer. Delivery patterns that are optimal for distribution centers and other intermediaries are different from when they were shipped by the producer. Such movements are often made by truck fleets whose travel is organized into tours with many more stops than person travel and have different sensitivities to travel time and network delay" (Donnelly, 2005, cited in Kuzmyak, 2008).

These characteristics call for different analytical approaches than those used for person travel. In addition, specialized data are required to satisfy these different approaches. Chief among these specialized data are vehicle classification counts and data on actual freight movements. Data on actual freight movements are the source for key "behavioral" data such as type of commodity being moved, vehicle type, origin and destination, and nature of stops. However, to deal with the high degree of variability found in this type of data, large samples are generally needed. The type, amount, and quality of these data have major implications for the types of modeling approaches that can be considered and the accuracy of the eventual methods. Many freight specialists believe that it is impossible to have a model that is credible for freight forecasting unless it is somehow based on economic flows. Such a connection greatly raises the bar, however, in terms of data acquisition and handling, and introduces a new level of complexity to the modeling process that most MPOs have not seen as achievable, at least in the near term (Kuzmyak, 2008).

In 2006, Turnquist identified four characteristics he believed are important for the development of effective freight models:

1. "The model produces an output someone actually wants and knows how to use. Freight models may be built with different ideas in mind about who will use the results and aim different types of models at different users. Often, the user is an organization whose ability to use a model is constrained by its culture and

knowledge. It is important to know who the eventual model users will be, the applications to which the model will be put, and that practitioners are properly trained in the use of the model.

2. The model includes important variables that describe how the system works and represents their interactions clearly and correctly. The freight system is complex, making it difficult to describe concisely what elements of the system are most important to represent in the model. NCHRP Report 388 (Cambridge Systematics Inc. 1997) is recommended as an excellent guide in this process. A particular facet of freight transportation that is highlighted is the critical role of logistics which has significantly affected urban freight distribution patterns over the past 20 years.

3. The model operates in a way that is understandable and verifiable. Because model users are usually not model builders, they may fail to appreciate the elegant mathematical and statistical methods used to develop a model as opposed to the model's versatility, consistency, and transparency. It must produce results that are reasonable, defensible and relevant.

4. The model is based on data that can be provided so that it can be calibrated and tested. The issue of supporting models with appropriate data is particularly relevant in the case of public sector freight forecasting. If models are to reflect the practical logistics concerns of shippers and the ever-improving ability of carriers to optimize distribution with technology, having access to appropriate data for capturing such behavior is critical. However, these types of data are typically private and closely held because of their competitive nature" (Turnquist, 2006).

Turnquist's conclusions suggest an approach to freight flow forecasting that is quite different from past practice. Such an approach starts with the decisions made by representative firms as they design their supply and distribution networks. This would include decisions on facility location, transportation and inventory levels, and service characteristics to their customer base. For specific movements in this network, a more detailed analysis of inventory and transportation costs would be done to create representative shipment sizes, frequencies, and mode choices. Then, on the carrier side, these shipments would be translated into vehicle movements on an origin–destination basis. The data challenges in following such an approach are significant, but moving in this general direction is critical if the profession is to seek greater understanding of freight movements and increase its ability to make effective public policy (Kuzmyak, 2008).

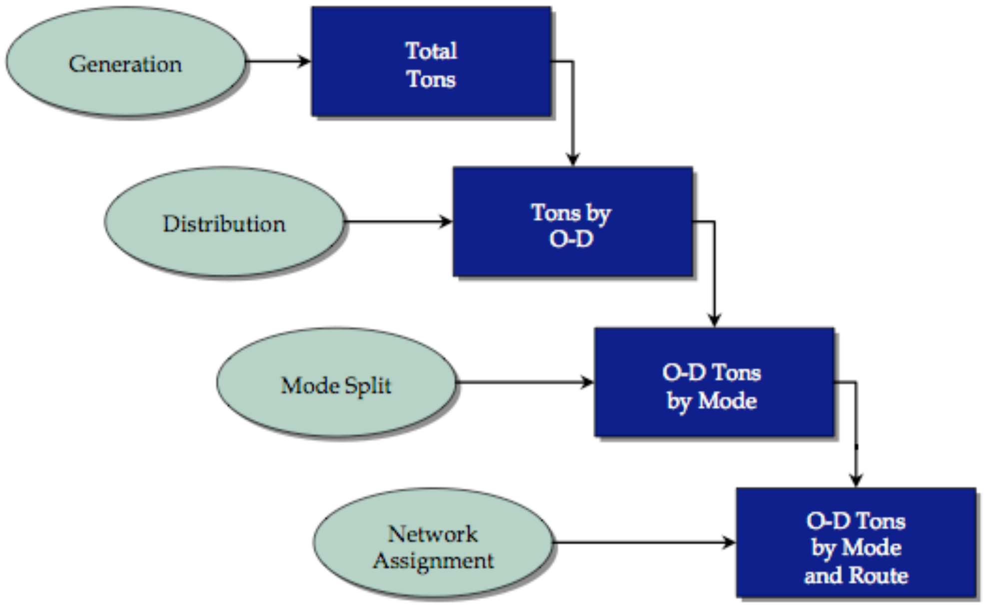
The logical conclusion one reaches from these observations, and those of numerous other freight modeling specialists, is that a proper model of freight transportation should be ultimately linked to the flow of commodities in the economy, as well be capable of simulating real-world distribution patterns. However, that is not the situation we find at the metropolitan planning level today. Instead, we observe that virtually all MPOs that model "freight" transportation are actually modeling "trucks," albeit, to varying degrees of specificity and sophistication in terms of the classes of vehicles and the simulation methodology (Kuzmyak, 2008).

There are several reasons for the situation we find in metropolitan freight transportation modeling. These include the recency with which MPOs have become serious about modeling freight; most MPOs conduct transportation planning through some variation of the four-step process, based upon their years of modeling person travel; data acquisition is viewed as an unrealistic burden for metropolitan areas; MPOs beliefs that there are no relevant, working versions of such models; and there is now a sense of urgency because trucks are a real and significant concern for regional planning organizations because of their visible role in traffic congestion, highway safety, air pollution, noise and other issues to which public and elected officials are now quite sensitive (Kuzmyak, 2008).

MPOs that do model freight are actually modeling heavy trucks, and in some instances, light commercial vehicles, using a variation of the conventional four-step process involving trip generation, distribution, and assignment. A formal mode choice step is not employed because alternatives to truck (e.g., rail) are not considered in the urban transportation realm. Distinction among the different truck classes is done for trip generation, distribution, and assignment, but conventional urban truck models do not compute “choice” among types of trucks (Kuzmyak, 2008).

In considering the four-step process for freight forecasting that is commonly used today by metropolitan areas that engage in such planning, we find the flow of freight can be measured in two forms – commodity and trucks. The following figure depicts the four steps to forecasting freight at any geographic level. Trip generation and distribution can either be in the form of commodities or trucks. The basic difference between commodity- and truck-based models is the form of the input data. However, for trip assignment purposes all forms of freight are converted to vehicles to be assigned onto a roadway network.

Figure 11.2: "Four-Step" Process of Freight Forecasting



SOURCE: Beagan, Fischer and Kuppam, 2007.

Following are brief descriptions of each of these steps in which freight is incorporated into the four-step transportation model.

Trip Generation

Using equations, the trip generation step uses economic variables to forecast freight flows/vehicle flows to and from a geographic area. These trip generation equations are either borrowed from other sources or developed locally by using an existing commodity flow table or by estimating from vehicle surveys. The outcome of trip generation is the amount of a commodity and/or the number of vehicles that comes into or goes from a particular geographic unit in a specified unit of time (Beagan, Fischer and Kuppam, 2007).

In the case of freight forecasting, trip generation models include a set of annual or daily trip generation rates or equations by commodity. These rates or equations are used to determine the annual or daily commodity flows originating or terminating in geographic zones as a function of zonal or county population and/or industry sector employment data (notice, we are talking about annual or daily flows – no hourly, etc. periodicity is addressed). In short, employment and/or population data are essential input data for computing freight trip generation (Beagan, Fischer and Kuppam, 2007).

These data usually dictate the level of detail of the freight flows that can be generated using a trip generation model. These may be at a county or a traffic analysis zone (TAZ) level. Travel demand models usually use TAZ data, thus a freight forecasting model could be developed at a TAZ level so long as the base and forecast year data at the required level of industry detail are available at that geographic unit level (Beagan, Fischer and Kuppam, 2007).

Typically, one set of regression equations for the productions and one set of regression equations for consumption are estimated. These regression equations are either developed for each commodity group or truck type. A commodity group is analogous to a “trip purpose” in passenger modeling. The observations used to estimate the regression model are the inbound tons of the commodity or number of trucks and the independent variables are usually employment, industry type, population, etc. for each geographic area (Beagan, Fischer and Kuppam, 2007).

Truck trip generation rates can be developed from a variety of sources. For example, regression equations could be utilized that regress the number of commercial vehicles on the number of employees in various industries and household populations. Or, there could be land-use types that could be related to truck trips into and out of particular land use areas, and the employment associated with the land use. Or, the QRFM values developed in 1996 could be used, or similar values developed by NCHRP, as well as truck trip rates developed for the Phoenix Metropolitan Urban Truck Model (Cambridge Systematics, 1196; Fischer and Han, 2001; Ruiter, 1992).

It should be noted, that an additional step is introduced in this process, although it is essentially a trip generation step, that is the step of generating trips at external stations. This is necessary because, although a significant number of truck distribution and service trips may remain entirely within the metropolitan area, many heavy trucks on metropolitan roadways will have one end outside the metropolitan area, or in the case of pass-through trips, both ends outside the metropolitan area. Specific efforts are made to measure and characterize the number and type of trips that have external elements. These internal and external trips are then combined in the trip distribution step (Kuzmyak, 2008).

Trip Distribution

In trip distribution, the objective is to determine the flow linkages between origin and destination for those commodity tons/truck trips that were developed in trip generation. Trip distribution uses those flows/trips to and from and independent variables on the transportation system to forecast the flows/trip interchanges between geography areas. The trip distribution equations can be borrowed from other sources or developed locally by using an existing commodity flow table or local vehicle surveys. Frequently, gravity models are used to describe the relationship between transportation zones (Beagan, Fischer and Kuppam, 2007 and Kuzmyak, 2008).

The average trip lengths needed for trip-length frequency distributions and friction factors are normally obtained from surveys. The degree of difficulty of travel, usually a function of some impedance variable used in the distribution model, needs to match the survey data (free flow time, congested travel time). Further, there must be a source of the impedance variable. The calculation of the degree of difficulty is often called a friction factor. With limited survey data, the models are typically calibrated at the district level, and the friction factors developed are assumed to apply at smaller units of geography. However, it is sometimes difficult to get survey data for trip distribution, and friction factors are often borrowed from other sources. Friction-factors are usually calculated as a negative exponential function of the average trip time from origin TAZ to destination TAZ. The parameters in the exponential function are calculated from the trip length frequency distribution, which describes the shape of the curve that is summarized by the average trip length (Beagan, Fischer and Kuppam, 2007 and Kuzmyak, 2008).

When analyzing freight demand by market area, it is important to note that trucking dominates (more than 80 percent of freight movement in most metropolitan areas) the short-haul freight market due to its flexibility and cost characteristics relative to other modes (see Beagan, Fischer and Kuppam, 2007 and Kuzymyak, 2008 for more on this issue). Further, trucks are also used for "service trucking." Urban models that include freight, local goods movement, and service vehicles are often referred to as "commercial vehicle" models. Not surprisingly, metropolitan areas have significant service trucking activity. These service trucks often account for a notable share of the total truck traffic at key locations in any given metropolitan area. This has significant implications in the development of commodity-based urban truck models (we'll discuss these models shortly), which need to account for service-related truck traffic to accurately predict total truck traffic in the region. Distinguishing service trucks from freight trucks in empirical data is difficult, and it entails the need for more rigorous data collection through surveys to determine the share of service versus cargo trucking on specific highway facilities (Beagan, Fischer and Kuppam, 2007 and Kuzmyak, 2008).

