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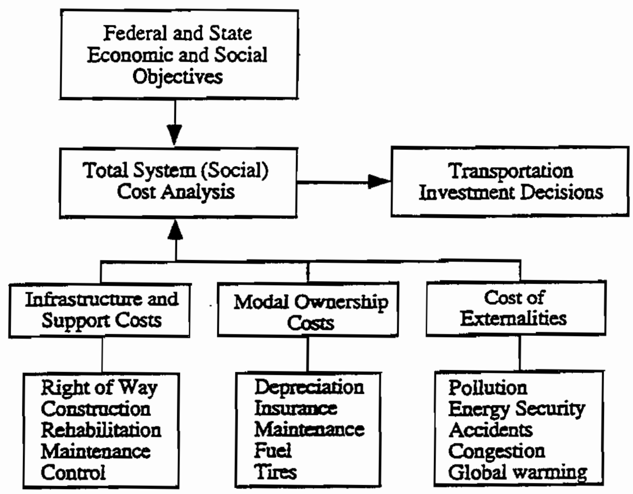
An efficient transportation system requires a coordinated transfer for people and goods moving from one mode to another. In the past, neither the process of planning nor the environment for supporting analysis of the total transportation system has been viewed from a multimodal perspective. Tremendous changes in federal and state policies have created a new contextual environment for transportation. Based on these changes, the private sector is rapidly embracing the advantages of an intermodal transportation system. For the future, a total system, or social, cost analysis of transportation must be pursued to address mobility problems and other state and national priorities. This framework, illustrated right, includes all costs associated with transportation. Various studies have demonstrated that inclusion of all system costs in analyzing transportation alternatives will yield transportation operations different from what now exists. This model will assist decision-makers in evaluating alternative transportation policies, particularly if combined with a multi-attribute methodology. While additional work is needed to evaluate marginal costs, this report establishes a point of departure for more efficient analysis of transportation alternatives.

Multimodal Transportation Evaluation Model



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A FRAMEWORK FOR EVALUATING MULTIMODAL TRANSPORTATION INVESTMENT IN TEXAS

by

Mark A. Euritt

and

Robert Harrison

Research Report 1282-2F

Research Project 0-1282

Increasing Mobility and Economic Development Through Multimodal Centers

conducted for the

TEXAS DEPARTMENT OF TRANSPORTATION

in cooperation with the

U.S. Department of Transportation

Federal Highway Administration

by the

CENTER FOR TRANSPORTATION RESEARCH

Bureau of Engineering Research

THE UNIVERSITY OF TEXAS AT AUSTIN

May 1994

IMPLEMENTATION STATEMENT

This report presents a framework (see Chapter 9) for evaluating transportation alternatives from a system, or social, cost perspective. (Important data for analyzing modal alternatives are presented in the appendices.) This framework can be utilized by transportation planners and analysts to investigate transportation alternatives, guide transportation investment, and serve as a basis for allocating transportation revenues, as well as for identifying economic distortions created by current transportation policies. The report provides a contextual basis for reviewing multimodal transportation opportunities. Major trends, key implementation issues, and policy changes affecting multimodal and intermodal transportation are summarized.

Prepared in cooperation with the Texas Department of Transportation
and the U.S. Department of Transportation, Federal Highway Administration

DISCLAIMERS

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

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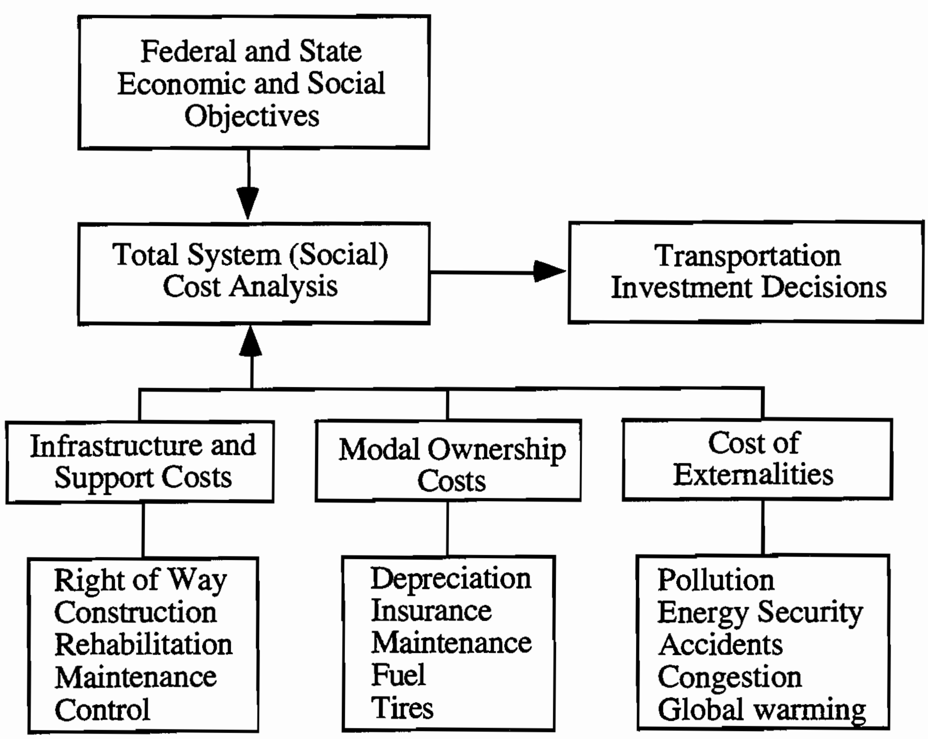
ABSTRACT

An efficient transportation system requires a coordinated transfer for people and goods moving from one mode to another. In the past, neither the process of planning nor the environment for supporting analysis of the total transportation system has been viewed from a multimodal perspective. Tremendous changes in federal and state policies have created a new contextual environment for transportation. Based on these changes, the private sector is rapidly embracing the advantages of an intermodal transportation system. For the future, a total system, or social, cost analysis of transportation must be pursued to address mobility problems and other state and national priorities. The framework, illustrated below, includes all costs associated with transportation. Various studies have demonstrated that inclusion of all system costs in analyzing transportation alternatives will yield transportation operations different from what now exists. This model will assist decision-makers in evaluating alternative transportation policies, particularly if combined with a multi-attribute methodology. While additional work is needed to evaluate marginal costs, this report establishes a point of departure for more efficient analysis of transportation alternatives.

Multimodal Transportation Evaluation Model



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LIST OF ACRONYMS USED IN REPORT

AA/DEIS - Alternatives Analysis/Draft Environmental Impact Statement
AASHTO - American Association of State Highway and Transportation Officials
Amtrak - National Railroad Passenger Corporation
ANSI - American National Standards Institute
ASQC - American Society for Quality Control
ATS - Austin Transportation Study (MPO for Austin, Texas)
ATSF - Atchison, Topeka & Santa Fe Railroad
BN - Burlington Northern
BTU - British Thermal Unit
CAAA - Clean Air Act Amendments of 1990
Capital Metro - Capital Metropolitan Transportation Authority in Austin, Texas
CARTS - Capital Area Rural Transportation System
CBD - Central Business District
CMAQ - Congestion Management and Air Quality Improvement Program
CO - Carbon Monoxide
CO_2 - Carbon Dioxide
COFC - Container-on-flatcar
Conrail - Consolidated Rail Corporation
DART - Dallas Area Rapid Transit Authority
DFW - Dallas/Fort Worth International Airport
DOT - Department of Transportation
EC - European Community
EPACT - Energy Policy Act of 1992
EPA - Environmental Protection Agency
FDOT - Florida Department of Transportation
FHWA - Federal Highway Administration
FRA - Federal Railroad Administration
FTA - Federal Transit Administration
GAO - U.S. Government Accounting Office
GIWW - Gulf Intracoastal Waterway
H-GAC - Houston-Galveston Area Council
Hobby - William P. Hobby Airport, Houston
HOV - High Occupancy Vehicle
ICC - Interstate Commerce Commission
ICSC - International Customs Service Center
IDOT - Illinois Department of Transportation
IG - Interim Guidance
IMS - Intermodal Management Systems
Intercontinental - Houston Intercontinental Airport
ISO - International Organization for Standardization
ISTEA - Intermodal Surface Transportation Efficiency Act of 1991
IVHS - Intelligent Vehicle/Highway System
KCS - Kansas City Southern Railroad
km - kilometer
LCDC - Land Conservation and Development Commission
LNG - Liquefied Natural Gas
LPG - Liquefied Petroleum Gas
LP gas - Liquefied Petroleum Gas
LRC - Long-Range Component
LRP - Long Range Plan
LRT - Light Rail Transit

LRV - Light Rail Vehicle
MagLev - Magnetic Levitation
MDOT - Michigan Department of Transportation
METRO - Metropolitan Transit Authority of Harris County
MnDOT - Minnesota Department of Transportation
MPO - Metropolitan Planning Organization
MPT - Multimodal Passenger Terminal
MSA - Metropolitan Statistical Area
MTP - Maryland Transportation Plan
NAAQS - National Ambient Air Quality Standards
NAFTA - North American Free Trade Agreement
NARC - National Association of Regional Councils
NCDOT - North Carolina Department of Transportation
NHS - National Highway System
NITS - National Intermodal Transportation System
NO_x - Nitrogen Oxides
NPRM - Notice of Proposed Rule-Making
NS - Norfolk Southern Railroad
NUMMI - New United Motor Manufacturing, Inc.
O_3 - Ozone
PAC - Policy Advisory Committee
Pb - Lead
PM-10 - Particulate Matter
PCC - President's Conference Committee
PE/FEIS - Preliminary Engineering/Final Environmental Impact Statement
Quad - Quadrillion BTUs
SIP - State Implementation Plan (for clean air)
SO_2 - Sulfur Dioxide
SP - Southern Pacific Railroad
SRAC - Short Run Average Cost
SRMC - Short Run Marginal Cost
SSW - St. Louis-Southwestern Railroad
STIP - State Transportation Improvement Program
STP - Surface Transportation Program
TAC - Technical Advisory Committee
TEXAS TGV - Texas High-Speed Rail
THSRC - Texas High-Speed Rail Corporation
TIP - Transportation Improvement Plan
TOFC - Trailer-on-flatcar
TRB - Transportation Research Board
TRDF - Texas Research and Development Foundation
TxDOT - Texas Department of Transportation
UMTA - Urban Mass Transportation Administration, now FTA
UP - Union Pacific Railroad
UPWP - Unified Planning Work Program
USDOT - United States Department of Transportation
VIA - San Antonio Metropolitan Transit
VMT - Vehicle Miles of Travel
VOC - Volatile Organic Compound
WisDOT - Wisconsin Department of Transportation
WRI - World Resources Institute

SUMMARY

This report presents the results of a two-year research project into multimodal planning and transportation centers and their applicability to the network of transportation systems in the state of Texas. What emerges from this effort is a more comprehensive framework for evaluating multimodal transportation alternatives. The report is separated into four sections and is summarized below.

Part I describes the multimodal transportation environment. The basic problem, including a clarification of the relationship between multimodal, intermodal, and transportation centers, is presented. The major catalysts, both public and private, driving the move towards multimodalism and intermodalism are discussed. This provides a basis for examining the current state of affairs in multimodal transportation.

Part II summarizes current activities relating to multimodal transportation. The role of transportation centers in multimodal and intermodal development is explored based on an extensive review of the literature. One chapter is devoted to reviewing the extensive multimodal planning activities among various states. This planning has heightened the level of responsibility at the metropolitan level. The expanded role of metropolitan planning organizations, is examined including two case studies in Texas. Finally, private-sector initiatives in multimodal and intermodal activity are analyzed.

Part III analyzes the various issues that affect successful multimodal planning as well as the implementation issues associated with the development of transportation centers. Part III culminates in the development of a total system, or social, cost framework for analyzing transportation investment. This framework represents a new paradigm for evaluating transportation alternatives. The framework includes the traditional facility costs, but is expanded to include owner's motive costs, and externalities. Three case studies highlight the impact of this approach on transportation investment.

Part IV presents extensive data on rail, aviation, waterways, and highways in Texas. Modal infrastructure is inventoried, as well as current utilization. The information in the appendices presents the basic modal information available for Texas. These data, as well as additional information, are necessary to examine multimodal transportation impacts and opportunities.

PART I

THE MULTIMODAL TRANSPORTATION ENVIRONMENT

CHAPTER 1. PROBLEM OVERVIEW

INTRODUCTION

Every day, people and goods move about the state of Texas for a variety of reasons on their way to a myriad of destinations. An interconnected transportation network provides the means for these movements. In general, this transportation network has five major components: the load-carrying system (vehicles, pipeline, conveyor belt); the guideway; transfer facilities (intra- and intermodal); the maintenance system; and the management system.[1]

For a network of transportation systems to operate efficiently, a coordinated interface must be provided for people and goods transferring from one mode to another. The network is a mix of public and private operators providing long-haul and terminal services. Freight movement is characterized by the complex interaction of subsystems for handling general, bulk, and containerized cargo. Whether associated with long-distance travel or with an intracity trip, passenger movements can be equally complex. Urban areas show the most serious effects of uncoordinated interaction between transportation modes. Time and money are lost to individuals, businesses, and government as a result of severe congestion. Nearly $30 billion in delay costs result from highway congestion in the nation's major urban centers.[2]

The willingness of the public to support planning, design, investment, maintenance, and regulation of infrastructure is based on two objectives: improved mobility and economic growth. An integrated network of transportation systems accomplishes these objectives by reducing travel cost and duration, improving safety, and providing smooth, quick, and fewer transfers between modes.

Initially, this study focused on intermodal transfer facilities with access by two or more intercity modes. These "transportation centers" are locations where either a long-distance trip begins or ends, or a change of transportation mode occurs. Airports,

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[1] Marvin L. Manheim, Fundamentals of Transportation Systems Analysis, Volume 1: Basic Concepts (Cambridge, MA: The MIT Press, 1979), 164-166.

[2] Office of Technology Assessment, U. S. Congress, Delivering the Goods: Summary, Public Works Technologies, Management, and Financing (Washington, D.C.: GPO, April 1991.), 1.

railroad and bus stations, railroad yards, break-bulk terminals, and ports are the classic examples of these facilities. Integration of modes is an important factor affecting the success of a transportation center when trips involve transfers from one mode to another. Europe has led the way in development of this type of terminal, though smaller transportation centers have enjoyed limited success in North America.

However, in the course of reviewing material on transportation centers, it became apparent that the process of planning and the environment for supporting analysis of the total transportation system have not been viewed from a multimodal perspective. This necessarily implies that multimodal planning and the tools to evaluate and analyze different modal options, either individually or in combination, that involve the public as well as the private sector must be developed.

Given the recent shifts in the U.S. Department of Transportation's national transportation policy, it is important to begin exploring opportunities for more effective multimodal coordination. The Texas Department of Transportation faces the issue of developing a statewide multimodal transportation plan under the requirements of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. This plan is also a process for viewing transportation as an integrated system emphasizing the productive and efficient movement and transfer of goods and people. Toward that end, the development of tools to analyze and evaluate modal tradeoffs is required. In addition, the coordinated interfaces between transportation modes provided by transportation centers can be an integral element in such a plan.

SCOPE OF REPORT

The principal objective of this research project, and of this report, is to identify the potential impact of multimodal planning and transportation centers on the Texas Department of Transportation's mission to provide a transportation infrastructure to support economic development through economical and efficient movement of people and commerce. This report presents the results of research into multimodal planning and transportation centers and their applicability to the network of transportation systems in the state of Texas.

The goals of this report are to:

1) Define terminology uniformly and synthesize a definition of a "transportation center" in keeping with current national policy.

2) Perform an in-depth literature review and contact appropriate federal, state, and local officials outside of Texas to identify experiences with multimodal planning and transportation centers.

3) Identify key issues affecting the implementation of multimodal planning and transportation centers.

4) Develop investment decision methodologies that will aid engineers, planners, and decision-makers.

5) Inventory the status of non-highway transportation systems in Texas.

This report is separated into four parts. The first part explores the environment that has created the need for a more coordinated multimodal transportation system. It begins with this chapter, which outlines the scope of the report, and continues with Chapter 2, which attempts to clarify the terminology used in discussing and evaluating multimodal and intermodal transportation systems. The synonymous use of these terms has created confusion and uncertainty and hinders meaningful dialogue. Chapter 3 explores the major catalysts that have sparked a renewed interest in multimodal transportation. Together, these three chapters provide a context in which to review experiences with multimodal transportation planning and development (Part II) and to formulate options for promoting more efficient multimodal systems (Part III).

Part II summarizes current experiences with multimodal transportation systems and planning. Chapter 4 explores the role of multimodal transportation centers through an extensive review of the literature documenting their use. Chapter 5 defines the current state of affairs regarding multimodal transportation planning. Chapter 6 examines the role of Metropolitan Planning Organizations (MPOs) and the influence they have on multimodal transportation systems. Two case studies, Austin and Houston, summarize MPO review opportunities for multimodal transportation. Intermodal activities in the private sector are reviewed in Chapter 7.

Part III serves as the basis for formulating and promoting more effective multimodal transportation planning and development in Texas. Chapter 8 identifies the key factors that affect the success of a multimodal transportation network. Chapter 9 identifies a new framework for evaluating public-sector investment in transportation.

Chapter 10 provides a brief summary of the report and presents some basic recommendations for future multimodal transportation planning.

Finally, Part IV details the state of affairs in non-highway transportation by taking inventory of the state rail system (Appendix A), commercial aviation (Appendix B), maritime commerce (Appendix C), and highway transportation (Appendix D).

CHAPTER 2. MULTIMODALISM AND INTERMODALISM DEFINED

At the outset it is essential to clarify the terminology used in discussing multimodal and intermodal transportation. The words multimodal and intermodal have several different meanings depending on the context, and in some cases are used interchangeably. Multimodal, when used as an adjective to describe a transportation center, generally implies that two or more intercity modes use the facility in addition to local access modes. However, it has often been applied in an intracity context for transit centers. Intermodal is commonly used as a term to describe rail freight movement using trailers, or containers, on flat cars (TOFC/COFC), or a double stack of containers in special rail cars. Alternatively, it may describe people or goods movement within a transportation center.

Intermodalism focuses on connecting several different modes into a seamless transportation system with efficient intermodal transfer terminals. These connective terminals, or nodes, are perhaps the most important part of an intermodal transportation network. If intermodal transfers are slow or inconvenient, users will resort to what they perceive as the more efficient unimodal system. To best utilize intermodal transportation resources, the planning of these intermodal transfer terminals requires the coordination and cooperation of all modal planning authorities that will utilize the terminal. Without such cooperation, inefficient modal gaps can develop. An example of such an occurrence is the construction of a new airport without the consultation of local transit authorities, who are in a position to construct a light-rail line or other appropriate service from the central business district (CBD) to the airport. Without efficient "built-in" transit service, airport users would be forced to use indirect and slow bus service, expensive taxis, or private automobiles to fill the modal gap between the CBD and the airport.

Rather than focusing on transportation system nodes, multimodal transportation systems focus on transportation system links and providing system users with a choice of modes along those links. An example of a multimodal system is two cities connected by air routes, highways, and railroads. In an urban sense, a multimodal network might consist of linking the airport with the CBD utilizing public transit, private automobiles, and taxis. Much of the United States has such a system, but, because of federal, state, and local governments' modal preference towards highways, many modes have not been equally represented in the national transportation network. Modal preference can involve direct governmental funding of a transportation mode or can be much more subtle, such as failing to consider other modes in the planning process or failing to charge users the true cost of their transportation decision. The Intermodal Surface Transportation Efficiency Act (ISTEA) has attempted to reduce the preferential treatment of highways, by making funding programs more flexible and attuned to local needs, but it remains to be seen if state and local governments are willing to pursue multimodal networks by equalizing modal subsidies. The preference question raises two key multimodal issues: choice and competition. These issues are interrelated, since the choice of a particular mode will inevitably depend on how competitive that mode is with other modes. Governmental preference towards a particular mode usually implies that it will be more competitive than the other modes because of the direct or indirect subsidies. In such a situation, mode choice is no longer determined by the free market, but is instead pre-determined by the public sector. A "level playing field" upon which all modes can compete equitably for traffic is a requirement for successful multimodal transportation systems. This concept is explained in greater detail in Chapter 9.

A meaningful way of viewing multimodal and intermodal from a planning perspective is presented by Myers:[1]

> Multimodal planning is a process of:
>
> 1) defining a transportation problem in a generic way (that is, in a non-mode-specific manner);
>
> 2) identifying more than one modal option to solve this problem; and
>
> 3) evaluating these modal options in a manner that provides for an unbiased estimation of each mode's contribution, either individually or in combination, to assessing a transportation problem.
>
> Intermodal planning is a process of:
>
> 1) identifying the key interactions between one or more modes of transportation where affecting the performance or use of one mode will affect another;
>
> 2) defining strategies for improving the effectiveness of these modal interactions; and

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[1] Michael D. Meyer, "The Future of Transportation Planning: Jump-starting the Push Toward Intermodalism," paper presented to the Transportation Research Board Conference on Transportation Planning, Programming, and Finance (Seattle, WA: Transportation Research Board, 19-22 July 1992), 10, photocopy.

3) evaluating the effectiveness of these strategies from the perspective of enhancing overall performance of the system affected by intermodal connections.

In this context, multimodal is viewed from a larger, transportation systems planning perspective, while intermodal refers to the study of modal interactions as they affect system performance. "Multimodal planning provides the general context within which intermodal planning occurs."[2]

APPLICATION OF MULTIMODAL AND INTERMODAL TRANSPORTATION

With the terms "intermodal" and "multimodal" thus defined, one question remains: why should intermodal and multimodal transportation systems be pursued? There are many reasons why intermodal and multimodal transportation systems can improve transportation networks. These reasons are grouped into three broad categories: 1) efficiency, 2) quality, and 3) choice.

Intermodal transportation networks improve efficiency by using modes best suited to each portion of a transport route. Intermodal efficiency gains can be illustrated with a freight shipping example. A shipment of electronic devices needs to be transported from a manufacturing plant in Seoul, Korea, to a retail outlet in San Marcos, Texas. The shipper contacts Containerized Freight Company, Inc., to pick up the shipment, which has been loaded into a freight container. The container is lifted on a trailer and hauled to the nearest port via truck. At the port, the container is loaded on a ship and carried to Long Beach, California. In Long Beach, the container is loaded on a train which transports the container to San Antonio, Texas, over the tracks of two railroad companies. In San Antonio, at a distribution center, the contents of the container are broken down into separate shipments and loaded into trucks. One of these trucks carries the San Marcos shipment to the retail outlet. The receiver pays a single freight bill from Containerized Freight Company, Inc., which has utilized the lowest-cost modes, particularly containerized rail transport, for each trip leg. Assuming the intermodal transfers were handled with minimum cost, efficiency has been improved over shipping the components overland solely by the more resource-consuming truck mode. The same type of efficiency improvement can be realized with intermodal passenger transportation.

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[2] Michael D. Meyer, "Conference Findings," in ISTEA and Intermodal Planning: Concept, Practice, Vision, Special Report 240, Transportation Research Board, National Research Council (Washington, D.C.: National Academy Press, 1993), p. 6.

Park-and-ride transit facilities which reduce single-passenger vehicle congestion, thus reducing transportation costs, are an example.

In addition to efficiency, intermodal systems can also improve transportation system quality. This gain in quality can be illustrated by the containerized freight example above. Freight, well-packed into its container in Seoul, is much less susceptible to damage than if shipped break-bulk on truck lines across the Continental United States. Break-bulk requires more handling and is also subject to pilferage.

Improved quality and choice can result from an effective multimodal transportation network. Quality results from the competitive forces that underlie multimodal systems. Choice is of course inherent in an effective multimodal network. This choice allows shippers to select the mode they believe can best serve their needs. In this way, increased choice combined with free market dynamics can lead to transportation efficiency gains.

CHAPTER 3. MULTIMODAL AND INTERMODAL CATALYSTS

The emergence of intermodal and multimodal focuses in the transportation arena has not happened without provocation. In the United States, the "catalysts" that have forced transportation professionals to consider multimodal and intermodal transportation systems are numerous and come from both the public and private sectors. This chapter details these catalysts and analyzes their impact on the U.S. transportation system.

PUBLIC-SECTOR CATALYSTS

The public sector has several compelling reasons to pursue intermodal and multimodal transportation solutions. Many of these reasons are related to federal transportation legislation. To be effective, such legislation must promise substantial rewards for shifting to intermodal paradigms or impose substantial penalties for resisting change. The Intermodal Surface Transportation Efficiency Act (ISTEA) is a good example of the reward approach, and the Clean Air Act Amendments of 1990 (CAAA) are good examples of the penalty approach. Both pieces of legislation are examined in detail below. In addition to legislation, increasing global competition and shrinking public-sector resources are forcing the public sector to reconsider intermodal and multimodal transportation systems.

Intermodal Surface Transportation Efficiency Act of 1991

ISTEA is probably the most powerful of the catalysts mentioned. This power, however, has more to do with ISTEA's status as federal legislation than it does with the legislation's content. With ISTEA, the federal government gave intermodal transportation national recognition and credibility. The legislation also promised extensive funding for such systems, but, so far, few of these promises have materialized. Will the promises be enough to build intermodal and multimodal momentum? To answer such a question, the promises themselves should be analyzed.

One of ISTEA's major objectives is "to develop a National Intermodal Transportation System that is economically efficient, environmentally sound, provides the foundation for the nation to compete in the global economy and will move people and goods in an energy efficient manner." In pursuit of this goal, ISTEA explicitly emphasizes the development of a National Intermodal Transportation System (NITS). ISTEA envisions NITS as a unified, combined transport network consisting of air, road, rail, and sea links connected by efficient intermodal terminals. The legislation implicitly assumes that optimization of transportation system performance inherent in the development of such a system can simultaneously reduce resource consumption, increase network connectivity, and reduce transportation costs.

Unfortunately, the intermodal aspect of ISTEA has often been overshadowed by the legislation's provisions related to pre-ISTEA transportation programs. In fact, most of ISTEA's intermodal coverage is restricted to one title (Title V) of this eight-title act. Title V authorizes the creation of the Office of Intermodalism. This Office, independent of the United States Department of Transportation's (USDOT) traditional modal oriented organization scheme, reports directly to the Secretary of Transportation. It is charged with maintaining and disseminating intermodal transportation data and coordinating federal research on intermodal transportation. Title V also authorizes the Secretary of Transportation to grant states up to $3 million to develop model intermodal transportation plans. Moreover, Title V establishes a National Commission on Intermodal Transportation to study the status of intermodal standardization, impacts on public works infrastructure, legal impediments to efficient intermodal transportation, financial issues, new technologies, research and development needs, and the relationship between intermodal transportation and productivity. However, as of September 1993, funds have not been appropriated to pay Commission members' salaries. As a result, the Commission has never met to resolve the issues with which it is tasked.

In addition to the explicit coverage of Title V, ISTEA implicitly promotes intermodal and multimodal transportation systems by emphasizing funding flexibility across modes and facilities. Performance and cost-effectiveness, rather than mode selection, are the key criteria for appropriating funds. In addition, ISTEA makes substantial progress towards eliminating cross-modal funding barriers to enable the development of creative multimodal and intermodal solutions to transportation dilemmas.

Another revolutionary characteristic of ISTEA is the legislation's delegation of transportation planning and programming responsibilities to state and local governments. This delegation of authority allows those most familiar with the problems, state and local governments, to develop appropriate solutions. Metropolitan Planning Organizations (MPOs) are assigned the responsibility for developing a long-range transportation plan and a transportation improvement plan (TIP) for their area. The planning process must include such factors as land use, intermodal connectivity, methods to enhance transit services, and congestion management measures. Newly required under ISTEA are statewide planning processes, statewide transportation plans, and statewide TIPs. Statewide TIPs must be consistent with both long-range transportation plans and air quality implementation plans. States, in cooperation with MPOs, must develop and implement management systems for highway pavement, bridge, highway safety, traffic congestion, public transit, and intermodal transportation facilities and systems. The new flexibility provided in the Act encourages programming decisions which best reflect state, regional, and local priorities. The management system requirements reinforce the philosophy of strengthening local planning methods, and encourage systematic evaluation of conditions and needs, as well as consideration of life-cycle costs and cost-effectiveness in the development of improvements.

Clean Air Act Amendments of 1990

The 1990 Amendments to the Clean Air Act are having a profound impact on the transportation planning and project development process in non-attainment areas. These areas are required, through implementation of transportation control measures, to reduce vehicle-miles (vehicle-kilometers) of travel and congestion. The most significant provision of the CAAA with respect to planning is that of strengthened requirements for conformity between the state implementation plan (SIP) for air quality and the approval for federal funding of regional transportation plans, programs, and projects. Conformity must now be based on a demonstration that the total emissions from mobile sources which would occur due to the combination of projects and programs in the transportation plan are consistent with emission levels in the SIP.

The transportation plans must be analyzed once every three years in order to comply with the standards set by the area's air control authority. The CAAA, together with the transportation/air quality provisions of ISTEA, necessitate much closer cooperation between transportation and air quality planning agencies, and a broader evaluation of the impacts of transportation projects.

North American Free Trade Agreement

The governments of the United States, Canada, and Mexico ratified the North American Free Trade Agreement (NAFTA) on December 17, 1992. NAFTA creates the largest free trade zone in the world, comprised of over 360 million consumers with a combined annual output of $6 trillion. Canada and Mexico are already the first and third largest trading partners with the U.S., respectively, and this agreement will strengthen and cement the relationship. Through progressive reductions, NAFTA eliminates all tariffs on industrial and agricultural goods produced by the three countries. Approximately 50 percent of U.S. exports to Mexico will enter that country completely duty-free, while Mexican tariffs on all remaining industrial products and most agricultural items will be phased out over a five- to ten-year period. Reductions in tariffs on trade between the United States and Canada were negotiated in 1987 and incorporated into a U.S.-Canada free trade agreement shortly thereafter. This agreement remains in effect, augmented by additional changes included in the latest version of NAFTA.

Trade between the three countries has already grown strongly since Mexico joined the General Agreement on Tariff and Trade in 1986, and such trade has aggravated infrastructure conditions along both U.S. land borders. While NAFTA will help to boost trade among the three countries, the degree to which it will increase border congestion is unclear.[1] NAFTA will eliminate a number of transportation practices and restrictions currently in place that contribute significantly to congestion and will open the trade for growth in all other modes. Currently, the predominant land surface transportation mode for non-petroleum products is that provided by the trucking sector, and there are specific opportunities for this sector under the legislation. First, previous restrictions on motor carriers will be gradually phased out over a ten-year period. Currently, U.S. carriers are not allowed to operate in Mexico, but three years after signature of the agreement (December 1995), U.S. motor carriers will be allowed access to contiguous Mexican border states with reciprocal Mexican access to the U.S. for international shipments. At the same time, Mexico will allow foreign investment of up to 49 percent in Mexican truck companies that deliver international cargo. This would arguably lead to significant productivity increases among the Mexican trucking industry, which is currently undercapitalized and lacks the modern equipment operated by U.S. counterparts. Six

[1] U.S. Department of Transportation, "Assessment of Border Crossing and Transportation Corridors for North American Trade." Intermodal Surface Transportation Efficiency Act: Section 1089 and Section 6015, Report to Congress, Federal Highway Administration, 1993.

years after ratification of the agreement, all signatories will be allowed full cross-border access for international shipments. Seven years following the enactment of the agreement, foreign investments in Mexican motor carriers will be permitted to reach 51 percent; in other words, a controlling interest. A decade after the agreement goes into effect, foreign interests can control 100 percent of international trucking companies. Even so, no party is required to lift ownership restrictions on companies transporting domestic cargo.[2]

Intermodal opportunities for trade within the NAFTA countries are very great. Already, maritime and air modes are emphasizing intermodal movements, and, as a result, the air share of trade has increased significantly. As an example, air now accounts for 6 percent of U.S.-Mexico trade by value and is expected to grow strongly over the next five years. In terms of land-based intermodalism, NAFTA is expected to streamline border crossing movements, particularly those relating to in-bond shipments that can be inspected at centers deep within each market. Currently, the process is highly complex, with interchanges between trucking companies and rail trucking companies being affected by drayage systems across the border.[3] NAFTA should simplify and streamline these procedures and allow the growth in through-shipments both on trucks and by rail. As Mexico continues to improve its investment in its rail freight hub systems (building new ramps at Monterey and Mexico City), we would expect trailers and container traffic to grow significantly through use of these modes.

Other opportunities will be created by the privatization of Mexican ports and the use of containers by Mexican shippers. Thus, within a decade different patterns of freight movements will arise within the NAFTA markets. Essentially, the competitiveness between modes and the use of advanced technology, together with targeted capital investment, will give a wider range of choices to those shipping goods between the various markets.[4] In this sense, we may expect a significant change, away from the supply to the demand side in terms of modal choice decisions.

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[2] Governments of Canada, the United Mexican States, and the United States of America, Description of the Proposed North American Free Trade Agreement, August 1992.

[3] C. Said, R. Harrison, and W.R. Hudson, Transborder Traffic and Infrastructure Impacts on the City of Laredo, Texas. Research Report 1312-1, Center for Transportation Research, The University of Texas at Austin, November 1993.