Another, less popular, method is the growth factor approach for trip distribution, also known as the Fratar method. This usually requires an existing base year trip table of freight flows or trip interchanges. The Fratar method assumes that change in the number of trips in an O-D pair is directly proportional to the change in the number of trips in the origin and destination. Clearly, this method lacks system sensitivity to the change in network-level characteristics such as congestion. Also, these methods allow preservation of observations as much as is consistent with information available on growth rates. If part of the base year matrix is unobserved, then this error is carried over in the forecasts. Thus, these methods cannot be used to fill in unobserved cells of partially observed trip matrices. Hence, they are of limited use to test new policy options (Beagan, Fischer and Kuppam, 2007 and Kuzmyak, 2008).

Mode Split/Conversion to Vehicle Flows

Mode choice modeling is used if multimodal trip tables need to be prepared. (Note: as Kuzmyak, 2008, reports, very few metropolitan areas perform this step.) This step allows the forecasting of mode splits as they change over time. The four major categories in which various factors that affect mode choice decision-making process fall into are:

1. **Goods Characteristics –** These include physical characteristics of goods such as the type of commodity, the size of the shipments, and the value of the goods;

2. **Modal Characteristics –** Speed of the mode, mode reliability, and the capacity;

3. **Total Logistics Cost –** Inventory costs, loss and damage costs, and service reliability costs; and

4. **Overall Logistics Characteristics –** Length of haul and the shipment frequency (Beagan, Fischer and Kuppam, 2007 and Kuzmyak, 2008).

The two common methods of computing mode splits market are the segmentation method and the choice method. Regardless of the mode split method chosen, in the current MPO environment, the reality is that what is being split is among the truck types, not truly between modes, e.g., truck vs rail. The market segmentation method does offer the option of addressing shifts to rail, but it requires the use of national rail commodity data and rail vs truck market share to be computed and then imputed to the metropolitan areas (see Beagan, Fischer and Kuppam, 2007 and Kuzmyak, 2008, for more discussion on this issue).

Network Assignment

The final step in the four-step process is the traffic or network assignment task. This step is comprised of the process of allocating truck trip tables or freight-related vehicular flows to a predefined roadway network. There are many types of assignments that may be developed. The particular assignment step chosen is dependent on a number of factors such as, level of geography, number of modes of travel, type of study and planning application, data limitations and computational power such as software.

The key issues and model components that need to be addressed and evaluated in developing a truck trip assignment methodology are:

- **Time-of-Day Factors –** These distribution factors by truck type separate truck trips that are in motion during each of the four modeling time periods; these factors need to be examined through recent data.

- **Roadway Capacity and Congested Speeds –** A single truck will absorb relatively more of the available capacity of a roadway than an automobile, and a given volume of trucks will often result in a much greater impact on congested speeds than a similar volume of automobiles. So passenger car equivalent (PCE) factors are required to convert the truck flows to PCEs before the assignment process.

- **Volume-Delay Functions –** These functions are used to estimate average speeds as a function of volume and capacity may be different for trucks than for automobiles.

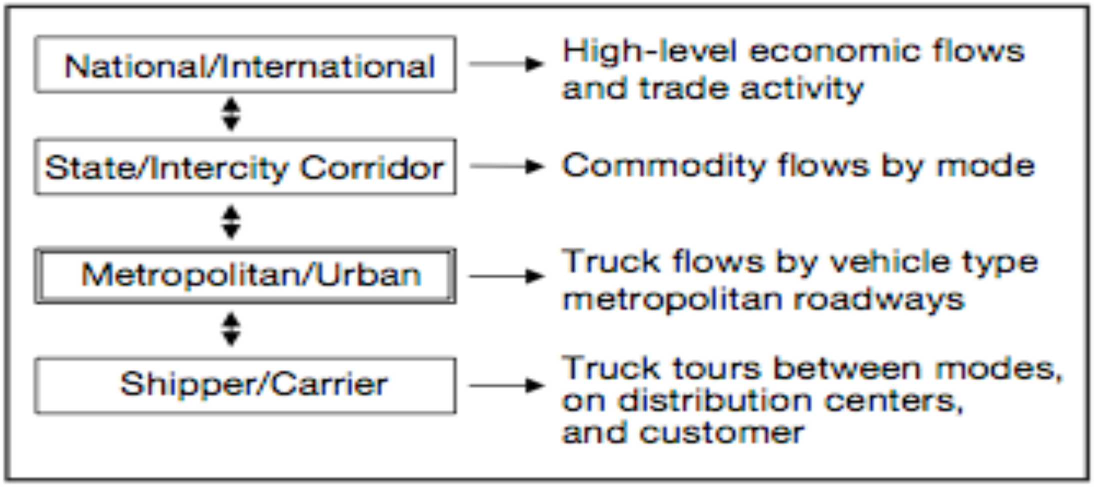
- **Truck Prohibitions –** Some freeways and major principal arterials in the region have prohibitions for certain classes of trucks, and this needs to be addressed before the assignment. A truck network also may be built based on the local knowledge of truck prohibitions and truck routes (Beagan, Fischer and Kuppam, 2007 and Kuzmyak, 2008).

Kuzmyak (2008) summarizes how metropolitan and commercial freight transportation are being handled in the United States today. While there are variations on the four-step process, essentially that is the process used by MPOs today if they doing freight forecasting. Further, as mentioned previously, while in principle the process could address other modes, as practiced today, the four-step freight process for metropolitan areas is a truck-only traffic generation, distribution and assignment tool.

So, even though it is generally agreed by most freight modeling specialists, as well as MPOs that are attempting to address the freight issue in their planning, that a proper model of freight transportation should be ultimately linked to the flow of commodities in the economy, as well be capable of simulating real-world distribution patterns, that is not the current state of affairs in modeling metropolitan freight flows. Thus, as we look toward identifying how to handle freight modeling and forecasting in this country going forward into 2035 and 2050, it is clear that shifts are necessary in the approaches being taken to address this problem. Furthermore, the character of some of the negative feedback loops and deviation amplifying systems are becoming painfully evident not only in the transportation system itself, but also in the environment within which it operates. In short, we are lacking a meta-architecture within which our modeling efforts can be placed and logically linked such that we can move up or down the level of abstraction as necessary to allow evaluations and analyses to be performed that can inform policy and decision makers as to possible scenarios for investments, legislative or policy interventions, etc.

The linking of policy interests, modeling tool and data availability suggests a “modeling hierarchy,” where different levels of geography coincide with models of different structure and aggregation. In Figure 11.3 this is illustrated as ranging from models at the national or international level, state or corridor level, metropolitan area and down to the distribution networks of the shippers and carriers. In this hierarchy, the top-level models address major national and international economic flows. These provide a system of control totals for states and economic regions to gauge overall activity levels reflecting economic trends occurring nationally, but also reflecting global trade influences. In the second tier of models, are those developed by states and applied at a statewide level, or within intercity corridors. Here we would see commodity flows, linked to national trends. These commodity flows would be translated into freight flows by mode of carriage. The metropolitan models would focus on the movement of freight within and across its borders. The state models would provide the commodity-based control totals at the metropolitan boundaries. At the bottom of the hierarchy, the activities of the shippers and carriers involved in goods distribution within metropolitan areas would be addressed by optimization of tours to maximize efficiency and minimize logistics costs (Kuzmyak, 2008).

Figure 11.3: Freight Modeling Hierarchy



SOURCE: Kuzmyak, 2008.

If we look for possible examples of how this hierarchy might manifest itself in transportation planning in the United States, there is some evidence that freight modeling in Europe is moving in this direction. Tavasszy reports the current emphasis in freight modeling in Europe is toward more detail in types of vehicles, logistics, and location, and a more deliberate extension of freight into the broader transportation system and its link with the economy. The existence of the European Union (EU) and its Common Transport Policy has had a major influence on freight modeling. The policy has led to the creation of continental models in which domestic and global freight are intertwined, all modes of transport are relevant, and borders play a critical role. Priorities in individual countries have subsequently developed in close parallel with the EU policy and EU-level research (Tavasszy, 2006, cited in Kuzmyak, 2008).

One can imagine a similar pattern occurring in the United States wherein the USDOT could begin addressing freight transportation as a national issue, whether sponsored by FHWA or the Secretary's office (or perhaps an entity such as NASTRAC), by bringing together a team comprised of representatives from the Federal, State, metropolitan and local agencies, as well as representatives from the private sector to undertake the development of a national freight transportation plan. This nationwide endeavor, and subsequent policies would likely see individual states developing parallel policies and research endeavors.

To some extent, it could be argued that is happening now through more or less ad hoc efforts sponsored by TRB, FHWA, NCHRP and others with their conferences and assorted research efforts related to freight modeling. What this author is suggesting is that this move to a clearly articulated national policy level – as called for by National Surface Transportation Policy and Revenue Study Commission in *Transportation for Tomorrow* (National Surface Transportation Policy and Revenue Study Commission, 2007).

Chapter 12: Freight Villages/Integrated Logistics Centers/Transflow/ Transload Options in Freight Distribution

In this chapter we briefly look at the evolution of freight distribution in the United States that led to the current pattern of most intermodal terminals, warehouses and distribution centers being located on the periphery of most metropolitan areas. Drawing on examples from different parts of the world, we posit some thoughts on possible future directions for collecting and distributing freight within metropolitan areas.

The Evolution of Freight Distribution Facilities in the United States

In the modern industrial era, prior to the development of the Interstate Highway System, most freight, if it was transported from outside the metropolitan area, arrived by train. There were commodities brought into the metropolitan areas by truck, but in large measure, they were coming in from proximate areas – frequently agricultural areas or small industrial manufacturers that had grown up around a particular source of materials, e.g., silica sand for glass making, or an early source of power, usually water.

As the cities grew, the industrial areas tended to be located where they could be served by rail. As commerce and industry continued to expand to meet the growing urban populations, raw materials were gathered from farther and farther afield as the rail network expanded to reach the sources of factor inputs, such as coal, grain, cattle, iron ore, etc. Certain cities, such as Chicago, became major rail hubs with raw materials flowing in and finished goods and products going out.

In addition to the movement of commodities for manufacture, rail was the means of small parcel and mail delivery. These items generally were brought into the central rail station – or in the cases of cities such as Chicago, Philadelphia, New York and others, into the competing railroads' central terminals. Usually situated in close proximity to the central terminals were U.S. Postal Service sorting centers and the main Post Office, as well as package centers.

With the advent of the Interstate Highway System in the mid- to late-'50s, this pattern of freight, parcel and mail delivery began to change as the metropolitan areas began to experience rapid suburbanization. Trucks increasingly became the primary mode of transport for most goods, small parcels and mail. With the flexibility of the truck came the ability of manufacturers to move away from rail connections. At the same time, increasing levels of mechanization and automation led to very different manufacturing processes and the need to have larger, single-storey facilities. In general, land was less expensive in areas outside of the center city and old industrial districts. Thus manufacturing and assembly facilities began to migrate to the outskirts of the metropolitan areas into industrial parks that were sometimes served by rail, but frequently not.