[4] Lyndon B. Johnson School of Public Affairs, Texas-Mexico Multimodal Transportation, Policy Research Project Report 104, August 1993.

Enhancement of Global Competitiveness

Efficient transportation is one of the keys to a strong economy. A transportation system should provide a fluid movement of goods and services. The development of an efficient transportation system requires public- and private-sector coordination during the planning, design, construction, and management of transportation services. Businesses that are "of markets" and not "of nations" are a new reality in which the U.S. maintains a dominant voice in research and advanced technologies among its trade partners. Likewise, expanding the scope of free-trade agreements and regional trade formations will foster greater public-private collaboration.

Two of ISTEA's major objectives are the promotion and the planning of transportation systems which enhance economic development and support America's leading position in the global market. Ports and airports provide vital infrastructure to international commerce. These are the intermediary points in international transportation, providing transfer of cargo between modes. Consistent standards are most important in ensuring that containers can be safely and easily interchanged between transport modes and between nations. Standardization of equipment increases productivity, speed, safety, reliability, and efficiency for both shippers and consumers. The size and structural integrity of transportation equipment and facilities are standardized by International Organization for Standardization (ISO) regulations. Both the American National Standards Institute (ANSI) and American Society for Quality Control (ASQC) have adopted these standards.

Landside access to both ports and airports is given increased emphasis in the new legislation. Ports are the least understood component of land, water, and air intermodal movements. Issues such as land availability, land accessibility, and trade policy require coordination of many public and private entities. Air cargo movement has always been intermodal. Boeing projects worldwide air cargo fleets to increase in size by 110 percent by the year 2015. U.S. international trade is increasing, requiring more intermodal terminals at ports and airports and improved landside access. In addition, the effects these expansions will have on traffic congestion, noise, and other environmental restrictions must be considered. Enhancing the global competitiveness of the U.S. requires changing the single-mode perspective to intermodal and multimodal perspectives of transportation systems.

Reallocation of Funding Priorities

Transportation resource allocation decisions are becoming more difficult and complex. Resources are continuing to shrink while the set of problems needing to be addressed grows and diversifies. The list of concerns competing for transportation funding includes aging and decaying infrastructure, urban and suburban traffic congestion, improving traffic safety, balancing new growth with infrastructure to support it, strengthening the economy, achieving air quality standards, and reducing energy consumption. The legislation described above is forcing stronger integration of some of these concerns into transportation decisions.

The focus of these current transportation problems has changed to demand management strategies, maintenance and preservation, operational and efficiency improvements, multimodal solutions, and land-use controls. In many metropolitan areas, expansion of highway facilities is no longer considered a viable solution. Instead, views are shifting to the efficient operation of a multimodal system. ISTEA dramatically increases flexibility in the use of federal transportation funds. Instead of directing what funds should be used for, it emphasizes the use of sound management approaches to resource allocation decisions, and consideration of the full range of solutions to solve transportation problems. In reality, some portion of the funds available are likely to be allocated to modes, program categories, and geographic regions at the start of the programming process. The more this occurs, the more difficult it will be to examine key tradeoffs and establish true multimodal and multi-objective programs. It is hoped that some balance can be achieved between modal funding stability and modal funding flexibility.

Taking full advantage of ISTEA presents technical, institutional, and political challenges. While improvements in technical methods can play a strong supporting role in reshaping planning process, fundamental changes in how resource allocation decisions are made will require strong leadership and revision of current roles and responsibilities, both with agencies and among institutions which participate in transportation decisions.

PRIVATE-SECTOR CATALYSTS

Much like the public sector, the private sector must have concrete reasons to abandon unimodal networks in favor of intermodal movements and multimodal transportation systems. There are five primary reasons that are compelling the private sector to shift to an intermodal and multimodal focus: 1) maintaining competitiveness; 2) increasing transportation efficiency; 3) improving transportation quality; 4) securing greater regional, national, and international markets; and 5) meeting international standards.

Maintaining Competitiveness

To remain competitive in the private industry, it is important that companies employ all applicable technologies to provide the most cost-efficient and reliable service. In the past, many trucking firms were content to see themselves as a single-mode operation. They believed that their markets were distinct from the rail markets, and therefore focused efforts only on over-the-road operations rather than on attempting to open new markets by collaborations with rail. Intermodal service was also believed to be unreliable, and was not seen as a threat to the over-the-road market. This was the prevailing attitude in the trucking industry until the recent recession, when growth of the industry slowed and truckload firms faced greater competition as firms competed for additional freight.[5]

Trucking firms needed to find innovative ways to improve their service and maintain competitive pricing. The increased competition in the industry caused companies to rethink their single-mode transportation operations and investigate the possibilities of intermodalism.

A natural choice for trucking firms was to use rail lines to move freight over long distances, creating an intermodal freight transportation system. One of the first major alliances, under the name Quantum, was formed between J.B. Hunt Transport, Inc. and the Santa Fe Railroad in 1990. This alliance has proved very successful for both companies, and stands as an example of the possibilities of intermodalism for other firms in the freight transport business.

This is only one example of the way those in the freight movement industry will need to rethink intermodalism. Many small freight movers, such as Federal Express, have used intermodalism successfully for years, relying on planes and trucks to move

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[5] Dan Smith, "Mercer Management Study of Rail/Truckload Initiatives, Part II: The Evolution of Partnerships." Intermodal Trends, An AAR/Market Development Report, Vol. IV, No. 14, 1992, pp. 1-2.

freight. As competition in the industry increases, single-mode transportation will no longer be adequate for maintaining a competitive edge.

Increasing Efficiency

In general, an increase in efficiency should lead to either a cost or a time savings, or both. Intermodalism offers many possibilities to increase efficiency in a transportation network. For example, the Association of American Railroads estimates that a railroad can move a given quantity of freight for one-fifth the fuel of a motor carrier, and carry seven times as much freight per employee.[6] This makes it much more efficient in terms of fuel and labor cost to use rail when transporting over long distances.

With the use of computerized operating systems to manage large intermodal transportation networks, a variety of modes can now be used while still maintaining high levels of efficiency and reliability. Before such operating systems, the logistics of moving different types of freight with several modes would be extremely difficult, resulting in unreliable service to the customer.

A highly efficient use of intermodalism is displayed by New United Motor Manufacturing, Inc. (NUMMI), based in Fremont, California. NUMMI is a joint venture between Toyota Motor Corporation and General Motors Corporation that produces approximately 300,000 vehicles per year, including Toyota Corollas, Toyota compact pickup trucks, and Geo Prizms. Parts and materials for the plant arrive from Japan, Canada, Mexico, and the U.S. NUMMI operates its plant on a "just-in-time" basis, bringing in materials and parts only as needed. NUMMI generally operates on a one-day inventory for parts coming from within California, and a two- to three-day inventory for items coming from elsewhere. Four ships arrive at the Port of Oakland each week with materials bound for NUMMI. Midwest suppliers are organized through NUMMI's Midwest Orderly Pickup System, which consolidates materials in Chicago and then ships them by train to Fremont. Suppliers in Southern California, Mexico, and Texas use long-haul truck routes to deliver materials. Because of the various materials and parts that are constantly arriving at NUMMI, it is vital that an efficient container system be used to

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[6] David R. McKenzie, Mark C. North, and Daniel S. Smith. Intermodal Transportation - The Whole Story. Simmons-Boardman Books, Inc., Omaha, NE, 1989, p. 263.

reduce the cost of handling materials and to allow the materials to go directly to where they are needed.[7]

By using the "just-in-time" delivery approach, NUMMI reduces handling costs, inventory control costs, and floor space needs. This translates into reduced manufacturing costs, which allows for greater profitability. The vital link to this manufacturing approach is an efficient intermodal transportation system.

Improving Quality

Improving quality is necessary for acceptance of intermodal transportation. Several changes have occurred in recent years that have increased the reliability and simplified intermodal transportation use for the customer. An analogy to the phone system is appropriate in this case. It does not matter to the caller over which lines his/her call is routed or who owns those lines, only that his/her call goes through.[8] Likewise, for the freight customer, the concern is not the method used to deliver the freight, but rather the reliability and cost.

Many intermodal freight companies are now working with this in mind, delivering an end-to-end service.[9] Previously, the customer had to make arrangements if freight were to be transferred from one rail line to another. Freight companies can now take advantage, through partnerships and alliances, of intermodalism using trucks, rail, and ships, making all the necessary arrangements for the customer. The customer's only concern is the pick-up and drop-off points of the freight; all transportation in between is the responsibility of the freight company. This can result in cost and time savings for both the freight company and the customer, as well as an increase in reliability.

Securing Greater Regional, National, and International Markets

The use of intermodal transportation may be vital for a company to expand into new markets. As seen in the NUMMI example, the company's use of different transportation methods allows it to tap markets for automotive parts in several different

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[7] Bill Borton, Assistant General Manager, Production Control, New United Motor Manufacturing, Inc.
[8] David R. McKenzie, Mark C. North, and Daniel S. Smith, p. 278.
[9] Ibid.

countries. This would not be possible if an efficient and cost-effective transportation network were not available.

For freight movement companies that do not use intermodalism, the loss of possible markets may undermine company profitability. In the opposite case, use of intermodalism can allow access to markets that may have been unavailable to single-mode transportation companies. The purchase of Sea-Land Service by CSX Corporation in 1985 allowed CSX immediate access to the global transportation market. There is a great deal of potential for intermodalism to open new markets to a company, whether the company be a manufacturing or a freight transportation company.

Meeting International Standards

ISO is made up of the standards organizations from 91 countries, including ANSI, which represents the United States. ISO 9000 is a set of quality management and quality assurance standards developed by ISO in 1987. The standards do not apply to any particular products or manufacturing processes; instead, they were developed to help provide the framework for companies to implement a total quality management program, and to gain certification under the ISO 9000 standards. The standards have gained wide acceptance among members of the European Community (EC) and are gradually gaining greater acceptance in the U.S. In November of 1992, there were approximately 400 U.S. companies with ISO 9000 certification, with several thousand other U.S. companies actively seeking certification.[10]

There are several implications of ISO 9000 for the transportation field. First, in order to gain certification under ISO 9000, a company has to meet a series of quality management and quality assurance standards. For many companies, increasing quality may mean increasing the use of intermodal services. The question of reliability of the companies' intermodal service must also be addressed. In short, companies will have to examine the way they move freight and look at implementing improvements in each area.

The second impact of ISO 9000 will most likely be the ease of freight movement between international boundaries. This idea is already being pushed in the EC. Certificates given for exports in one country would be valid in all other EC countries,

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[10] Todd Leeuwenburgh, "Quality Standards That Can Open Doors." Nation's Business, U.S. Chamber of Commerce, Washington, D.C., November 1992, p. 33.

allowing easy access to all EC markets.[11] If ISO is accepted worldwide, it could mean easy access to global markets. This type of access will demand an increase in intermodal freight transportation in order to keep pace with global markets.

Finally, ISO has been working to develop a standard for wide-body containers. These containers would be used for shipping, rail, and trucking operations. ISO has held several meetings on this issue, but representatives have yet to agree on an international standard. Representatives continue to study the issue to determine the ideal dimensions, but remain several years away from a consensus.[12] The eventual creation of a standard container for freight movement will increase the efficiently of intermodalism, and further the acceptance of intermodalism as a standard practice in freight movement.

CONCLUSIONS

Market forces, driven by increased competitiveness resulting from deregulation, have moved the private sector to adopt intermodal and multimodal transport systems of product distribution. In many cases, this has occurred without any governmental intervention or stimulation. Multimodal operations in Texas have been developed over the past decade without a statewide multimodal plan. In this regard, private sector investment decisions represent the vanguard of multimodal decision-making and the participation of the private sector in state planning is crucial to its success. In Chapter 7, a shipper's survey is reported which shows that the key motivation for switching from unimodal surface transport to intermodal operations is cost. Other factors, including service levels and reliability, remain somewhat weak and need improvement in order to generate the efficiencies that warrant expanded intermodal operations. The private sector is working diligently to correct these weaknesses and Texas should witness growth in multimodal operations during the 1990's. Again, the engine of this process is the private sector and any statewide multimodal planning must be structured to incorporate, monitor, and, where possible, influence private sector investment decisions.

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[11] Yves Van Nuland, "The New Common Language for 12 Countries." Quality Progress, June 1990, p. 40.

[12] David R. McKenzie, Mark C. North, and Daniel S. Smith, p. 273.

PART II

CURRENT MULTIMODAL AND INTERMODAL TRANSPORTATION ACTIVITIES

CHAPTER 4. TRANSPORTATION CENTERS

The thrust of this research project is to identify the potential impact of transportation centers on the mission of the Texas Department of Transportation. Central to this evaluation are experiences from other areas. Unfortunately, information related to the review and analysis of multimodal transportation centers has not been comprehensive. Numerous papers focus on detailed analyses of passengers or containers moving between modes within a specific facility. This information includes reports on the development of "multimodal" transportation centers at various locations. Most of the passenger facilities are a combination of intercity and commuter rail, and of intercity bus and various modes of local access, old train stations being the primary structure. The majority of these papers, articles, and reports are of U.S. or Canadian origin, but they most often call upon European examples. On the freight side, the focus has been on the combination of long-haul modes (ship, barge, air, rail) and cartage by trucks within a terminal or urban area. Publications offering a broad conceptualization of the problem are few in number. For this reason, the goal of this chapter is to organize the many contributions on the subject of transportation centers 1) using uniform terminology and 2) as applicable to multimodal planning.

PASSENGER TRANSPORTATION CENTERS

Bell defines multimodal passenger terminals as "one-stop" centers, which combine bus, train, subway, and taxi services under one roof with connecting links to nearby airports, bridging gaps that separate different transportation networks.[1] This concept is seen as a great success story in transportation innovation -- not, however, in the U.S. or Canada. The author cites European examples in The Hague, Utrecht, Hamburg, Paris, Lyon, and Birmingham. The multimodal passenger terminals offer many advantages: reduced transfer time and cost and through-ticketing for passengers, as well as common ticketing, baggage handling, and lower operating costs for operators. Because a fixed plant is involved, buses are easier to reroute to train stations. VIA (Metropolitan Transit - San Antonio) Rail and intercity bus companies are reluctant to participate in the creation of multimodal passenger terminals because of fears of reduced ridership. This leads to the question, "Do the two modes really compete for the same

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[1] Dave Bell, "What Are We Missing?" Transpo 11, No. 2 (1988): 13-15.

passenger?" Whether they do or not, both modes are engaged in a service business where convenience is very advantageous. The companies providing multiple service options will attract new customers from private automobile operators.

Bell and Braaksma identify critical factors for a successful multimodal passenger terminal policy.[2] These factors were determined through literature review, data collection, and analysis. Two questionnaires were used for data collection -- an open-ended form administered in the U.S., Europe, and Japan, which was used as input to a closed-end questionnaire administered to all multimodal passenger projects in Canada. The results indicated that the critical factors, in order of importance, were: integrating the various modes of transportation, promotion of public transportation, cost of the terminal, government cooperation, operating factors, historical building preservation, environmental concerns (noise and air pollution), urban development, and reduction of local traffic congestion.

A Transport Canada report examines the multimodal passenger terminal (MPT) concept.[3] An MPT is defined as a passenger facility shared by two or more modes, making it easier for travelers to complete their journeys by changing from one intercity carrier to another, or from the intercity mode to a local access mode. This concept primarily focuses on consolidation of facilities for intercity bus, intercity rail, and the local transit provider. Advantages and disadvantages are explained for the various affected parties, including the benefits and problems for the carriers, the travelers, the community, and each level of government. The need is cited for further research in targeted areas because of the potential significant benefits of MPTs.

Using the examples of Montreal and Vancouver, Fisher develops three basic requirements for "integrated terminal systems": 1) creation of strategic interfaces between urban and intercity modes of transportation; 2) reasonably high levels of traffic at each terminal in the system; and 3) relatively high level of urban activity in the vicinity of each terminal.[4] Potential benefits are: 1) creation of subcenters outside the downtown core, consisting of complementary, mutually reinforcing urban nodes and satellite

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[2] David W. R. Bell and John P. Braaksma, "Critical Factors in Planning Multimodal Passenger Terminals," Transportation Research Record 1221 (1989): 38-41.

[3] Eric Darwin, Multimodal Passenger Terminals: A Canadian Analysis (Ottawa, ON: Transport Canada, Systems Planning Directorate, Intermodal Systems Branch, 1982).

[4] Ewen S. Fisher, "The Potential Requirements of Passenger Terminals in Metropolitan Areas," In Proceedings 16, by the Transportation Research Forum (Oxford, IN: Richard B. Cross, 1975): 222-228.

transportation terminals; 2) accessibility of service to passengers originating and/or terminating outside the downtown core (this can also be applied to the subcenters); and 3) terminal efficiency. The purpose of multimodal facilities is to improve the accessibility of transportation services and to facilitate connecting movements between modes.

Kilvington et al considered the factors which influence the demand for interchange: the organization, ownership, and management of interchange facilities; and the principles of successful interchange design from the viewpoint of passengers and operators.[5] The general concepts in the paper that are useful include: through-ticketing, coordinated service, passenger view of the interchanges, and facility design. Though these are developed in the transit context, they are applicable to a multimodal interchange location.

The term "multimodal" is defined by Mass Transit as a situation where "two or more types of transit meet in an off-street facility that allows passengers to transfer from one to another."[6] Amtrak; heavy and light rail transit; intercity, local, airport and charter bus; vans; limousines; taxis; and private autos are modes commonly included in multimodal centers. Ferry and helicopter services may be included, and many airports are now reached by most of the above modes, "making them true multimodal centers." Some locations around the U.S. are specifically mentioned: Braintree, Massachusetts; Oceanside, California; Tacoma, Washington; and Bakersfield, California.

Pandi discusses the factors that determine the quality of a multimodal system's performance: the performance of the component subsystems, interfaces (transfers between modes), and organization (coordinated schedules and integrated tariff structures).[7,8] In Europe, high-quality service is provided through the use of vending automats to issue standard tickets, computerized tickets linked through computers across the Continent, multiple access to boarding platforms and to rail cars, and multimodal cooperation where competing modes rely on the attractiveness of their service (i.e., choice of mode is not forced). The most extensive European multimodal terminals have

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[5] R. Kilvington; A. Mellor; and D. Pearman, "Interchange Facilities in Urban Public Transport," in Forum Papers of the Australasian Transportation Research Forum (Perth, Western Australia: Western Australia Department of Transport, 1989): 29-44.

[6] "Multimodal Centers Offer Key to Efficient Transit," Mass Transit 11, No. 9 (September 1984): 136-137.

[7] G. R. Pandi, "Multimodal Transport: Europe's Example (I)," Transport-Action, No. 12 (1982): 16-18.

[8] G. R. Pandi, "Multimodal Transport: Europe's Example (II)," Transport-Action, No. 13 (1982): 14-15.

developed from central railway stations because of the station's central location as a gateway to the city. Frankfurt Hauptbahnhof, Den Hague Centraalstation, and Lyon-Perrache et Centre d'Echanges are used as examples. The European practice of linking airports with rapid transit to the central city and its rail stations is mentioned.

Rallis describes the problem of terminal access time for different modes of long-distance travel due to the combination of long-distance and short-distance trips in the peak hours that are a mix of visitor, employee (commuter), and goods traffic.[9] Statistics are presented for peak-hour modal distribution, capacity, and mode of access (airport and rail station) in London based on Smeed's mode choice model. Three components of urban form are discussed: spatial organization, activity distribution, and transportation network. Using an economic theory (Losch) that has been previously applied to London, Paris, Los Angeles, Copenhagen, and Calcutta, one can calculate the number of terminals necessary to handle the activity in a given area. However, the hinterland for a terminal will be varied due to the individual hinterlands of each person or merchandise using the terminal.

Rice and Anderson describe the experience of the Michigan Department of Transportation (MDOT) Passenger Terminal Program to consolidate terminal facilities for local buses, paratransit, and intercity bus and rail systems in small communities.[10] A 1985 MDOT report found that sound market research, site selection, and property management skills contributed to the success of the nine centers studied.

A report by the Tri-State Regional Planning Commission defines a transportation center as primarily a multimodal mass transit facility which attracts, generates and/or transfers intracity and intercity person-trips, thereby providing for circulation, distribution, and access transportation functions.[11] Other related functions include: vehicle receipt, holding, and dispatch; shelter and security; and information and communication. Secondarily, a transportation center can be multifunctional in that it fulfills non-transportation-related purposes (e.g., joint development). It may appear as a

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[9] Tom Rallis, "The City and the Intercity Transport Centers," in Transport Research for Social and Economic Progress: Proceedings of the World Conference on Transport Research held in London, 14-17 April 1980, Volume 2, ed. J. Stuart Yerrell (Aldershot, Hants: Gower, 1981): 969-989.

[10] Brenda Rice and Carol Anderson, "Multimodal Centers Offer Economic Development, Improved Service," Community Transportation Reporter 7, No. 2 (February 1989): 13-15.

[11] Tri-State Regional Planning Commission, Developing Transportation Centers, by Carmen Jones (New York, NY: Tri-State Regional Planning Commission, 1978).

single structure or as contiguous structures in proximity to one another; in either case it should be a substantial destination in its own right. The author asserts that transportation centers are supportive of the central business district (CBD) whether regional or local in scale and that transportation centers are of two geographic types -- CBD and satellite. The report continues to define transportation services, possible candidate locations, and associated funding problems in the New York/New Jersey area.

Much of the work on transportation centers has focused on the consolidation of service providers at a single location. Papers, articles, Environmental Impact Reports, and Environmental Impact Statements about individual facilities are abundant, most often concentrating on modes of local access. Many of these studies provide evaluation of costs and performance of the transportation center before implementation. However, qualitative analyses of the post-implementation operation are lacking. Table 4.1 identifies locations found as examples of transportation centers or those where studies toward implementation have been completed. The majority are focused on railroad stations, with a few exceptions.

The planned development of the Oceanside, Fullerton, and Del Mar transportation centers in the Los Angeles-San Diego Corridor is presented by Bramen and Kooner.[12] There are four principal objectives in developing these centers: 1) to offer better service to existing rail and bus patrons; 2) to provide new or enlarged travel opportunities which will attract choice riders; 3) to increase the operating efficiency and effectiveness of the existing transportation systems; and 4) to bolster community development plans. Combining intercity bus and rail terminals including local distribution modes yields several advantages. There are economies of scale for the transit carriers (i.e., they can jointly use public services, concession space, bus bays, parking, and circulation facilities), as well as greater transit presence (i.e., a larger consolidated facility is more visible and, consequently, better promotes transit riding than do scattered terminals). Local distribution modes (buses, taxis, vans, etc.) can focus on one site rather than trying to serve multiple scattered terminals. This offers a better level of service and/or choice of modes for completing intercity trips, and results in some operating cost savings to local carriers. The concentration of public transportation modes in one location can help spur

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[12] Robert Bramen and Jaswant Kooner, "Rail/Bus Transfer Facilities - L.A./San Diego Corridor," in Proceedings of the Specialty Conference on Design, Construction, and Rehabilitation of Public Transit Facilities, in San Diego, California, March 26-28, 1982, by the American Society of Civil Engineers (New York, NY: American Society of Civil Engineers, 1982): 315-327.

Table 4.1
Transportation Centers Cited in Literature

Description	Location	Reference
Niagara Falls International Transportation Center	Niagara Falls, New York	Acres American, Inc., 1981
White Plains, New York Transportation Center	White Plains, New York	Howard, Needles..., 1981 Adler and Gersten, 1982
Washington Union Station	Washington, D.C.	Baxter, 1975
Village of Hemstead, New York	Hemstead, New York	–
Roma Street Transit Centre (formerly the railway station)	Brisbane, Australia	–
Michiana Regional Airport	South Bend, Indiana	"First Year Success...," 1982
Aurora Transportation Center	Aurora, Illinois	Hanks and Schafer, 1988
Transbay Transit Terminal	San Francisco, California	McConnell and Gray, 1991 Transbay Terminal, 1974 Altshuler and Lu, 1982
Santa Ana Transportation Center	Santa Ana, California	"A New Multi-Modal...," 1983
Union Station	New Orleans, Louisiana	"New Orleans...," 1980
Ferry Terminal/Rail Station	Edmonds, Washington	Parsons Brinckerhoff, 1979
Rail Station	Trois Rivieres, Quebec	Smith, December 1987
Rail Station	Long Beach, New York	Storch Associates, 1980
Transit Center	Oceanside, California	Strauss, 1984
Transit Center	West Palm Beach, Florida	Tokich, 1990
Transportation Center	Kapusking, Ontario	Twidale, 1982
Transportation Center	Mineola, New York	The Urbanetics Corp., 1981
Joint development of existing adjacent intercity bus and stations	Pittsfield, Massachusetts	Wilbur Smith Assoc., 1981
Transportation Center	New Rochelle, New York	Wilbur Smith Assoc., 1980
South Station	Boston, Massachusetts	Steward, 1982; Kivett, 1980
Multimodal Transportation Terminal	San Jose, California	Final EIS and EIR, 1984
Bridgeport Transportation Center	Bridgeport, Connecticut	Bridgeport..., 1983
Fitchburg Intermodal Transfer Facility	Fitchburg, Massachusetts	Modal Services..., 1984
Poughkeepsie Transportation Center	Poughkeepsie, New York	Roger Creighton Assoc., 1979
Downtown Multimodal Transportation Center	Beaumont, Texas	Barton-Aschman Assoc., 1980
Multimodal Transportation Service Facility	Danbury, Connecticut	Gannett, Fleming..., 1981
Joliet Union Station	Joliet, Illinois	Bandos and Melcher, 1979
Downtown Transportation Center	Milwaukee, Wisconsin	W.C. Gilman Assoc., 1978
Union Station	Chicago, Illinois	Herbert, 1980
Transit Center	Palo Alto, California	Lightbody and Walters, 1982

land development in surrounding areas, if pursued in conjunction with the transportation center.

A community-based participation process is the focus of Mandle et al, wherein the underlying objective is to facilitate and improve passenger transfer and encourage community development and revitalization.[13] It is important to balance community objectives and efficient transportation services, since sometimes these goals are in conflict. Four underlying elements exist in the process: physical characteristics (transportation uses and joint development factors), institutional characteristics, public-sector involvement, and private-sector support. The method used in the reviewed studies was to first coordinate a balance of the physical characteristics, then subject them to institutional review by public and private interests. These interests were allowed to change in order to increase the likelihood of public/private involvement and implementation.

Strobach has found in Canada that the intent for intermodal coordination is shared by individuals in the rail and bus industries, but wide acceptance and implementation of these practices is slow.[14] The hesitation is due, primarily, to misunderstanding and mistrust of the other group's motives. Each side has no clear visualization of how operations would work together. An example cited is the joint study for rail and bus service on Vancouver Island. This study concluded that joint terminal space requirements are less than those required by individual carriers: a 30 percent reduction in waiting room space as well as a reduction in passenger parking spaces, and a 15 percent increase in commercial space. In addition, due to increased traffic volumes and extended hours of operation, a perceived improvement in personal safety occurs and enhances the attractiveness of the terminal as a business location. Project experience indicates three drawbacks to implementation: 1) a project may become a political issue, with many groups involved (more than five or six); 2) participants become passive and reactive as opposed to generating new ideas; and 3) often, projects extend beyond the original target

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[13] Peter B. Mandle, Susan Orcutt, and David J. Sampson, "Balancing Development and Transportation Objectives in Transportation Center Planning," in Proceedings of the Specialty Conference on Design, Construction, and Rehabilitation of Public Transit Facilities, in San Diego, California, March 26-28, 1982, by the American Society of Civil Engineers (New York, NY: American Society of Civil Engineers, 1982): 328-342.

[14] Peter Strobach, "Canadian Intercity Terminals," Planning and Development of Public Transportation Terminals, edited by Lester A. Hoel and Larry G. Richards (Washington, D.C.: U. S. Department of Transportation, Research and Special Programs Administration, 1980): 157-165.

date for non-technical reasons, which could result in additional delays or cancellation due to changes in the participant's financial position.

European transportation terminals are the focal point of Braaksma.[15] Definite geographic and cultural differences between European and North American cities are noted. In Europe, cities are downtown-oriented with active city centers; gasoline cost is high, and land use is closely tied to transportation. The fundamental principle is for all modes to complement one another and function as an integrated system. This includes integrated ticketing across modes in addition to physical linkage. As an example, Table 4.2 presents the modal split as a function of city size for Dutch intercity rail stations. These stations are located in the city center, physically connected to local access modes. The distance represented by a terminal's sphere of influence corresponds to an access time of approximately 10 to 15 minutes.

Table 4.2
Percent Modal Split of Access Traffic to Dutch Intercity Stations

City Population	Walk	Bicycle	Bus,Tram, and Metro	Car	Other
Less than 80,000	37	36	18	7	2
80,000 - 200,000	25	29	36	7	3
More than 200,000	21	11	55	9	4

SOURCE: John P. Braaksma, "Some Functional Aspects of European Transportation Terminals," Planning and Development of Public Transportation Terminals, edited by Lester A. Hoel and Larry G. Richards (Washington, D.C.: U. S. Department of Transportation, Research and Special Programs Administration, 1980): 170.

A British study of rail stations found a much different modal split, shown in Table 4.3. The category "other" reflects the use of taxis as an access mode. Also note that regional and intercity buses do not use rail stations as terminals.

Five conclusions can be drawn from this analysis: 1) to maintain and increase ridership, a good level of service (vehicles, terminals, and scheduling) must be provided; 2) public transportation is integrated throughout Western Europe with common ticketing,

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[15] John P. Braaksma, "Some Functional Aspects of European Transportation Terminals," Planning and Development of Public Transportation Terminals, edited by Lester A. Hoel and Larry G. Richards (Washington, D.C.: U. S. Department of Transportation, Research and Special Programs Administration, 1980): 167-190.

Table 4.3
Percent Modal Split of Access Traffic to British Rail Stations

City	Walk	Motorcycle	Bus	Car	Other
Leeds	12	-	23	51	14
Newcastle	9	-	20	60	11
York	15	1	14	60	410

SOURCE: John P. Braaksma, "Some Functional Aspects of European Transportation Terminals," Planning and Development of Public Transportation Terminals, edited by Lester A. Hoel and Larry G. Richards (Washington, D.C.: U. S. Department of Transportation, Research and Special Programs Administration, 1980): 174.

interlaced schedules, and coordinated management; 3) joint development should be promoted at terminal facilities to enhance the transportation system, stimulate urban development, and finance infrastructure; 4) maturing systems have complicated problems that are being solved through innovative design and computer traffic control; and 5) in the United States and Canada, agencies must be careful not to simply transplant European solutions -- the philosophies, approaches, and methodologies should be examined. Even though the characteristics of European cities are very different from those of North American cities, the characteristics of the transportation problems do not differ.

Some specific comments and findings from individual studies are useful. In the study for Poughkeepsie, New York, it was found that there were few transfers between intercity buses and rail modes (Amtrak and commuter service). This also held true for air connections to the city. Facilities consolidation was not recommended because there was little linkage and few transfers between modes. The Bridgeport, Connecticut, study found that the major problems were schedule coordination (as affected by on-time performance), inadequate user information, and poor physical connections between modes. Transportation planning model trip distribution of modal transfers was: rail to bus, 28 percent; to car driver, 23 percent; to walk, 21 percent; to car passenger, 18 percent; and to ferry, 4 percent.

Reports by Schneider for the Urban Mass Transportation Administration (UMTA, now the Federal Transit Administration, FTA) examine present metropolitan travel patterns in American cities and develop a 10-step planning framework to aid planning and design of transit centers.[16,17] Examples are taken from case studies from sites across the U.S. Rabinowitz et al discuss transit facility design using market-based criteria.[18] Some of the ideas from these reports can be applied to transportation centers because the primary mode of local access is, in many cases, transit.

The intermodal design of public transportation terminals can provide useful information applicable to transportation centers, including long-distance modes, because of the interface with transit and other local access modes. Hoel provides guidelines on station function and station design from both passenger and operator perspectives.[19] The basic function of a station is to process the flow of passengers between modes. In addition, it must attract the user to the system and provide space for service functions, access, and joint development. From the passenger's perspective, convenience, comfort, and safety are the primary factors. A clear pathway is important and will serve to reduce the need for information, improve safety and security, and facilitate consumer services. Sufficient entrances/exits, dependable ticketing and fare collection, adequate platform dimensions, and facility maintenance are the important considerations for the operator in station design. An earlier paper by Hoel and Roszner presents an analysis of transit station planning and design.[20] The process is discussed in terms of applicable design parameters and standards, design of station environment, and design methodology.

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[16] U.S. Department of Transportation, Urban Mass Transit Administration, University Research and Training Program, Planning and Design of a Transit Center Based Transit System: Guidelines and Examples from 22 Cities, by Jerry B. Schneider, et al., Urban Transportation Program, Department of Civil Engineering, University of Washington ([Washington, D.C.]: U.S. Department of Transportation, Urban Mass Transit Administration, University Research and Training Program, September 1980), Report #UMTA-WA-11-0007-81-1.

[17] U.S. Department of Transportation, Urban Mass Transit Administration, University Research and Training Program, Planning, Designing, and Operating Multi-center Timed Transfer Transit Systems: Guidelines from Recent Experience in Six Cities, by J. B. Schneider, et al., Urban Transportation Program, Department of Civil Engineering, University of Washington ([Washington, D.C.]: U.S. Department of Transportation, Urban Mass Transit Administration, University Research and Training Program, September 1983), Report #UMTA-WA-11-0009.

[18] U. S. Department of Transportation, Market Based Transit Facility Design, by Harvey Z. Rabinowitz, et al ([Washington D.C.]: U. S. Department of Transportation, February 1989).

[19] Lester A. Hoel, "Guidelines for Planning Public Transportation Terminals," Transportation Research Record 817 (1981): 36-41.

[20] Lester A. Hoel and Ervin S. Roszner, "Planning and Design of Intermodal Transit Facilities," Transportation Research Record 614 (1976): 1-5.

FREIGHT TRANSPORTATION CENTERS

By their very nature as trans-shipment points, ports, rail intermodal facilities, and airports are transportation centers for freight shipments. The focus of much of the research in this area is on intrafacility operations. There is a significant amount of movement from one long-distance mode to the other by cartage within the terminal itself. Some locations have integrated more than two modes within one facility, and others have married unlikely combinations. Freight transportation centers can provide efficiencies to freight terminals, operators, shippers, and carriers.

Ganzel, North, and Seafarer discuss the growth potential of the Huntsville/Madison County (Alabama) Jetplex.[21, 22, 23] The airport was located in 1961 near rail access, the subsequent route of I-565, and the Tennessee Tombigbee waterway system. The focal point of the operation is the International Intermodal Center, which combines air, rail, and motor carrier freight trans-shipments with an automated warehousing system. International shipments (60 percent of traffic) are made by rail from/to both coasts, since the Jetplex is designated a port of entry. Air cargo operations are almost entirely domestic.

One of the concepts discussed by Gbur is a public rail/highway transfer facility created to minimize handling and to further the goal of eliminating direct carload delivery within a terminal complex.[24] The advantage for railroads is the abandonment of unprofitable operations, once shippers are persuaded to move traffic through the transfer facility.

Sea-air freight transportation was initially used by Air Canada to speed delivery of high-value Japanese goods through Vancouver.[25] Goods arrive by ship, then are trucked from the harbor to the airport, broken down, and transformed into air cargo

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21 Neal Ganzel, "Putting It All Together: Rail/Air/Barge/Land Customs," American Shipper 29, No. 11 (November 1987): 44-46.

22 Mark North, "Alabama's Intermodal Innovation," Cargo Systems International 13, No. 5 (May 1986): 70-71.

23 "Huntsville Courts Future with Multi-modal Jetplex," Seafarer 36, No. 12 (November 1987): 10-14.

24 Jonathan Gbur, "New Concepts in the Intermodal Movement of Freight," Proceedings of the Transportation Research Forum 19 (1978): 153-158.

25 Gunter F. Mosler, "Air Canada's Sea-Air Shipping Success," Airport Forum 11, No. 6 (December 1982): 64-65.

consignments. Several articles introduce this concept and discuss its use.[26, 27, 28] The advantages of this shipping option include a 50 percent reduction in sea freight time and a 30-50 percent cost savings compared to air freight. Additionally, the option avoids congestion delays and capacity constraints of Asian air terminals. Faster shipment is provided, using short-haul road transfer between ports and inland airports, and re-routing at a trans-shipment point, if possible. The concept has expanded to include additional trans-shipment points: Seattle, San Francisco, Los Angeles, the Persian Gulf Emirates, and Singapore. New hub locations may be created in developing countries as capacity constraints increase due to a congested environment at existing hubs.

Hazzard identifies the West Coast cities that are in a position to take advantage of this market.[29] Seattle is considered the leader because it is 310 miles (499 km) closer to Asia, has less congestion, and has the best security rating; the Port of Seattle is 20 minutes closer to Seattle-Tacoma International Airport than the Port of Tacoma. In 1987, Seattle experienced the largest tonnage and growth, though additional capacity through airport expansion is unlikely. The San Francisco Bay Area ranks next, primarily due to participation by high-tech companies. Los Angeles is farther behind because handling and ground security at the airport are poorer.

Roma proposes the creation of an "Interport" anchored by an intercontinental airport facility located on the coast with rail and highway transportation directly connected to three sides of the airport complex.[30] Maritime service would cover the fourth side. The author envisions a fully integrated freight and passenger terminal for four modes: air, rail, road, and sea.

Vickers examines multimodalism in the context of the economic and regulatory environment and its potential effect on the shipping industry.[31, 32] Multimodalism is the offspring of intermodalism and deregulation of the rail and trucking industry (in 1980)

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26 "Sea-Air Cargo: An Introduction," Airport Forum, No. 2 (May 1988): 8-16.

27 John Hummer, "Seattle's Boat to the Plane," Portfolio 2, No. 4 (Winter 1989): 59-62.

28 Stanley E. Fawcett and David B. Vellenga, "Sea-Air -- Opportunities and Challenges in Intermodal Transportation," Journal of the Transportation Research Forum 29, No. 1 (1988): 101-110.

29 Lawrence Hazzard, "Netting Sea and Air," Air Cargo World 76, No. 7 (July 1986): 20-26.

30 Guiseppe Roma, "Intermodal Airport Network Proposed: Where Geographically Feasible Why Not Use the Airport as a Hub to Which Other Transportation Modes Are Connected?" ICAO Bulletin 35, No. 2 (February 1980): 21.

31 Peter F. Vickers, "Growth of Multimodalism is Changing International Transportation," World Wide Shipping 49, No. 5 (July/August 1986): 17-23.

32 Peter F. Vickers, "Intermodalism and Multimodalism," Intermodal Forum (Autumn 1986): 46-56.

and subsequent "re-regulation" of the maritime industry (1984). Intermodalism is defined as the movement of containerized cargo from one mode of transportation to another, and multimodalism is described as the brand of transportation services offered by the "super-transportation" companies that are evolving in today's market environment (i.e., all modes are under one corporate control). The implication of this shift toward multimodalism is that many ports are too expensive to operate or too far from the open sea to be competitive, although some are being upgraded to optimize the ship-rail interface. The current trend is toward the creation of "load centers" which accept traffic from barges, unit trains, and feeder vessels from smaller ports.

TRANSPORTATION CENTER SYNTHESIS

The summary of literature, while detailed, is not exhaustive. The different customer focuses and modal orientations of the authors combine to provide a varied, and sometimes conflicting, view of this issue. This may lead the reader to ask the question, "What *is* a transportation center, and is the definition uniform between modes, goods and passenger movement, and urban versus rural locations?" One must view this question in light of the definitions of multimodal and intermodal put forward in Chapter 2. Issues of a multimodal nature are seen from the broader perspective of transportation systems planning, while intermodal refers to the detailed analysis of modal interactions as they affect performance efficiency of the system. The definition of the transportation center is from the multimodal perspective, as that is our major focus, and will be sufficiently expansive to answer the previous question.

The names used for transportation centers in the literature are varied: intermodal terminals, multimodal transportation centers, multimodal transportation terminals, integrated terminal systems, transportation facilitation centers, etc. However, there are common traits among them. In the most inclusive sense, any urbanized area where transfers between modes take place can be considered a transportation center. For example, in the arena of sea-air cargo, the transfer point is viewed as a node on the global transport network, whereas on a national basis the linkage between the port and airport is an important system consideration.

An examination of the regional or urban area is necessary to understand the relationship between spatial organization, activity distribution, and the transportation system. The interaction of these three elements will determine where a transportation center may be appropriate. The purpose of multimodal facilities is to improve the accessibility of transportation services and to facilitate connecting movements between modes. In some cases, existing single-mode transportation facilities may be converted to a multiple-mode transportation center.

From the multimodal planning perspective, a transportation center is a location where two or more modes of long-distance transportation interface to provide transfers among these modes and allow local connections which provide access to the surrounding activity system. This description is sufficiently broad to be valid for freight and passenger traffic, and inclusive of varied levels of land-use activity from urban to rural.

Additional description of their attributes can be added to this definition to focus the concept of transportation centers more specifically on the movement of goods or people. It should be noted that one cannot entirely separate freight and passenger movement in the transportation system. This is demonstrated by airports, where runways are common to both sectors but terminals, freight, and passenger traffic operate independently. In multimodal and intermodal planning, the conflicting movement of freight and passenger traffic must be explicitly considered.

There are various definitions presented in the literature of a passenger-oriented transportation center. It may be viewed as a "one-stop" center to bridge gaps that separate different transportation networks, and one which combines buses, trains, subway, and taxi services under one roof with connecting links to nearby airports.

Many transit centers are locations where two or more types of transit meet in an off-street facility that allows passengers to transfer from one mode to another. These are often called "multimodal" facilities or transportation centers, even though intracity trips are the predominant uses of these centers. However, much useful information can be learned from these locations that may be applied to the more complex transportation center which includes intercity travel.

A transportation center can be described as primarily a multimodal mass transit facility which attracts, generates and/or transfers intracity and intercity person-trips, thereby providing for circulation, distribution, and access transportation functions. Other related functions include: vehicle receipt, holding, and dispatch; shelter and security; and information and communication. Secondarily, a transportation center can be multifunctional in that it fulfills non-transportation-related purposes (e.g., joint development). It may appear as a single structure or as contiguous structures in proximity to one another; in either case it should be a substantial destination in its own right.

A passenger facility shared by two or more modes -- making it easier for travelers to complete their journey by changing from one intercity carrier to another, or from the intercity mode to the local area mode -- is a transportation center. A MPT offers more to the users than unimodal terminals, through economies of scale and increased efficiency of a shared facility. Carriers using the MPT may be complementary (one mode bringing customers to the other, e.g., local transit to intercity carriers) or competitive (e.g., intercity bus and intercity rail competing for the traveler).

The passenger transportation center is a very complex system of people interfacing with different modes to reach their trip destinations. Many different modes of transportation may participate in a transportation center: high-speed, intercity (e.g., Amtrak, VIA Rail) and commuter rail; heavy- and light-rail transit; intercity, local, express, airport and charter bus; paratransit (vans; limousines; taxis, dial-a ride service); and private autos. For autos, long-term parking, commuter parking (park-and-ride), short-term parking, and drop-off areas (kiss-and-ride) are provided, and of course bicycle and pedestrian access. Successful transportation centers also have direct rapid transit connection to airports to interface with commuter air, major air carriers, and helicopters; and/or a connection to ports for ferry, hovercraft, and ships. Passenger transportation centers may need to combine only a few of these modal elements to be successful. Within the center, amenities for the traveler are provided: ticketing agencies, information, services, small commuter-oriented retail, etc. In addition, non-transportation uses can play a significant role in the activity and financing of transportation centers, especially through joint use development, which may include office, retail, residential, open space, and civic uses. These descriptions of the elements of passenger transportation centers provide a better idea of how the concept is implemented in a multimodal environment.

CHAPTER 5. MULTIMODAL TRANSPORTATION PLANNING

The previous chapter outlined experiences with transportation centers which are the product of effective intermodal coordination and multimodal transportation planning. As noted in Chapter 3, the environment for multimodal transportation has changed in recent years. This chapter outlines governmental responses to this new environment, particularly through their transportation planning activities.

FEDERAL INVOLVEMENT IN STATE INTERMODAL TRANSPORTATION SYSTEMS

The Federal government is encouraging states and Metropolitan Planning Organizations (MPOs) to pursue intermodal transportation systems with two pieces of legislation: the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Clean Air Act Amendments of 1990 (CAAA). This section of the report enumerates the specific provisions of these acts as they relate to statewide intermodal transportation planning.

ISTEA declares that "the policy of the United States to develop a National Intermodal Transportation System that is economically efficient and environmentally sound, provides the foundation for the Nation to compete in the global economy, and will move people and goods in an energy efficient manner."[1] ISTEA places the responsibility for achieving this policy in the hands of those most familiar with their region's transportation needs: state governments and MPOs. In terms of state responsibilities, ISTEA proclaims:

> It is the national interest to encourage and promote the development of transportation systems embracing various modes of transportation in a manner that will serve all areas of the State efficiently and effectively. ...the State shall develop transportation plans and programs for all areas of the State. Such plans and programs shall provide for development of transportation facilities...which will function as an intermodal State transportation system. The process for developing such plans and programs shall provide for the consideration of all modes of transportation and shall be cooperative and comprehensive to the degree appropriate based on the complexity of the transportation problems.[2]

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[1] *Intermodal Surface Transportation Efficiency Act of 1991*, Public Law 102-240, December 18, 1991, Sec. 2.

[2] Ibid, pp. 1962-3.

One of the ways ISTEA enables the states to meet this mandate is by giving them "more flexibility in determining transportation solutions, whether transit or highways."[3]

Most of this flexibility stems from the Surface Transportation Program (STP), which eliminates many of the restrictions on the use of federal funds that existed prior to ISTEA. The STP accounts for $23.9 billion of ISTEA's $120.86 billion in apportionments over the next six years.[4] This level of funding may be augmented by the transfer of funds from other programs and by equity funds (including Donor State Bonuses, Reimbursement, Hold Harmless, and 90% of Payments). With this augmentation, the Texas Department of Transportation's (TxDOT's) Planning and Policy Division predicts $37.82 billion in funds will be available to states over a six-year period under the STP.

There are a few restrictions concerning the allocation of STP funds within a state. Ten percent of STP funds must be provided to safety programs, and an additional 10 percent must be used for "transportation enhancement activities."[5] In terms of project distribution, 62.5 percent of the remaining 80 percent of STP funds must be allocated to urbanized areas with populations greater than 200,000. The remaining 37.5 percent can be allocated to any other areas within the state.

ISTEA permits states to allocate STP funds for the following intermodal projects:

- Construction, reconstruction, rehabilitation, and improvements to highways and bridges...including any such construction or reconstruction necessary to accommodate other transportation modes;
- Capital costs for transit projects eligible for assistance under the Federal Transit Act and publicly owned intracity or intercity bus terminals or facilities;
- Carpool projects, fringe and corridor parking facilities and programs, and bicycle transportation and pedestrian walkways;
- Transportation management systems including congestion and intermodal management systems.

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3 *A Summary: Intermodal Surface Transportation Efficiency Act of 1991*, p. 5.

4 *Intermodal Surface Transportation Efficiency Act of 1991 Fact Sheets*, p. 7.

5 Transportation enhancement activities are defined by the ISTEA as "the provision of facilities for pedestrians and bicycles, acquisition of scenic easements and scenic or historic sites, scenic or historic highway programs, landscaping and other scenic beautification, historic preservation rehabilitation and operation of historic transportation buildings, structures or facilities, preservation of abandoned railway corridors, control and removal of outdoor advertising, archaeological planning and research, and mitigation of water pollution due to highway runoff" (*United States Statutes*, Vol. 105, p. 1931).

The scope of projects allowed under STP in ISTEA is much broader than the scope allowed under previous transportation funding statutes. It is hoped that this broadened scope will serve as a "carrot" to lure states into pursuing an intermodal transportation network. However, it must be noted that STP does not require states to pursue intermodal or multimodal transportation networks. As a result, under STP, the initiative for planning and constructing innovative intermodal networks must come from the states themselves.

The Congestion Management and Air Quality Improvement Program (CMAQ) contained in Section 1008 of ISTEA is another program that encourages states to develop intermodal transportation systems, albeit indirectly. CMAQ program funds account for $6 billion of ISTEA's six-year apportionment and, in air quality non-attainment areas, can be used only for projects which will contribute to the attainment of National Ambient Air Quality Standards (NAAQS). Many intermodal projects such as the construction of efficient transit terminals can result in improved air quality by removing private automobile users from the highways and easing traffic congestion. These projects are eligible for CMAQ funds.

In addition to the funding provided by the programs above, Title V of ISTEA allocates $3 million in grants to be used to develop model state intermodal transportation plans. These funds are allocated to individual states at the discretion of the Secretary of Transportation, with $500,000 the maximum grant any one state can receive.

In addition to the funding "carrot," ISTEA uses several "sticks" to induce states to pursue intermodal transportation systems. Most of these inducements involve requirements for states to develop transportation planning procedures, management systems, and project programming systems that are geared towards intermodalism. Most of these requirements are contained in Section 1025 of ISTEA, which details twenty factors that must be considered in the state transportation planning process. The factors that deal directly or indirectly with developing efficient intermodal transportation are:

- Strategies for incorporating bicycle transportation facilities;
- International border crossings and access to ports, airports, intermodal transportation facilities, major freight distribution routes;
- Connectivity between metropolitan areas within the state and with metropolitan areas in other states;

- Transportation system management and investment strategies designed to make the most efficient use of existing transportation facilities;

- Methods to reduce traffic congestion and to prevent traffic congestion from developing in areas where it does not yet occur, including methods which reduce motor vehicle travel, particularly single-occupant motor vehicle travel;

- Methods to expand and enhance transit services and to increase the use of such services; and

- The effect transportation decisions have on land use and land development, including the need for consistency between transportation decision-making and the land-use and development plans.

Many of the above factors do not deal directly with intermodal transportation systems, but their consideration could conceivably contribute to the development of an intermodal network. The fifth factor, which deals with congestion mitigation, is a good example; intermodal park-and-ride transit terminals may be included in a transportation plan because the state was required to consider congestion mitigation methods in the planning process.

In addition to the consideration of these factors, states are required under ISTEA to develop both a long-range transportation plan and a State Transportation Improvement Program (STIP). The long-range plan and the STIP must be developed in cooperation with metropolitan planning organizations, local government agencies, private transportation providers, and the citizenry at large. In addition, these plans must also be consistent with implementation plans required by the CAAA and the plans and Transportation Improvement Programs (TIP) developed by MPOs. Ideally, these state planning requirements will lead states to develop procedures to address transportation problems from a multimodal perspective.

The strongest federal requirement for intermodal transportation development is contained in Section 134 of ISTEA requiring states to develop six transportation management systems, three of which can apply to intermodal development and traffic monitoring system. These are: (1) a traffic congestion management system, (2) a public transportation facilities and equipment management system, and (3) an intermodal facilities and systems management system. ISTEA does not specify what the scope of the first two management systems should be, but is quite specific about intermodal management system requirements:

> The management system required under this section for intermodal transportation facilities and systems shall provide for improvement and integration of all of a State's transportation systems and shall include methods of achieving the optimal yield from such systems, methods for increasing productivity in the State, methods for increasing the use of advanced technologies, and methods to encourage the use of innovative marketing techniques, such as just-in-time deliveries.[6]

If states fail to develop and implement such a management system by 1995, up to 10 percent of their ISTEA apportionment may be withheld. Thus, with this section, the federal government forces state governments to consider intermodal transportation networks. This regulatory "stick" serves as a complement to the flexible funding "carrot" and sends a strong message to states about the importance of intermodal transportation planning.

The CAAA have also been guiding states towards intermodal transportation solutions. The regulatory framework of the Clean Air Act was greatly enhanced by these Amendments, which stated strict and specific air-quality improvement measures that must be implemented in non-attainment areas. Many of these measures concentrate on reducing vehicle emissions.[7] The CAAA approach this reduction from the standpoint of reducing total vehicle-miles (vehicle-kilometers) traveled (VMT) in non-attainment areas. Although intermodal methods of reducing VMT are not explicitly mentioned, intermodal transit and freight projects definitely could contribute to such reductions. As a result, intermodal projects should be viewed as a critical portion of the State Implementation Plans (SIPs) for attaining the NAAQS set forth by Title I of the CAAA. However, for the CAAA to be an effective intermodal promoter, financial penalties for non-attainment of the NAAQS must be implemented and enforced. If states feel the financial pinch from the federal government, the development of intermodal projects that reduce VMT will become important state goals.

Additional federal guidance concerning both ISTEA and CAAA has been forthcoming in the "Notices of Proposed Rulemaking" in *The Federal Register*. The first of these, detailing federal requirements for ISTEA-mandated management systems, appeared June 3, 1992. Of key interest are the proposed requirements for Intermodal

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[6] *United States Statutes at Large*, Vol. 105, p. 1977.

[7] *A Summary: Transportation Programs and Provisions of the Clean Air Act Amendments of 1990*, p. 2.

Management Systems (IMS). The June 3 document first defines an intermodal facility as "a transportation hub that interconnects different modes of transportation," and an intermodal system as providing "a means for moving people and goods using various combinations of modes."[8] The proposed rules also outline the following five IMS elements:

1. Identification of Intermodal Facilities: including passenger and freight facilities;
2. Identification of Efficiency Measures and Performance Standards: including, but not limited to, travel time, transfer time, and total cost;
3. Data Collection and System Monitoring: perpetual inventorying of the condition and operational characteristics of intermodal facilities;
4. System and Facility Performance Evaluation: determination of specific causes for the efficient or inefficient movement of goods and people in the intermodal transportation system;

5 Strategy and Action Identification and Evaluation: consisting of the identification and evaluation of future state intermodal opportunities, including the consideration of advanced technologies and innovative marketing techniques.

These five elements are to be incorporated into a statewide IMS that addresses both short- and long-range intermodal needs and opportunities. In the end, the IMS should result in:

> An inventory of intermodal facilities and systems, incorporation of IMS strategies and actions into State...transportation plans and transportation improvement programs, and an implementation plan as part of the statewide...transportation plan.[9]

A second set of proposed rules, appearing in the March 2, 1993 *Federal Register*, detail statewide transportation planning requirements. These proposed rules specify many of the details concerning statewide planning procedures and scope. However, like ISTEA itself, these rules relegate intermodal issues to the background. Generally, intermodal transportation is mentioned only in broad terms as being one of the factors that must be considered in the statewide transportation plan. Despite this weakness, important pronouncements on the subject of inter-agency cooperation are made. The proposed rules state that data collection activities, intermodal planning, environmental

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[8] United States, *Federal Register*, June 3, 1992, p. 23466.
[9] Ibid.

analyses, and financial planning for transportation must be coordinated with all involved parties, including MPOs, private transit providers, and the general public.[10]

EXPLORATION OF METHODS AND CONCEPTS TO MEET NATIONAL MANDATE

Prior to the passage of ISTEA, the status of multimodal and intermodal transportation planning and the need for expanded emphasis in these areas were already known. A report prepared for the National Council on Public Works Improvement in 1987 examined the relationship between intermodal transportation and public works programs.[11] This report defined intermodal transportation as the movement of goods and/or persons by two or more modes of transportation between specific origins and destinations. Public investment was found to be predicated on two objectives: stimulating economic growth and development and improving the United States' competitiveness in world trade. Almost every freight or passenger movement involves some form of interruption due to a change of mode. For intermodal transportation to work efficiently, the report found, the cost of modal transfers must be reduced through integrated and coordinated infrastructure, integrated and standardized facilities and equipment, coordinated communication, coordinated management and administration, coordinated paperwork (documentation), and clarity of liability responsibility. A "mismatch" of any of these intermodal requirements would lead to increased cost of transportation.

A 1989 study by the Lyndon B. Johnson School of Public Affairs was performed to provide a comprehensive overview of state efforts to use multimodal and intermodal transportation plans, programs, and projects to promote economic development or to respond to competitive market considerations.[12] As an economic growth and development mechanism, state transportation and economic development officials typically created incentive programs designed to attract and retain business. These programs financed infrastructure improvements or additions to capacity which benefited local companies and communities. Few officially designated intermodal programs exist.

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[10] United States, *Federal Register*, March 2, 1993, p. 12091.
[11] Joseph S. Revis and Curtis Tarnoff, The Nation's Public Works: Report on Intermodal Transportation, prepared for National Council on Public Works Improvement (Washington, D.C.: National Council on Public Works Improvement, May 1987).
[12] Lyndon B. Johnson School of Public Affairs, State Multimodal and Intermodal Transportation: An Overview of Policies and Programs Promoting Economic Growth, Policy Research Project Report 90 (Austin, TX: The University of Texas at Austin, 1989).

In many states, freight transportation was found to be almost entirely the realm of the private sector and, as such, considered private-sector domain. Multimodal planning of freight movement primarily concentrated on port facilities. States declaring that their transportation plans are multimodal, actually were producing unimodal plans that operated independently under the statewide master plan. Some state transportation trust funds used flexible funding mechanisms (Maryland). For an intermodal project to occur, sufficient funding or at least a stable financial situation was required. No consistency was found as far as local, county, or state involvement in the process beyond federally mandated requirements, nor did MPO and/or local community involvement appear to significantly affect states' actions.

In July of 1992, following ISTEA's passage, the Transportation Research Board convened a conference on Transportation Planning, Programming and Finance in Seattle, Washington. The conference was held in conjunction with meetings of the National Association of Regional Councils (NARC) and the American Association of State Highway and Transportation Officials (AASHTO). The goal of the conference was fourfold: 1) to review emerging environmental issues affecting planning and programming decisions; 2) to assess current and new approaches to programming and planning, including technical and institutional aspects; 3) to determine steps to address these issues; and 4) to develop a research and action agenda. During the conference four issue papers were presented in the areas of planning, programming, finance, and institutional issues dealing with the impediments to creating a truly multimodal process.

In addition to providing the definitions of multimodal and intermodal planning, Meyer discussed the shift in transportation planning towards multimodalism.[13] Past barriers to multimodal planning were due primarily to institutional and financial issues. These included limits and incentives to local decision-making regarding federal aid projects using formula-based or categorical funding, traditional modal orientation due to an agency's mandate which is reinforced in daily operation, and the restriction of revenues to either highway or transit purposes. The new, changing environment for the development of transportation alternatives independent of modal prerequisite is part of the context of ISTEA. Two examples of good multimodal planning were cited -- the Maryland Commuter Assistance Study and the I-15 Corridor Analysis in Salt Lake City.

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[13] Michael D. Meyer, "The Future of Transportation Planning: Jump-starting the Push Toward Intermodalism," paper presented to the Transportation Research Board Conference on Transportation Planning, Programming, and Finance (Seattle, WA: Transportation Research Board, 19-22 July 1992), photocopy.

Overall, an effective multimodal planning process includes policy goals and objectives, problem definition, criteria, analysis and evaluation tools, public involvement, a defined relationship between agencies performing multimodal planning, and other institutional issues.

In spite of the optimism expressed by Meyer, AASHTO has found that, in general, multimodal planning is virtually non-existent within state department of transportations (DOTs). The agencies are not well-organized for multimodal planning, staff training in multimodal concepts is insufficient, and databases are unequal and generally inadequate. Identification and involvement of customers is a problem. In spite of ISTEA, categorical funding barriers still remain, especially at the state level.

Financial planning elements are required under ISTEA at both the state and metropolitan level. A strategic fiscal planning process will be necessary to balance congestion relief, air quality, and financial feasibility by considering conformity and concurrency.[14] Capital, operating, and maintenance expenditures must be evaluated on a life-cycle cost basis. Cash flow management and risk/uncertainty analysis are some of important tools that should be examined as methods to assure realistic financing of transportation investments. In addition, public-private partnerships and other new funding sources, including impact fees and tolls, must be placed on the table to fund transportation infrastructure. A transition must be established between the existing process and a new process that meshes with changes to occur in the transportation planning and programming environments.

To take advantage of the new opportunities presented by ISTEA, public agencies must work toward fulfillment of the following public finance objectives:

- establish a new transparent and flexible planning and resource allocation process;
- improve the recognition of real cost and shortfalls;
- give increased attention to new resources, pricing, and benefit assessment;
- increase the pressure for funding stability to meet program commitments;

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[14] Stephen C. Lockwood and Gerry Williams, "Finance," paper presented to the Transportation Research Board Conference on Transportation Planning, Programming, and Finance (Seattle, WA: Transportation Research Board, 19-22 July 1992), photocopy.

- invite new players to cooperatively participate; and
- establish a strategic perspective within life-cycle asset management.[15]

The result should be a funding process credible to state and political leaders which contains elements of realism and accountability. This new process should lead to a change from a wish-list mentality toward an investment strategy based on policy goals and objectives of the transportation plans.

The issue paper on transportation programming presented by Neumann began with a review of objectives and methods of this process.[16] Then, the directions were identified toward which programming practice must turn to function effectively in today's environment. Expanded attention is necessary for demand management strategies, multimodal solutions, operational improvements, maintenance and preservation of existing infrastructure, and land-use planning in the programming process. Integrated planning and programming which considers these requirements is used infrequently by public agencies.

Changes in the structure of the overall programming process and the supporting data and technical analysis are necessary. Individual projects should be funded cost-effectively and resources must be designated in an effective way to address policy objectives. To facilitate trade-offs in the programming process, engineers and planners will be required to reach consensus decisions. The ability to inform technical and policy decision-makers by indicating alternatives and explaining the cost/benefit trade-offs among the alternatives is as important as the end results of the process. Project coordination and resource scheduling are efficiencies that should be built into a programming process and will aid in effective project delivery. Neumann proposes a new, more productive framework for the programming process.[17]

- Explicit linkage with policy objectives and system planning to ensure that the program is responsive to the full range of policy objectives.
- A simplified overall program structure that can facilitate relating policy objectives to program categories (maintenance, preservation,

[15] Ibid.
[16] Lance A Neumann, Frances D. Harrison, and Kumares Sinha, "Resource Paper: Transportation Programming," paper presented to the Transportation Research Board Conference on Transportation Planning, Programming, and Finance (Seattle, WA: Transportation Research Board, 19-22 July 1992), photocopy.
[17] Ibid.

improvement) and make it easier to integrate management systems into the programming process.

- Use of bridge, pavement, and transit facility management systems to guide the maintenance and preservation program needs analysis, target funding analysis (i.e., trade-offs of different funding levels and facility conditions), project identification and evaluation, and program evaluation.

- Use of a broad range of transportation criteria, together with congestion, safety and intermodal management systems, to guide development and evaluation of service improvement programs.

- Explicit program evaluation and trade-off analysis examining the implications of alternative program funding levels.

- Program and system performance monitoring to establish better accountability for program decisions and to provide feedback to policy-makers and an ongoing long-range process.

However, this framework faces dangers evolving from the new decision-making atmosphere resulting from ISTEA. The environment, economic growth, and mobility are feeding a wide-ranging and oftentimes conflicting set of policy goals. The new funding flexibility provided under ISTEA removes one of the barriers when a range of program choices is being considered. Multi-jurisdictional and multimodal coordination will have increasing significance in the future.

The proposed framework can address these issues in a number of ways. The linkage between government and planning needs to be strengthened, though in a manner which improves communication and simplifies the process to understandable levels for citizens and legislatures. The technical tools and procedures necessary to establish credibility among engineers, planners, and policy-makers must be developed and used. A wide range of program alternatives and trade-offs including multimodal choices must be explicitly considered in the process, as well as extending the needs assessment criteria to include an expanded set of policy goals. Accountability for program decisions can be improved by creating a program and system performance monitoring structure as an integral part of the process. Unfortunately, the financial reality at state, regional, and local government levels has heightened importance because of current fiscal constraints. Political reality requires collaborative effort among agencies, and from both the public and private sectors.

Institutional questions and intergovernmental relations issues of ISTEA were addressed by McDowell and Edner.[18] ISTEA could cause state DOTs to reformulate their planning processes, reaching beyond their own resources within state government, and dramatically reform the relationship between MPOs and state DOTs. Institutional issues are structured around the current system, making it difficult to adapt to a changing environment. The changes are concerned not merely with technical issues; explicit involvement of governors, legislatures, local politicians and governments, transportation agencies, the public, and other government agencies are also necessary. Only a small number of states meet the requirements for statewide transportation planning considering energy conservation, land-use and development policy, environmental protection, and all modes of transportation. Transportation is becoming, more often, a means toward larger state objectives. State and metropolitan transportation planning put the state DOT in partnership with programs for spurring economic competitiveness and growth, protecting the environment, conserving energy, managing growth, and organizing local government.

The state planning process is modeled after the MPO conceptually. The required content of state and MPO plans is explicit; the process of integration of those plans is not. The state must address the content of MPO plans within its planning effort, but the nature and content of integration is ambiguous. The operational meanings of coordination, consultation, and cooperation remain open until federal rule-making make them clear. State officials become members of MPO policy boards under ISTEA. The state develops a long-range transportation plan for all areas of state and needs to consider coordination only with the MPOs transportation plans. This opens the door for possible difficulties and inconsistencies in the transportation planning process. Planning at the rural and small urban area level is of concern as well, along with the capacity for planning analysis at the state and regional level. New decision-making capability at the state and regional levels should be built to avoiding gridlock in the process. Clearly defined roles are needed for those who set policy and those who impact or affect policy. In addition, many new partnerships developed in the spirit of cooperation and with common goals will be useful to the process.

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[18] Bruce D. McDowell and Sheldon M. Edner, "Reinventing Metropolitan and State Institutions For Surface Transportation Planning," paper presented to the Transportation Research Board Conference on Transportation Planning, Programming, and Finance (Seattle, WA: Transportation Research Board, 19-22 July 1992), photocopy.

STATE MULTIMODAL AND INTERMODAL PLANNING

Since the passage of ISTEA, various states have focused their new strategic plan development activities on the preparation of statewide transportation plans to fulfill the multimodal aspects of the Act. Some states had a head start on their work due to the particular nature of those states' transportation system environments. This section examines the status of plans and processes formulated to meet the multimodal planning requirements from a cross-section of state DOTs. These states were provided documentation and draft documents of their current efforts to meet ISTEA's multimodal planning requirements, including material on coordination efforts with metropolitan areas and the methods used to transition from the existing planning process to the new requirements. Any changes in organizational structure or culture of an agency necessary to meet the new goals were noted.