Our earlier discussions covered the decline of the rail industry during this time of rapid highway expansion and suburbanization. Following the deregulation of the rail industry in 1980, it started to compete aggressively with the trucks to regain some of the business it had lost over the ensuing years. With the advent of intermodal operations, the rail industry began to be competitive with the trucking industry for freight that had been moving in trailers, and later containers. To successfully compete with the long-haul trucks, the railroads needed to develop intermodal yards that were easily accessible to the metropolitan areas, as well as to the freeway and expressway systems that had been built around the cities. At the same time, the Class I railroads were focusing on improving the efficiencies of the intermodal (and other) operations. This led to increasingly longer trains, specialized yards devoted entirely to intermodal, specialized equipment and sophisticated IT ties with their customers (and sometimes competitors), the long-haul trucking and package express companies.

The result of all these shifts is that, for the most part, Class I intermodal terminals, some of which are large and recently completed, are mostly found “outside the belt” of the metropolitan areas they serve today. Indeed, for the most part, major classification yards and other specialized rail facilities are no longer situated within the metropolitan areas. There are still local switching and industrial yards within some metropolitan areas for some Class I carriers.

The impact of these developments is, with the exception of a few cases, intermodal traffic that is destined for Chicago, for example, is “grounded” in a yard outside the metropolitan area and then trucked into the city. So, while the trailer or container may have traversed the country on rail, and thus not contributed to highway congestion along the way, once it gets to Chicago, or any other destination city, it becomes part of the congestion mix on the highways entering the city.

Similarly, if there is a trailer or container of originating goods inside the city, it must be moved by truck out to the intermodal yard to be loaded on to the train. Again, putting the truck and trailer/container into the congestion mix on the highways leading out of the city. Aside from the increased costs due to delays, etc. of the truck in traffic, which get passed on to the consumer, there are the costs associated with the environmental pollution, the delays to other vehicles, accidents, etc.

Hence, the focus of this report, which seeks to identify if there are some other options for getting freight into and out of the metropolitan areas without resorting to moving it on the freeway and expressway routes going into and out of cities that are exhibiting significant congestion problems now, and likely into the future. The following section begins to address that question.

Possible Directions for Collecting and Distributing Freight within Metropolitan Areas

There are a number of possible ways to locate distribution and collection facilities “inside the belt” of metropolitan areas so as to address the congestion issues and provide cost-effective freight service within these areas. In addition, there are options such as off-peak pick-up and delivery to production and consumption facilities, peak pricing and tolling, truck-only lanes, etc. In the following comments we focus on those options that are either freight rail linked, or could be done in conjunction with freight rail, and some of the benefits that have been identified for each of the options.

Freight Villages/Integrated Logistic Centers

The terms “freight village” and “integrated logistic center” tend to be used somewhat interchangeably within the literature. Freight village seems to be the more common terminology for European operations, while ILC seems to be the United States variant. Regardless of the particular terminology, they have in common characteristics that may make them particularly attractive as a means for addressing some of the issues surrounding metropolitan congestion. These facilities are defined as being an area within which activities related to freight transport, logistics and goods distribution are carried out, and coordinated by various operators. These include shippers, warehouses, storage areas, public agencies and planners, businesses and supporting ancillary services such as security, maintenance, office space, meeting/conference rooms, eating facilities, banking, mail, extra warehousing and public transport/internal transport. Some facilities even include employment centers to handle the fluctuations in staffing characteristic of freight transport periodicities associated with arrivals, departures, shifting seasonal demand, etc. (for more detailed discussions of these types of facilities, see Mann, 2007; Rodrigue, 2009; Strauss-Weider, 2008; Theofanis, 2007; Weisbrod, et al., 2002).

The development of logistics clusters has many benefits for managing the freight flows generated by several unrelated users. These benefits are derived through economies of scale because they are sharing the same facilities and equipment, mostly around a transport terminal or a depot. This reduces transport costs and promotes its reliability. In addition, because they are situated proximate to one another, within a defined area, services such as secured perimeters, maintenance and, depending upon the particular facility, customs and similar functions to facilitate international trade are more readily provided and represent value-added benefits to those within the ILCs. Such facilities are commonly the outcome of the strategies of port authorities, regional governments or private terminal operators.

In general, the European model tends to place such facilities outside the metropolitan areas. In the United States, such facilities are also outside the metropolitan areas. However, there are proposals for introducing them into places such as the North Jersey and the New York City metro areas (Theofanis, 2007; Mann, 2007; Weisbrod, et al., 2002).

The benefits to be derived from such freight villages or integrated logistics centers are at least the following: reduced future truck volumes on some roadways, improved traffic operations on some roadways, increased rail mode share in the regions, the creation of a more efficient and cost-effective freight delivery system. In addition, these facilities provide the opportunity to leverage freight operations to create local value and support the businesses that serve the facility and surrounding area. Such facilities also provide the opportunity to utilize primarily private funds to achieve local community development goals, which may include the reuse of brownfield properties. Finally, they encourage multimodal freight use (Theofanis, 2007; Mann, 2007).

However, one of the characteristics of such facilities is that they occupy significant acreage – something not easily found “inside the belt” of most highly urbanized metropolitan areas. This is where the possible reuse of brownfields can come into play. In most of the metropolitan areas experiencing high levels of congestion, see Table 3.1, there are numerous old manufacturing facilities, sometimes abandoned, some old railroad serving yards, now either abandoned or underutilized, etc. Sometimes such facilities are proximate to one another and thus can be consolidated into sufficiently large parcels for redevelopment as freight villages/ILCs. In other cases, they may not be adjacent to one another, but are close enough such that through the utilization of today’s more sophisticated information technologies, it may be possible to create “virtual” freight villages/ILCs.

Finally, the creation of freight villages/ILCs requires planning, a long time frame and government financing and support in bringing the disparate parties together, addressing such matters as demolition, site remediation and preparation, etc. At the same time, the role of private business partners is critical for maximizing the likelihood such facilities will be managed cost-effectively, bringing the capital and design/build expertise to the table.

One other point worth keeping in mind as related to this concept, freight villages/ILCs are compatible with the increased intermodal traffic pattern that has emerged in the United States. However, within the metropolitan areas, there may not be enough real estate available to allow for the long intermodal trains that currently traverse the country. Thus, it may be necessary to “break” these trains prior to bringing them into “interior” villages or ILCs. Such operations would introduce some delays in getting the train sets to the villages/ILCs, but may not result in delays much greater than those experienced by trucks navigating the congested highways coming into the cities. To the extent that short lines within the city could come out to the outlying intermodal yards to pick-up the shorter intermodal train sets, then there should be limited impact on the Class I operations.

One other operating point here. Getting “inside the belt” of some metropolitan areas (like New York City) by freight rail means addressing clearance issues – tunnels, track curvature, bridges, etc. Some of these clearance issues are truly significant and may not be feasibly resolved for doublestack intermodal operations. Thus, not only would the train sets have to be “broken,” but they would also have to be “filleted,” i.e., top containers removed, or “toupeed,” i.e., top containers added on the outbound side. This would impact the intermodal yard operations.

We discuss some of the processes and players that may need to be involved in these, and other, efforts to develop solutions to the metropolitan congestion issue in Chapters 10, 13 and 14.

City Logistics

An interesting option that has been implemented in about 80 German cities to reduce the number of trucks coming into the cities goes by the name of “City Logistics.” The rationale behind these projects is based upon trying to counteract some of the impacts of the increasingly specialized transportation services that are manifesting themselves in this global economy. These factors are product differentiation, reduced warehousing and declining shipment size. The net impact of them is the tendency to reduce freight efficiency because trucks are seldom filled to capacity and shippers have to handle many shipments (The Wuppertal Institute, 2009).

Several German companies now offer a service where shipments are consolidated outside the city center. In about 80 German cities these companies have set up “City Logistic” projects whereby shipments are consolidated outside the city limits and better organized within the city. The municipalities, chambers of commerce and large haulers set up trans-shipment facilities and new companies that provide coordinated delivery services within the cities. The service uses vehicles with state-of-the-art air and noise emission reduction features. To expand the service, geographic coverage can be increased, and services like cold transport and retail delivery may be added. To be competitive, the quality of service needs to be better than average. The benefits of this type of service are municipalities spending less money on roads, citizens being exposed to less noise and pollution, freight railways attracting new inter-city traffic and reduced costs for the shippers (The Wuppertal Institute, 2009).

A possible variant on this idea would be to have a short line railroad provide the service of bringing the consolidated shipments into the city, then local drayage companies handling the distribution to the final customer. Of course, for that variant to be successful, a short line or regional railroad would have to have trackage (or rights) that went to the consolidation point. There are some short line and regional operations in metropolitan areas in the U.S. where this might be a viable option.

It seems likely that these consolidated shipments would most likely be handled in carload freight, although some might well be handled in containers or trailers. As mentioned above, and below, such train operations would represent a departure from current Class I operating philosophies.

Pooled Shipping

Another option, analogous to the City Logistic programs described previously, is a pooled shipping program that has been initiated in Vancouver, BC. In this case, rail carloads of grain arriving at the Port of Vancouver are pooled to reduce congestion, irrespective of the originating railway and grain company terminal. The railroads have created common terminal railroads in some cities. There are some examples of such terminal railroads in the U.S., although they are not common today. It is argued that inter-city couriers such as Purolator, FedEx, UPS and DHL could operate a common urban delivery system in the Greater Vancouver area to also reduce vehicle mileage (Victoria Transport Policy Institute, 2008).

What this requires is working with shippers/3PL providers, and railroads to coordinate their shipping times and train schedules and blocking to facilitate such pooling. To some extent, this type of carload, trailer and container gathering runs counter to Class I operating practices that seek to run the railroad more efficiently. However, in those metropolitan areas where there is an ILC situated on the periphery, and a short line with access to it, there could be ways to make this option work effectively.

A variant on this approach is found in New Zealand. In this case it is freight coordination using web-based software to match shippers and carriers. A New Zealand software company, 4Technology, has created a website which matches empty trucks with one-off shipments. The website, at www.4Freight.net, promotes transport efficiency by providing a way both shippers and carriers can match freighting needs with available services. It is aimed particularly at individuals and companies moving irregular large consignments. Carriers are charged 5 per cent of freight won and carried through use of the service. A service fee is charged to the shipper/ supplier (Victoria Transport Policy Institute, 2008). This website is not limited to matching freight shippers and carriers. A perusal of the site shows it also offers matching of people for social connections, etc. So, it is unclear (at least to this author) as to how much the freight matching service is utilized and to what extent it is a significant business for 4Technology.

Nevertheless, to the extent there are short lines or regional railroads within a metropolitan area that could participate in such an online shipper matching service, then it represents a potentially viable option for helping move trucks off the highways within metropolitan areas. One of the obvious benefits to such a system is that it is software and web driven, i.e., this is not a capital-intensive solution. Thus, it could represent a relatively low-cost, early-entry vehicle into the arena of metropolitan congestion relief.

The Logistics Campus

The logistics campus, a concept promulgated by Excel Worldwide, an international logistics service provider, represents a combination of City Logistics and Pooled Shipping. In this option, the "campus" is a collection of multiple manufacturers focused on consumer products with similar distribution channels. The collection of companies in a single location achieves critical mass in several key areas. It allows for the sharing of resources, freight consolidation and flexibility. There are clear practical benefits and economic efficiencies to the campus. These include having facilities and resources close to consumer goods customers; being able to share labor resources among clients and operations; improved transit time and reduced order cycle time; and reduced inventory velocity and lower freight costs through volume leverage. In addition, there are also important environmental efficiencies made possible through the campus model (Victoria Transport Policy Institute, 2008).

Typically, a "campus" begins with establishing individual account(s) within a narrow geographic area, and grows organically through new business acquisition. In this model, the acquisition of new business is that of the logistics provider adding new customers within the geographically limited area. For this to work most effectively, as noted above, the manufacturers/shippers are generating products/goods that move through similar distribution channels. To some extent, the "campus" concept is analogous to industrial parks that sprang up outside the growing urban centers, beginning in the '60s through the present. In this instance, however, we are suggesting there may be some possibilities to introduce this concept within metropolitan areas, particularly where there are underutilized, old industrial areas that require clearing and remediation.