Florida

The current STIP, consistent with the State's Long-Range Plan, is based on the Florida Department of Transportation (FDOT) adopted work program and projects in the MPO TIP. STIP projects for non-attainment areas conform to projects contained in the SIP for air quality. STIP projects, or related phases, reflect ISTEA priorities and must have funding available for each project or phase. Projects in areas under 50,000 population are selected by FDOT in cooperation with local governments, except for National Highway System (NHS), bridge, and interstate maintenance projects.

The Long-Range Component (LRC) of the 1993 Florida Transportation Plan is based on adopted MPO long-range transportation plans and FDOT plans following state and federal policies and procedures used since the mid-1980's. The role of the current LRC (1993) is to establish a policy framework to provide direction for future transportation policy development.[19] It will inventory the total transportation system and evaluate specific changes necessary to accommodate intermodal and multimodal planning. The goal is to establish a comparison benchmark. This inventory will establish an information base for the periodic transportation needs assessment summary mandated by Florida law and will provide the basis for Ten-Year Program Guides. FDOT will also designate a major corridor system to emphasize statewide mobility, using the most efficient and cost-effective choice of modes and their interconnections. The LRC will

[19] FDOT Long-Range Component.

direct the updates of the statewide modal plans which are integral parts of the long-range element of the Florida Transportation Plan and provide guidance to updates of local and MPO plans. Future LRCs are to build on these results, conclusions, and policy changes in the initial LRC.

The 1994 LRC is oriented towards developing an understanding of what transportation facilities and services are contained in current adopted long-range plans and the needs they represent. It will provide direction to FDOT and guidance to other partners regarding implementation of recent policy changes -- including the CAAA, ISTEA, and major department policies -- that directly affect the mix of facilities and services provided by the state. The 1995 LRC will include a more comprehensive examination of policies and policy alternatives than the 1994 LRC. It will establish long-range goals and policies for transportation in Florida and will serve as the Statewide Multimodal Transportation Plan required by ISTEA. The LRC for 1997 will be the first to reflect the complete incorporation of ISTEA mandates in the partners' plans, particularly the MPOs'. In addition, it may propose changes in federal policy to influence the next federal surface transportation act. After the 1997 LRC is adopted it may be necessary to prepare interim updates on targeted issues. Subsequently, every three to five years, FDOT will prepare a comprehensive LRC update to include changes in policy direction and to extend the LRC planning horizon.

Illinois

Development of the statewide transportation plan is already underway by the Illinois Department of Transportation (IDOT). Philosophically, it is a policy plan, though the proposed federal rule-making hints against that emphasis. Available information on the state transportation system will be documented in advance of public hearings, e.g., here is our transportation universe as it exists: system issues, problems (i.e., air quality), technology, resources, and a strategic inventory. Public forums, not "hearings," will be held from April 1994 through the end of summer. The goal is to promote discussion and consensus development and avoid adversarial conflict. The draft plan is to be released in the fall of 1994, followed by a comment period through January of 1995.

The IDOT Office of Planning and Programming is divided into statewide (primarily highway) and urban program (transit, MPOs, and airports) planning, with a separate Bureau of Railroads.[20] The intermodal management system is viewed as a regular forum for discussion of freight and passenger issues. This will provide a cross-modal communication and check system for state plans, in addition to a system inventory. Private parties, railroads, trucking, and shippers will be included in future meetings. The idea is to promote an open communication system whereby private-sector plans can be coordinated with state planning efforts. As an example, the Burlington Northern Trailer-on-Flatcar (TOFC) ramp in Galesburg, Illinois, developed in conjunction with IDOT, included a bridge replacement and access improvements.

IDOT is very concerned with the federal government being realistic about the relationship between the roles of government and industry, especially in freight transportation. IDOT's goal is to facilitate improved efficiencies for freight movement by improving public facilities in conjunction with private initiatives.

Maryland

The Maryland Statewide Commuter Assistance Study was undertaken to determine how best to improve the daily commuter's trip to work in that state's 24 most heavily congested corridors.[21] Other major objectives of the study include: 1) educating the public as to how various transportation improvements addresses different types of transportation needs and conditions; 2) identifying multimodal options for short, medium, and long terms; and 3) establishing an ongoing statewide transportation planning process which can be updated as new information becomes available. The process established an analytical and institutional framework to evaluate and define alternatives, forecast travel demand, and estimate the capital, operation, and maintenance costs. This framework yielded transportation improvement recommendations responsive to the needs of the commuters and the environmental goals of the state. Analytical criteria were established for measures of the problem, possible solutions, practicality, and cost. A full range of transportation options, including mixed-mode solutions within a corridor, were examined by the joint Maryland DOT/consultant team using matrix evaluation for the different measures.

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20 Telephone interview with Keith Sherman, Chief of Transportation Planning Illinois Department of Transportation, March 22, 1993.

21 Jit N. Bajpai, et al, "Maryland Statewide Commuter Assistance Study," preprints of Papers Presented at the 70th Annual Meeting of the Transportation Research Board, Washington, D.C., 13-17 January 1991.

Transportation facilities and programs in the Maryland DOT are separated into the following divisions: the State Highway Administration; the Mass Transit Administration (Baltimore area, commuter rail, freight, and statewide grants); Washington Metropolitan Area Transit Grants (Washington Suburban Transit grants); Maryland Port Administration; Maryland Aviation Administration (Baltimore-Washington International Airport, and other aviation facilities and programs); and the Motor Vehicle Administration. The Maryland Transportation Plan (MTP) identifies the objectives of the department and its modal administrations; discusses accomplishments, current activities, and future plans; and highlights issues that require attention. The Consolidated Transportation Program is developed within the framework of the MTP. The program element is updated annually by the department and contains cost estimates for operating, constructing, and improving transportation facilities during the current year, the budget request year, and the succeeding four-year period. It is developed in accordance with the six-year projection of financial resources.

Ninety percent of Maryland's population lives within its Metropolitan Statistical Areas (MSAs). The Maryland DOT is represented on all the MPO Policy Boards and has a working relationship with local elected officials. These groups are consulted before Maryland DOT presents its transportation plans and programs to the General Assembly. The statewide transportation plan, the MTP, will build on the Maryland Commuter Assistance Study methodology. No organizational changes are anticipated for the Maryland DOT in developing its multimodal planning structure. Modal administrators are in charge of the state plan and meet weekly to monitor progress by their different modes in reaching goals of department policy (developed jointly).[22]

A key element of Maryland's transportation policy is the use of a generic fund to allocate money to transportation system investments. All transportation investments are funded out of the Transportation Trust Fund, established in 1971, based on identified needs. Specific financial resources are not set aside for regional or district allocation. The fund is supported by taxes, fees, charges, bond proceeds, federal grants for transportation purposes, and other miscellaneous receipts of the department. All department expenditures are made from the Fund, with unexpended appropriation remaining in the fund at the end of the fiscal year. Between 1991 and January 1, 1993, the Maryland General Assembly transferred $74 million from the Transportation Fund to

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22 Conversation with Paul Wiedefeld, Director of the Office of Systems Planning and Evaluation of Maryland DOT.

the state's General Fund and $13.2 million from the drivers' education account of the Transportation Fund to the General Fund.

Minnesota

The last statewide plan, completed in 1978, provided the basic framework for transportation planning in Minnesota, mainly by individual modal programs. Since then, multimodal and intermodal planning activities have received greater attention.[23] Currently, the Minnesota Department of Transportation (MnDOT) mission statement encourages multimodal planning and intermodal coordination. This emphasis is guided by four factors: 1) the agency promotes a "family of vehicles" concept which is subdivided into two groups -- those that move people and those that move commodities; 2) public and private support exists for multimodal transportation solutions; 3) funding sources are available for multimodal transportation programs; and 4) private-sector initiatives have emerged to identify and promote opportunities.[24]

Two activities point to MnDOT's efforts to respond to the intermodal elements of ISTEA. Initially, efforts were made to focus the vision and goals of the statewide plan. Two focus group sessions were conducted, along with interviews of key officials, to identify critical plan development issues, to discuss relationships between various transportation planning activities, and to outline optimal purposes and dimensions of the plan. As part of this process, a statewide geographic information system (GIS) was identified as a key tool for implementing management systems and state planning requirements of ISTEA.

A second activity involved the creation of a strategic management process outlining preferred futures of the transportation system using input from state agencies, cities, citizens, and other interested stakeholders. Within the Strategic Management Process, two of the key issues identified relate to intermodal transportation planning:

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23 Jonette Kriedeweis, Manager, Intermodal Policy Section, Minnesota Department of Transportation.

24 Morris Gildemeister and Fred Tanzer, "Multi-modal Transportation Approaches in Minnesota," preprints of papers presented at the 70th Annual Meeting of the Transportation Research Board, Washington, D.C., 13-17 January 1991.

ISSUE: Intermodal

Issue Statement: Inefficiencies result from limited access to an integrated multimodal transportation system for moving Minnesota's people and goods.

Strategic Direction: Minnesota will build partnerships to develop an integrated multimodal transportation system which provides for the efficient movement of goods and people.

Perspectives on Direction: Minnesotans are currently committed to moving people by automobile. We have a heavily weighted infrastructure that allows trucks to move most commodities. MnDOT's organization reflects its long-standing highway tradition; consequently, it is not a principal player in major transportation decisions and has little or no influence over the private modes. Transportation decisions are unduly influenced by a) funding sources, b) dedication of road user taxes, c) categorical restrictions of federal aids, d) the inability of certain modes to successfully compete for General Fund dollars, and e) the lack of infrastructure investment by the private modes. Modal systems essentially function independently from each other. No relationship exists between land use and transportation.

ISSUE: Planning

Issue Statement: There is a lack of unified planning among government agencies and the private sector, resulting in non-integrated transportation, socio-cultural, environmental and economic planning.

Strategic Direction: MnDOT takes the lead by establishing an integrated transportation planning framework. This framework includes different disciplines and levels of government and diverse members of the private sector.

Perspectives on Direction: A joint effort by state, regional and local governments, and the private sector is required to develop a statewide transportation system. Presently, each jurisdiction and the private sector plays a role defined largely by tradition, federal funding requirements and legislative mandates. Future planning and development will become even more complex, with fiscal and environmental limitations calling for new approaches to meeting access needs.[25]

Identification of two issues and MnDOT's response is illustrative of its attempt to address the intermodal concerns of ISTEA. The response also takes on a realistic tone regarding the existing demands for broader participation in transportation decisions. MnDOT recognizes the necessity of public/private partnerships for an efficient intermodal transportation system.

Related to this process, MnDOT has adopted a total quality management philosophy with a customer focus to provide transportation consumers with good information and meaningful participation in the planning process. MnDOT is expanding its transportation investment strategy to a multimodal perspective by identifying

[25] Executive Summary: Strategic Management Process, MnDOT, 1992.

statutory, legal, and regulatory barriers to funding flexibility and recommending methods to overcome these institutional impediments.

New Mexico

New Mexico's statewide multimodal planning process consists of three primary steps: 1) identify current theory and practice; 2) develop a statewide multimodal team; and 3) start a phased program to improve theory and practice.[26] The multimodal modeling process is to include passenger and freight transportation and provide a method for guiding the expenditure of public transportation funds. To date, no reports on the status of this process have been prepared.

North Carolina

North Carolina Department of Transportation prepares a seven-year transportation improvement program which is revised annually. In the introductory material for the 1993 STIP, the linkage between transportation, jobs, and economic growth is noted, as well as the broader implications of ISTEA. Safety, environmental issues, and a shortfall in state highway funding are identified as top priorities. The STIP is mainly oriented toward highways; public transportation and rail projects have a minor role. North Carolina Department of Transportation (NCDOT) is pushing to release a new document by October 1, 1993. It is unknown what role intermodal systems will have in this document.

Ohio

In November 1992, the state released for public comment a draft of their Access Ohio statewide transportation plan. The plan is divided into two phases: a macro-plan element and a micro-plan element. The first year, 1992, macro-plan effort is to provide "a comprehensive, statewide look at multimodal networks, including how they function together in intermodal facilities and hubs, and how they interact to promote a more efficient and effective movement of people and goods."[27] This portion contains the preliminary goals, policy statements, and initiatives for structuring the complete plan.

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[26] David Albright, "Statewide Multimodal Planning in New Mexico," presentation to the 70th Annual Meeting of the Transportation Research Board, Washington, D.C., 13-17 January 1991.
[27] Access Ohio, Ohio Department of Transportation, Nov. 1992, p.1.

This first phase designates the state's highway and rail corridors, airport and water port hubs, and transit clusters. During 1993, the second phase will analyze and define regional and local transportation access links, the micro plan, macro-level corridors, and any other issues that might impede the execution of the macro-level plan.

With the macro-plan as a framework, a prioritized statewide transportation system is developed. This system is made up of corridors defined and evaluated according to five basic criteria as shown in Table 5.1. Passenger travel is not explicitly included in the corridor identification criteria, but is assumed to be a function of the population and economic activity criteria. Parameters for each criterion are defined and numerically ranked on a scale from 1 to 5; then corridors and hubs in the state are scored.

Five strategic policy goals for the state of Ohio are outlined: 1) systems preservation and management; 2) economic development and quality of life; 3) cooperative planning process; 4) transportation efficiency, transportation safety and convenience; and 5) funding. The plan is targeted to promote meaningful governmental cooperation and coordination to achieve these policy goals. The subsidiary policy statements are sufficiently broad to encompass all transport modes.

Table 5.1
Access Ohio Corridor Identification Criteria

Criterion	Weight
1. Average Traffic	
- Commercial Truck Traffic (Daily)	20%
- Class I/II Rail Freight (Yearly)	5%
2. Population	20%
3. Economic Activity	
- Number of Manufacturing Establishments	10%
- Manufacturing Employment Density	10%
- Number of Manufacturing Employees	10%
4. Trade/Intermodal Centers	15%
5. Natural Resources/Agriculture	
- Natural Resource Centers	(5%)
- Agribusiness Centers	(5%)

Source: Access Ohio Draft Plan, Ohio Department of Transportation, Nov. 1992, p. 10.

Oregon

The policy of the Oregon Transportation Plan is to develop a safe, convenient, and efficient transportation system which promotes economic prosperity and livability for all Oregonians.[28] This policy is operationalized through four goals consistent with the Oregon Progress Board's "Benchmarks"[29] and the requirements of Land Conservation and Development Commission (LCDC) Goal Number 12: Transportation.[30] These goals are:

> Goal 1 - System Characteristics: To enhance Oregon's comparative economic advantage and quality of life by the provision of a transportation system with the following characteristics: balance, efficiency, accessibility, environmental responsibility, connectivity among places, connectivity among modes and carriers, safety, and financial stability.
>
> Goal 2 - Livability: To develop a multimodal transportation system that provides access to the entire state, supports acknowledged comprehensive land use plans, is sensitive to regional differences, and supports livability in urban and rural areas. Transportation facilities and services should support the development of compact urban areas.
>
> Goal 3 - Economic Development: To promote the expansion and diversity of Oregon's economy through the efficient and effective movement of goods, service and passengers in safe, energy-efficient, and environmentally sound manner. One mode must be connected with others through intermodal hubs which allow goods to move from truck to rail to ship or plane.
>
> Goal 4 - Implementation: To implement this plan by creating a stable but flexible financing system by using good management practices, by supporting transportation research and technology, and by working cooperatively with regional and local governments, the private sector, and citizens.

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[28] *Oregon Transportation Plan, Multimodal System Element* (Public Review Draft), prepared by Cambridge Systematics in association with David Evans Associates, Wilbur Smith Associates, Barney and Worth, and Joseph R. Stowers for the Oregon Department of Transportation Strategic Planning Section (Salem, OR: May 1992).

[29] The Oregon Benchmarks were created by the Oregon Progress Board and adopted by the 1991 Legislature to monitor progress in achieving the state's objectives in human resources, livability and the economy. As an example a benchmark for livability is for 100% of residents to be within a 30-minute one-way commute between where they live and where they work.

[30] Land Conservation and Development Commission Goal 12: Transportation requires that per capita vehicle-miles (vehicle-kilometers) of travel in each metropolitan area be reduced by 10% in the next 20 years and 20% in the next 30 years.

Implementation of the Transportation Plan requires close coordination between land-use policy and transportation planning. Of particular interest are two fundamental assumptions with respect to land-use policy:

1. Regional and local governments will continue to contain development within established urban growth boundaries. Should these boundaries not hold, the resulting low-density developments would not be effectively served by transit and additional highway investment would be needed.

2. Urban areas will use compact and mixed-use development patterns to enhance livability and preserve open space. These patterns will support public transportation service and other alternatives to the automobile.

Other aspects of the Transportation Plan include the following:

1. The transportation system will achieve the transportation-related economic and livability standards of the Oregon Benchmarks.

2. State, regional, and local governments will cooperate to achieve the vehicle-miles traveled (vehicle-kilometers traveled) reduction standards of the LCDC Transportation Rule.

3) In rural areas, personal transportation will continue to be the only alternative available for most purposes.

4) Telecommunications will be developed so as to provide a significant alternative to vehicle trips.

5) The price for transportation services can include a wider variety of costs, leading to expanded alternatives to the single-occupant vehicle.

6) Most transportation services, other than public transit, will be provided by the private sector.

One of the basic concepts in the Oregon plan is that managing the transportation system is as important as constructing and operating it. Developing a rational pricing strategy for transport services, including use of the highway system to influence travel behavior and land-use patterns, is in line with the livability goals of the Transportation Plan.

Wisconsin

Wisconsin Department of Transportation (WisDOT) places ISTEA in the context of an integrated transportation system, and not as separate modal plans. The WisDOT statewide multimodal transportation planning process contains three interrelated elements: a strategic/policy plan, an intercity multimodal plan, and metropolitan multimodal plan.[31] The strategic/policy plan purpose is to examine broad issues, identify public concerns, scan past trends and consider future trends, and postulate transportation implications. Strategic issues facing WisDOT include financing, economic development, intercity freight transportation, the environment, urban mobility (land use, demand management, and transit), and intercity passenger service. In addition, this element of the statewide plan addresses ISTEA requirements which focus on federal, state, and local energy goals; social, economic, energy, and environmental impacts; efficient use of existing facilities; enhancement of transit and reduced single-occupant vehicle travel; transportation/land-use consistency; and innovative financing of transportation.

The statewide intercity multimodal plan element is the result of a multi-step interactive process. A strategic analysis of market and technology trends, state of the art practice, environmental issues, and state, national, and international trends is an important input to the development of goals and objectives (efficiency, equity, environment, economic development, mobility, energy) for this element and the creation of different multimodal system scenarios. Goals and objectives relate to efficiency, equity, environment, economic development, mobility, and energy implications of the statewide system. System scenarios are developed from a description of existing passenger and freight systems and their forecasts from socio-economic data within the context of the goals and objectives and the strategic analysis. This leads directly to a multimodal interaction analysis of passenger and freight system scenarios based on preference surveys and demand models which yield a preferred alternative for each system. This results in the recommended intercity multimodal system scenario from which the statewide modal system plans are built. The statewide modal system plans alternatives in terms of mode level of service, long-term needs (year 2020), system level cost/benefit analysis, and intermodal connectivity issues. Multimodal corridor plans, limited to high-density corridors, are also developed from the recommended scenario. These provide more specificity in passenger modeling and freight analysis, detailed intermodal connectivity/terminal analysis, detailed capital, operation and maintenance cost data, and public-private-sector cost contributions. The statewide modal system plans and the

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[31] Roger L. Shrantz, "A New Environment for Transportation Planning," presentation to the Statewide Multimodal Planning Committee of the Transportation Research Board at the 72nd Annual Meeting of the Transportation Research Board Washington, D.C., 11 January 1993.

multimodal corridor plans are combined to form the state intercity multimodal transportation element.

The metropolitan multimodal plan element is viewed by WisDOT as a "new partnership" between MPOs and WisDOT. WisDOT expects to provide the statewide framework, planning criteria and standards, and technical assistance, and to actively participate in MPO committees. Conversely, MPOs are to provide land-use plans and multimodal transportation plans and to be actively involved in WisDOT committees. WisDOT will provide guidance to the MPOs on alternative land-use scenarios, alternative transportation responses, bicycle planning, pedestrian planning concepts, transit system planning, highway level of service, intermodal/multimodal integration, and system-level environmental evaluation.

Metropolitan planning components follow the common process of formulating a strategic plan, data collection, forecasting, alternatives development and analysis, plan selection, and, finally, implementation. MPO plans are to be developed in cooperation with the state and transit operators in an atmosphere of interdependence. Statewide long-range plans are to be developed, coordinated, and reconciled with MPO plans. As a result of state approval of the TIPs, WisDOT influences MPO plans; in turn, MPOs have a voice in state plans.

CHAPTER 6. - THE ROLE OF METROPOLITAN PLANNING ORGANIZATIONS

BACKGROUND

Highway legislation, beginning in 1962, delineates a "continuing, cooperative, and comprehensive" relationship between federal, state, and local agencies. This was the beginning of an effort aimed at reducing the backlash from local governments and citizens over the planning process for the interstate highways being built through their communities. Initial design and location decisions leaned more toward physical planning than social or economic planning. The experts were optimizing their resources to generate a product that often sacrificed or neglected local needs while developing the nation's transportation network. Further legislation in 1973, 1984, and 1991 has worked to refine that relationship in an overall effort to increase local input into the nation's transportation planning processes.[1]

The entity called the Metropolitan Planning Organization (MPO) was created to allow local governments input into the regional planning process. While a number of regional planning organizations have existed since before the turn of the century, there were no requirements for regions to bring together the planning efforts of their population subsets. Today federal law requires the governor of each state to designate an MPO for any region recognized by the Census Bureau as a metropolitan area of 50,000 or more persons.[2] Most MPOs are commissions made up of at least one representative from every governmental jurisdiction within the agreed-upon boundaries of the planning region. This format is intended to blend diverse local input with the technical expertise of transportation planners in order to develop a transportation system that will optimize both the efficient use of state and federal funds and the planning for the social, economic, and physical needs of the local and regional populations.

The evolution of the MPO as a responsible force in regional planning has taken time and will continue into the future. The Intermodal Surface Transportation and Efficiency Act (ISTEA) legislation of 1991 continues the decades-long practice of

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[1] Luedecke, Alvin, Jr., Conference on Transportation Planning for Livable Communities, Austin, Texas, March 5-6, 1993.

[2] Intermodal Surface Transportation Efficiency Act of 1991, Public Law 102-240, 105 Stat. 1914.

improving local input by providing the MPO additional authority coupled with additional responsibility. In an effort to promote the autonomy of today's MPO, the law provides many broad guidelines and few specific criteria. While this method provides great latitude for creativity and regional individuality, it creates difficulty in promoting a specific concept like intermodalism. The next few paragraphs review the three sources currently available to guide MPOs in their pursuit of effective multimodal transportation planning.

INTERMODAL SURFACE TRANSPORTATION AND EFFICIENCY ACT

While ISTEA has continued the shift toward local participation in planning, it has not clearly defined the role of the MPO in pursuing intermodalism. Section 1034 of Public Law 102-240 provides guidelines for metropolitan planning. Subsections address a variety of topics as follows:

a) General Requirements
b) Designation of Metropolitan Planning Organizations
c) Metropolitan Area Boundaries
d) Coordination in Multistate Areas
e) Coordination of MPOs
f) Factors to Be Considered
g) Development of Long-Range Plan
h) Transportation Improvement Program
i) Transportation Management Areas
j) Abbreviated Plans and Programs for Certain Areas
k) Transfer of Funds
l) Additional Requirements for Certain Non-attainment Areas
m) Limitation on Statutory Construction
n) Reprogramming of Set-Aside Funds

These subsections provide substantial information regarding the framework within which the MPO must operate, but offer little in terms of promoting expansion of intermodalism at the local level.

ISTEA requires the MPO to develop a twenty-year Long Range Plan (LRP) to guide the three-year Transportation Improvement Program (TIP). All of a state's TIPs are then combined with the State Transportation Improvement Program (STIP). This framework seems plausible, and the legislation provides for public participation at the local level. The only intermodal reference in the MPO guidelines is found in the subsection that discusses factors to be considered while developing these plans and programs.

The MPO must, at the minimum, consider these 15 factors in developing transportation plans and programs:

1. Preservation of existing transportation facilities and, where practical, ways to meet transportation needs by using existing transportation facilities more efficiently.

2. The consistency of transportation planning with applicable federal, state, and local energy conservation programs, goals, and objectives.

3. The need to relieve congestion and prevent congestion from occurring where it does not yet occur.

4. The likely effect of transportation policy decisions on land use and development and the consistency of transportation plans and programs with the provisions of all short- and long-term land-use and development plans.

5. The programming of expenditure on transportation enhancement activities.

6. The effects of all transportation projects to be undertaken within the metropolitan area, without regard to whether such projects are publicly funded.

7. International border crossings and access to ports, airports, intermodal transportation facilities, major freight distribution routes, national parks, recreation areas, monuments and historic sites, and military installations.

8. The need for connectivity of roads within the metropolitan area with roads from outside the metropolitan area.

9. The transportation needs identified through use of the mandated management systems.

10. Preservation of right-of-way for construction of future transportation projects, including identification of unused right-of-way which may be needed for future transportation corridors and identification of those corridors for which action is most needed to prevent destruction or loss.

11. Methods to enhance the efficient movement of freight.

12. The use of life-cycle costs in the design and engineering of bridges, tunnels, and pavement.

13. The overall social, economic, energy, and environmental effects of transportation decisions.

14. Methods to expand and enhance transit services and to increase the use of such services.

15. Capital investments that would result in the increased security in transit systems.

Only factor number seven makes a direct reference to intermodal transportation. Several other factors could include intermodalism in the consideration process, but the legislation leaves the MPO without any specific parameters regarding intermodal transportation or how to promote the concept at the local level. The intermodal management system, referred to by factor number nine, is a broad definition of the last of the six required management systems and does not provide adequate guidance for planning by the MPO. The legislation fails to clearly define multimodal or intermodal anywhere within its broad framework.

Interim Guidance - April 1992

The Interim Guidance (IG) was issued to aid Federal Highway Administration (FHWA) and Federal Transportation Administration (FTA) field offices in clarifying the statutory requirements and target dates for states and MPOs.[3] It was intended to emphasize the specific metropolitan planning activities and requirements that must be underway until the formal rule-making process is completed. There are no additional inputs or definitions regarding multimodal and intermodal planning.

The topics addressed by the IG are details and technicalities rather than concepts. The IG addresses designation and redesignation, boundaries and coordination, and project selection and certification, but still fails to even define multimodal transportation planning or intermodalism. The IG is another document that supports ISTEA's effort to increase local inputs but falls short in promoting multimodal transportation planning.

Notice of Proposed Rule-making - March 1993

This third document, the Notice of Proposed Rule-Making (NPRM), is the most helpful in informing MPOs about multimodal transportation.[4] The NPRM is divided into

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[3] Interim Guidance on the ISTEA Metropolitan Planning Requirements, issued April 6, 1992, published in the Federal Register on April 23, 1992, 57 FR 14943.

[4] Notice of Proposed Rulemaking, March 2, 1993.

three sections, General, Section-by-Section Analyses, and Rule-Making Analyses and Notices, and provides some encouraging insights for MPOs.

The first section provides a definition of intermodal planning:

> Intermodal planning reflects a focus on connectivity between modes as a means of facilitating linked trip making. It emphasizes connections (transfers of people of freight in a single journey), choices (provision of transportation options to facilitate trip making), and coordination and cooperation (collaboration among transportation organizations).[5]

It goes on to explain how previous projects by different entities were analyzed and pursued independently. ISTEA "permits" local officials to "decide the specific institutional arrangements and procedures to be used in the consideration of transportation alternatives." MPOs are empowered to coordinate the analyses of implementing agencies in order to allow full consideration of various modes and the connections, choices, coordination, and cooperation the traveler or package must face in moving around or within its boundaries.

The Section-by-Section Analysis summary on the purpose of ISTEA delineates "The overall rationale for requiring this transportation planning process is to achieve an efficient, effective, integrated, intermodal transportation system for each metropolitan area." The comments on the Transportation Plan in Section 450.122 describe the intent of ISTEA as an effort to "strengthen the planning process and make it a central mechanism for structuring effective investments to enhance overall metropolitan transportation system efficiency."

The NPRM is useful to the MPO, as it elucidates the authority and responsibility of the MPO to plan an efficient multimodal transportation system. However, the MPO is, at this point, given full discretion as to the form and extent it chooses to pursue this objective. As currently defined, the MPO must include intermodalism in its planning process but is not required to implement any specific intermodal efforts in its investments.

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[5] Ibid.

MPO OVERVIEW

MPOs nationwide are relatively similar in structure. The designated MPO for an urbanized area is usually composed of elected and appointed city, county, state and other transit authorities. The MPO provides a forum for cooperative decision-making by local government officials. The MPO is responsible for the urban transportation planning process through the development of the Unified Planning Work Program (UPWP), the TIP, and a Regional Transportation Plan. Because of its wide range of responsibilities, the MPO relies on the support and recommendations for transportation project planning from a Technical Advisory Committee (TAC) and a Policy Advisory Committee (PAC). The technical unit reviews the technical accuracy of transportation plans and provides routine guidance to the technical procedures employed in the planning process. The TAC establishes and approves, when necessary, any technical procedures for the implementation of the transportation planning process. The policy organization is normally comprised of elected officials, transportation agency representatives, and other public members involved in transportation, including air quality and congestion management teams. The PAC is a forum for communication and deliberation between all parties involved and impacted by the transportation planning process.

A limited survey of several planning agencies in various cities reveals a severe lack of intermodal planning. The efforts that have taken place focus on intermodal passenger services.

The most common type of intermodal passenger service is the basic park-and-ride facility. Most cities with transit, whether bus or rail, offer park-and-ride opportunities. Other cities, such as Seattle and Boston, have expanded this service to include water transport by boat and ferry, known as Park-and-Boat.[6, 7]

Transit centers allow passengers to transfer from one mode of travel to another. North Central Texas Council of Governments, which oversees the Dallas/Fort Worth area, has plans for constructing several transit centers to allow patrons to transfer between bus and light-rail transit. These centers will also accommodate park-and-ride participants. Future plans also include two Dallas central business district (CBD)

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6 *VISION 2000 Growth and Transportation Strategy for the Central Puget Sound Region*, Puget Sound Council of Governments, October, 1990.

7 *Transportation Improvement Program 1993-1995*, Boston Metropolitan Planning Organization, August 14, 1992.

Multimodal Transfer Facilities which will accommodate bus riders, vanpools, taxis, and possibly an adjacent light-rail transit line.[8] The city of Boston has similar transit stations, including bicycle parking facilities.[9] In the Orlando area, intermodal opportunities associated with the proposed magnetic levitation train (MagLev) project are being reviewed.[10] Seattle residents, in a local election, voted for the development of Major Centers or Multiple Centers transportation alternatives, which will require the development of transit stations throughout the area.[11]

Several other intermodal projects have been proposed around the country which deserve recognition. Boston plans to expand its shuttle bus service from the subway stations to the Logan Airport terminals. As added incentive, the fare will be abolished for persons making the subway-to-shuttle bus connection.[12]

Requests for proposal on an intermodal terminal planning and feasibility study in the San Antonio CBD are currently being accepted. San Antonio hopes to encourage tourism and economic development by providing its visitors with access to various modes of travel. The terminal plans to "link AMTRAK, local transit, intercity bus, high-speed rail, rail service to Mexico, taxi, airport shuttle, and highway travel modes together in a centralized hub."[13]

An inventive intermodal project was proposed in Orlando by the Greater Orlando Aviation Authority and the Canaveral Port Authority "to build a rail line and utility corridor linking the Orlando International Airport and Port Canaveral." The corridor would include rail lines for both passenger and freight trains, power and fuel lines, water lines, and bicycle/jogging paths financed by a program of user fees. Unfortunately, the

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[8] *1993 Transportation Improvement Program for the Dallas-Fort Worth Metropolitan Area*, North Central Texas Council of Governments.

[9] *Transportation Improvement Program 1993-1995*, Boston Metropolitan Planning Organization, August 14, 1992.

[10] *Orlando Urban Area Transportation Study, 1992 Annual Report*, Orlando Urban Area Metropolitan Planning Organization.

[11] *VISION 2000 Growth and Transportation Strategy for the Central Puget Sound Region*, Puget Sound Council of Governments, October, 1990.

[12] *Transportation Improvement Program 1993-1995*, Boston Metropolitan Planning Organization, August 14, 1992.

[13] *San Antonio - Bexar County 1992-1993 Unified Work Program*, San Antonio - Bexar County Metropolitan Planning Organization, August 1992.

Canaveral Port Authority has withdrawn its support for the project due to lack of funding and public support.[14]

Intermodalism is gaining support and being promoted for passenger service. Most cities have provided interconnecting services between auto and public transportation; freight transportation, however, has been overlooked. This may be due to the history of transportation planning organizations, which have been concerned in the past solely with people movement. Most planning agencies have well-established working relationships with transit operators. Unfortunately, most intermodal freight projects are handled by the private sector. For improving freight movement, transportation planing organizations will need to work with and understand freight shippers' concerns.