A case study of how this concept has manifested itself within the Canadian context may be found in *Moving Goods in the New Economy: A Primer For Urban Decision Makers* (Miller, Kiguel and Zielinski, 2002).

Transload/Transflow/Team Tracks

There are some "classic" options for getting freight off the highway and on to rail for delivery "inside the belt" of metropolitan areas. These are transload (aka cross-dock), transflow and team track facilities servicing off-rail customers that want to take advantage of the economies associated with rail service. Most of these types of facilities inside metropolitan areas have been abandoned long ago as door-to-door trucking became freight solution of choice. However, to the extent that trackage and acreage still exist within metropolitan areas, these could become viable solutions for providing rail service to off-track customers "inside the belt." There are still operations in dense urban areas where these facilities exist. The Class I railroads typically offer such services, although not necessarily "inside the belt." There are short line operations in metropolitan areas that continue to offer service to these facilities (see for example the New York and Atlantic website).

The benefit of such facilities is that they offer the economies of rail service to companies not located on the railroad. They also offer those companies the opportunity to pick-up or load their freight during off-peak traffic hours so their trucks are not caught up in the roadway congestion.

The primary characteristic of the types of freight rail traffic that would move to such facilities is that it is carload traffic. Again, to some extent, generating more of this traffic flies in the face of current Class I railroad philosophies of longer and heavier trains. However, if it is possible to link the concept of pooled shipping with the possible carload shippers/receivers "inside the belt," there may be ways of creating train operations that are consistent with, or at least not incompatible with, Class I operating philosophies.

Shared Rights of Way

Another option that warrants consideration is the sharing of rights of way between commuter rail and freight operations. This is currently done in some metropolitan areas, such as on Long Island, in and around Philadelphia, Boston, etc. However, there are possible opportunities for pursuing this option in other cities where commuter rail operations are the sole occupants of their rights of way, frequently these are former freight rights of way that were abandoned or sold to commuter operations. There are real, and sometimes serious, liability and operating issues with shared rights of way operations. However, by combining some of the above approaches, e.g., freight villages/ILCs and logistics campuses, with the sharing of commuter rail rights of way, there may be some opportunities to bring rail freight deeply “inside the belt” of congested metropolitan areas.

In this scenario, it is likely the commuter rail authority would continue to own and dispatch the commuter operations (perhaps through a contract operator). However, given the significant differences between freight and commuter operations, the preferred freight scenario would probably be through contracts with existing (or new) short line or regional railroad operators.

Aside from moving freight off the highway, with all the concomitant benefits described above, a possible significant benefit of sharing commuter rail rights of way is the ability to utilize an existing continuous route, typically from outlying suburban communities into the heart of the city. In many instances, the existing rights of way may have room for additional trackage so the freight operations would not be on the same track as the commuter operations. To the extent this is possible, then substantial time and money savings could be realized in adopting this option.

Operating Strategies

Beyond the kinds of scenarios outlined above, there are possible operating strategies that could be utilized to get trucks off the congested metropolitan highways. These options require both the Class I and short line and regional railroads to think a bit “outside the box,” as they look at operations in and around specific metropolitan areas. For example, consider two possible scenarios (Sullivan, 2009):

1. Destination traffic within the urban core of the metropolitan area where the bottleneck(s) occur(s);
2. Through traffic traversing the metropolitan area.

In terms of today’s rail infrastructure and modal transfer technologies, it may be easier to address the second scenario with operational changes, than the first. Regardless, time is a factor for both of them in terms of modal shift (truck to rail to destination or truck to rail to truck). The quicker these can be achieved, the easier it will be for the social benefits to overcome the economic factors (Sullivan, 2009).

A possible solution for the second scenario, say, in a place like Chicago, might be to employ the iron highway concept of trucks w/driver rolling on and off dedicated shuttle trains at each end of the metropolitan area. Based on the density of traffic, train starts could be established with whatever frequency is required to handle the volume. In theory, the additional transit time should be minimal (Sullivan, 2009).

A possible solution for the first scenario (destination traffic inside the urban core) might be to transfer from truck to rail at an outlying point, consolidate freight like a 3PL and then transfer in the urban core from rail to smaller truck for local delivery. This operational will lengthen the delivery time by at least a day but, keep a significant number (hopefully) of the big trucks out of the bottlenecks (Sullivan, 2009).

In contrast to some of the options identified above, these two operational scenarios offer ways to put into place with little capital cost, and no great amount of elapsed time, freight rail alternatives for potentially alleviating some of truck impacted congestion in metropolitan areas. While that does not suggest the previous options should not be considered, it does illustrate there may be ways to begin to address urban truck traffic congestion quickly – or to use the popular parlance of the times, these are "shovel-ready" solutions that can be implemented fairly quickly.

Demand Management Strategies

Operational strategies reduce congestion on the supply side of the transportation equation. There is a range of strategies that exists on the demand side, known as demand management strategies. Among others, these include congestion (or value) pricing, truck only toll lanes (TOT), high-occupancy vehicle (HOV) lanes, alternative work schedule and telecommuting programs, and land-use strategies. Proponents of demand management strategies argue that just as adding a few extra cars/trucks on a roadway can make a big difference in terms of extra delay, removing a few cars/trucks can make a big difference in terms of reducing delay. Thus, while all of the above strategies are ones that are, or could be, directly tied to freight rail solutions, the types of demand management solutions represented here are much more related to highway operations, both automobile and truck. For those interested in learning more about such strategies, there are numerous documents that describe them in varying degrees of detail (see for example, Jones, 2007; Mallett, 2007; McElroy and Taylor, 2007; Shrank and Lomax, 2007).

In summary, as is clear from earlier chapters, the congestion issue in metropolitan areas is bad and getting worse. What this chapter offers are some options for addressing some of freight-related congestion issues to move some of the truck traffic off of highways moving into and out of congested urban centers. These options show there are ways, some relatively easily implemented, to begin relieving truck-based congestion issues now, as well as taking actions that have longer-term impacts and require longer-term planning and implementation actions. In the following chapter, we look more closely at some possible roles for short line and regional railroads to play in addressing these issues.

Chapter 13: Possible Roles for Short Line Freight Railroads in Metropolitan Freight Origination and Distribution

In the preceding chapter, several possible options, that could include short line and regional railroads, were discussed for reducing the level of truck congestion on freeways and expressways leading into and out of major metropolitan areas. In this chapter, we discuss more specifically how these various options could be employed with short line and/or regional railroads as full-fledged partners in their implementation. These scenarios are meant to be illustrative of how, within any given metropolitan area, one or more of these solutions might be implemented over time. The examples discussed below are only illustrative. Further, they have not been discussed by the author with any entities that might be involved in implementing any of these example proposals.

In the following chapter, we suggest some possible pilot projects that could be initiated within one or two metropolitan areas identified in Table 3.3, along with perhaps one or two other metropolitan areas that are likely to be added to that list over the next 25 to 40 years as a result of increased population, and the concomitant increased need for moving freight into and out of those cities. Again, the suggested pilots have not been discussed with any of the parties that would need to be involved, nor have possible funding sources been approached

Short Line Opportunities "Inside the Belt"

There are many possible ways in which short line and regional railroads that operate "inside the belt" of metropolitan areas may become active partners in working with other parties to help divert freight traffic off the highways coming into those areas. Some of the opportunities require little capital, but may require working with the Class I railroads to achieve operational changes at the interchanges to maximize the likelihood such attempts at diverting trucks will succeed. In the following descriptions, we look at each of these opportunities in the context of a particular metropolitan area so as to provide more concrete examples of how the illustrative mechanism could work.

Freight Villages/Integrated Logistics Centers

In the New York City/Northern New Jersey metropolitan area, several possible sites for freight villages have been discussed. On the New York side of the river, three specific sites have been identified for further analysis: Harlem River Freight Village, Maspeth Freight Village and Pilgrim State Hospital Freight Village (Mann, 2007). On the New Jersey side, one site has been considered in a case study, Tremley Point (Weisbrod, et al., 2002). In the New York case, the serving short line is the New York and Atlantic Railway, while on the New Jersey side, the serving railway is Conrail Shared Assets. In both cases, the serving railroad connects to the national network via Class I interchanges. In the case of Tremley Point, Conrail also connects to New York City through the Arthur Kill lift bridge, while the NY & A Railroad operates within some of the boroughs, as well as on Long Island.

The options available for the serving railroads to participate in the development of any of these suggested freight villages range from being the developer through being a partner in the development to simply providing rail service to the sites. While it is unlikely either railroad would be willing to take on the role of developer, there are precedents for railroads being in the development business, and certainly there are Class I railroads that have developed ILCs, although usually in conjunction with other parties. In any event, in whatever role the railroads decide to play, they need to be an integral part of the discussions and decisions about how to lay out the facility to ensure efficient rail freight service so as to maximize the likelihood that such service would provide a competitive alternative to truck delivery or pick-up in the village.

Notwithstanding NYMTC's interest and pursuit of possible freight villages in the New York metro area (Mann, 2007), the current NY DOT State Rail Plan contains no mention of such facilities, nor are there any funds identified for the NY & A Railway that relate to such a program (NY DOT, 2009). While State Rail Plans are not completely binding in terms of future funding, there will certainly be additional hurdles to state participation should NYMTC, NY & A and others seek to develop one or more such freight villages.

Similarly, the current New Jersey State Rail does not contain any projects of monies tied to the possible freight village at Tremley Point, nor were there any monies or identified projects in the 2006-2008 Plans (NJ DOT, 2008).

An additional complication regarding the Pilgrim State Hospital site is that approximately seven years ago, a developer bought 460 acres of the approximately 800 acre site from the state with the intention to build a project dubbed "Heartland Town Square." There are some 9,000 apartments and three million square feet of commercial space to be built over a 15-year buildout (Clancy, 2009).

Clearly, such a development would likely severely limit what could/would be built as a rail freight-based village on the remaining land. Whether this development will proceed is an open question because there are significant disagreements regarding the proposal specified in a preliminary environmental report (Clancy, 2009).

This situation is indicative of the challenges facing metropolitan areas in finding and securing parcels that are big enough, and proximate to a rail line, to build an efficient rail-served freight village. Certainly, that is the case for Long Island. There are not other large parcels so situated that they could be developed as rail-served freight villages (Lieberman, 2008). This then raises the question as to whether there might be other parcels that could effectively be linked together through web-based technologies, such that virtual freight villages could be developed. The answer to that question is beyond the scope of this report, but it would appear to be worth investigating more fully, both in terms of available parcels and how such a virtual freight village might actually be designed and built.

City Logistics

Recall from the preceding chapter that City Logistics facilities are essentially a two-part mechanism for consolidating shipments outside the city that move into the city, as well as shipments that are picked up in the city, and provide more efficient delivery within the city. In the German model, these are truck-oriented services and businesses. However, there is no inherent reason why short line and regional railroads could not be the freight mover between the outlying consolidation facility, perhaps analogous to a freight village, and the “within the belt” facilities.

An example of how this might possibly work is to develop such a consolidation “park” or village within the airport development zone at Gary/Chicago International Airport, Gary, IN, with shuttle freight rail service into one or more Chicago distribution centers “inside the belt.” There is currently developable industrial land both within the airport development zone at the airport, as well as adjacent to the airport (McGrath, 2008). Further, freight railroad tracks lie alongside, indeed go through the property and are proposed for relocation to allow for extending the main runway (Gary/Chicago International Airport Authority, 2009).

In this instance, the likely logical developer of this City Logistic facility might be the airport authority, or its contract developer, and the railroads primary role would be in ensuring the rail layout allowed for safe and efficient and developing a shuttle service that would move freight in and out of the city in a timely manner with competitive rates. The railroads servicing this area are the EJ & E (now owned by Canadian National Railways), CSX and NS – all Class Is. The role of a short line operator might be that of the contract operator for the shuttle service, while the Class Is bring in and carry out freight to and from the airport site that originate or terminate elsewhere in North America. In short, this would marry the strengths of the Class Is with the strengths of a short line railroad in providing the specialized rail shuttle service.

Pooled Shipping

In this scenario, the challenge is to match shippers with similar distribution channels to freight rail to move the “pooled” freight to outlying ILC and then hand it off to a short line to carry it into the urban core, perhaps to a terminal railroad for final delivery to the end-customer. To accomplish this efficiently and effectively requires the railroads, both Class Is and short lines to utilize shared software – perhaps web-based as described above – to be able to gather the freight to be pooled and match it with freight train service into the desired end-point (NOTE: this is not the “data transparency,” issue, and represents a different solution from Railinc, -- for a brief discussion on “data transparency” and Railinc, see Marshall, 2006).

One can imagine, again, Chicago as a place where this could work. Most of the Class Is serving Chicago have their intermodal facilities on the periphery of Chicago. While, in most cases these are not true 3PL facilities, some could perhaps be modified to provide those services. Currently, the Belt Railway of Chicago (BRC) connects to all Class Is servicing, or “passing” through Chicago. In addition, it directly serves 70 or so industries. Thus, in this instance, the pooling of shipments mostly requires the development and implementation of the requisite software. This could be done through third-party suppliers, or the Class Is or the BRC could develop the appropriate software. Once the software is operational and de-bugged, then it would become feasible to put it into place among the Class I owners of the BRC, as well as with shippers or 3PL providers to begin to “pool” the shipments.

The Logistics Campus

Recall from the previous chapter, that a logistics campus is a collection of multiple manufacturers focused on consumer products with similar distribution channels. In the context of “inside the belt” of metropolitan areas, there are two challenges: first, finding settings wherein a “campus” could be built; and, second, agglomerating enterprises that utilize the same distribution channels. The first challenge may be met by identifying brownfield sites in older industrial areas that can be assembled into sufficient acreage, remediated and prepped, to bring in modern manufacturing, assembly or distribution facilities, in essence creating new “in-town” industrial parks/campuses. In cities such as Chicago, New York City, North Jersey, Baltimore, Kansas City and others, there are old industrial areas, some abandoned, some greatly under-utilized, that may lend themselves to such forms of redevelopment. This is generally a task that falls upon the city, or some level of government, to undertake the assembly and prepping of such sites. In some instances, private developers may step into that role. But, in any case, this typically is not something that will be done by a railroad, unless one or more of the brownfield sites happen to be railroad-owned land, perhaps old yards, shops, etc. In those cases, the railroad may be part of the developer team.

The task of meeting the second challenge, attracting the right mix of enterprises to the “campus” may involve the railroad’s industrial development department, local, regional and state economic development departments and, perhaps, site location/logistics consultants. These two components have to be worked in an integrated manner to ensure the right kind/size of properties are assembled with the right infrastructure support and understanding of the market for the enterprises being sought. At the same time, the process of attracting new businesses to the “campus” has to be pursued such that the land, once cleared and prepared, does not lie fallow for an extended period of time.

In any case, the development of such “campuses” inside the belt of metropolitan areas is a longer-term process requiring significant capital and persistent coordination and follow-through on the part of the entities involved. The typical short line roles will include track design and layout (sometimes handled through contract engineering firms), industrial development support and perhaps a financial partnership role if part or all of the project lies on old railroad lands.

Transload/Transflow/Team Tracks

Transload/transflow/team tracks could all be part of a freight village or logistics campus. In addition, they can be standalone facilities on smaller parcels of land and less track infrastructure. However, in today's urban environment, such facilities are more likely to be utilized if they have secure perimeters and limit access to only those that are patrons of the facility, or that service it.

Typically, these facilities are owned and managed by the railroad. They were quite common prior to the '80s, but have certainly fallen by the wayside in terms of traffic flow as more and more rail customers switched to trucks.

The main characteristic of the freight that will move to such facilities is that it is carload traffic. The types of cars and the commodities carried can range quite substantially. For some types of commodities, say for example food grade plastic pellets, there are requirements with regard to the cleanliness, etc. of the transfer facility. So, in developing these kinds of customers, the short lines will be better served if they can group customers by commodities moved, distribution channels used, etc.

While this sort of carload traffic is generally not in favor with Class Is because of the drive toward "hook and haul" operations, if the right kind of collection and blocking of traffic can be performed such that the Class Is can handle the carload traffic efficiently, they do it very well. As Marshall has noted regarding an innovative program developed by one regional railroad, the Class Is did their job, the regional railroad was the partner that could not meet the commitments because of warehouse problems (Marshall, 2006 and 2008). Yet, it is the carload type of traffic that most commonly finds itself moving via truck into and out of congested metropolitan areas. Thus, the use of the "pooled shipping" option discussed previously may be the mechanism to build carload traffic destined for transload/transflow/team track facilities "inside the belt" of metropolitan areas.

As mentioned previously, the NY&A Railway currently has active transload/transflow/ team track facilities in the New York City metropolitan area. In most other American urban areas, there are sites that are/were/could become such facilities. While carloads trains of mixed freight are not as obvious in taking trucks off the road, it is worth remembering that a single freight car can haul as much as three to four truckloads of product, depending upon the commodities carried. Thus, if carload traffic were to move into the cities at the rate of one train per day, with reverse hauls out at the same rate, we could see as many as 1,400 to 2,500 trucks per week disappear from the roadways leading into and out of the heavily congested metropolitan areas. As a Mercer study suggests, the potential revenue for the railroads (Class Is, short line and regional railroads) from successfully addressing the carload business is on the order of $14 billion (Mercer, cited by Marshall, 2006). So, done right carload rail freight can make a significant contribution to the railroad bottom lines as well as significantly reduce truck congestion moving in and out of metropolitan areas.

Shared Rights of Way

The option of shared rights of way is only viable in those cities that have commuter rail operations. In many instances, those commuter rail operations take place on former freight railroad rights of way that were abandoned and/or sold to commuter authorities. What is being proposed here is to consider the possibility of re-instituting freight service in these corridors that lead into the heart of the cities. This is not sharing of tracks, although that is done today in some cities. Rather, it is laying new freight rail track in the rights of way and then developing small collection and distribution terminals closer to the receivers and shippers “inside the belt.” Since freight service has been abandoned along these rights of way, in many instances 10-15 years ago, there are no current rail freight shippers or receivers along the lines. Thus, new facilities could be located just on the freight rail side of the right of way, thereby reducing operating conflicts with the commuter rail operations. While this option certainly requires capital for new track, perhaps signals and communication equipment, and maybe pedestrian overpasses or subways to avoid freight rail conflicts with passengers walking to and from the commuter trains, the total costs of in essence starting a whole new freight rail service into metropolitan areas would be substantially less than acquiring new rights of way (even if it could be done), and could be implemented in a relatively short period of time. Of course, the sites for the terminals would also need to be acquired and prepped, but in general, this may be a way to bring freight rail service into some metropolitan areas, particularly where there are no existing short line operations “inside the belt.”

One concern typically raised in regard to shared rights of way is that of liability. In the case where new rail is being laid, freight operations only occur on the freight rail side of the right of way and pedestrian separations are created and maintained, it should be possible to largely resolve such liability concerns. The shared right of way would continue to be owned by the commuter rail authority. Freight operations would be on a lease basis, or operating contract – indeed, many of the commuter rail operations are contract run by an operating company, not by the commuter rail authority itself. So, there are good legal and operating precedents for considering increased utilization of existing rail corridors.

One other issue that would need to be resolved is where these new freight rail lines would connect with the Class I carriers serving the metropolitan area. Clearly, if such connections are not easily achieved, then this option may become moot. But one possible construct would be for the new freight rail operation to be basically served by over the road, long-haul trucks that deliver their trailers and containers to a newly constructed railhead on the periphery of the metropolitan area and proximate to the Interstate system. In fact, this could be taken further with a truck-only access road coming off the freeway to directly feed into the railhead terminal – which could be part of an ILC. In short, provide a peripheral truck transfer facility to keep the trucks from having to enter the congested links of the roadways leading into and out of the cities.

Operating Strategies

Finally, we consider some possible changes in operating strategies that may improve the ability of freight rail to cost-effectively move more freight in and out of the metropolitan areas. Operating strategies are not strictly limited to changes in rail operations. There are many changes that can be made in the freight customer's facilities and internal operations that can significantly improve the receipt and shipment of freight by rail. These may be as simple as changing the hours of receiving freight, to re-positioning receiving doors and tracks to improve industrial switching, etc. At the same time, there are fairly straightforward operating changes that can be made by the Class Is and short lines to improve carload handling, such as building blocks of cars that can be pulled by the Class Is like unit trains, etc. And, there are operational changes that need to be made with regard to data transparency for tracking and managing shipments. Many of these changes can be accomplished through the joint decisions of a couple of Class Is and their short line partners. To the extent that Class Is and short line and regional railroads can begin to truly run their railroads as scheduled operations, then to that extent, there will be increased opportunities to attract carload freight and make the move all the way "inside the belt" (Marshall, 2006).

In Chapter 12, two such shifts in operating strategies were described. There are probably as many such potential changes as there are short lines serving metropolitan areas. In the next chapter, we discuss some possible pilot projects that could test one or more options described in this chapter.

Chapter 14: Metropolitan Area Railroad Pilot Projects: Some Proposals

In this chapter our focus is on how to explore potential short line and regional railroad solutions to road traffic congestion via "inside the belt" freight rail service. As is clear from Chapter 7, highway congestion is a multi-faceted problem. At the same time, as Table 3.1 graphically demonstrates, the amount of truck delay found in the top 20 or so metropolitan areas is staggering. The negative impacts of these delays redound through the economy, as well on the environment – both locally in terms of pollution levels and nationally in terms of the amount of diesel fuel wasted by slow and/or stopped trucks in congested metropolitan areas.

Thus, it behooves us to broaden our approaches to finding solutions to congestion, particularly on the freight side of the equation, and find ways to test possible approaches to improving the distribution and pick-up of freight "inside the belt." In the two following sections, we explore some of the processes that might be invoked in this search for solutions, and we posit some metropolitan areas that might be appropriate test bases for pilot projects.

Testing the Waters

The first point that should be made is that it is highly unlikely there will be a single solution that works for all metropolitan areas. In the first instance, there are not short line railroads "inside the belt" for most metropolitan areas. So for those cities without short line railroads in their midst, any congestion-relief proposal involving short line railroads will not apply. In the second instance, as seen in Chapter 3, short line and regional railroads come in many different sizes and flavors. And, metropolitan areas also come in many different sizes and flavors. So, are there ways to test for the feasibility of various freight rail solutions to metropolitan congestion that can be generalized across different railroads and different metropolitan areas?

In our opinion, the answer to this question lies not in the specific solutions to moving freight into the metropolitan areas, but rather in the processes used to arrive at the solutions. We believe it is possible and feasible to develop planning, analysis and decision processes that can be used by many metropolitan areas. The difference will not be in the process, but in the particular players in the process and in the selected solutions to be tested and implemented. In fact, it is likely that for any given metropolitan area the parties to the process will come from the same class of interests, just that the individuals involved will be different. Thus, for example, the MPOs will certainly be represented in the process, but given that there will be different MPOs for different metropolitan areas, the individual MPO representatives will be different. At the same time, there may be situations where the individuals participating in the process in two different metropolitan areas will be the same. For example, the state DOT representatives may be the same for more than one metropolitan area within a given state. Or, the Class I railroad representatives may be the same for multiple metropolitan areas served by their respective railroads.