AUSTIN MPO CASE STUDY

Background

Austin, Texas, is situated on IH-35 about three hours south of Dallas-Fort Worth and just over an hour north of San Antonio. Houston, an approximate three hours' drive to the east, completes a triangle that has one of the nation's ten largest Metropolitan Statistical Areas (MSAs) at each apex. The Austin MSA is home to over three-quarters of a million people and realized over 45 percent growth in population during the boom and bust cycle of the 1980's.

IH-35 passes north-south through the Austin MSA and roughly follows the Balcones Fault. This geologic feature divides the prime agricultural plains on the east from the environmentally sensitive central Texas hill country on the west. Most of the city is located over the Edwards Aquifer and encompasses a large portion of the recharge zone.

As the capital of Texas, Austin tends to be politically charged. The City of Austin has more than its share of political fireworks. Strong no-growth sentiments often go head to head with ever-increasing development pressure. The University of Texas and the various high-tech industries in the area create economies of agglomeration that are hard

[14] East Central Florida Regional Planning Council, *1993-1998 Orlando Urban Area Transportation Improvement Program,* Orlando Urban Area Metropolitan Planning Organization, September 1992.

for other research facilities and clean industries to resist. Some see Austin as the next "Silicon Valley," or the "Silicon Prairie," in this case.

Even with this wide view of Austin, it is not difficult to see that the sheer volume of people and activities, the environmental configuration and sensitivity, the political and economic forces, and innumerable other impacts all come together to make planning difficult. The Austin Tomorrow Plan is the long-range comprehensive plan that is currently in use, while a more recent one, AustinPlan, was developed but never adopted. Even though the Austin Tomorrow Plan has been approved, the city's growth since the plan's 1980 adoption illustrates weak implementation of its goals. Leap-frog development, taxpayer revolts, the Save Our Springs referendum, and myriad other factors impact Austin's transportation needs and serve to make transportation planning in this city a challenging activity.

The Austin Transportation Study

The Austin Transportation Study (ATS) is the designated MPO for Austin, Texas.[15] The local transit authority, Capital Metropolitan Transportation Authority (Capital Metro), the State of Texas, Travis County, and the City of Austin have worked together within ATS for a number of years. Originally headed up by and housed with Travis County, ATS is now located in Austin's City Hall Annex. Transportation Planning Director Mr. Michael R. Aulick is in the process of expanding the ATS staff to handle the new demands ISTEA places on the MPO. In an interview, Mr. Aulick expressed concerns over the lack of guidance in regard to intermodal planning.[16] ATS is pressing on to meet the various technical requirements and deadlines that will allow continued funding and is looking forward to opportunities to incorporate any intermodal projects that would improve the efficiency and effectiveness of Austin's transportation system.

Planning Tools

The first of the three ISTEA planning tools for the MPO is the UPWP. The ATS adopted its current UPWP on August 18, 1992. The UPWP includes seven activities that categorize the tasks necessary to implement ISTEA in Austin. The UPWP addresses a public transportation element, a bicycle element, a pedestrian element, and a roadway

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[15] Unified Planning Work Program, Austin Transportation Study, August 18, 1992.
[16] Aulick, Michael R., ATS Transportation Planning Director, interview on February 2, 1993.

element. Some of the elements within the UPWP require "identifying important linkages with other modes of transportation" as a part of the task.

The second tool is a LRP. The ATS had developed a Transportation Plan that was adopted in 1986. A revision of that plan was underway at the time the ISTEA legislation was passed.[17] The current LRP is fundamentally composed of this previous plan and incorporates the additional requirements created by ISTEA.

The third MPO tool is the TIP that is derived from the LRP. ATS issued a draft TIP for the 1994 to 1996 fiscal years on March 2, 1993. Part I lists the Texas Department of Transportation (TxDOT) projects that are planned within the MPO boundaries. Part II contains project requests for Surface Transportation Program (STP) 4C funds from TxDOT, the City of Austin, Travis County, Williamson County, the cities of Round Rock, Bee Cave, and Cedar Park, and Capital Metro. Part III is the expanded information that Capital Metro must provide for FTA funding.

The draft TIP does not mention intermodalism or intermodal projects. About 80 percent of the projects seeking STP 4C funding are directed toward adding travel lanes or building new roads. Fewer than 15 percent of the projects impacted modes other than automobile travel. Only six of the 50 projects listed are seeking to improve the choices, connections, and coordination and cooperation aspects that have been used to define intermodal planning.[18]

These three planning tools are continuing to evolve as guidance from FHWA is promulgated. With these tools, the ISTEA objective of coordinating diverse interests, public and private, local and regional, is being met. However, the freight industry has not been involved in this integration process.[19]

Summary

Currently there are several of the more common intermodal opportunities available in the Austin area. There are a number of park-and-ride facilities to encourage carpooling and transit use, Capital Metro offers a rubber-tired trolley service in the

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17 Aulick interview.

18 Draft Transportation Improvement Program, Fiscal Years 1994-1996, Austin Transportation Study, March 2, 1993.

19 Aulick interview.

downtown area and shuttle services for The University of Texas, cab services are available at the airport, and the Capital Area Rural Transportation System (CARTS) offers services to Austin and its neighboring communities. As these projects illustrate, most of the intermodal effort to date has been for passenger travel.

With the UPWP, LRP, and TIP underway, ATS is making great strides toward complying with ISTEA and shows substantial potential to improve intermodal planning and service provision for Austin. There are a number of issues that merit attention within this planning process that are not apparent. Given Austin's location on the IH-35 corridor between Dallas-Fort Worth and San Antonio and its proximity to Houston, what are the implications of the North American Free Trade Agreement (NAFTA)? With the closing of Bergstrom Air Force Base, the 18 years of uncertainty for relocating Robert Mueller Airport will apparently becoming to an end in the near future; what will this mean to all other surface modes? As further growth knocks on Austin's door, how can this plan work to keep Austin off the non-attainment list?

The transition from the old "you do your thing, I'll do mine" planning and implementation methods to the proposed integrated methods of ISTEA will take some time. ATS has begun to move in that direction with regard to technicalities and requirements, but has barely begun to incorporate intermodal planning. There are two main problems delaying the start. First, and curable, is the lack of specific direction and motivation by federal law regarding intermodalism. Second, and incurable, is the planning-resistant environment of Austin. Both of these factors will impact the ability of ATS to introduce intermodalism and improve the Austin transportation system within the guidelines of ISTEA.

THE HOUSTON MPO

Background

Houston, Texas, has become one of the most dynamic cities in the southwestern United States, surpassed in size only by Los Angeles. Houston's beginnings were modest, but it soon displayed growth patterns unique to those cities of the American West. The city has a consistent history of doubling population every 20 years since 1850. This growth has been a fact which continues to both astonish and concern, as it has continued largely unabated. During the previous 20 years Houston has come, in a sense, to represent the accepted norm of urban growth in the United States. The city's nearly geometrical progression of increased development sustains the image of its newness, a phenomenon which belies the very real fact that urban issues, on a variety of scales, have been a part of its history from the very beginning.[20]

Houston was one of the earliest towns to be planned after Texas won its independence from Mexico, and ultimately the most successful if measured by size and population. The city was laid out in the grid pattern from its inception, and each acquisition of new land also fell subject to the grid. The grid pattern later proved to be a source of irritation when traffic increased, because traffic streams were continually crossing. "From the very beginning, transportation and the technologies used in providing it have been basic factors in the vitality of Houston's urban development and its physical form."[21]

Houston is a relatively new, low-density city which is heavily oriented towards automobile transportation. Half of the city's residential and commercial real estate has been built since 1960.[22] Two-thirds of all office space was built during the 1980's. Employment is distributed within a large number of activity centers other than the CBD. Commuting distances are long, with work trips of 25-30 miles (40-48 km) not uncommon.[23]

Today, Houston represents all the negative consequences of allowing a city to grow unchecked. It has been rated as having the second worst traffic congestion in the country after New York City, but this is just one item on a very long list. "Houstonian politics have always embodied a laissez-faire attitude in terms of government and private practice. During the boom years this system appeared to work, with Houston's successful growth coalition promoting the city's free enterprise system and the anti-state attitude of minimal government interference with land use. However, a lack of zoning restrictions and realistic planning for the future has left Houston at risk."[24]

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20 Transportation and Urban Development in Houston, 1830 - 1980.
21 Ibid., pg. 2.
22 "Analyzing Urban Decentralization." *Regional Science and Urban Economics*. Vol. 21, 1991, pg. 187.
23 Ibid., pg. 187.
24 "A Ghost in the Growth Machine: the Aftermath of Rapid Population Growth in Houston." *Urban Studies*, Vol. 24, 1987.

Houston's lack of zoning restrictions has yielded violations of residential areas by industry, most noticeably in predominantly African-American sections of the city. Overbuilding throughout Houston has also increased the potential for land subsidence.

The Politics of Houston

"Most Houstonians, not only conservative boosters, would contend that any analysis of Houston's success must also include the role of the political culture of unregulated capitalism. This argument has it that since the Allen brothers successfully marketed a Gulf Coast swampy area, the city of Houston has known growth and prosperity due to its free market economy -- an economy unbridled by government intervention and supported by an ideology of laissez-faire capitalism. In Houston free enterprise is still the gospel."[25]

The predominant thrust in Houston during the twentieth century has remained anti-government, anti-regulation, anti-union, anti-public planning, and anti-taxes. The reigning authorities have been against anything which might represent a limitation on the economic privilege and activity of the city's business community. For example, Houston was the last major city in Texas to adopt a zoning ordinance. Planning has been done, until very recently, by the private sector, or done by the public sector at the request of and under the guidance of private-sector leadership. There are no state or city income taxes, and property taxes have always been low. The private sector is the driving force in the city. In this atmosphere, the government provides a minimum of basic services and assists business growth. Citizens who want more than the minimum go the private sector to get support.[26]

Density

The urbanized area of Houston lies on a flat, featureless plain covering some 900-plus square miles (2,330 plus square kilometers). Unlike many other large metroplexes, Houston is not enclosed by suburban jurisdictions, but instead dominates the metropolitan area. It has managed to do this by annexing surrounding areas, through which it has expanded to 590 square miles (1,528 square km).[27] Houston's population has increased

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[25] "Urban Policy in Houston, Texas." *Urban Studies,* Vol. 26, 1989, pg. 146.
[26] Ibid., pg. 146.
[27] Ibid., pg. 188.

almost exclusively through annexation. Since 1940, the city's population increased fourfold, but the population of the city's 1940 boundaries has remained essentially unchanged at 375,000.

Population decentralization in Houston has been occurring for a number of years. Employment is somewhat more centralized than population. The CBD's share of total employment has been steadily declining during the previous two decades and now constitutes less than 11 percent of total metropolitan employment.[28] Most of the recent growth in metropolitan employment has occurred outside Loop 610. Between 1970 and 1985, total inner-city (within Loop 610) employment grew by 92,000 jobs, whereas 671,000 new jobs, or 87 percent of the total, were created outside the Loop 610 area. During the 1980's, all of the growth in population occurred in areas 20 to 30 miles (32 to 48 km) from the CBD. Much of the new construction occurred in master planned communities. There has been little population-altering, residential development in the inner-city. Since 1960, the inner-loop population has fallen from 535,000 to 442,000.[29]

Houston is not a city that developed in concentric, symmetrical rings. In general, the eastern side of Houston is dominated by the petroleum and chemical industries and blue-collar residential communities. The more affluent neighborhoods have developed primarily in the western and northern sections of the metropolitan area.

The average population density in Houston is a low 3,000 persons per square mile (1,159 persons per square km). The densest areas of the city are less dense than the average of many of the large older cities of the northeastern United States. The low density of Houston is largely due to large amounts of vacant land, Houston's transportation system, and leap-frog development. There are seven major freeways leading into the CBD and three major loops or circular roads: the inner loop, about 5 miles (8 km) from the CBD; Beltway 8, which is about 10 to 12 miles (16 to 19 km) from the CBD; and FM 1960/Highway 6, which has recently been expanded to form a continuous six-lane arc around two-thirds of the metropolitan area at a distance of between 20 to 25 miles (32 to 40 km) from the CBD. The intersections of circular and radial highways have promoted concentrations of employment and retail activity.

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[28] Ibid., pg. 188.
[29] Ibid., pg. 188.

"A non-ubiquitous transportation system results in a complicated distribution of population density. Housing, retailing and other businesses gather along high-speed transportation corridors. Spread-out, leapfrog, spider-like development is promoted. In Houston's case, the development of freeways increased density along the freeways and decreased density in suburban area locations away from the freeways. Land considerably distant from freeways or circular roads that provide access to the freeways tends to remain vacant, while land close to the freeways, but 10 to 15 miles (16 to 24 km) further out, is developed."[30]

The road system has an important impact on the pattern of employment decentralization. Of the total 156 million square feet (13.9 million square meters) increase in office space during the 1970's and 1980's, 117 million square feet (10.9 million square meters), or 75 percent of the total, were built in employment centers at or near the intersections of major freeways or thoroughfares. By 1989, more than 30 percent of office space was in suburban locations; employment decentralization encouraged residential decentralization and increased the forces leading to linear and leap-frog development. Leap-frog development can also be explained by the heterogeneity of the land. Some parts of the Houston area contain small faults or old oil and gas fields, or have poor access to roads. Other parts of the Houston metroplex suffer from poor drainage characteristics. Developers have turned to the best wooded land for development, even if it means greater distances from the CBD.

The Houston-Galveston Area Council (H-GAC) has been designated by the Governor of Texas as the MPO for transportation planning in the Gulf Coast State Planning Region. The region consists of 13 counties -- Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, Walker, Waller, and Wharton. The H-GAC utilizes a Transportation Planning Committee, composed of 21 locally elected officials and technical representatives of area agencies, to provide policy guidance and overall coordination of the multimodal planning in the region. These 21 members also work in cooperation with TxDOT and the Metropolitan Transit Authority (METRO) of Harris County. The Transportation Planning Committee and the H-GAC Board of Directors have complementary roles in transportation planning. The Council's Board of Directors establishes the overall policy for comprehensive planning coordination for the region, whereas the role of the Transportation Planning

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[30] Ibid., pg. 193.

Committee is to provide a single policy direction for multimodal transportation planning and development.

METRO was created in 1978 through voter approval. At the same time, the voters approved a local one-cent sales tax to partially support the construction and operation of a comprehensive regional transit system. METRO works in cooperation with the H-GAC, TxDOT, and area government officials. METRO operates numerous park-and-rides, as well as high-occupancy vehicle (HOV) lanes, and has plans for the construction of a light-rail line from Katy to downtown. METRO views its primary objective as a mobility enhancer in the Houston metroplex. Its principal tool in addressing the region's traffic problems is its bus system. METRO officials also fund a number of "mobility projects," which are street maintenance and improvements. At least 25 percent of METRO's funds from the one-cent sales tax are used for this purpose.

Current Modes of Transportation in the Houston Area

Automobile Transportation

The typical Houston transitway, or HOV lane, is located in the median of a major thoroughfare, usually a freeway. It is 20 feet (6 meters) wide, reversible, and separated from main traffic lanes by concrete barriers. These lanes move large numbers of people in commuter and express buses, carpools, and vanpools at maximum speeds of between 50-55 miles/hour (80-88 km/hour) during peak traffic periods. At first HOV's did relieve some of the congestion on the freeways, but a recent independent study revealed that they are now having little impact.

As of November 1992, METRO was operating 46.5 miles (74.8 km) of transitways in four major Houston traffic corridors, providing more than 65,000 passenger-trips each day.[31] The Katy (IH-10 West), the Northwest (U.S. 290), and the North (IH-45) are complete and operational. The Gulf Freeway has 6.5 miles (10.5 km) of finished transitway, and another 9 miles (14.5 km) are under construction. The Southwest Transitway between Bellfort and Shepherd has recently opened. Design and construction are underway for segments of the Eastex Transitway from Loop 610 to Will Clayton, and the segments are scheduled to open in early 1996. A transitway in the Westpark corridor is part of the Regional Bus Plan. In October 1992, the METRO Board

[31] Curbside. Winter 1992, pg. 5.

gave approval to go ahead with the design of the facility. Plans are now on the drawing board to expand the North Transitway. When complete, the transitway network will contain about 100 miles (161 km) of transitway facilities.

The Smart Commuter Program

This two-component project combines the transitway network and high technology to promote commuting by bus, carpool, and vanpool. Smart Commuter is based on the belief that commuters who have access to accurate information about bus routes and schedules, instant ride-matching programs, and current traffic conditions will more likely use public transportation or some other high-occupancy commute mode.

The first element of the pilot program focuses on the suburb-to-downtown bus market along IH-45, north of downtown. It may use leading-edge videotext or advanced telephone technologies placed in commuter homes and workplaces to convey current traffic and transit information. The second component focuses on the suburb-to-suburb travel market in the IH-10 West to Post Oak/Galleria corridor. It will be structured to encourage a shift from driving alone to carpooling with two or more persons. The first year of the four-year Smart Commuter Project will be spent on design and development, followed by a three-year demonstration project.

As part of the larger $17 million intelligent vehicle/highway system (IVHS), this $5 million project has several funding sources. In August of 1992, the FTA awarded METRO a $500,000 grant that the authority combined with a $125,000 contribution of its own to help finance the project. TxDOT also is participating by contributing $1.25 million, with FHWA contributing an additional $2 million.

Bus Transportation

Currently, METRO operates a fleet of 1,072 buses. During peak periods, 1,022 buses are operating on the street. METRO adopted a regional plan in 1992 that will increase the fleet by 650 buses. The agency will also replace the 1,040 diesel buses with clean-burning liquefied natural gas (LNG) vehicles. In addition, it will make use of a "smart bus" system which will carry numerous electronic enhancements to monitor passengers, fares, communications, motor functions, driving, and traffic. An automatic vehicle locator will give the exact location of the bus at all times, allowing both traffic flow and scheduling of buses to be closely controlled.

Between now and 2010, METRO will acquire 650 new buses, over and above replacing the current fleet, to meet the demands of the region's growing ridership. Under the Regional Bus Plan, the Authority's strengthened bus system will provide inner-city riders with significantly expanded cross-town service, and it will offer park-and-ride patrons more direct service to activity centers from suburban origins.

The Regional Bus Plan relies on operational changes to provide riders with greater latitude in moving from one point to another point. For example, each park-and-ride location will have two services -- one non-stop to downtown and a second that will stop at a regional transit center en route to its primary destination (Greenway Plaza, Galleria, etc.). In each of these operations, there will be a maximum of one transfer to other major destinations. Because the Regional Bus will make it easier to use public transit from residential areas to densely developed employment centers, ridership is expected to increase noticeably by 2010, almost 60 percent compared to 1988 levels.[32]

There are two events which must be completed before the plan can take shape. First, the preliminary engineering and final environmental impact studies must be completed, tasks which are scheduled for this spring. Second, fully authorized federal funding is anticipated by June 1993 in the form of a Full Funding Grant Agreement.

Air Transportation

There are 149 airports in the 13-county H-GAC region. There are three primary airports: 1) William P. Hobby Airport, primarily used for domestic passenger flights; 2) Houston Intercontinental, primarily used for domestic and foreign air travel and freight movement; and 3) Ellington Field, which is operated by the U.S. Air Force. Currently, the City of Houston operates a shuttle from downtown to Intercontinental Airport as its only intermodal passenger link.

Rail Transportation

Information on heavy rail capable of servicing freight traffic is nearly non-existent. Information on rail tonnage and type of freight through Houston is also

[32] Ibid., pg. 5.

unavailable. To date, this sort of information has not been compiled for all of the railroads servicing the Houston area, and the individual rail lines refuse to reveal the information. The City of Houston has been requesting this information as well in order to plan hazardous materials evacuation procedures, but the railroad companies have not been forthcoming. METRO has acquired two abandoned rail lines, and TxDOT is about to acquire a third. Both agencies are hoping to use the newly acquired lines to implement a light-rail system in the metroplex. Currently, METRO is negotiating with four rail companies to determine their best offers to operate demonstration commuter lines in four transportation corridors -- Katy, Clear Lake, Missouri City and Harris County -- sharing some of the existing 300 miles (483 km) of track in Houston.

Port of Houston Authority

The Port of Houston currently has four docks, with a fifth dock near completion and a sixth dock about to begin construction. The port has rail, trucking, and pipeline facilities. ISTEA has had little affect on the Port's planning activities. Sealand handles a majority of the rail freight into and out of the Port of Houston, but Southern Pacific is the primary rail line. Approximately 100 truck lines operate in and out of the Port of Houston. The Port of Houston will be discussed more fully in the following chapter on public/private partnerships.

Houston's Future Transportation Plans

The 1993 TIP for Houston and surrounding areas was developed by the H-GAC. Listed below is a summary of the planned improvements.

1. Completion of the Congestion Management Plan

   Rideshare Computer: Purchase of hardware and software for matching potential carpool/vanpool users.

   Advanced Transit Scheduling: An automated telephone system for schedule and route information.

   Automatic Vehicle Locator: Development and purchase of a Geographic Information System -- will assist in providing a prompt response in the event of an emergency; will also provide information for other transit information systems, such as screens at transit centers.

   Regional Computerized Traffic Signal System: Will optimize signal timing and operations by unifying the signals into a manageable system so that progressions can be programmed to facilitate traffic flow.

2. Completion of Transportation Control Measures as Part of the Conformity Analysis

   Vanpools: Purchase of 50 vans through funds donated by TxDOT; METRO will administer the program.

   Park-and-Ride: Increase the number of parking spaces by 4,833 by December of 1995.

   Peak Hour Bus Service: Increase the number of buses operating during peak hours by adding 114 new vehicles by 1996.

   Transitways: Increase HOV lane mileage by 53.5 miles (86.1 km).

   Employer Trip Reduction Program: Businesses with over 100 employees commuting to work during peak periods must submit a plan to reduce work-related vehicle trips by 25 percent or increase vehicle occupancy rates by 25 percent by 1996. The plans must be submitted by 1994.

   Central Control Facility: Develop a central control facility for the Computerized Transportation Management Systems (CTMS). The CTMS will consist of surveillance and traffic signalization optimization.

   LNG Conversions and Facilities: Upgrading existing bus operating facilities to accommodate LNG operations so as to reduce particulate emissions from METRO fleet vehicles.

CHAPTER 7: PRIVATE-SECTOR PARTICIPATION IN MULTIMODAL CENTERS

Most transportation services are provided in the United States by the private sector, and hence any discussion about productivity and efficiency through the adoption of multimodal centers must consider the role of the private sector. This chapter focuses on three categories of policy issues influencing the performance of the private entity. First, some basic economic concepts are presented that might determine private-sector involvement in multimodal centers. Second, having established these key determinants, consideration is given to the challenges facing the private sector when considering investment in multimodal centers. The range of options is both wide and complex. Rather than attempt to develop a taxonomy of multimodal center investment types, the third section reports on a variety of case studies taken both from individual modes and from a total system impact evaluation. General conclusions are then presented.

ECONOMICS

Cost analysis is central to an understanding of private-sector involvement in intermodal activities. The objective of any private entity is relatively simple. It must survive, prosper, and ideally grow within the marketplace. Any attempt to evaluate private-sector participation, either in intermodal systems in general or in multimodal centers in particular, must recognize the key role played by costs. Such cost analyses are not complicated, and, like any other industry, the typical transportation company has a cost structure which consists of average fixed costs, average variable costs, average total cost, and marginal costs, all associated with different outputs of product service. First, let us consider total average costs. These are the sum of the fixed costs (such as land, facilities, and equipment) and variable costs associated with different levels of output. A facility such as a multimodal center has to be designed with some level of optimal output in mind. This could be the number of planes landing, ships in berths, or rail cars in intermodal terminals. Such output is associated with a mix of total costs which together form the basis for the facility design. Typically, such facilities are designed to meet some future level of demand higher than that currently observed. This is particularly true for multimodal centers, where at times few (if any) such services currently exist. Here it is the logic of lowering costs and improving service that predicates such an investment and determines the different levels of associated demand. What this implies is that the short-run average costs are non-linear with respect to output. Typically, they fall with increasing output to some point where efficiency is maximized and then climb (sometimes rapidly) as demand exceeds the ability of the facility to supply particular levels of service. Congestion would be a good example of a case in which short-run average costs steeply increase.

Multimodal centers are frequently designed in phases so that when demand exceeds the ability of the facility to supply the desired level of service, additions in fixed costs can be made to change the capacity of the facility. This is seen in capital improvements at ports, rail intermodal yards, and airports. However, such costs take a relatively long time to design, fund, construct, and bring into operation, requiring careful phasing within the company's operations. Figure 7-1 shows the relationship between short- and long-run average costs for two phases of a multimodal center facility. The short-run average total costs in the first phase ($SRAC_1$) are shown to fall, reach a minimum, and then climb with output. The short-run average total costs for the second phase of the same facility are shown as $SRAC_2$. The demand curve D_1 fits the short-run average cost rather well as long as average costs are falling, but as demand shifts outwards to D_2, it can be seen that the first phase of the multimodal facility now faces increased short-run average costs. It is only when the next phase of the facility is in place that short-run average costs fall again ($SRAC_2$). The long-run average cost for the facility is shown on the figure and, though not usually equating exactly to minimum short-run costs, is tangentially close and can be thought of as representing SRAC efficiencies. Without the facility being enlarged, output at O_2 would involve substantial rises in average costs (not to mention marginal costs) which would make the facility noncompetitive. Therefore, an analysis of short- and long-run average total cost relationships is critical for the success of any private-sector multimodal center. Publicly owned multimodal facilities (such as Mexican seaports) have been able to ignore these critical economic factors, albeit at a tremendous financial price. In order to keep the facilities operating, substantial state and federal subsidies are required. Therefore, we would expect private-sector involvement only where cost analyses can be clearly developed and where the private company has an opportunity to affect both short- and long-run costs.

This clear understanding of costs is essential to calculate the financial impacts of a company and the prices it can charge for its services. In order to examine how costs and prices impact, Figure 7-2 introduces the relationship between marginal costs and average cost curves for a multimodal center. The short-run average cost is the same as in Figure 7-1, and here we introduce short-run marginal costing, shown as $SRMC_1$. Succinctly,

Figure 7-1
Short- And Long-Run Average Total Cost Curves For Multimodal Centers

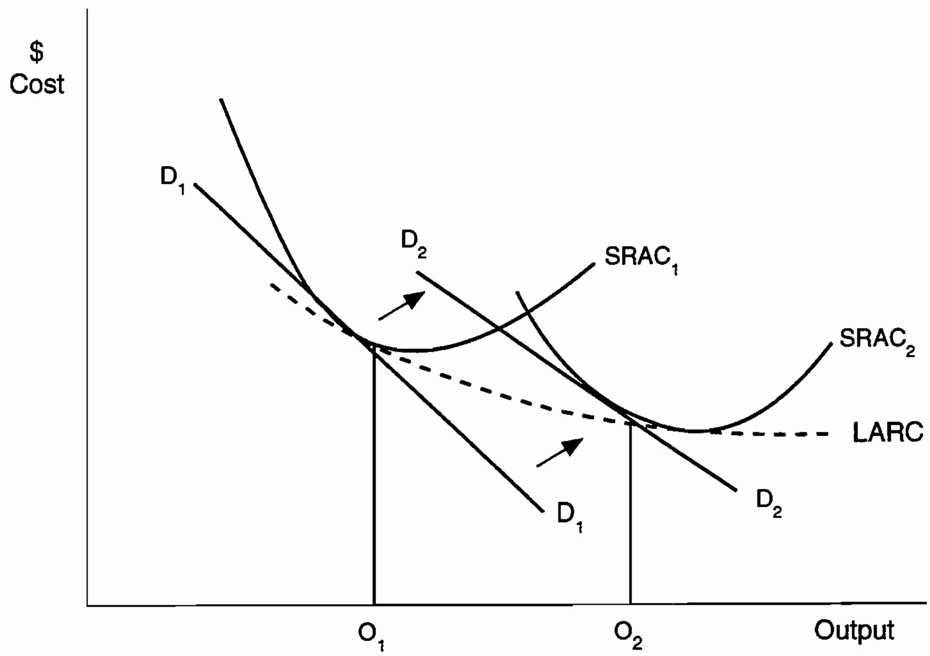
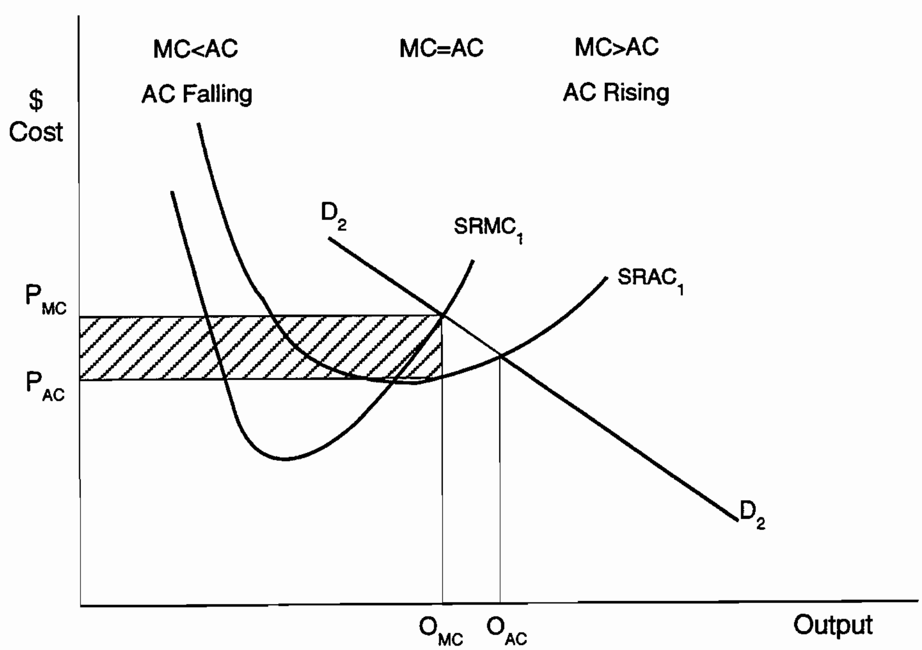


Figure 7-2
Average And Marginal Cost Curves For Multimodal Centers



marginal cost equals the slope of the total cost curve. Under the assumptions of variable proportions, marginal cost falls, hits a minimum value at the point of inflection of the total cost curve, and then rises. As long as marginal cost lies below average cost, the average is falling. If marginal cost lies above average cost, the average is rising. Where marginal cost equals average cost, the average is at a minimum. These values relate directly to economies of scale. If long-run average costs are falling as output rises, the company is said to have economies of scale. If long-run costs rise as output rises, there are dis-economies of scale; and where there is no change, the company is said to experience constant returns to scale.

There is a considerable body of literature on the question of economies of scale in transportation services. Broadly, they appear in most modes, and it may be argued that intermodalism will accelerate the opportunity for greater economies of scale. This is certainly true with respect to electronic data and information sharing services, which are now critical elements of transportation services. Returning to Figure 7-2, we see the marginal cost curve under the short-run average cost curve for low output levels and then sharply turning and cutting the short-run average cost curve at the total minimum cost point. Then short-run marginal costs rise steeply above short-run average costs. If we consider the case in which demand has moved to a point above the optimal level for the facility, shown as D_2 in Figure 7-2, we see that the company faces a dilemma. Should the company base its transportation facility prices on short-run average or on short-run marginal costs? As is well documented in the microeconomics literature, in terms of efficiency, it should use short-run marginal costs, which would reduce output from 0_{ac} to 0_{mc} and generate a price of P_{mc} rather than P_{ac} with additional profits for the company, shown in the shaded area. This directly equates with the pricing rules for most transportation facilities facing situations where demand exceeds the ability to supply optimal levels of service. Highway congestion is a good example of a situation wherein short-run marginal pricing should be used to bring about economic efficiency and the maximization of social welfare.

Economic theory would therefore argue that private-sector involvement in multimodal centers cannot be expected unless average short- and long-run costs are explicitly understood, together with average and marginal cost calculations. Without such measures, the private sector cannot optimize its operations in either the short or the long term (the latter being critical for medium- to long-term investment purposes), and will miss opportunities to fix its pricing at levels which make optimal financial contributions to the company. Furthermore, if these costs are not fully determined within any analysis of the multimodal center, the true impact of the center will be lost, sub-optimal decisions concerning investment and pricing will be made, and social welfare will not be substantially improved and will certainly not be maximized. We now pass to private-sector investment.

PRIVATE-SECTOR INVESTMENT

The previous section established the internal considerations that managers of transportation facilities must face, namely how productivity and costs vary with output. This information, together with other data on market characteristics and customer behavior, allows the company to address the issue of profit. It is possible to minimize costs and maximize output, but to do so in a way which ensures bankruptcy. Along with producing transportation services efficiently, the private sector must price its products appropriately and market them effectively.

It is in this context that multimodal centers may be considered. All firms participate in two major markets simultaneously: they are in the factor-of-production market as demanders and in the transportation services market as suppliers. Private-sector management has control over some parameters in both these markets, slight control over others, and virtually no control over yet others. It cannot control the activities of its competitors in selling, in transportation services, or in the purchasing of input factors. It must therefore anticipate actions and accommodate them to the market environment that they create.