The question now becomes what process or processes might be developed or proposed for investigating solutions to metropolitan congestion that could include consideration of rail freight as a potential mechanism for addressing this problem? As seen in Chapter 8, there has been increasing concern, at the federal level, that freight congestion is a serious problem, with a recognition that there are few institutional arrangements that coordinate this activity (FHWA, 2008). In 2001, FHWA published a primer on regional transportation operations collaboration and coordination (FHWA, 2001). In this primer, it is argued that regional collaboration and coordination evolve from a focus on problem solving to a focus on integrated transportation systems. This is graphically portrayed in Figure 14.1.

In April 2004, this concept is further articulated with the identification of five key elements associated with successful regional operations collaboration and coordination. These are:

- Structure,
- Process,
- Products,
- Resources, and
- Performance measures that gauge success.

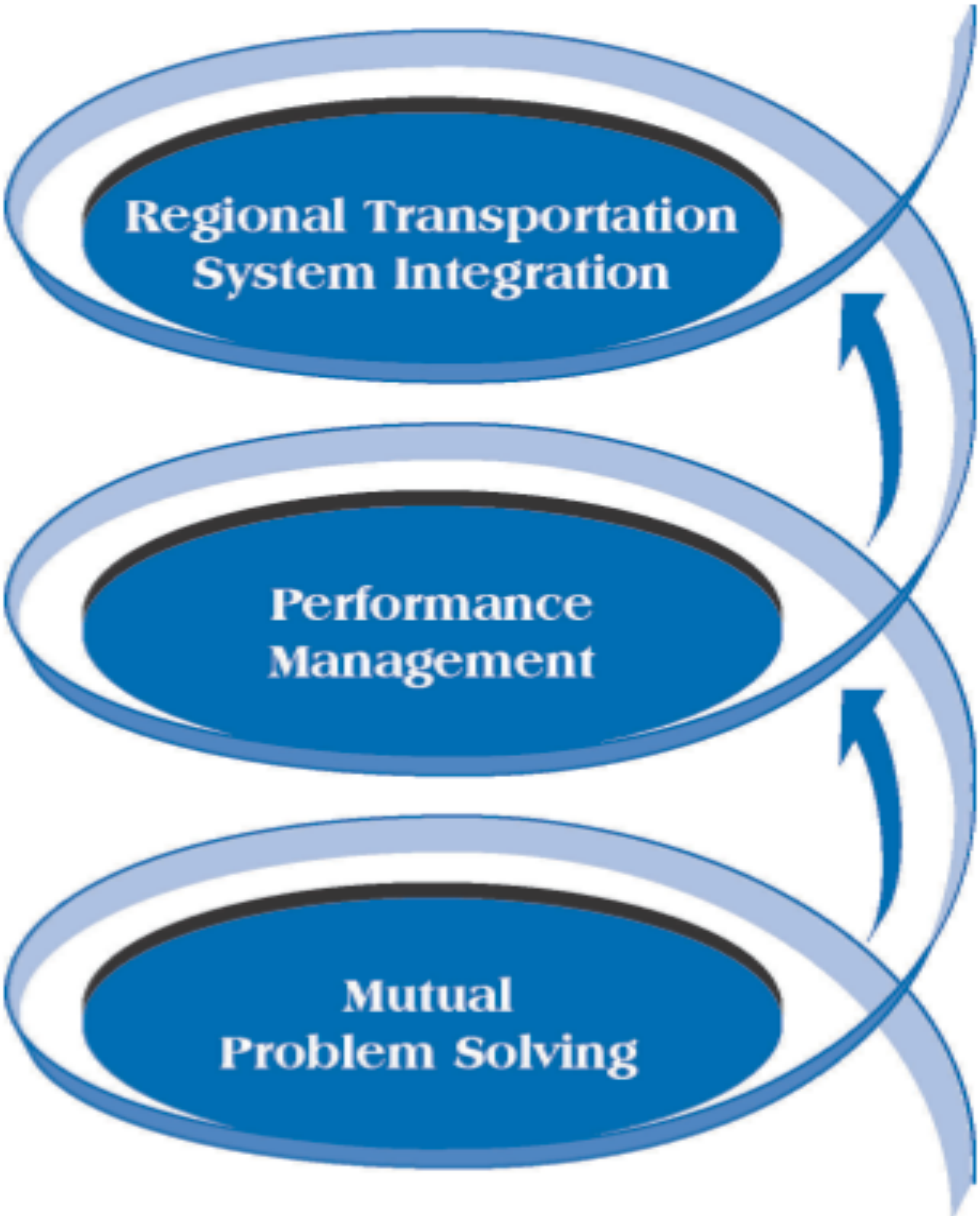
Figure 14.2 illustrates the relationship among these elements. As is clear in the publication, the focus is on developing collaboration and coordination among managers with day-to-day responsibility for providing transportation and public safety (FHWA, 2004a).

By November of 2004, a regional concept for transportation operations is proposed, along with a series of case studies that are illustrative of how this concept might operate in metropolitan areas (FHWA, 2004b). Figure 14.3 illustrates the vision for linking planning and operations.

There are two obvious characteristics of these documents. First, the focus is on collaboration and coordination among agencies within a region. While there is recognition that non-transportation entities have impacts on the regional transportation system, there is no mechanism proposed having them as an integral part of the process. Nor are transportation providers, other than public transportation authorities included. The second obvious characteristic in this primer is that the focus is on passenger transportation. There is virtually no mention of freight transportation and its importance within the region, either from a transportation standpoint or from an economic perspective, let alone environmental concerns.

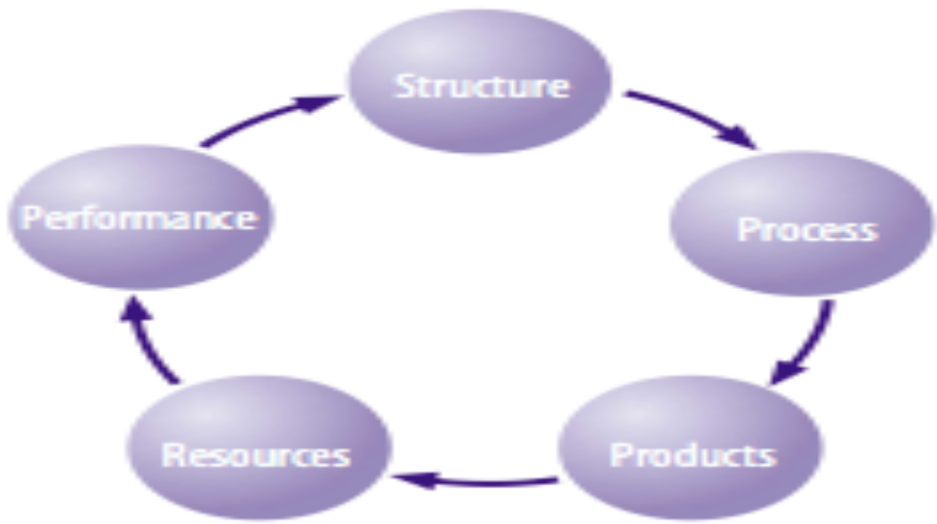
In 2007, two additional reports were issued by FHWA on the collaboration of management, operations and planning in the metropolitan and regional transportation planning process. In the first report, the focus is on demonstrating the benefits that can be derived by collaboration and cooperation among agencies responsible for regional transportation options. Through case studies, some of the benefits are found to include

Figure 14.1: Regional Collaboration and Coordination Evolution



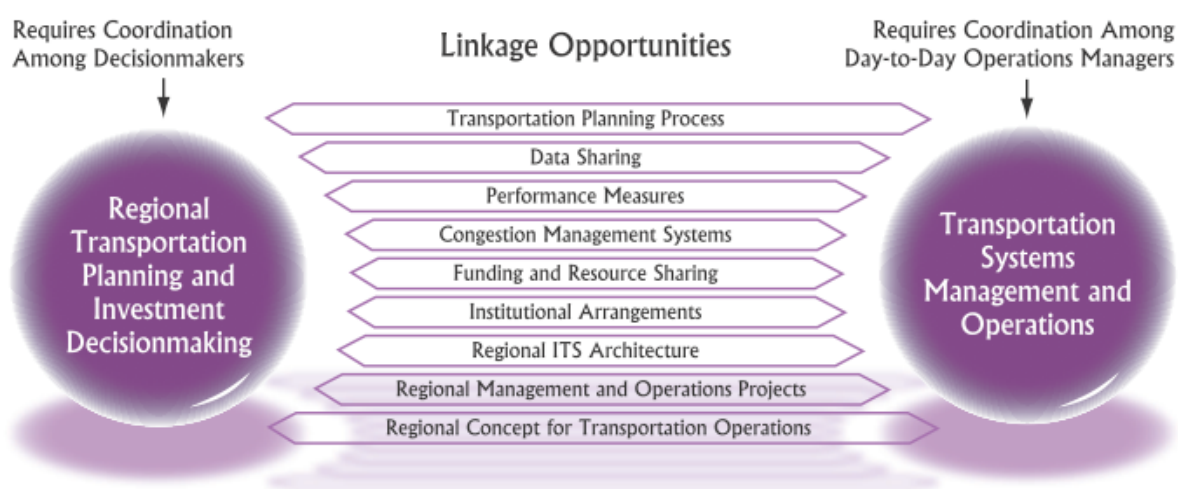
SOURCE: FHWA, 2001.

Figure 14.2: Five Key Elements of Regional Collaboration and Coordination



SOURCE: FHWA, 2004a.

Figure 14.3: Scope of Linking Planning and Operations



SOURCE: FHWA, 2004b.

access to funding and other resources, improvements in agency operations and productivity and outcomes that help agencies achieve their mobility and safety goals (FHWA, 2007a). In this report, the focus is still on passenger transportation, with all the examples cited focusing on automobiles and transit. There are some obvious ways to include freight in this collaborative approach, but those are not discussed in the report.

The second report drives this theme further along with a description of an objectives-driven, performance-based approach to management and operations in the metropolitan transportation planning process. In this report we see specific mention of freight shippers and the business community. It states that, while the MPO serves a coordinating function in developing the Metropolitan Transportation Plan (MTP), the process of developing operations objectives requires involvement of a full range of agencies involved in operating the transportation system. This includes:

- State DOTs
- Local jurisdictions
- Transit agencies
- Bridge and toll facilities
- Port authorities

It goes on to say there is a need to reach out to broader customer stakeholders, including the freight and business communities, and agencies responsible for emergency management, such as:

- Police and fire officials
- Emergency medical service (EMS) officials
- Emergency managers
- Public works officials
- The tourism industry
- Freight shippers
- Business organizations, such as chambers of commerce

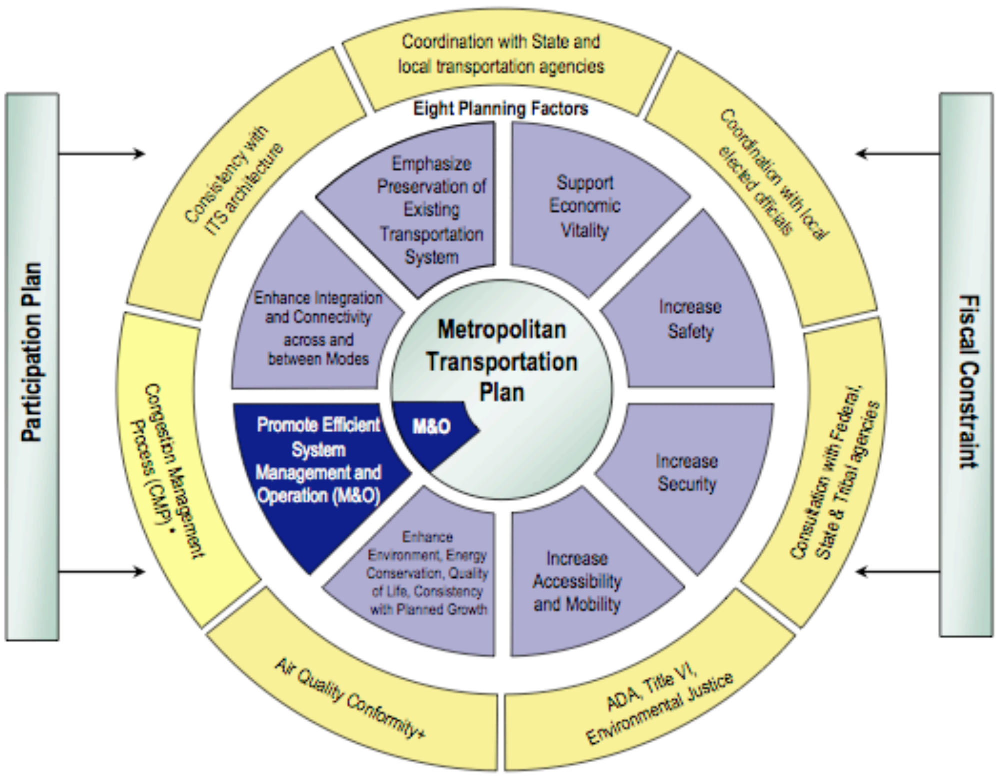
In addition, elected officials and the general public also need to be included in stakeholder involvement (FHWA, 2007b).

Two diagrams illustrate both the conceptual components of an MTP, and the process of integrating regional operations objectives into the MTP. These are shown in Figures 14.4 and 14.5, respectively. In Figure 14.4 it is clear that FHWA intends that many of the factors identified in previous chapters need to be addressed in the MTP. For example, one element deals expressly with air quality, while another specifically brings in congestion management processes. Thus, we see in a conceptual scheme the recognition of transportation as part of a larger system that needs to be addressed in the MTP.

Figure 14.5 illustrates the relationship of the MTP to a process that begins with the development of a regional vision and goals. These are to arise from a thoughtful and deliberate regional process that takes into account the eight planning factors shown in Figure 14.4. The regional vision and goals are supposed to provide a broad sense of what the region agrees it wants the transportation system to achieve (FHWA, 2007b).

Figure 14.4: M & O in the Context of Metropolitan Transportation Planning

Requirements



*Required for TMAs
+Required for non-attainment and maintenance areas

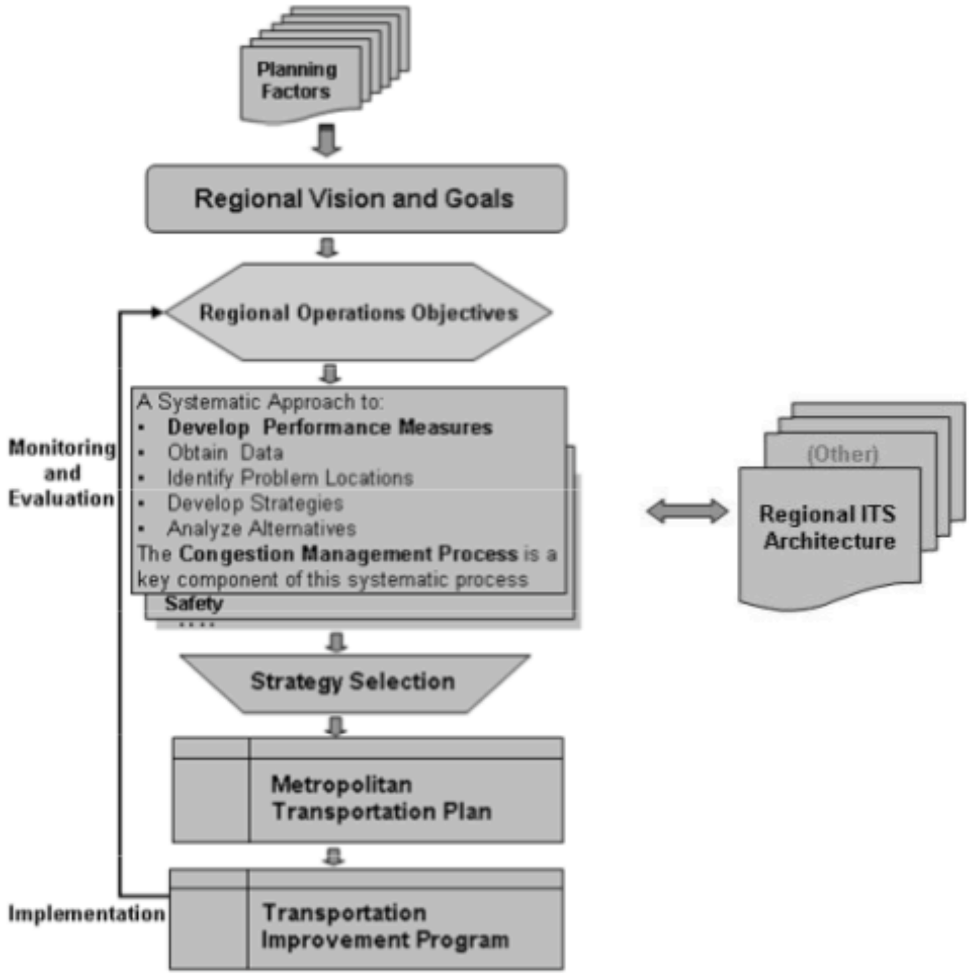
SOURCE: FHWA, 2007a.

As shown in Figure 14.5, the regional operational objectives flow directly from the goals. The objectives are measurable and define desired outcomes that make progress toward the goals. The operations objectives are developed through collaboration and coordination with operating agencies and play a key role in the planning process. These regional operations objectives are used to develop performance measurements, analyze problems and develop recommended strategies for inclusion in the MTP. The Congestion Management Process is a key component in this process, focusing on managing congestion in the metropolitan area (FHWA, 2007b).

The result of this process is an MTP with a 20+ year outlook that includes a better mix of operations strategies and capital investments, along with a Transportation Investment Program (TIP) that has a near-term focus, including specific programs and projects. The monitoring and evaluation of transportation system operations then feeds back into the development of an update of the regional vision, goals and objectives in the next MTP development cycle (FHWA, 2007b).

Figure 14.5: Integrating Regional Operations Objectives in the Metropolitan

Transportation Planning Process



SOURCE: FHWA, 2007b.

In this regional transportation planning process, we have a conscious attempt to integrate many of the elements impacting on metropolitan transportation and to draw in many of the relevant players within the region. There are some limitations to the process as described, for example, the focus still remains on public agencies in terms of measurements, investments, etc. The focus is entirely regional. There are no explicit or implicit connections to national factors, such as interregional freight flows, national and international economic trends, etc. (It should be noted that, as discussed in Chapters 1, 7, 10 and 11, effectively, there has been no national transportation policy or plan since the creation of the Interstate Highway System in the late 1950s – for all intents and purposes, transportation planning, design and development have devolved to the states and local areas.)

In fact, in this regional transportation planning process, there is no explicit tie to any state transportation plan. However, the process does offer a systematic means of planning for transportation in metropolitan areas. Thus, as we discuss in the following section, we propose to adopt the framework of this process in working within one or more pilot metropolitan areas for empirically assessing roles short line and regional freight railroads might play in alleviating some of the truck congestion on the highways entering and leaving those pilot metropolitan areas.

Proposed Pilot Projects

The objective of pilot projects would be to test the viability of the planning process, outlined above, to bring the appropriate players together to investigate what roles the short line and regional railroads could perform in addressing the truck congestion issues in metropolitan areas. To provide a reasonable test of the planning process, at least two metropolitan areas should be selected. Further, these areas ought to provide contrasting situations in terms of size, character of freight moving in and out of them, etc. Finally, the level of congestion and the complexity of the chokepoints should be such that it is possible to assess the efficacy of rail freight alternatives in settings that range from fairly straightforward to significantly complex, i.e., from operational changes to solutions that require sufficient capital and lead times that will by necessity occur over multiple years and may also require staging to be accomplished.

As a first cut on freight flows, the two scenarios outlined in Chapter 12 offer a starting point in picking possible metropolitan areas for pilot project investigations.

1. Destination traffic within the urban core of the metropolitan area where the bottleneck(s) occur(s);
2. Through traffic traversing the metropolitan area.

Another selection criterion for pilot projects is that the metropolitan areas are non-attainment in terms of pollution levels. From a population standpoint, the pilot areas should provide a contrast in size, ideally at least one smaller metropolitan area (say in the neighborhood of 1,000,000 people currently) and at least one large metropolitan area (say 5,000,000+ people), as well as growth rates, from relatively slow to rapid – e.g., 10 percent or less by 2030, to 50 percent or more by 2030. From a congestion and chokepoint perspective, the metropolitan areas should be experiencing at least 1,000,000 hours of truck delay annually and have three or more bottlenecks. For the purposes of the proposed pilot projects, the metropolitan areas need to have at least one short line or regional railroad operating “inside the belt.” Finally, while it would be ideal if the selected metropolitan areas were currently implementing the regional planning process described above, but, if that is not the case, then the pilot project may become a mechanism for introducing the planning process to the metropolitan commission.

Based upon these criteria, there are at least four metropolitan areas that may provide good base-case pilot project sites: for the large metropolitan areas – Chicago-Northwestern Indiana and Dallas-Fort Worth – provide contrasts in population growth, while each has extensive destination traffic, as well as through traffic traversing the metropolitan area. For the smaller metropolitan areas – Portland-Vancouver (OR-WA) and Providence-Pawtucket-New Haven-Meriden-Bridgeport-Milford – similarly provide contrasts in population growth rates, while both have significant levels of destination traffic. Other possible metropolitan areas could be posited, however, these four certainly offer an interesting range of characteristics for exploring possible rail alternatives to the distribution and collection of freight "inside the belt" that range from straightforward operational changes to more complicated options such as forming freight villages, pooling shipments or sharing rights of way.

The participants in any of these pilot projects would include the full range of agencies identified previously, as well as representatives from short line, regional and Class I railroads serving the given metropolitan area. Further, the dominant trucking firms delivering into, and picking up within, the given metropolitan area would be invited to participate. Depending upon the nature of the solutions under consideration, additional parties might include industrial real estate developers, shippers and receivers within the metropolitan areas and representatives from FHWA and FTA.

The lead for integrating this freight focus into the MTP process would be the MPO for the given metropolitan area. In terms of identifying and bringing the freight carriers into the process, the American Short Line and Regional Railroad Association and the Association of American Railroads could act as facilitators for involving the freight rail representatives. Identification of representatives from the relevant trucking firms will be determined by the nature of the solutions under consideration. The railroad representatives may be the most knowledgeable about "whom" within the over-the-road trucking industry should be invited to participate.

In identifying possible freight rail solutions to metropolitan area congestion, it will be necessary to avoid the danger of suggesting a particular option simply because there is an available parcel of land, for example, or some other asset that is currently underutilized (McClellan, 2008). Further, the solutions have to be economically viable over the long-term. However, in performing the calculus of benefits for any proposed option, it is necessary to account for, in some metricized form, what have been historically viewed as externalities – for example, GHG. In the case of GHG, part of the analysis of a proposed rail option needs to be the calculation of reduction in O_3, CO, SO_2, PM-10, Pb, NO_2, as well as the population exposed to these contaminants. Thus, part of the value in proceeding through the regional planning process is the requirement to include such factors as air quality measures in the development of the MTP.