In the language of microeconomic theory, these competitive considerations determine the shape and position of the demand curve the private sector faces for its output of transportation services, as well as the supply curve of its factor inputs. If there are large numbers of direct competitors, the private sector's product demand and factor supply will be relatively low. If the competition is less vigorous, demand and supply will be relatively higher. The competitive situation can range all the way from local markets in which there are no competitors at all (monopoly), to world-wide markets where literally hundreds of transportation companies exist (pure competition). Product market may be one that is protected by patents (like road railer technology) or one that is exactly like everyone else's (over-the-road trucking). Similarly, the labor market may be comprised of readily available unskilled labor, or it can be tightly organized (such as the Teamsters Union) or of limited supply (such as airline pilots).

The generalized theory of the firm deals with these situations and economics has developed analyses for conditions of pure competition, pure monopoly, oligopoly, and monopolistic competition in product markets and pure competition, pure monopsony, oligopsony and monopsonistic competition in the factor markets. It is not the objective of this chapter to go into details of such analyses, but the wide range of decisions facing the private sector in the area of transportation is clearly complex. Additionally, economic theory suggests that the private sector will maximize profits when possible. It has already been noted that the first goal of a company in the private sector is to survive. Under market conditions of pure and monopolistic competition, long-run economic profits are squeezed to zero. Therefore, if a company is to survive in this sector, it must maximize its profits since anything less would mean losses. There is little doubt that easy entry of competitors into the transport services industry produces profit-maximizing behavior.

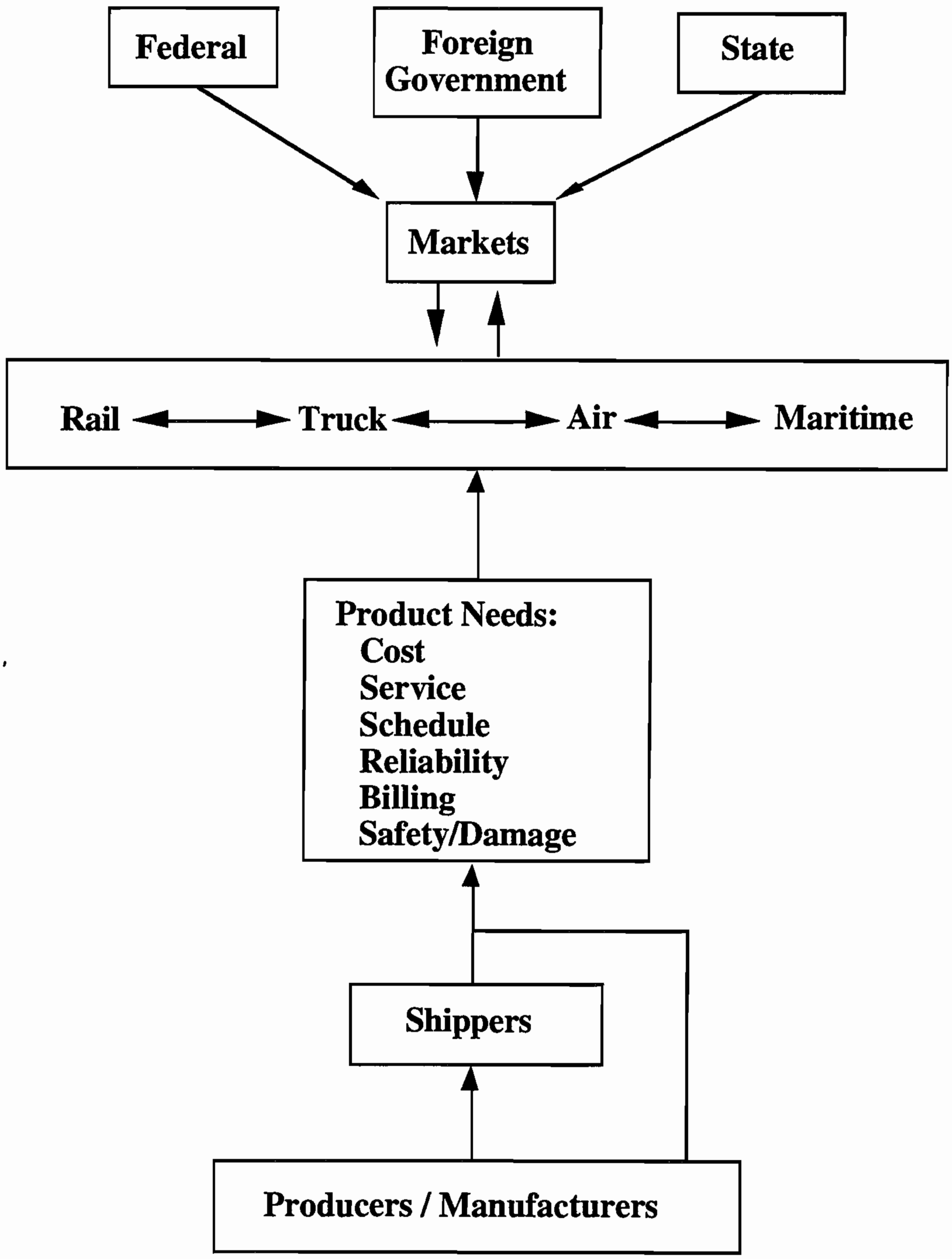
Oligopoly and monopoly leave room for discretion on the part of management. Firms in these markets can survive on less than maximum profit, and because ownership and management are separated in large private entities, it is quite possible that managers may not be motivated to earn maximum profits for the shareholders. They may find other goals that suit the needs of the company more directly. For example, some economists believe that sales revenue maximization rather than profit maximization is a more realistic goal for a management intent on job security and market share. Others have theorized that management will strive for satisfying, earning a profit just sufficient to keep the board of directors and shareholders content. There is also a major school of thought that stresses planning and stability rather than profitability as the most important goal of today's corporate giants.

In a sense, all this adds to the complexity of private-sector participation in multimodal centers. We need, therefore, to develop some basic approach to the investment challenges facing transportation companies in the era of intermodal activity. Figure 7-3 is a schematic identifying some of the key factors impacting modal choice and therefore multimodal center investment. Multimodal centers are simply one item in a long chain of activities that comprise passenger and freight movements. However, they may crucially influence customer choice with respect to trip patterns. The schematic identifies the markets which are being supplied by various producers and manufacturers through transportation services. These markets are affected by foreign government, U.S. government, and state regulations which, in part, constrain the ability to supply the market through intermodal chains. The intermodal element is shown as rail, truck, air, and maritime, but actually encompasses all modal elements including pipelines and coastal shipping.

Originally, manufacturers developed transportation departments whose staff considered the characteristics of the product and of the market and attempted to set up channels of distribution employing either company resources or those of independent transportation companies to distribute company output efficiently. Increasingly, as manufacturers examined their costs and concentrated on the assembly and marketing of products in an increasingly competitive market environment, they began switching the responsibility of transportation choices to specific companies that specialize in such matters. This movement, called outsourcing, has resulted in a fast-growing body of shippers and entities choosing channels of distribution for particular products. The list of product characteristics that affect modal choice are significant and include, first, those related to cost, then service requirements, scheduling (particularly important for just-in-time shipments), reliability in providing the services (currently a severe problem with intermodal equipment shortages on Class I U.S. railroads), billing accuracy (truck billing is far superior to rail billing), and safety and damage considerations. These define the profile characteristics of the product which the transportation industry will address. Increasingly, intermodal shipments are taking a wider share of the market for transportation services, and shipments are switched at centers such as intermodal yards and ports.

The private sector, therefore, becomes involved in multimodal centers — either through direct investment, which at times can be substantial, as in the case of the new Santa Fe intermodal rail terminal at the Alliance Airport, which cost upwards of $100 million in 1993 prices. Or, involvement can take the form of a customer at one of the sites, as in the case of Southwest Airlines or American Airlines buying gates at key regional airports in the network. In any event, investments are made into multimodal centers for reasons of economic advantage. These can be categorized as (1) improving competitiveness, (2) a defensive move against other modes, or (3) an attempt to improve market share and penetration. Investments can also be the result of a decision to broaden the range of transportation services provided by the company, which will strengthen its financial performance in the medium to long term. It must be remembered that all this has to be done within the environment of long-run profitability in order to ensure economic survival and health. This results in a complexity of opportunities for the private sector, the diversity of which is reflected in the following section.

Figure 7-3
Schematic: Factors Impacting Modal Choice and Multimodal Investment



MULTIMODAL CASE STUDIES

The schematic in Figure 7-3 identifies key elements in the transportation distribution channel, which includes not only modal players but also state, federal, and foreign governments, and state impacts. Table 7-1 represents the key elements of Figure 7-3 and identifies case studies which are presented to show the elements of typical impacts on intermodal movements. Again, this is deliberate. It is not possible to examine multimodal centers without considering the context of intermodal shipment channels of distribution. In doing so, it can be seen that there are many risks inherent in private-sector investment in multimodal centers, and this could argue that prices have to repay the investment in the short to medium term rather than leaving it for the long period. This poses particular challenges to very large investments such as airports and ports, where a long life-cycle is required for recovery of the investments. In this context, state agencies such as Texas Department of Transportation (TxDOT) must recognize the underlying assumptions of investment and the potential for adverse impact on cash flows in two such facilities. In this way, the work is linked to the development of statewide multimodal planning, both for passenger and for freight movements. The case studies are now presented.

Table 7-1
Case Studies of Intermodal Issues in the Private Sector

Focus	Case Study and Issue
Government	Asian markets: Air route regulation U.S. highways: National Highway System
International	U.S.-Mexico: Union Pacific's intermodal operations
Intermodal	Alliance Airport: Intermodal Center Alameda: Landside port corridor
Rail	Norfolk Southern: Market share and seamless movements Union Pacific: Interlining with Burlington Northern
Maritime	Sea-Land: Maritime cost cutting
Highway	Landstar: Innovative trucking organization
Shippers	Shippers' Survey: Shifting rail-highway intermodal traffic

Air Traffic Routes: Case of Government Regulation

Well over 70 percent of all air cargo is carried as part of passenger plane movements and not on dedicated cargo flights. Therefore, passenger flight routes, which are highly regulated by the world's governments, are critical to the success of air freight business among major airlines. The politics of route allocation are complex and are generally contained within aviation treaties or national agreements between governments. In some cases, routes are awarded on the basis of broad reciprocity (as in the case of U.S.-European routes); but in other areas, historic route allocations (some biased) have now been overtaken by the growth in world markets. The latter is particularly true of the Asian markets, where Pacific Rim airlines do not have the same access to U.S. and European markets as do their world counterparts.

Top Asian airline executives are now combining forces to alter the long-standing agreements giving the United States and Europe favorable air traffic rights.[1] A U.S. official in Washington stated that while the Orient Airlines Association has been making similar statements over the last eighteen months, the U.S. has not yet been asked by any of the country governments to change any aviation agreements. The official noted that the United States has liberal aviation agreements with many Asian countries including Taiwan, Singapore, and South Korea. The president of Singapore Airlines demanded recently that Asia be given equal opportunity in the market. The Manila Philippines Association represents fifteen Asian and South Pacific carriers including Japan Airlines, Thai Airways, and Quantus Airlines of Australia. Asian airline executives oppose the series of aviation pacts with the United States that date back to the 1950's, a time when most Asian airlines were in their infancy and most international passengers were American.

They also oppose a common international aviation policy proposed by the European union. Under the arrangements, American travelers can visit every major Asian business center on a single trip without once flying an Asian airline. No similar rights were given to Asian airlines, although Asia is the fastest growing air travel market. The splitting of commercial aviation into negotiating blocks could create barriers to growth, and it is projected that international passenger traffic in the Pacific region will grow by almost 9 percent annually to the year 2000, compared with 6 percent for the world as a whole. Boeing Corporation's research predicts that Asian markets will account for over 40 percent

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[1] "Asian airlines plan tough stance on U.S., European treaties," Journal of Commerce, March 1, 1994.

of the world air travel by the year 2010 compared with the current 25 percent. This illustrates the complexities associated with the air passenger and freight routes and the need for airlines and governments to work together to develop effective and equitable patterns of trade. Government regulation is a critical element in forming the environment for passenger or freight international intermodal movements and must be regarded as a key component of any evaluation process.

The Proposal for a National Highway System: Intermodal Needs

The U.S. Department of Transportation's (USDOT) proposed 160,000-mile (257,440-km) national highway system (NHS), the backbone of the economic program over the next two decades, lacks a final plan regarding how it will connect with ports, airports and other intermodal facilities. It also needs performance-assessment standards and a framework to guide future changes, such as adding length to the system.[2] The USDOT plans to set criteria for the development of facilities and to determine appropriate intermodal access, first within two years and then two years after approval of the system. But that could result in Congressional approval of an NHS that does not specify what connections will be established to other modes of transportation. Designating a new system of highways of national importance and other major roads was mandated under the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). USDOT unveiled its proposed system in December 1993, and Congress has until September 30, 1994, to pass implementing legislation. The U.S. Government Accounting Office (GAO) official stated that the proposed system has many goals, but they will not be realized unless the system performance expectations related to these goals are established.

Traditionally, as reported earlier in this study document, highway systems have been constructed and improved with little regard to other modes of transport. The ISTEA proposals were to change this; but, as can be seen from these examples, there is a considerable gap emerging in the ability of this system to adequately link other modes and, apparently, no formal process for evaluation has been determined. Without this evaluation, it is unlikely that the NHS will yield the intermodal benefits envisioned when it was released to the public in 1993.

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[2] Testimony of K.M. Mead, General Accounting Office's Director of Transportation and Telecommunications, to House Public Works and Transportation Committee's Surface Transportation Subcommittee, March 8, 1994.

International Trade: The Case of Union Pacific and U.S.-Mexico Trade

Since 1987, Union Pacific (UP) Railroad has undergone significant reforms, including decentralized decision-making. Over the past seven years, it has reduced employment by 32 percent and has spent almost $4 billion on internal improvements, including new locomotives and a dispatching center.[3] It currently employs over 140 staff working to develop trade opportunities with Mexico, one of its fastest growing market segments. Projected revenues derived from Mexican business exceeded $300 million in 1992 and are expected to grow at around 15 percent in the short-term. In order to strengthen its business in this market, UP developed an international customs service center (ICSC) located in Laredo, Texas, to provide customer service for all Mexico-bound freight in the Laredo, El Paso, and Brownsville gateways. The largest interchange point with Mexico is Laredo, where a new intermodal facility was constructed in 1990. Previously, the facilities were situated downtown, adjacent to the river; this location caused significant private and social costs when rail traffic moved at grade through the city. Accordingly, UP purchased land 12 miles (19 km) north of the downtown Laredo area adjacent to Interstate Highway 35 and constructed an 1,100-car capacity facility with intermodal cranes for trailers and containers.

The dynamic nature of the international business has meant continual investment changes relating to intermodal services. These include:

1. Alliances with major trucking companies, including J.B. Hunt Transport, Inc. and Schneider National.

2. Plans to construct an intermodal yard at Huehuetoca, north of the Mexican capital. This facility should expect a sizable share of the intermodal traffic to Mexico City and requires an alliance with three major Mexican trucking companies, together with a terminal operations company, in order to facilitate the construction and operation of this facility.

3. A double stack run-through service, initiated in February 1991 between Chicago and Mexico City. This route boasts the advantages of being 15 percent shorter and 25 percent faster than other companies' lines. This service, initially three times per week, has now been expanded to every day.

4. Leasing its shipping and tracking software to the Mexican rail company, FNM, in an attempt to increase dispatching and tracking

[3] Texas-Mexico Multimodal Transportation, Policy Research Project Report 104, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, August 1993.

efficiency. This is critical in improving the reliability of through route schedules.

Therefore, it can be seen from the range, complexity, cost, and timing of the above investments that the provision of intermodal facilities on an international scale is complex and requires a number of phased interacting activities that can be introduced only by a private company over a relatively long period (at least five years).

Alliance Airport Intermodal Transportation Center

In 1991 the Alliance Airport was opened, located 20 miles (32 km) north of the Dallas-Ft. Worth International Airport. This private airport is dedicated to freight handling and occupies a large site adjacent to Interstate Highway 35. Santa Fe's carload and intermodal transportation center at Alliance will consolidate current classification yards at Saginaw, Zacha Junction, and East Dallas and the intermodal yards at Saginaw and Zacha Junction. After a slow start, it has now begun to attract partners, and Federal Express recently announced the construction of a mini-hub at Alliance to handle much of its southwest domestic traffic. In addition, and significantly, the Santa Fe Railway decided to construct a 575-acre (227-hectare) carload and intermodal transportation center at the airport which will open in May 1994. This $100 million facility is the largest freight-handling complex in the southwest, and will double Santa Fe's intermodal capacity in the Dallas/Ft. Worth area to approximately 300,000 links annually. In terms of land development, the main line track occupies 200 acres (70 hectares), the car load facility occupies 250 acres (99 hectares), and the intermodal facility occupies 150 acres (59 hectares). Eight miles (13 km) of relocated main track have been laid, together with 42 miles (68 km) of intermodal and car load facility track.

The facility is comprised of eight receiving and departure tracks for inbound and outbound trains, together with four block exchange tracks for transferring freight to trains passing through the facility. It has 18 classification tracks for terminating or originating traffic with associated engine service trackage. Also, it has a maintenance-of-way service building, a car repair facility, a fueling and engine service, and an administrative and yard office.

At the intermodal facility, there are two travelifts and two side loaders for moving containers and trailers, three loading and unloading tracks for trailers and containers and two storage tracks; and over 3,400 parking spaces, with a future capacity of more than 6,000. The intermodal yard has facilities for maintenance, repair, and fueling together with an administrative and checkpoint center.

These details highlight the range of investments required at a modern intermodal yard and show that the costs of entry into the intermodal business remain initially high, even if they are subsequently profitable.

Intermodal Port Investment: The Alameda Corridor

The ports of Long Beach and Los Angeles are inadequately connected in terms of current highway links. In order to facilitate switching between the ports, the Port Authority has proposed the purchase of right-of-way from the Southern Pacific (SP) to build a rail container corridor, which would then be rented to other railroads, including Santa Fe and UP. The project cost is estimated at $1.8 billion and would serve as a cornerstone for freight movement through the nation's busiest port complex. This figure includes $240 million to purchase the SP right-of-way which serves the ports. In order to effect this project, the need for federal funds is critical, and a House hearing on infrastructure projects examined this corridor proposal in March 1994, providing a self-imposed (but not publicly declared) deadline for corridor officials to resolve issues. It has been claimed that without ISTEA money, the project cannot be effective. Class I railroad users of the corridor would pay a user fee in part to finance the project, and the movement of containers along this system would have a beneficial impact on the highway capacity adjacent to the ports. It is unclear whether such benefits are being treated as externalities or are being included in the proposal for ISTEA funding. This is a good example of the need to broaden the traditional financial evaluations of intermodal projects in order to encompass social impacts and other externalities which constitute explicit benefits of the project but are frequently not directly included in the financial evaluation. This is the major subject of the study conclusion and recommendations in Chapter 9.

Seamless Movements, Market Share, and Investment Constraints: The Case of Norfolk Southern Railroad

A major policy objective of the Association of American Railroads is to promote an intermodal seamless freight transportation system that employs railroad services and assets. However, in practical terms, much remains to be done in terms of effecting smooth transportation across various modes. Norfolk Southern[4] (NS) believes there is much to accomplish before seamless service becomes a reality. First, most truck traffic is never interchanged, since one trucker handles a shipment from door to door. This represents a formidable challenge in service levels that intermodal must attempt to match and will require a number of significant improvements over the next decade. NS has decided to rethink the operation of its systems. Essentially, NS officials believe they do a good job of maximizing the efficiency of each of their respective railroads but need to pay increased attention to interline traffic. For NS business, interline traffic accounts for 45 percent of revenue and is concentrated on a limited number of carriers at a limited number of gateways. NS is developing a program to improve these gateways starting with the largest one in Hagerstown, Maryland.

In order to meet the challenge of highway competitive services, NS is dependent on connecting carriers for its intermodal as well as carload network. First, NS is strengthening its relationship with the Consolidated Rail Corporation (Conrail) and developing new services. The East Coast Clearance Project, selling half of Triple Crown (a new service from Columbus to Cincinnati), is aimed at creating a network of intermodal services to link important markets. NS management believes intermodal to be a highly effective, competitive tool, enabling the railroad to be more competitive with over-the-road truckers. The cooperative efforts between carriers required to drive intermodal services may also be transferable to improving the handling of carload business, which remains an important revenue source for most U.S. Class I railroads. Also, NS is working hard to provide carload distribution services that are also intermodal in nature: that is, they involve rail-to-truck transfer or rail-to-warehouse-to-truck logistics. This is a market growing in excess of 15 percent annually. NS is attempting to build a robust network of intermodal services, recognizing that capacity must be improved, both at terminals and line-of-road, although it must be done carefully by investing limited resources at its disposal in order to meet prospective profit margins.

The NS 1993 capital budget was $680 million, excluding North American Van Lines and Triple Crown. Excluding newly authorized spending not expected to occur until after 1994 and including spending on projects carried over from 1993, total spending for capital improvements in 1994 is expected to be $627 million. The lower capital spending in 1994 reflects the financial pressures facing private companies and represents barriers to the

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[4] Interview with Norfolk Southern CEO, David Goode. Railway Age, January 1994.

adoption of technological systems and physical investments, even when these raise competitiveness and efficiency.

Essentially, there are greater demands for company capital than can be supplied from the revenue sources of the company. The demand for greater rolling stock, much higher levels of handling technologies, new intermodal yards, new and more powerful locomotives, new tracking systems, and development of information technology in general — all represent constraints to the development of seamless operations. Therefore, a private company like NS must program and time these investments so that over a period of five to ten years they form a coherent program which raises competitiveness. Finally, NS feels that it is burdened with having to compete with the trucking industry, which does not have to earn return for its fixed plant (i.e., track) or pay for all the cost of maintenance. For that reason, NS believes that it cannot, of itself, provide track to all major markets and must interline with other Class I railroads. In other words, they would rather share facilities than be out of a market altogether because sole access costs are too high or because they could not make an adequate return to satisfy their shareholders.

Dynamics of Intermodal Strategies: The Case of Rail Interline Agreements

As noted earlier, in order to cover national markets and compete with the trucking sector, Class I railroads have entered into a variety of agreements governing the sharing of track, locomotives, rolling stock, and related equipment. These arrangements are categorized under the heading of Interline Agreements, and it is important to recognize that these are dynamic and not static instruments. Recently, the Burlington Northern (BN) railroad decided to pull out of the intermodal market in Texas in order to concentrate on other key areas of its operations. Succinctly, the company claimed operations had grown too fast and it needed to regroup in order to focus investments in other key areas. This policy review led it to change other intermodal interline agreements, with potentially serious impacts on the operating practices of other railroads.

One of these was the trailer-use agreement with UP, and that has now forced UP to rethink its equipment purchasing strategy. BN's cancellation becomes effective on April 3, 1994, and will prohibit BN trailers from being loaded on UP's Chicago and Northwestern networks. BN officials maintain that the move is driven by equipment shortages and that it made more sense to dedicate the equipment to its customers and generate direct revenue than to have it tied up in a trailer pool arrangement. UP is the largest user of BN trailers, with as many as 1,000 BN trailers on UP trains on any given day. By contrast, UP averages 20 or less on a given day on BN trains, according to intermodal industry experts. UP must now evaluate its policy of trying to avoid extensive intermodal equipment purchases. The cancellation gives BN a commercial advantage over UP, since it can use trailer supply as an economic weapon. This move has created fears among users of intermodal services, but some eastern railroads may rally to UP's defense by canceling agreements with BN.

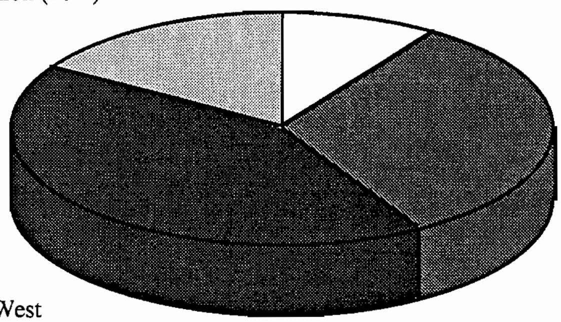
This highlights the dynamic element of railroad interline agreements and cautions against the labeling of freight intermodal agreements as static. The competitive nature of railroad operations is still an important element in company policy and plays itself out in ever-changing ways. Therefore, the continued growth of intermodal services in the 1990's may itself generate significant changes within individual railroads and interlining partnerships. It is therefore vitally important that planners bear in mind these dynamics, which need at least to be monitored regularly in order to ensure that statewide multimodal planning takes these developments into account.

Maritime Cost Cutting: The Case of Sea-Land

Private transportation companies face great competition, particularly in maritime services where competitors employ cheaper labor and enjoy subsidies and capital investment programs. Accordingly, U.S. companies must closely monitor, control, or reduce all costs. Since 1991, Sea-Land has eliminated $262 million, or about 9 percent of the company's annual costs excluding depreciation. As a result, even though Sea-Land's revenue grew only 3 percent last year, with container volumes stagnant in certain core trade lanes, its operating profit grew by almost 30 percent. Officials at Sea-Land, the largest U.S. shipline, say they will attempt to extract an additional $100 million from the company's cost base on top of the $262 million in reductions already achieved.

This is a good example of the pressures toward efficiency and cost control existing in the private sector. Figure 7-4 gives a snapshot of capital expenditures for Sea-Land in 1993, but because of the limited nature of capital flows within even the largest U.S. shipping line, it would be necessary to take a ten-year time series of capital expenditures in order to determine all elements of capital investment. It is interesting to note the cost of purchase and refurbishment of containers, representing over one-third of 1993 capital expenditures, while only $12 million is allocated to technology, terminal facilities, and

Figure 7-4
Sea-Land Service, Inc., Capital Expenditures



Source: Journal of Commerce

other upgrades. This shows the limitations that private companies have with respect to taking advantage of technological developments. Such limitations mean that even when new technology can impact the efficiency of operations, it must be phased in gradually over a period of time and shared wherever possible with other companies in the shipping business.

It is interesting to note where savings have been effected. First, several years of cost cutting through staff reductions and business reorganization has now made Sea-Land workers the most productive in the world, more so even than Japanese or German staff. About one-third of the amount Sea-Land has managed to reduce from its budget has come from staff reductions, while another 25 percent has come from dock-side labor efficiencies achieved by running ships on schedule. Sea-Land ships arrived on schedule 88 percent of the time in 1993, up from 86 percent in 1992. This highlights the need for all modes to meet schedules given to shippers and that need is a key determinant for rail, truck, air and maritime movements. The remainder of the savings has been derived from a variety of initiatives, including reducing the volume of cargo claims, negotiating volume discounts on telephone and other services, benchmarking, and eliminating multiple vendors. This shows the drive of the private sector to control costs in order to remain profitable and competitive. It also demonstrates how vulnerable such organizations are to national and international regulations.

Specialized Units Integrating to Form One Large Trucking Company: The Case of Landstar Systems, Inc.

Landstar Systems, Inc. is the third largest trucking company in the United States after Schneider Corp. and J.B. Hunt Transport, Inc. Yet, it has an entirely different organizational structure from those of its competitors. Essentially, the company has broken operations into five separate operating companies sharing common technological services. Each operating company in the Landstar group has its own specialty, as shown in Table 7-2. Ranger Transportation, Inc. does just-in-time truckload movements. Inway does flatbed movements. Poole Truckline, Inc. does high-density truckload shipping for short and medium hauls. Ligon Nationwide, Inc. specializes in heavy hauls. Finally, Gemini Transportation Services is an intermodal drayage specialist.

Table 7-2
The Landstar System, Inc.

Company	Headquarters	1992 Revenue ($ Millions)	Principal Trailers	Cargo
Ranger	Jacksonville, FL	257	Vans 70% Flats 30%	general commodities
Inway	Rockford, IL	176	Flats 70% Vans 30%	metals, paper machinery, building materials
Poole	Evergreen, AL	111	Vans 60% Flats 40%	general commodities
Ligon	Madison, KY	107	Flats 80% Vans 20%	heavy-haul
Gemini	Jacksonville, FL	19	Containers, Piggyback trailers	drayage

Source: Journal of Commerce.

The Chief Executive Officer of Landstar believes that having five companies allows flexibility in terms of market penetration. However, there are certain key centralized integrating activities, particularly the computerized operating systems and marketing units which aim at unifying, over many areas, the company's operations. Therefore, Landstar is highly flexible, with some of the units employing owner-operators to support the supply of transportation services. Agents for Landstar are tied together through an electronic administrative and dispatch system handling schedules, dispatching, and billing among the five companies. Using this agent network, Landstar has built its business with small and medium-sized companies which today form three-quarters of the company's total revenue. Landstar is approaching large, national accounts through a new unit, Landstar Transportation Services, Inc. (LTSI), which presents itself as a logistics service company providing customers with a single point of contact to the entire Landstar System. This equates with the growth of outsourcing among the larger companies in the United States in terms of logistical services.

This newer type of trucking organization is comprised of smaller operating units (where scale economies are limited) linked through common central financial, computing, and marketing systems (where scale economies are present) to form a modular administrative structure. In addition, the smaller companies may be able to employ non-union labor or more effectively contain union power. This model may be more widely adopted in the future, challenging the monolithic trucking companies for a share of the intermodal market.

Shifting Intermodal Traffic: A Shipper's Perspective

A recent survey of 500 shippers indicates that any growth for intermodal carriers will come from within the ranks of their current customers and not from companies that have shunned intermodal use in the past. This survey[5] shows that while more than half of the current intermodal shippers plan to use the mode more, 81 percent of non-users say they do not want to switch freight away from over-the-road delivery. The wide-ranging analysis shows that shippers think intermodal has not closed a long-standing performance gap compared with all-highway trucking. The study shows that shippers believe over-the-highway trucking has an 18 percent advantage in service performance (as determined from the shipping survey) over intermodal movements.

Despite that perceived gap, intermodal operators continue to set volume records, reaching 7.15 million shipments in 1993, up from 6.63 million in 1992, according to the

[5] "National Industrial Transportation League and the Intermodal Association of North America," International Index, Washington, D.C., December 1993.

Association of American Railroads statistics. The lower cost and rates of intermodal shipments seem to be a major factor in growth, since more than half the shippers surveyed pinpointed intermodal cost advantages as a reason to switch more freight off the highway. The report is interesting in that it identifies many shortcomings in current rail/trucking intermodal movements. Nearly three-quarters of shippers said they believe intermodal services have improved but must continue to get better. The survey demonstrates that intermodal operators are now falling farther behind in terms of service factors shippers value most, such as quality of delivery and low risk of service failure. Even those areas where intermodal improved in 1993 relative to over-the-road, such as availability of equipment and service reliability, still show rail truck service lagging nearly 20 percent behind.

Interestingly enough, the area where an intermodal shipment was judged to exceed all truck service was in electronic data interchange capabilities, which shippers considered the least important of the seventeen performance factors they were asked to rate. However, such interchange may well become critical in terms of tracking and billing in future freight moves, and this may become an important benefit in rail intermodal operations. The trucking component of intermodal service received low marks, with plant managers rating intermodal shipments behind all the highway moves by up to 32 percent on factors such as pick-ups, deliveries, and tracked quality and appearance. This is clearly an area where improvement will have to be targeted in the near future, but the investments currently being made in electronic data handling should effect constructive change. Finally, looking at all shippers and their selection of modes in 1993, 26 percent reported moving traffic from intermodal to highway, while 39 percent reported shifting from highway to intermodal. Therefore, the dynamic elements of the market can be seen in operation. Traffic is not shifting permanently from one mode to the other, but is being moved in response to the needs of the customers' products and performance of the relative systems. This is to be expected in a free market competitive system, but is rarely recognized in modal planning at the state level.

CONCLUSION

At times, it seems that the term intermodal is indiscriminately applied to traditional freight handling activities in the private sector that involve more than one mode of transport. The adoption of intermodal programs requires abandoning many traditional practices, and developing complex but cost-effective operations, accepting the need for significant investment packages that addresses capital, technology, and labor issues. Embracing an intermodal philosophy and implementing policies within the private sector requires a complete reorganization in the way business is traditionally conducted, demanding an enhanced marketing approach incorporating customer, product, service levels, and cost issues. This then leads to new business opportunities (such as trucking partnerships) and new cost efficiencies (such as logistics outsourcing). Costs remain the critical determinant for private-sector profitability, closely linked to margins, profit, share dividends, and ultimately to commercial survival. Capital investments to sustain intermodal performance represent a drain on financial reserves and must therefore be carefully programmed into company operations. Actual gains may be slower to achieve than theoretically predicted but they should be sustainable over a long period of time, particularly if states like Texas adopt effective multimodal transportation planning programs. Finally, the focus of this study — multimodal centers — represents significant financial investments for the private sector. Frequently, involvement is linked directly to medium- and long-term business strategies for private companies, and these strategies are linked to company survival. Participation in multimodal centers by the private sector is therefore likely to take time to develop and will require significant amounts of planning with both private partners and state entities in order to reach the full economic and financial potential promised by intermodal and multimodal operations.

PART III

A NEW FRAMEWORK FOR MULTIMODAL TRANSPORTATION EVALUATION

CHAPTER 8. FACTORS AFFECTING AN EFFECTIVE MULTIMODAL TRANSPORTATION SYSTEM

As demonstrated in Parts I and II, if the state, as well as the U.S., is to retain its economic posture and prosper in the future, the transportation infrastucture must respond to the growing demand for intermodal systems. Governmental initiatives, pressured by private- and public-sector needs, have fundamentally changed the environment for transportation planning. This chapter outlines the issues central to effective multimodal planning, as well as issues relating to the implementation of transportation centers.

ISSUES RELATING TO MULTIMODAL PLANNING

The new requirements and regulations associated with the trends identified in previous chapters, make the resolution of certain key transportation issues important. These issues relate to the planning and implementation of a multimodal transportation system and the development of transportation centers in Texas.

Planning and Analysis Tools

Planning and supporting analysis have not, in the past, been approached from a perspective of generic transportation investments. Approaching problems from a multimodal perspective is perhaps the most important element of transportation planning today. Multimodal plans should be specific to characteristics of the application and to the financial capabilities of the agency. Agencies must be careful not to introduce bias into the development of policy goals and objectives and into problem definition phases of transportation planning. Developing a multimodal perspective is difficult when modal networks are modeled separately and interaction of modes is not explicitly provided. There is also a question of the consistency of the networks, service levels, and assumptions used in modeling. Criteria to evaluate multimodal plans should be based on an index of mobility instead of congestion. This would provide the analyst with an estimate of the ease or timeliness of the movement of people or goods. Additionally, it is necessary to develop analysis and evaluation tools sufficiently sophisticated to eliminate bias toward individual modes. In conjunction with these tools is a need to develop common databases and decision support techniques.

North American Free Trade Agreement

The expectations for the trading zone that will accompany the North American Free Trade Agreement have already begun. The low cost of labor in Mexico will result in more production there, and a significant portion of the goods manufactured will be shipped north across the border to various markets. The method of shipping will be a significant consideration in future transportation planning in Texas, as will provision of additional passenger transportation capacity. The goods could be shipped in containers to facilitate rail-truck "intermodal" movement (trailer-on-flatcar, container-on-flatcar, or double-stack). Trucking across the border presents problems because U.S. highways are not designed for the heavy trucks (50 metric tons) allowed in Mexico. Ships or barges moving through the Intercoastal Waterway is another option, especially for bulk commodities. This raises a two-part question of whether a transfer between modes is necessary and where might it occur? An additional complication arises from the Texas-Mexico border towns which are nonattainment areas for air quality and the provisions of the Clean Air Act Amendments of 1990 (CAAA) in regard to these areas.

Interaction of Person and Goods Movement

The movement and transfer of goods must necessarily be considered in any multimodal planning process, and in so doing freight shippers and carriers must be included. Urban goods movement is often placed on the sidelines in transportation planning, until a ban on deliveries during rush hour, for example, is proposed before a city council. Passenger and freight movement in an urban area can be especially complex and interwoven; people and goods move on independent and sometimes conflicting schedules.

Programming

The objective of the transportation programming function is the prioritization of resources for allocation to projects based on their importance in meeting policy objectives. In addition, programming facilitates tradeoffs, and it supports effective project delivery and coordination. Most of the factors affecting the planning, funding, and organizational consideration of multimodal plans spill over into the programming area. Other issues specific to this area are: vague and conflicting policies among agencies; poor integration with the planning function; lack of emphasis on systematic evaluation; uncertainty; institutional factors; increased importance of preservation and maintenance; increased emphasis on management, operational, and multimodal solutions; and coordination among agencies, jurisdictions, and modes. The integration of new management systems into programming will improve systematic evaluation of the transportation system.

Funding

There needs to exist both public and private support, as well as funding sources for multimodal transportation solutions. One of the drawbacks to publicly funded projects regularly cited is the lack of sufficient funding for completion of a project cycle. Policy issues in transportation financing which affect multimodal planning are focused on increasing funding sources, providing funding flexibility and certainty, and encouraging partnerships. The objective in resolving these issues is to depoliticize the allocation of funds, to complete projects, and to meet transportation and air quality goals. The emphasis on developing new funding sources is not limited solely to the planning arena. Tolls (independently or in combination with federal or state aid), private investment and credit enhancement, local option taxes, special districts, and impact fees will inevitably be used to fund multimodal planning to some degree. Other issues of a more technical financial nature include: the move to life-cycle costing of projects; dealing with multimodal funding sources; and reducing revenue uncertainty caused by inflation, spending ceilings, or fund diversion. Scheduling of fund expenditures in accordance with deadlines for mandated requirements, as well as resource commitments toward conformity, preservation, and management, all add to the strain of paying for multimodal planning.

The issue of competitiveness will become a two-edged sword in the allocation of funds for transportation. On one hand, private companies are becoming increasingly interested in design, construction, and operation of transportation infrastructure. Arizona and California are already active in highway privatization as a way to fund expanded highway networks. On the other hand, if the goal of multimodal planning is generic transportation investment and the best alternative provided by the process favors the allocation of public money to a private enterprise, is this unfair subsidization or is it appropriate to change the basis for allocating funds?

Legal constraints require funds raised by state gas tax and license fees to be used for specific purposes only, either highways or transit. The trend now is toward establishing transportation trust funds for generic transportation investments to move people and goods in the most efficient and safe manner.

Intergovernmental Relations

Regulations and requirements for transportation planning, programming, and financing have been strengthened without a corresponding improvement of the technical and political capacity to respond. Intergovernmental relations are no longer just a technical issue; politics have been thrown into the arena due to the involvement of state executive and legislative branches, local government, regional transportation agencies, "other appropriate agencies" (i.e., environmental), and the public.

The most important organizational issue is the need for a strong institutional framework to support multimodal planning and decision-making. The interrelationship between statewide level multimodal planning and that occurring on the metropolitan level is an area of major concern. This partnership must be strong and respectful, and focused on shared common transportation goals and objectives. Otherwise the planning process will stagnate and lead instead to a widening gap between performance and expectations. Emphasis must be placed on consultation, cooperation, and coordination among interested parties. Keys to meeting goals of recent legislation are providing additional planning and decision-making capacity for transportation, developing many new partnerships, and avoiding gridlock.

Agency Mission

Barriers may impede the development of a true multimodal planning process. These impediments include the traditional modal orientation of major transportation agencies, often found in the agency's mandate. A need has been expressed in the literature for state transportation agencies to redefine their mission beyond building and expanding the highway system. A new mission created to express a broad set of goals beyond improved travel times, safety, and access, one which is tied to both economic and environmental objectives, would be appropriate to support the development of a multimodal transportation system. To have an effective process to plan from a multimodal perspective and to create transportation centers, the organizational structure and mission statement of the lead agency should strongly encourage multimodal planning and intermodal coordination.

Concurrency

Concurrency is a term that has been recently applied in two contexts. First, as a requirement in planning law, that infrastructure must be sufficiently in place to support a development's projected needs. It is also used as a term to relate the mobile source emissions reductions required by the CAAA to the multimodal transportation improvements encouraged under the Intermodal Surface Transportation Efficiency Act (ISTEA). It should be noted that planning requirements differ for air quality attainment and nonattainment areas and for large and small metropolitan areas. The concurrency issue is complicated by the conflicting and modeling policies of transportation planners and air quality planners. Reliable models, integrating the needs of both these groups are lacking. Little is known about the real impact of traffic control measures, for example, on urban mobility, air quality, and energy consumption.

IMPLEMENTATION ISSUES AFFECTING THE DEVELOPMENT OF TRANSPORTATION CENTERS

In addition to the issues related to multimodal transportation planning, there are other factors that directly impact the development of transportation centers. These issues are presented in this section.

Adaptive Reuse and Preservation

In many locations, construction of new transportation centers can be difficult due to a variety of factors, including land cost and zoning constraints, environmental considerations, and political and neighborhood concerns. With this in mind, adaptive reuse or retrofitting of existing facilities and activity centers to perform as transportation centers needs to be considered. Many urban and suburban communities have existing underutilized or unused buildings such as rail stations, bus stations, malls, and warehouses which could be converted to centers of transportation activity. However, emphasis must be placed on efficient connections to larger terminals and those with significant land-use requirements (e.g., ports and airports). Historically, old railway stations became transportation centers due to their central location as the gateway to the city, as have older city airports such as Love Field in Dallas. In addition, Amtrak is mandated to give preference to using station facilities that would preserve buildings of historical or architectural significance.

Joint Development

The role of joint development as a tool to increase the profitability of a transportation center is often underestimated. This requires participation by both the public and private sectors. It can be an anchor for additional new development and neighborhood revitalization while providing needed income to public agencies from the rental of parking, commercial, and office space. It is appropriate to reconsider land-use controls surrounding terminal sites and adjacent properties toward new multimodal transportation objectives. These goals include increasing the concentration of long-distance trips using a single facility so that convenient connections are available to the local transportation system. Ideally, a transportation center will include joint development to maximize profit potential and provide a trip purpose for people separate from simply being an intercity transportation center.

Small Communities

In many small and medium-sized communities, both suburban and rural, the cost of maintaining separate terminals can be quite high. Consolidation of facilities in a transportation center has been demonstrated to provide many economic advantages in staffing; enhanced image and safety; more storage and maintenance space; revitalization and land development in the community; cost sharing of commercial rents, utilities, and facility maintenance; and a single location for connections to local access providers.

Labor Agreements

Certain labor agreements include specific job protection clauses that, while providing employment security, can lead to a less efficient transportation center operation. As an example, if labor agreements with longshoreman did not preclude this alternative, direct loading of containers from ships to railcars on the docks could be investigated. There would be additional limitations involved with customs inspection and duties to overcome. Employees represented by organized labor are, on the whole, against facility consolidation to a single transportation center unless agreements on job protection are reached. However, systems made more efficient with transportation centers will likely require additional employees as business expands in that location.

System Performance

Factors that determine the quality of a multimodal system's performance are the performance of the component subsystems (different modes), interfaces (transfers between modes), and organization (coordinated schedules and integrated tariff structures). These overlap with the factors which influence the demand for an interchange: the organization, ownership, and management of interchange facilities; and the principles of successful interface design from the viewpoint of passengers and operators. To create a successful multimodal system, one should create strategic interfaces between urban and intercity modes of transportation to have reasonably high levels of traffic at each transportation center in the system, and a relatively high level of urban activity in the vicinity of each location.

Several questions on this topic arise. Must all interfaces be at the same location? Should some functions be decentralized to other parts of metropolitan area? There are many potential benefits to the creation of subcenters consisting of complementary, mutually reinforcing urban nodes and satellite transportation centers outside the downtown core. Benefits include accessibility of service to passengers originating and/or terminating outside the downtown core (also applicable to the subcenters), terminal efficiency from through-ticketing passengers, coordinated service, reduced transfer time and cost, consolidated baggage handling, and lower operation costs.

CHAPTER 9. NEW PARADIGM FOR PROMOTING MULTIMODAL TRANSPORTATION INVESTMENT

OVERVIEW

Parts I and II of this report have examined the multimodal transportation environment and current activities related to multimodal transportation. This final part outlines a basic framework for evaluating multimodal transportation alternatives. This framework is the first step in developing effective and efficient multimodal transportation centers for Texas. Currently, there is not a systematic procedure for anlayzing transportation alternatives. The available tools all emphasize a particular mode rather than a cross-modal comparison. This problem was highlighted at a major conference on intermodal transportation planning:

> Research is sorely needed in the development of analytical tools that will allow investment decisions to be examined from the perspective of mobility instead of modal characteristics.[1]

Equally, transportation investment must be concerned with other state and national policies regarding the environment and energy security. The Clean Air Act Amendments of 1990 (CAAA) and the Energy Policy Act of 1992 (EPACT) directly impact transportation alternatives. A more rational basis is needed to analyze transportation investment for the future. While the Intermodal Surface Transportation and Efficiency Act of 1991 (ISTEA) provides the legislative imperative for a more efficient transportation system, it does not provide or suggest mechanisms for making these decisions. Each state and regional authority must develop sound procedures to guide its expenditure of transportation funds. This chapter provides a framework to assist decision-makers in investing these funds in a more cost-effective manner. The following section summarizes the basic problem confronting transportation. Then, several case studies are reviewed examining transportation from a system or social cost perspective. Finally, a framework for evaluating future transportation investment and expenditures is presented.

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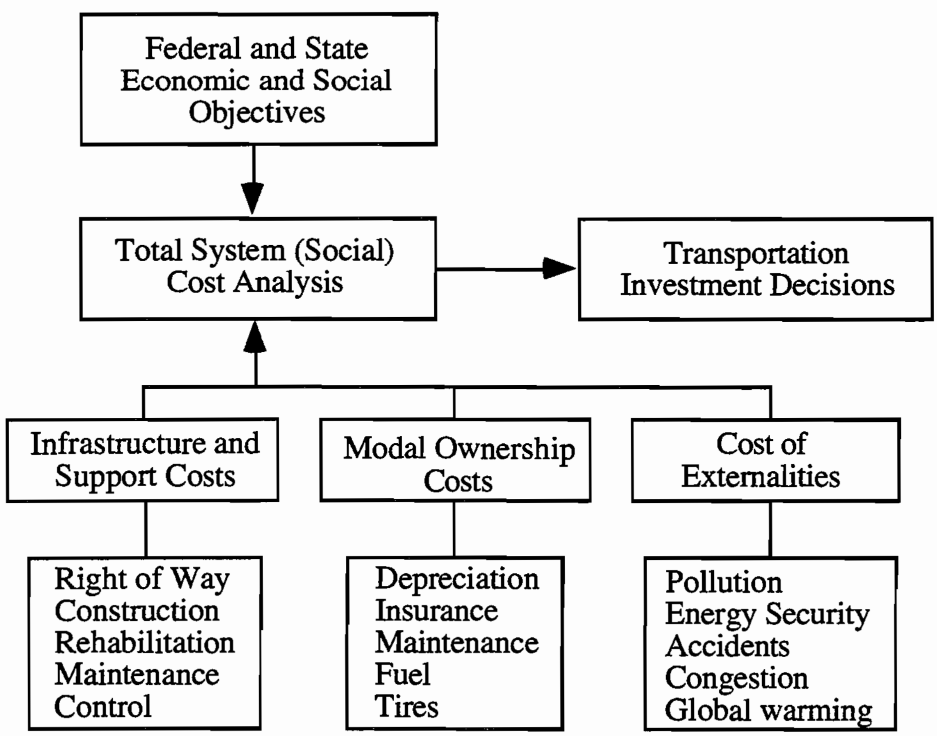
[1] ISTEA and Intermodal Planning: Concept, Practice, Vision, Special Report 240, Transportation Research Board, National Research Council, Washington, D.C., 1993, p. 43.

THE BASIC TRANSPORTATION PROBLEM

A new era has dawned on the transportation system. In the past, transportation primarily focused on providing accessibility for growing mobility demand. The transportation system was, and continues to be, vital to the economic growth of the state. During the last decade, the challenge was to address the dramatic growth in congestion with a resource base ill-equipped to keep pace. Numerous strategies and methods were enacted to address this challenge. For the future, transportation decision-makers will continue to battle this problem, but according to a new paradigm shown in Figure 9-1. Solutions to future transportation problems will address not only the state's mobility needs, but also sustainable energy, environmental, and other needs. In addition to promoting economic growth, transportation affects other state and national policy objectives. Any framework for multimodal transportation investment must complement the federal and state economic and social objectives that frame and define the context of U.S. transportation investment decisions. Foremost among these for the 1990's are urban and rural mobility, energy needs for transportation and the environmental (particularly air quality) consequences of growth in the transportation sector. These are now introduced, both for the continental United States and the state of Texas.

Figure 9-1
Multimodal Transportation Decision Model



The Mobility Crisis

Texas and American motorists confront congestion on a regular and growing basis. It is estimated that congestion costs U.S. consumers between $30 billion and $100 billion annually.[2] This strain on the system, coupled with the decay in the nation's infrastructure, has created a crisis of near-epidemic proportions. The transportation challenge over the next few decades is reflected in the authorizing language of ISTEA. "The National Intermodal Transportation System shall consist of all forms of transportation in a unified, interconnected manner, including transportation systems of the future, to reduce energy consumption and air pollution while promoting economic development and supporting the Nation's preeminent position in international commerce." Accomplishment of this objective -- particularly as it relates to multimodal transportation -- is problematic. The Transportation Research Board (TRB)-sponsored National Conference on ISTEA and Intermodal Planning Issues found that, although much progress has occurred in the multimodal planning area, "much remains to be done. Significant learning experiences need to be shared, and important analytical tools and evaluation methodologies need to be developed."[3] Responding to the transportation challenge is inherently complex. In the past, consumer mobility demands have been addressed through expanded road systems without regard to the total social costs of this investment decision. Addressing transportation problems requires a comprehensive approach that includes multimodal analysis, public/private partnerships, demand management, and the impact of transportation investment on other state and national priorities, i.e., energy conservation and security, clean air, and economic growth.

Multimodal system development has suffered because of the highway focus of transportation policy. Transportation problems are not viewed from a multimodal perspective. The U.S. transportation system is dominated by highway-oriented transportation, as shown in Figure 9-2. Of the $796 billion spent in 1990, 83 percent was for highway surface transportation.

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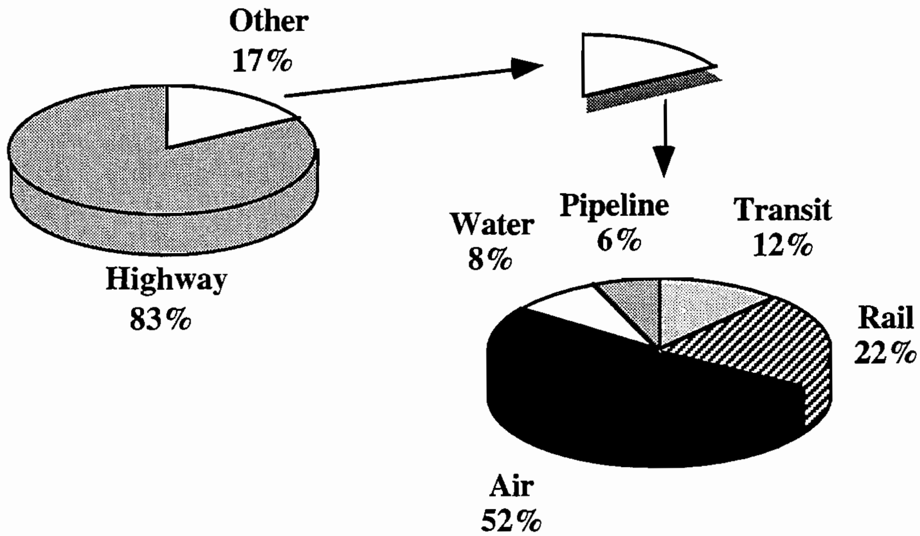
[2] Delivering the Goods, Summary: Public Works Technologies, Management, and Financing. Report OTA-SET-478, Office of Technology Assessment, U.S. Congress, April 1991, p. 1; and James J. MacKenzie, Roger C. Dower, and Donald D.T. Chen, The Going Rate: What it Really Costs to Drive, World Resources Institute, Washington, D.C., June, 1992, p. 19.

[3] ISTEA and Intermodal Planning: Concept, Practice, Vision, p. 15.

Figure 9-2
Modal Distribution of 1990 U.S. Transportation Expenditures

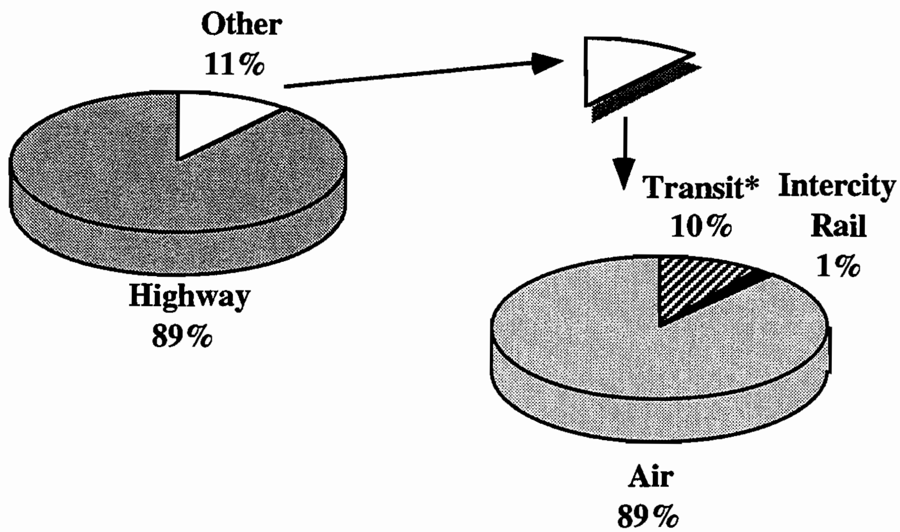


Source: Volpe National Transportation Systems Center, National Transportation Statistics: Annual Report 1992, U.S. Dept. of Transportation, Washington, D.C.: Government Printing Office, June 1992.

This highway expenditure emphasis is reflective of U.S. passenger travel. As shown in Figure 9-3, 89 percent of the 3,733 billion U.S. passenger-miles (6,006 billion passenger-km) of travel are by highway. Within the transit mode, slightly more than 50 percent of the passenger-miles are by highway-surface vehicles. Without a doubt, U.S. passenger travel is dependent on highway infrastructure serving private vehicle needs. The U.S. differs from most European countries, particularly in urban areas (see Figure 9-4), where reliance on highway private vehicle transport is less significant.

The distribution for freight transport is different from that for passenger transportation. As shown in Figure 9-5, there is a more even distribution for the surface transportation modes. Highways do, however, with 32 percent of the 3,558 billion revenue ton-miles (2,006 billion metric ton-km), haul more freight than any other mode. In addition to creating mobility problems, reliance on highway transportation has also contributed to other pressing state and national problems.

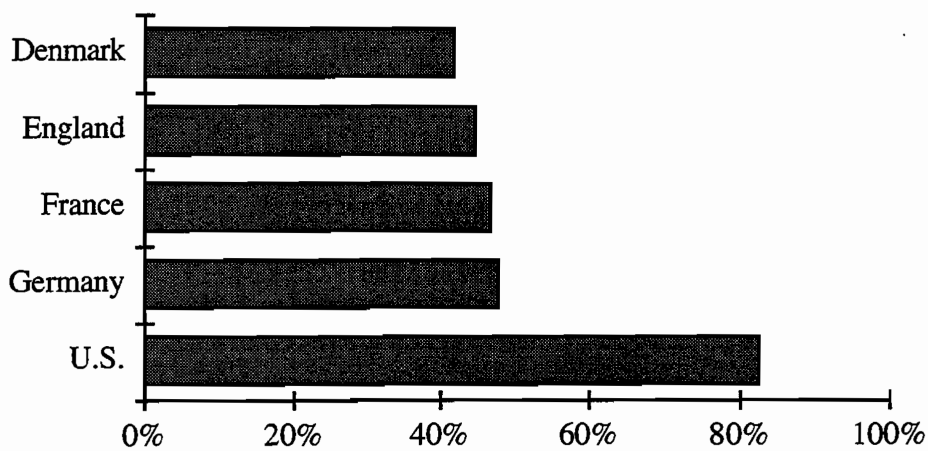
Figure 9-3
Modal Distribution for 1990 Passenger-Miles of Travel



*Transit includes intracity rail and ferryboat services.

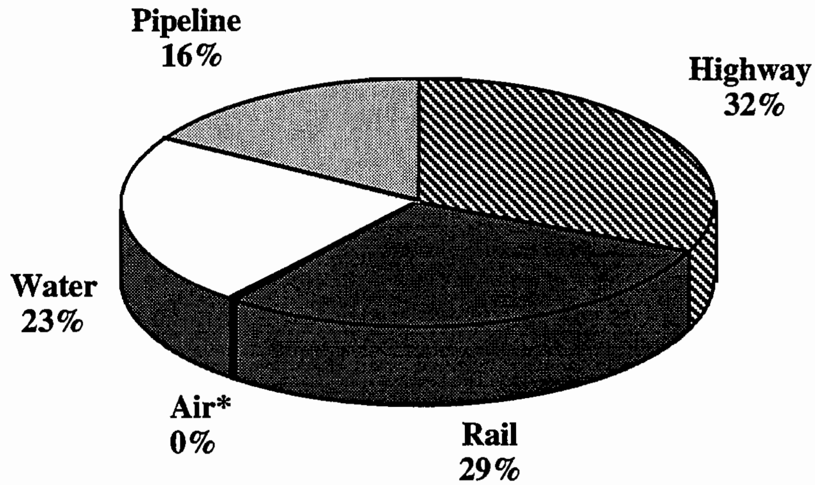
Source: Volpe National Transportation Systems Center, National Transportation Statistics: Annual Report 1992, U.S. Dept. of Transportation, Washington, D.C.: Government Printing Office, June 1992.

Figure 9-4
Percentage of Urban Trips by Private Highway Vehicle



Source: James J. MacKenzie, Roger C. Dower, and Donald D.T. Chen, The Going Rate: What it Really Costs to Drive, World Resources Institute, Washington, D.C., 1992, p. 1.

Figure 9-5
Modal Distribution of 1990 Revenue Ton-Kilometers



*less than 1%.

Source: Volpe National Transportation Systems Center, National Transportation Statistics: Annual Report 1992, U.S. Dept. of Transportation, Washington, D.C.: Government Printing Office, June 1992.

Transportation and Energy

The U.S. is a major energy consumer and the world's largest consumer of petroleum. The U.S. consumed nearly 33.5 quadrillion British Thermal Units (quads) of petroleum in 1992.[4] This dependence on petroleum has serious implications for national security. Most of the world's proven oil supplies are located in politically and socially unstable middle eastern and African regions -- over 70 percent in 1992.[5] Coupled with the significantly higher costs of extracting petroleum reserves ($2 dollars per barrel for middle eastern countries versus $20 or more per barrel in the rest of the world), the U.S. is heavily impacted by the actions of these countries. This influence was demonstrated by the oil embargo of 1973-74, the 1978-79 Iranian revolution, the significant price cuts in 1985-86, and most recently the 1991 Persian Gulf War. In all, the petroleum-dependent countries are highly susceptible to unpredictable shifts in the world market. Consequently, many countries have explored alternative energy sources and petroleum conservation.

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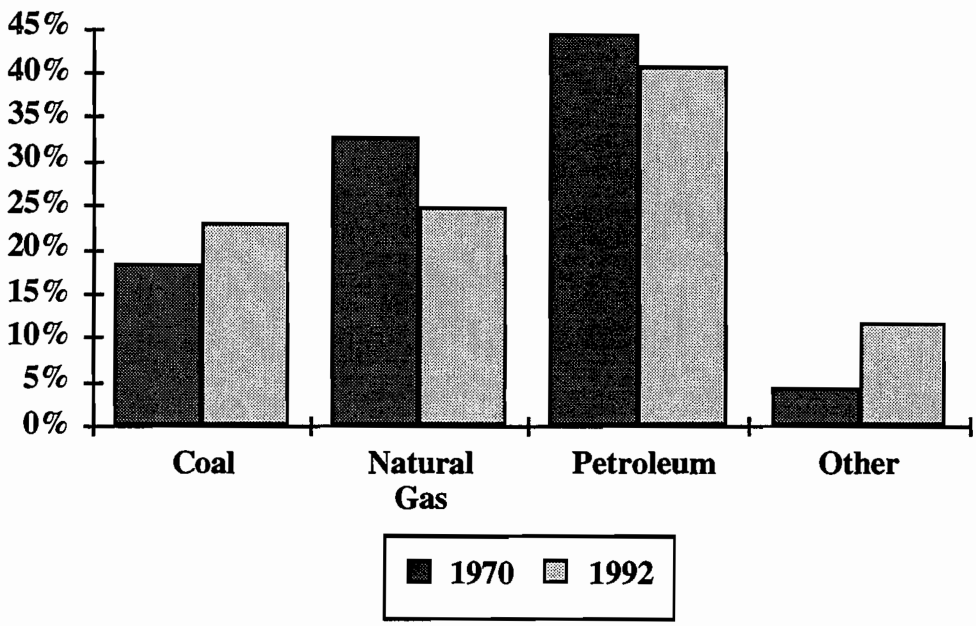
[4] Energy Information Administration (EIA), U.S. Department of Energy. Annual Energy Review 1992, Washington, D.C., June 1993.
[5] Ibid.

The vulnerability to unstable foreign petroleum sources has led to a reduction in petroleum use as a percentage of total U.S. energy consumption, as shown in Figure 9-6. Despite this trend, total petroleum consumption has increased from 29.52 quads in 1970 to 33.47 quads in 1992.[6] With the exception of natural gas, all sources have increased in use since 1970, as shown in Figure 9-7.

Figure 9-6
Distribution of U.S. Energy Consumption



Source: Energy Information Administration (EIA), U.S. Department of Energy. Annual Energy Review 1992, Washington, D.C., June 1993.

U.S. oil consumption comes into clearer focus when examining sector use. As illustrated in Figure 9-8, the residential, commercial, and electric utility sectors have reduced their consumption of petroleum since 1970, while the industrial sector has seen a small increase. On the other hand, the transportation sector's consumption of petroleum has risen dramatically from 7.78 million barrels/day in 1970 to 10.93 million barrels/day in 1993, a 40 percent increase. Within the transportation sector, petroleum accounts for 97

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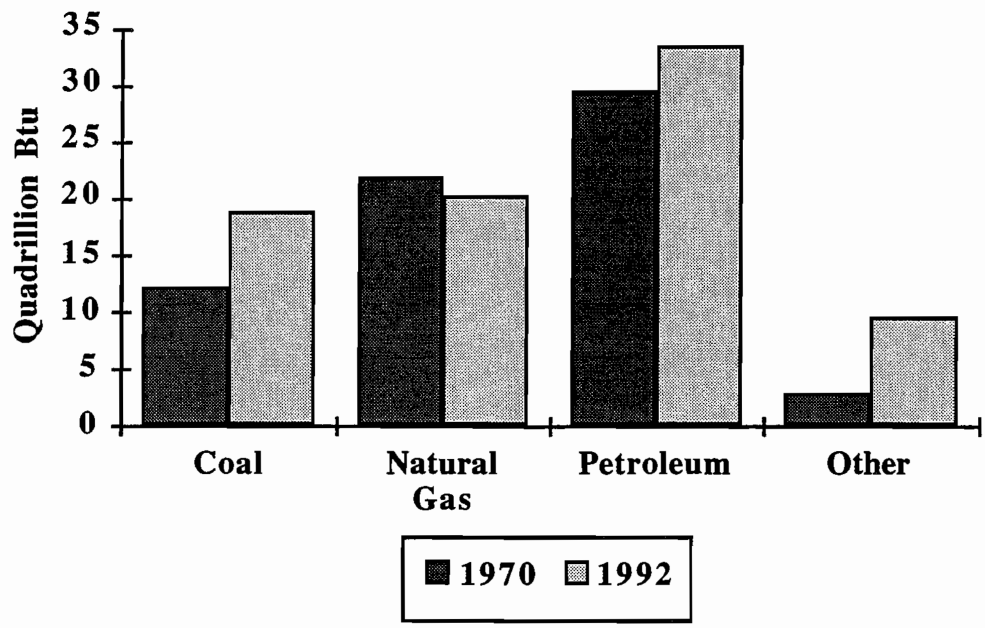
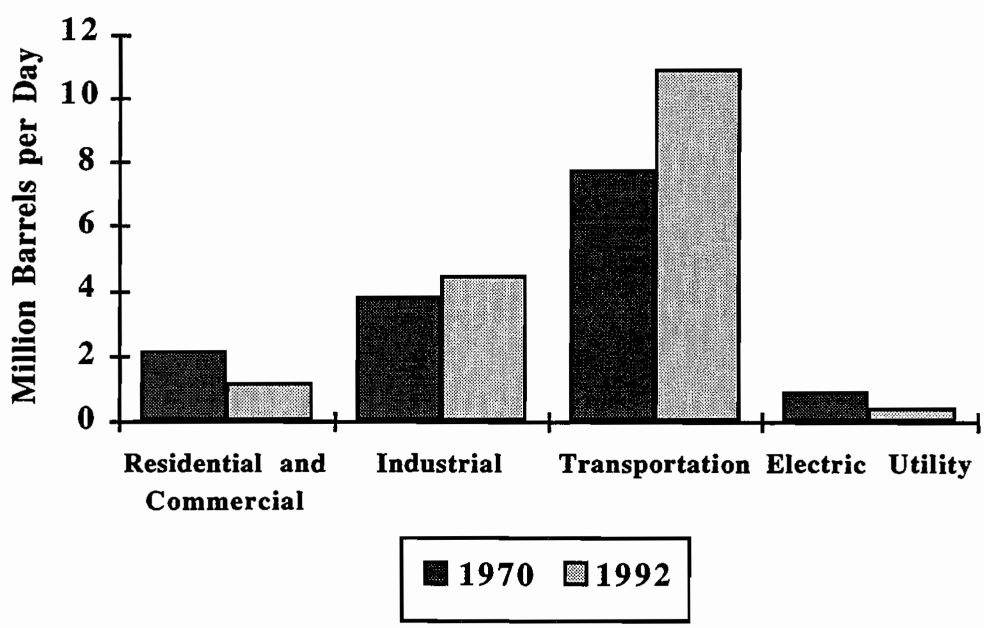
[6] Ibid.