Detailed proposals for pilot projects are being prepared under separate cover. Those proposals will specifically identify the metropolitan areas, the players to be brought to the table, the scale of the pilot projects and performance measurement for assessing the effectiveness of the proposed projects.

Chapter 15: Future Research Directions

Throughout the report, various areas have been identified as warranting further research. This chapter pulls together those suggestions, as well as related areas not specifically identified in the report. Beyond those suggestions, this chapter also includes recommendations for more detailed research into how short line and regional railroads could, perhaps, fit into concepts currently in vogue in supply chain management, as well as what these carriers could learn from rail/road ramp operation models, etc.

While not directly related to congestion in metropolitan areas, Chapter 2 briefly discusses the role of short line and regional railroads in state and local economies. It is clear that studies, such as those done by the Kansas Department of Transportation and the Washington Department of Transportation, demonstrate significant annual public benefits from the operations of short line and regional railroads in their respective states through reduced damage to highways and highway maintenance costs, lower costs for shippers and direct tax revenues for state and local economies.

An obvious opportunity for further research is to look at the benefits that short line and regional railroads contribute to the 49 states within which they operate – not just one of two states – as well as to investigate systematic ways of integrating such operations into statewide and national transportation planning models. A cursory review of State Rail Plans reveals a singular lack of integration into statewide comprehensive transportation plans. Further investigation into the barriers to this integration is warranted.

Finally, when one considers the Freight Corridors of the Future, illustrated in Figure 7.4, and discussed in Chapter 7, it is striking that freight rail – whether Class I or short line and regional railroads – are not part of the equation. In early discussions with FHWA officials, this author recalls conversations around whether it made sense to invest significant Federal dollars in building new Interstate capacity in areas that are proximate to short line and regional railroads, let alone Class I railroads. Indeed, there are two major Class I rail corridor projects currently underway wherein the express intent is to move trucks off the Interstate highways running through those corridors.

Thus, an area warranting future research is the identification of the conditions and requirements that would yield clear public benefit from investing in rail infrastructure – perhaps through some form of public-private partnership structures with the Federal government playing a leading role because of the multiple state, regional and local interests involved in such projects.

One could argue that research into a national freight rail network planning and funding mechanism (that includes both Class and short line and regional railroads) is a pressing need.

In Chapter 3, several opportunities for further research are suggested by the data portrayed in Tables 3.1, 3.2 and 3.3. For example, Table 3.1 identifies metropolitan areas that had three or more interchange bottlenecks for trucks in 2004. Over 20 such areas were identified. In 2004, those bottlenecks created over 111 centuries of delay for trucks moving into, through and out of those metropolitan areas. It seems highly unlikely that the situation has improved much, although the recent economic downturn may have provided some short-term relief. When one considers those areas in conjunction with the freight forecasts found in Chapter 4, and the population forecasts found in Chapter 6, it is clear the amount of truck delay will only worsen over time, and more metropolitan areas will have at least three or more interchange bottlenecks causing more than 1,000,000 hours of truck delay annually.

The economic, environmental and societal costs associated with this level of delay warrant rigorous investigation. In conjunction with this type of investigation, and considering the short line and regional railroads identified in Tables 3.2 and 3.3, some "orders of magnitude" research could be undertaken to estimate the level of benefits that could be derived locally, regionally and nationally if these carriers were to "interdict" truck freight before it got to the metropolitan areas, or, in the case of intermodal freight, not "ground it" at the peripheries of the metropolitan areas for truck continuation into the metropolitan areas.

Another topic briefly mentioned in Chapter 3 is the issue of freight operations within metropolitan areas having to work around commuter and passenger operations. In the U.S., commuter and passenger operations and schedules take precedence over freight operations and schedules – whether it is inside a metropolitan area or on long-haul freight mainlines with Amtrak passenger operations running over them. This is an area needing further research in terms of the proposals suggested in Chapters 12, 13 and 14. Part of the solution to these operating conflicts may lie in identifying flexible freight receiving and shipping schedules that are not coincident with peak commuter and passenger operations. These issues will become ever more pressing as the demand for commuter and passenger service increases in the larger metropolitan areas in the U.S.

Chapters 13 and 14 suggest some possible models of how truck freight could be shifted to short line and regional railroads in metropolitan areas. Four specific metropolitan areas (Chicago-Northwestern Indiana, Dallas-Fort Worth, Portland-Vancouver – OR-WA, and Providence-Pawtucket-New Haven-Meriden-Bridgeport-Milford) are recommended as potential pilot project areas to test some of these models. Other metropolitan areas could be similarly identified. In any event, one approach to investigating the applicability of these possible models is to first do some sensitivity analyses to determine what levels of freight shift have to occur to provide demonstrable and significant public benefits. Once these traffic levels are identified, then further detailed analyses of what it would take to effectuate such changes could be undertaken. Included in these latter analyses would be identifying the current institutional and business barriers (including current Class I operating procedures), some of which are discussed in Chapters 12 and 14.

In Chapter 7, in conjunction with Chapter 8, two fairly obvious arenas for future research are evident. First, research into how the traditional congestion mitigation strategies would work in conjunction with moving freight to short line and regional railroads, as described in the previous paragraph. Again, a first cut analysis would be to perform sensitivity analyses of selected metropolitan areas to determine what ‘mix” of mitigation remedies and diverted truck traffic yields some specified levels of delay reduction, GHG reductions, etc.

Following these sensitivity analyses, identification of what it would take (costs, institutional change, etc.) to achieve certain “mix bundles” would provide the basis analyzing the cost-effectiveness of implementation of any proposed mitigation strategy. This form of analysis requires developing evaluation frameworks that account for all of the associated “costs” and “benefits.” Without doubt, such research would yield further areas of work in terms of data requirements, acquisition and collection, as well as analyses. All are potential research areas.

The second arena the flows from the work in Chapters 7 and 8, revolves around the bottlenecks at foreign trade gateways – land border crossings, certain airports and water ports. At land crossings, congestion is caused by three main factors: inadequate transportation infrastructure to handle the volume of cars and trucks; import and security processing; and general urban road traffic congestion. There is also evidence that border delay and reliability problems have more to do with institutional and staff issues than infrastructure issues – although this may be crossing-specific. Likewise, delays at water ports may be the result of inadequate road and rail infrastructure, general road congestion and customs and security requirements. Certainly, one of the biggest challenges at international gateways since 9/11 has been balancing passenger and freight mobility with heightened security.

Each of these “causes” of foreign trade gateway congestion needs to be investigated much more rigorously. Further, there has been little work done that looks in any detailed or comprehensive way at the possible roles rail freight, and in particular short and regional railroads, could play in alleviating some of these gateway issues. Short lines do play an important role in some port operations – see Table 3.2 for the identification of some of those carriers. However, rigorous research into how short haul rail operations relating to marine terminals could work in practice with many common elements in the “agile ports” concept should be undertaken.

Interoperability of customs and security clearance procedures are other areas that warrant further research, particularly with regard to how short line and regional railroads can be integrated into such procedures in a “seamless” manner. Where a short line or regional railroad is a “captive” operation within a port, such interoperability issues may be more easily addressed than where short line or regional railroads are part of a cross-border freight system. In either case, identifying “best practices” and cost-effective solutions to interoperability present future research opportunities.

As noted in Chapter 8, freight rail congestion is a growing issue. While most of the evidence – largely anecdotal – suggests the congestion problem is most urgent on

Class I carriers, there are real issues associated with short line and regional railroads, as well. Addressing these congestion issues is complicated by the fact that, with the exception of a very small number of publicly-owned short line railroads – railroads are privately owned and make decisions with regard to investments, etc. based upon their particular business models. So, in essence, the freight rail system in the U.S. is "managed" in an ad hoc manner with little regard for addressing national rail freight issues. The level of this "ad hoc" character becomes quite obvious when it is recalled there are almost 550 short line and regional railroads in the U.S. An interesting research issue is developing a mechanism/process/etc. that provides a national framework within which individual railroads can then develop their own plans and operations. This is ***not*** a proposal for national ownership of rail lines, or in any other way directing rail operations. Rather, what is envisioned here is some sort of national framework that looks at the entire rail system in the U.S., short line and regional railroads included, and identifies opportunities for more effective freight movements – both rail and highway. In essence the objective would be to harness national data on system characteristics and then provide such information and data to the railroads for their respective use in developing their business models.

Chapter 8 also identifies eight freight-rail gateways and corridors where rail congestion is an issue. An opportunity exists to investigate what roles, if any, short line and regional railroads could play in addressing these concerns. As Chapter 14 suggests, there appear to be some opportunities in at least one of those identified gateways – i.e., the Chicago rail hub. But other opportunities may exist in the Pacific Northwest-West Coast corridor and the Mid-Atlantic rail network. Regardless, these represent possible opportunities for future research.

Chapter 9 identifies several global issues that will affect freight traffic in the U.S. in the future. Each of these areas represents an opportunity for future research in scenario building for assessing the impacts on Class I, short line and regional railroads. For example, there are going to be climate-based imperatives for dramatically improving how freight is transported in the U.S. Again, scenario-building research on possible "future" states represents an interesting research avenue.

Chapters 10 and 11 identify both institutional and modeling mechanisms that warrant "fresh eyes" on how to proceed with "changing our way of doing business." Whether that is in how we organize our processes for dealing with transportation – including agency and funding mechanisms; or with how we model our transportation system more effectively to capture the "system" effects and provide cleaner and clearer links between strategic, tactical and operational planning – need to be addressed.

At the institutional level, there is a pressing need to integrate freight rail interests (both Class I and short line and regional railroads) into the planning processes at the National, State and MPO levels. The National Surface Transportation Policy and Revenue Study Commission's report presents an interesting starting point for developing detailed case-study analysis of how implementation of their recommendations would manifest themselves at the short line and regional railroad level.

Numerous issues with the current state of freight modeling are identified in Chapter 11. In terms of the focus of this report, at whatever level of modeling and analysis one looks, there are no effective ways to integrate short line and regional railroads into the models or analyses – this is largely true for Class I railroads as well. Thus, we would argue that a new "modeling paradigm" needs to be developed to more adequately capture the vagaries and intricacies of freight transport in the U.S. Perhaps there are some illuminating European modeling efforts that could shed some light on how to develop a different model framework that includes domestic and global freight, where all modes are relevant and borders play an important role. Or, perhaps some other creative models may lead to better insights into freight movement, for example, "fuzzy logic" models or some other forms of "more behavioral" models. Regardless of the particular approach, we definitely need to explore different ways of modeling transportation in this country than has been the case heretofore.

Associated with this call for developing new models is the need to address data acquisition, storage, retrieval and analysis. While some may argue that our models are constrained by the types of data available, it is just as valid to argue that our data are constrained by our conceptual frameworks with which we organize our world. Thus, if we change our model frameworks, we may well change our data requirements. But even if that does not occur, if we do not start to develop data acquisition strategies that will lead us to the data we need (in an accessible and affordable manner), then we will never have those data. Thus, research into the whole data stream is warranted.

Chapters 12, 13 and 14 offer an array of options for collecting and distributing freight within metropolitan areas. Each of these options, and the role or roles short line and regional railroads could play in their implementation represent potential research areas – whether as the pilot projects as described in Chapter 14, or as "sensitivity analyses" described above.

Finally, there are several areas of future research that could look at how short haul rail fits in with the new concepts already applied in supply chain management. For example, inventory in motion, vendor managed inventory, forward-based inventory, etc. would all seem to be interesting potential areas for further research in terms of the applicability to short and regional rail operations. Thus, research could investigate the prospects for application of these concepts and under what conditions they would most likely succeed. Research could also address the institutional barriers to application. Finally, research could investigate, as described above, the level of benefit to be derived from such applications – particularly public benefits – perhaps in combination with the adoption of other combinations of congestion mitigation strategies.

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