Figure 9-7
U.S. Energy Consumption



Source: Energy Information Administration (EIA), U.S. Department of Energy. Annual Energy Review 1992, Washington, D.C., June 1993.

Figure 9-8
U.S. Petroleum Use by Sector

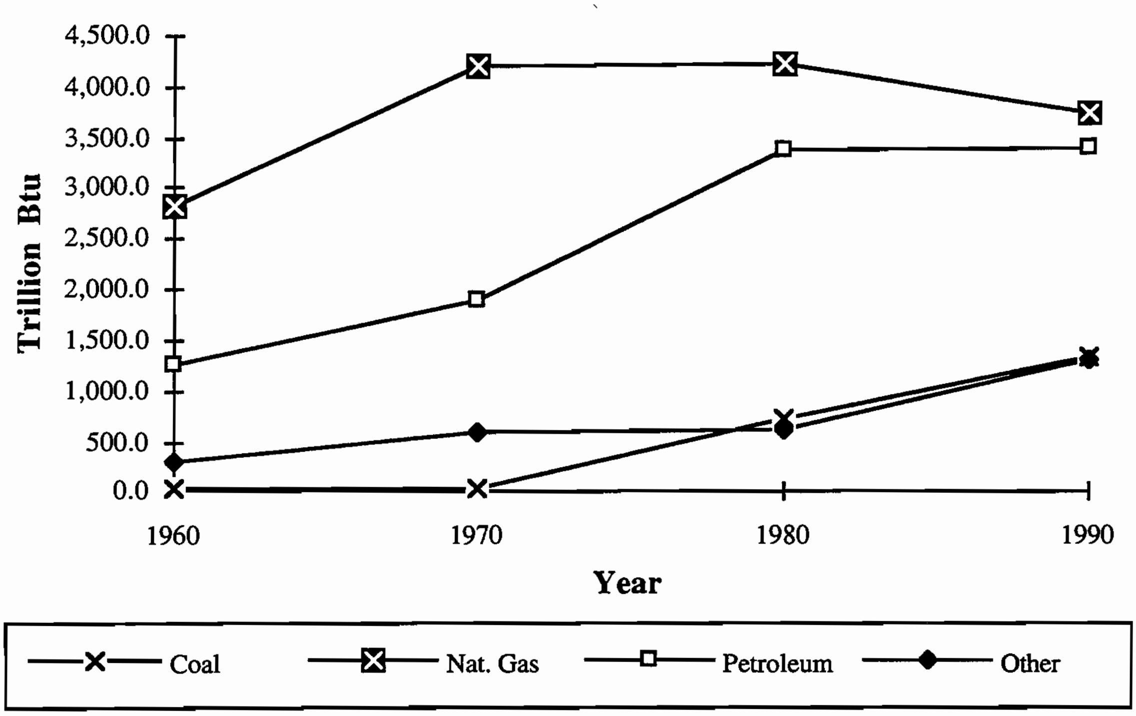


Source: Energy Information Administration (EIA), U.S. Department of Energy. Annual Energy Review 1992, Washington, D.C., June 1993.

percent of total energy consumption.[7] By mode, highways account for nearly 75 percent of total energy consumed in the transportation sector.[8]

Texas is the nation's major state consumer of energy. In 1990, Texas consumed 9,796.3 trillion British Thermal Units (BTUs) of energy, 25 percent more than California, the second largest state consumer.[9] By energy source, Texas was the largest consumer of natural gas, petroleum, and electricity, and the fourth largest consumer of coal. Over the last 30 years, natural gas has served as the major source of energy for Texas. (See Figure 9-9.) However, as a percent of total energy consumption, natural gas has declined

Figure 9-9
Texas Energy Consumption, 1960 - 1990



Source: Energy Information Administration (EIA), U.S. Department of Energy. State Energy Data Report: Consumption Estimates 1960-1990, Washington, D.C., May 1992.

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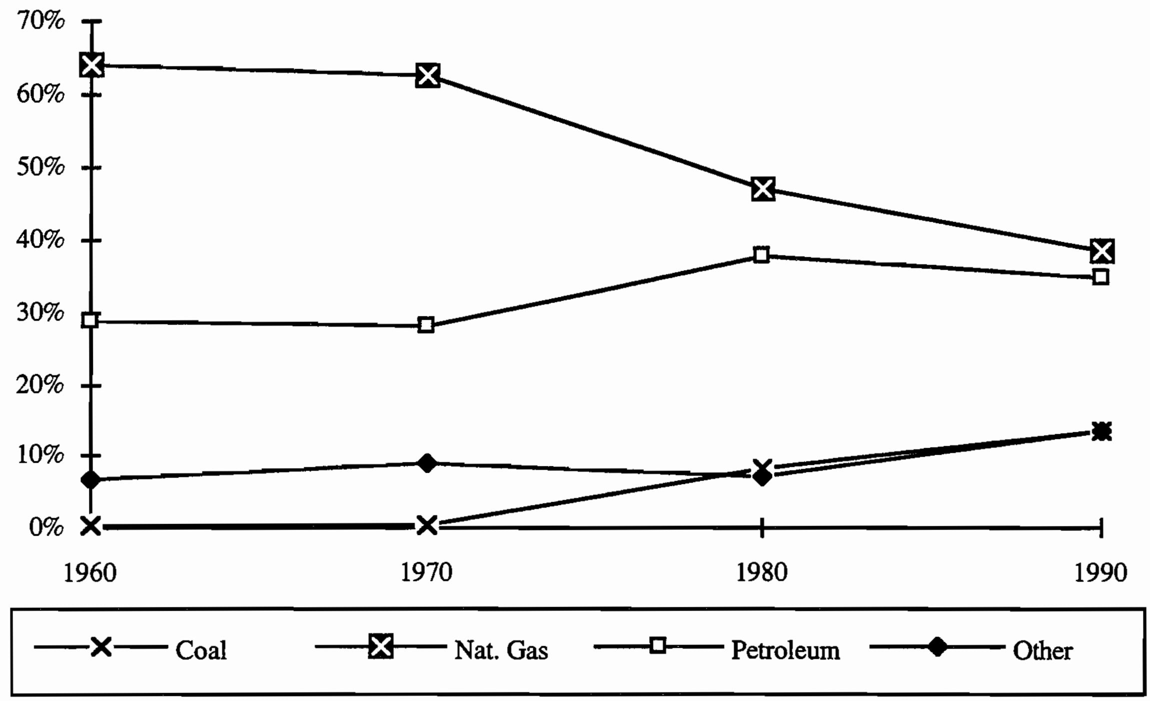
[7] Ibid.
[8] Stacy C. Davis and Sonja G. Strange. Transportation Energy Data Book: Edition 13. Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 1993.
[9] Energy Information Administration (EIA), U.S. Department of Energy. State Energy Data Report: Consumption Estimates 1960-1990, Washington, D.C., May 1992.

steadily since 1960, as shown in Figure 9-10. The largest gains have occurred in the consumption of coal, primarily due to the increased use of coal by electric utilities. Liquefied petroleum gases (LPG) accounted for 6.7 percent of Texas energy consumption in 1960, compared to 10.7 percent in 1990.

Figure 9-10
Percent of Texas Energy Consumption by Source, 1960 - 1990



Source: Energy Information Administration (EIA), U.S. Department of Energy. State Energy Data Report: Consumption Estimates 1960-1990, Washington, D.C., May 1992.

The transportation sector in Texas is somewhat below the national average in its use of petroleum, primarily due to its large natural gas reserves. Petroleum, however, is still the principal energy source for transportation, supplying over 90 percent of its energy needs since 1960. Natural gas is the next major source of energy for transportation, but it declined from 6.8 percent in 1960 to 5.1 percent in 1990. LPG supplied less than one-hundredth of a percent in 1990, down from 1.0 percent in 1960.

Without a doubt, an effective state energy policy must include discussions about transportation. And within the transportation sector, policies affecting the provision of and the demand for highway infrastructure must be seriously examined.

Transportation and the Environment

One of the most pressing issues during the last decade has been concern about environmental degradation. Significant debate has taken place regarding procedures to improve air, water, land-use quality, and global warming. Within the area of air quality, the U.S. Environmental Protection Agency (EPA) has been charged with monitoring urban emissions through establishing National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen oxide (NO_x), ozone (O_3),[10] particulate matter (PM-10), and sulfur dioxide (SO_2). All of these pollutants have deleterious effects on health. While the transportation sector has made significant progress in reducing emissions, it still remains a significant contributor to total emissions. As illustrated in Table 9-1, the transportation sector continues as the primary source of CO emissions, and is the number two contributor for all other regulated emissions, except SO_2. Although carbon dioxide (CO_2) emissions are not regulated, transportation accounts for between 70 and 90 percent of the U.S. CO_2 emissions, an important precursor to the development of greenhouse gases. Future efforts to improve air quality must continue to include the transportation sector.

Table 9-1
Percentage of Regulated Emissions by Sector, 1992

Emission	Transportation	Fuel Combustion	Industrial Processes	Solid Waste & Other
CO	80.2	7.1	5.7	7.0
Pb	30.6	9.7	45.4	14.3
NO_x	44.6	50.7	3.8	0.9
VOCs	36.2	3.1	13.3	47.4
PM-10	30.9	18.5	32.7	17.9
SO_2	4.7	85.8	9.2	0.3

Source: Environmental Protection Agency, Office of Air Quality. National Air Quality and Emissions Trends Report, 1992. EPA 454/R-93-031, Research Triangle Park, North Carolina, October 1993.

[10] Ozone formation is regulated through the control of volatile organic compound (VOC) emissions.

The situation in Texas is even more critical. Almost 10 percent of U.S. CO_2 emissions, 10 percent of U.S. volatile organic compound (VOC) emissions, and 12 percent of U.S. NO_x emissions occur in Texas. The latter two are primarily of local and regional concern through direct human impacts (NO_x and VOC), the formation of tropospheric O_3 (NO_x and VOC), and acid rain (NO_x). CO_2 is of national and international concern with respect to the potential for climate change (greenhouse effect).

Transportation in Texas contributes about 22 percent of the state's CO_2 emissions, 33 percent of its VOCs, and 32 percent of its NO_x. The latter two ratios are somewhat lower than the national average for the transportation sector, while the ratio of CO_2 is comparable to the national average.

CASE STUDIES

The previous section identified several key contextual elements impacting transportation investment decisions. Because of these issues, federal and state policies covering a range of subjects from economic development to social mobility are now more complex than a decade ago. Therefore, as identified in Figure 9-1, inputs traditionally regarded as not relevant to transportation operations (like externalities) now are an important factor in the investment decision.

Rather than listing and describing these inputs in this chapter, the dynamic interrelationships are demonstrated in a series of case studies. The first identifies and determines the full costs of motor vehicle use, linking the recognized direct costs of operation to hidden costs and subsidies that distort welfare efficiencies. This links all three major sub-components in Figure 9-1. Next, the results of a freight corridor analysis are presented where full system costs are considered and modal cost differences reduced when full system inputs are utilized. Again, this requires inputs from all sub-components listed in Figure 9-1. Finally, the planning of a national passenger transportation in Canada demonstrates the types of decisions reached when a total system cost philosophy is employed. Such decisions are typically different from those obtained from the traditional modal cost inputs. The case studies are now described.

Case Study 1: The Real Costs of Highway Transportation

The World Resources Institute (WRI) completed research in 1992 estimating the costs of motor vehicle transportation not directly borne by motor vehicle operators.[11] These costs represent subsidies to motor vehicle operators and result in distorted economic prices. The highway dependency of U.S. passengers is directly related to the effects of these distorted prices in the marketplace. WRI notes the following:

> Today's heavy use of cars and trucks in the United States did not just happen. Nor did it spring solely from some peculiarly American love affair with the automobile. Rather, economic and political forces that partially mask the full costs of driving are at work. Motorists today do not directly pay anything close to the full costs of their driving decisions. However steep the bills for cars, insurance, automobile maintenance, and gasoline may seem to drivers, federal and state policies spare them many other costs. The net effect of these policies is to make driving seem cheaper than it really is and to encourage the excessive use of automobiles and trucks.[12]

WRI identifies two basic cost categories -- market costs and external costs. Market costs are those that can be reflected in economic transactions, while external costs, or externalities, are not directly reflected in market transactions. Market costs include vehicle purchase, vehicle taxes and fees for roadway infrastructure, and other operating and ownership costs. Externalities include the cost to society for pollution, dependence on foreign oil, etc. The total, or social, cost of transportation is the sum of these two cost groups. There are two basic problems associated with these costs. First, vehicle operators do not pay for all of the market costs associated with their motor vehicle transportation. Second, externalities, by definition, are not factored into the transportation decisions of motor vehicle operators. Combined, these two problems create an economic distortion that contributes to the growing congestion problem, as well as higher pollution costs, greater dependency on foreign oil, etc.

Market Costs for Transportation Facilities

WRI identifies four components of market costs for transportation facilities: 1) roadway capital costs, 2) roadway maintenance, 3) highway services, and 4) free parking. Only a portion of these costs are paid directly by users; the rest is paid by society through various general taxes. Roadway capital costs include the construction, improvement, and

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[11] James J. MacKenzie, Roger C. Dower, and Donald D.T. Chen, The Going Rate: What it Really Costs to Drive, World Resources Institute, Washington, D.C., June, 1992.
[12] Ibid., p. 5.

rehabilitation of highways and bridges. Roadway maintenance includes routine patching, bridge painting, snow and ice removal, litter removal, mowing, etc. Highway services include traffic management and enforcement, emergency services to transportation accidents, police enforcement, and routine street maintenance. Finally, free parking, as the name implies, represents the parking provided to consumers at no direct cost. A good example is mall parking. The price for parking is reflected in the price of goods and services purchased and is not directly related to motor vehicle activity. These market cost components are summarized in Table 9-2.

Table 9-2
Market Costs of Motor Vehicle Transportation Facilities, 1989
($ millions)

	User Paid	Society Paid	Total Cost
Roadway Capital	19,980	13,320	33,300
Roadway Maintenance	11,800	7,900	19,700
Highway Services	21,525	68,000	89,525
Free Parking	0	85,000	85,000
TOTAL	53,305	174,220	227,525

Source: James J. MacKenzie, Roger C. Dower, and Donald D.T. Chen, The Going Rate: What it Really Costs to Drive, World Resources Institute, Washington, D.C., June, 1992.

Based on 1989 U.S. vehicle miles of travel (VMT),[13] users paid about $0.025/mile ($0.016/km), but were subsidized $0.083/mile ($0.052/km) by non-users. Users paid for less than 23 percent of the facilities and supporting operations necessary to operate their motor vehicles.

Moreover, the subsidy problem varies significantly by vehicle type. Recent highway cost allocation analysis for Texas shows that heavy trucks paid for only 52 percent of their roadway capital and maintenance costs. Lighter automobiles and pickup trucks paid 31 percent more than their assigned roadway capital and maintenance costs.[14] These inequities create an additional layer of economic distortion. This is explored in greater detail in Case Study 3.

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[13] 2,096,456 million vehicle miles of travel as reported in U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, 1989, Washington, D.C., 1989.

[14] Mark A. Euritt, C. M. Walton, Zane A. Goff, and Dock Burke. Texas Highway Cost Allocation Analysis and Estimates, 1992-1994. Research Report 1919-2/1910-3, Center for Transportation Research, The University of Texas at Austin, November 1993.

External Costs of Motor Vehicle Transportation

WRI identifies several external costs associated with motor vehicle transportation: 1) air pollution, 2) CO_2 emissions, 3) security costs of imported oil, 4) motor vehicle accidents, 5) noise pollution, and 6) vibration damage. The economic value of these externalitites is summarized in Table 9-3. (Since these are external costs, they are all borne by society and not users.)

Table 9-3
External Costs of Motor Vehicle Transportation, 1989
($ millions)

	Society Cost
Air Pollution	10,000
CO_2 Emissions	27,000
Energy Security	25,300
Accidents	55,200
Noise Pollution	9,000
Vibration Damage	6,600
TOTAL	133,100

Source: James J. MacKenzie, Roger C. Dower, and Donald D.T. Chen, The Going Rate: What it Really Costs to Drive, World Resources Institute, Washington, D.C., June, 1992.

Transportation's share of harmful air emissions has been noted previously. The economic cost of these emissions is variable, ranging from $10 billion to $100 billion annually depending on the value assigned to human life, reduced visibility, reduced agricultural productivity, etc. Even greater uncertainty is associated with global greenhouse gas emissions (CO_2). The $27 billion estimate is based on efforts to reduce carbon by 20 percent. The energy security estimate is based on annual federal outlays to maintain a petroleum reserve as well as a portion of the defense budget for maintaining a presence in the Persian Gulf. The accident cost represents the cost not borne directly by drivers and includes primarily losses suffered by pedestrians and bicyclists. Noise pollution is valued primarily in property value losses, and vibration damages are for housing and utilities alongside or underneath roadways. A final cost not shown is the opportunity cost of right-of-way used for transportation purposes. This cost is only partially reflected in the construction cost discussed previously. Overall, the cost of externalities is about $0.063 per vehicle-mile of travel ($0.039/vehicle-km). This amount represents more than a 150 percent increase over what users directly pay for facilities.

Impact of Non-User Market Costs and External Costs

In addition to the user fees and charges paid by vehicle owners and operators, which represent their contribution to roadway and support facilities, they also pay other ownership costs. These costs, as well as the cost per mile (km) traveled for a full-sized automobile, are presented in Table 9-4. In addition to these costs, vehicle operators also experience lost productivity due to congestion, as well as pain, suffering, and lost quality of life as a result of motor vehicle accidents. WRI estimates that these two user-incurred costs amount to $100 billion and $228.5 billion annually, respectively.

Table 9-4
Motor Vehicle Operating Costs, 1991
(¢/mile / ¢/km)

	User Cost
Vehicle Depreciation	13.5 / 8.4
Insurance	7.2 / 4.5
Maintenance	4.5 / 2.8
Tires	1.0 / 0.6
Finance Charges	2.5 / 1.6
Fuel and Oil (excluding taxes)	5.0 / 3.1
TOTAL	33.7 / 20.9

Source: Jack Faucett Associates, Cost of Owning & Operating Automobiles, Vans & Light Trucks, 1991. FHWA-PL-92-019, Federal Highway Administration, Washington, D.C., April 1992.

The total social cost of motor vehicle transportation is shown in Table 9-5. Congestion and accident costs not covered by insurance are often counted as an externality, since there is not a market for distributing these costs. Given this assumption, motor vehicle operators pay for only 54 percent of the social costs of highway transportation. Of the remaining 46 percent, 48 percent, or $0.146/mile ($0.091/km), is paid by society and 52 percent, or $0.157/mile ($0.098/km), is borne by user, albeit inefficiently.[15] The real impact on the consumer can be seen if these external costs and market costs not borne by motor vehicle users are translated into a fuel tax. Excluding congestion and insurance-suffering costs as externalities, i.e., assuming they are paid by motorists already although inefficiently, these costs translate into a fuel tax of $2.64/gallon ($0.70/liter). This is a 28 percent increase in vehicle operating costs for the

[15] Allocating congestion and non-insurance accident costs on a short-run marginal cost basis would reduce the overall associated costs. Short-run marginal costs more efficiently allocate these non-market costs.

Table 9-5
Market Costs of Motor Vehicle Transportation Facilities, 1989
($ millions)

	Total ($billions)	¢/mile	¢/km
User Paid Facility Costs	53.3	2.5	1.6
User Operating Costs	706.5	33.7	20.9
Subtotal	759.8	36.2	22.5
User Congestion Costs	100.0	4.8	3.0
User Accident Costs	228.5	10.9	6.8
Subtotal	328.5	15.7	9.8
Society Facility Costs	174.2	8.3	5.2
Society External Costs	133.1	6.3	3.9
Subtotal	307.3	14.6	9.1
TOTAL	1,395.6	66.5	41.4

Source: Previous tables.

average full-size vehicle.[16] Undoubtedly, this would have an effect on motorist driving patterns and even modal choice.

The WRI study represents an effort to identify the real costs of motor vehicle operations. This is an important element in considering future transportation investment. The current subsidies, either as non-paid market costs or external costs, are economic distortions that result in over-utilization of the nation's roadway assets.

Case Study 2: Pennsylvania Interstate 80 Freight Corridor Study

The problem of distorted economic prices is also demonstrated in recent work by the Texas Research and Development Foundation (TRDF) for the Pennsylvania Interstate 80 (I-80) coridor.[17] In this study, the system costs of intercity rail-freight transportation

[16] The cost increase is more dramatic if congestion and accident (suffering) costs are considered non-market costs and the average cost is used to allocate to society. In this case, the fuel tax would be $5.46/gallon ($1.44/liter). This would represents an 84 percent increase in vehicle operating costs. Using a marginal cost approach would yield a cost somewhere between $2.64/gallon ($0.70/liter) and $5.46/gallon ($1.44/liter).

[17] Robert Harrison, Michael T. McNerney, Mark Euritt, and W. Ronald Hudson, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, Texas Research and Development Foundation, Austin, Texas, September, 1991.

and truck-freight transportation are compared on a life-cycle basis for I-80. The basic premise of this study is captured in a 1992 problem statement from the National Cooperative Highway Research Program:

> Modally oriented planning and investment have been shown to be economically inefficient and generate fewer social benefits than might be achieved under a multimodal approach. For example, research has indicated that the abandonment of rail lines, or the diversion of truck traffic from rail to truck, can significantly increase highway infrastructure costs. Thus, the investment of public funds inrail branch lines can not only generate shipper benefits but also reduce future highway and bridge costs.[18]

Truck Freight System Costs

Historical records from the Pennsylvania Department of Transportation (PennDOT) were analyzed to identify the I-80 facility costs. These costs include initial construction costs, rehabilitation costs, and maintenance costs. Initial construction costs are further disaggregated to identify right-of-way costs, and the costs of bridge and roadway construction. Maintenance costs are detailed to identify snow removal costs, routine maintenance costs, and truck weight enforcement costs. The life-cycle facility costs attributed to trucks are summarized in Table 9-6.[19] Further analysis in the TRDF study reveals that of the 2.2¢/ton-mile (1.5¢/metric ton-km) facility cost, trucks pay only 1.0¢/ton-mile (0.7¢/metric ton-km) in user fees and charges. Trucks receive a 1.2¢/ton-mile (0.8¢/metric ton-km) subsidy from other vehicle users, or, in other words, trucks pay only 45 percent of their true facility costs.

External costs for truck operations in the I-80 study include only accidents and related costs. (Emission rates, without an associated economic value, are estimated.) Accident related costs for trucks on the I-80 corridor are shown in Table 9-7. In addition to emergency response-related costs, law enforcement costs include highway patrol activities excluding truck weight enforcement. Cleanup costs are defined as the costs to public agencies and private organizations for removing accident debris from the roadway and returning it to serviceable condition. Delay-time costs represent the monetary value of occupant time lost as a consequence of delay imposed by truck-related accidents. Likewise, delay-fuel costs are the additional fuel consumed from truck accident-induced

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[18] National Cooperative Highway Research Program, "Research Problem Statement," Project No. 20-29, 1992.

[19] Total facility costs for all vehicles was $8.6 million/mile ($5.3 million/km). Of the total costs, trucks are responsible for 76.8 percent of the life cycle costs (77 percent of initial construction, 79 percent of rehabilitation, and 70 percent of maintenance). See Robert Harrison, et al, 1991, for details.

Table 9-6
I-80 Facility Truck Costs, 1990

	$/mile of Highway[a]	$/km of Highway	$/ton-mile of Freight[b]	$/met. ton-km of freight[b]
Initial Construction				
Right-of-Way	6,943	4,315	.00027	.00018
Bridges	61,822	38,423	.00243	.00166
Roadway	304,176	189,047	.01194	.00818
Subtotal	372,941	231,785	.01464	.01002
Rehabilitation	150,222	93,364	.00589	.00403
Maintenance				
Snow Removal	13,883	8,628	.00054	.00037
Routine	29,782	18,510	.00117	.00080
Weight Enforcement	2,789	1,733	.00011	.00008
Subtotal	46,454	28,871	.00182	.00125
TOTAL	569,617	354,020	.02235	.01530

[a] Annualized cost from 1966 to 1990 based on a 7% discount rate.
[b] Based on 297 million tons of freight hauled on I-80.

Source: Robert Harrison, Michael T. McNerney, and Mark A. Euritt, "Determining Truck System Costs for the Pennsylvania Intersate 80 Corridor," in Transportation Research Record No. 1359: Economics, Finance, and Administration, Transportation Research Board, National Research Council, Washington, D.C., 1992, p. 70.

Table 9-7
I-80 Accident-Related Truck Costs, 1990

	$/mile of Highway	$/km of Highway	$/ton-mile of Freight	$/met. ton-km of freight
Property Damage	1,298	807	.0001	.00007
Injuries	26,367	16,387	.0012	.00082
Fatalities	61,543	38,249	.0028	.00192
Law Enforcement	14,022	8,715	.0006	.00041
Cleanup	392	244	.00002	.00001
Delay-time	4,853	3,016	.0002	.00014
Delay-fuel	1,127	700	.0001	.00007
TOTAL	109,602	68,118	.0050	.00344

Robert Harrison, Michael T. McNerney, Mark Euritt, and W. Ronald Hudson, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, Texas Research and Development Foundation, Austin, Texas, September, 1991, p. 70.

congestion. Overall, the delay costs represent costs imposed on others and not on the vehicles involved in the accident. For intercity traffic, accident-related costs are not particularly significant, accounting for only 5 percent of the total vehicle operating system cost for trucks on I-80.[20]

Truck operating costs currently paid by truck operators include labor costs for drivers, equipment costs, fuel costs, insurance, and other overhead costs. For the I-80 corridor, truck operating costs are estimated at $1.6 million/highway-mile ($1.0 million/highway-km) or $0.0706/ton-mile ($0.0484/metric ton-km) of freight.[21]

Total truck system costs are summarized in Table 9-8. As in the WRI study, truck highway operators do not pay for their system costs of highway transportation. Intercity truck operators on the I-80 corridor receive a subsidy amounting to 22.93¢/mile (14.24¢/km) of operation. Overall, truck operators on this corridor pay only 82 percent of their system costs. The TRDF study represents conservative values for the social cost of transportation, because it does not include energy security costs, pollution costs, and global warming costs. Admittedly, these costs per mile (km) of travel should be less, since I-80 moves over rural Pennsylvania. Nevertheless, truck operators receive a public subsidy for their freight operations along this corridor.

Table 9-8
I-80 Truck System Costs, 1990
(per distance traveled)

	¢/mile	¢/km	¢/ton-mile	¢/met. ton-km
Truck Paid Facility Costs	13.25	8.23	1.00	0.68
Truck Operating Costs	93.55	58.14	7.06	4.84
Subtotal	106.80	66.37	8.06	5.52
Society Facility Costs	16.30	10.13	1.23	0.84
Society External Costs	6.63	4.12	.50	0.34
Subtotal	22.93	14.25	1.73	1.18
TOTAL	129.73	80.62	9.79	6.70

Robert Harrison, Michael T. McNerney, Mark Euritt, and W. Ronald Hudson, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, Texas Research and Development Foundation, Austin, Texas, September, 1991, p. 70.

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[20] Robert Harrison, et al, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, p. 70.

[21] Robert Harrison, et al, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, p. 48-56.

Rail Freight System Costs

The Consolidated Rail Corporation (Conrail) operates a rail line that basically parallels I-80 in Pennsylvania. A similar systems cost analysis is performed for the rail freight operation, but with one major difference. Rail infrastructure is funded by private rail operators and not through a program of government user taxes and fees. As such, market costs are borne directly by the railroad. Table 9-9 presents a summary of Conrail's facility costs. These costs do not include the cost of yards along the route, since truck costs do not include their terminal or unloading costs.

Table 9-9
Conrail Facility Costs, 1990

	$/mile of Railway	$/km of Railway	$/ton-mile of Freight[a]	$/met. ton-km of freight[a]
Initial Construction				
Real Estate	2,212	1,375	0.000060	.000041
Track	148,849	92,510	0.004023	.002755
Bridges	32,075	19,935	0.000867	.000594
Switches	3,936	2,446	0.000106	.000073
Signal/Communications	6,000	3,729	0.000162	.000111
Subtotal	193,072	119,995	0.005218	.003574
Rehabilitation	79,313	49,293	0.002144	.001468
Maintenance				
Track	15,044	9,350	0.000407	.000279
Communication	1,278	794	0.000035	.000024
Signal	8,971	5,576	0.000242	.000166
Bridges	2,920	1,815	0.000079	.000054
Subtotal	28,213	17,535	0.000763	.000523
TOTAL	300,598	186,823	0.008125	.005565

[a] Based on 37 million short tons (33.6 million metric tons).

Source: Robert Harrison, Michael T. McNerney, Mark Euritt, and W. Ronald Hudson, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, Texas Research and Development Foundation, Austin, Texas, September, 1991, p. 62.

Operating costs for Conrail along this corridor vary by type of train. Unit trains of coal operate at $0.00936/ton-mile ($0.00641/metric ton-km), general merchandise cars operate at $0.01437/ton-mile ($0.00984/metric ton-km), and trailer-on-flatcars (TOFC) operate at $0.01571/ton-mile ($0.01076/metric ton-km). Based on their number of car loadings, the average Conrail operating cost is $0.01286/ton-mile ($0.00881/metric ton-km) for 1990.[22] Included in the rail operating costs are labor and fringe benefits, equipment, adminstrative, signal and dispatching costs, fuel, and the costs of locomotives and rolling stock.

Accident and related costs for the Conrail corridor are relatively insignificant compared to truck-freight transportation. Based on a five-year average of Conrail accidents and property damages reported to the Federal Railroad Administration (FRA), the total cost of accidents is estimted at $1.8 million per year for 15.7 billion ton-miles (22.9 billion metric ton-km) of freight. On a ton-mile (km) basis, the cost of accidents is 43 times greater by truck than by rail.

The total system cost for rail transportation is summarized in Table 9-10. Based on the identified costs, only a small portion (0.5%) of rail is subsidized. Again, emissions are estimated without an associated economic value. Total emissions for CO, VOCs, NO_x, and PM-10 amount to 51 tons per system mile (74 metric tons per system km) annually versus 96 tons per system mile (140 metric tons per system km) for I-80.[23]

Table 9-10
Rail Freight System Costs, 1990
(per distance traveled)

	¢/car-mile	¢/car-km	¢/ton-mile	¢/met. ton-km
Rail Paid Facility Costs	45.4	28.2	0.81	0.50
Rail Paid Operating Costs	72.0	44.8	1.28	0.80
Subtotal	117.4	73.0	2.09	1.30
Society External Costs	0.6	0.4	0.01	0.01
TOTAL	118.0	73.4	2.10	1.31

Source: Robert Harrison, Michael T. McNerney, Mark Euritt, and W. Ronald Hudson, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, Texas Research and Development Foundation, Austin, Texas, September, 1991, p. 68-77.

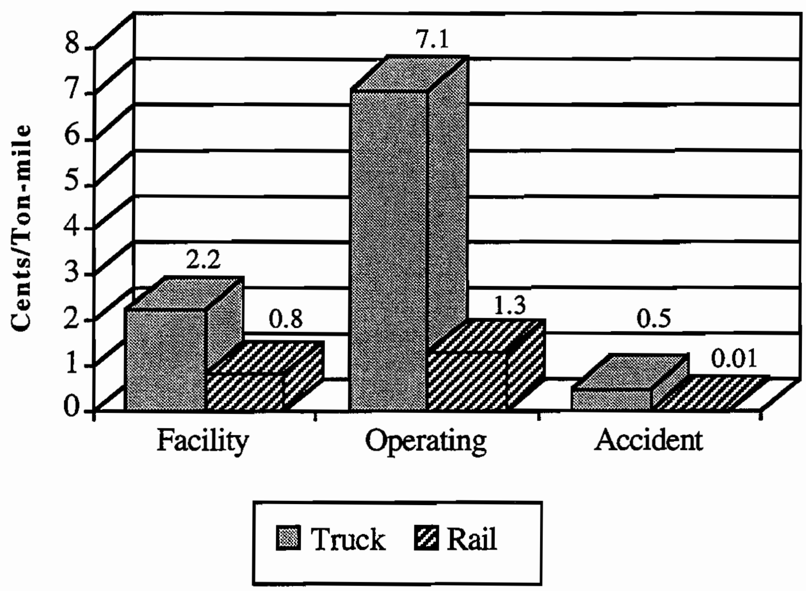
22 Robert Harrison, et al, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, p. 67.

23 Robert Harrison, et al, Truck Versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridors, p. 73.

Rail Versus Truck Comparison

As demonstrated in Figure 9-11, rail freight system cost per ton-mile (km) is significantly less (4.5 times less) than truck freight per ton-mile (km). The public subsidy received by the truck industry results in an economic disparity that shifts freight traffic from the rail to the highway. Followup work on this TRDF study demonstrated that truck operators paying their full system costs would result in a diversion of between 1.0 billion and 5.8 billion ton-miles (1.5 billion to 8.5 billion metric ton-km), or between $35 million and $204 million in revenues, from truck freight to rail freight.[24]

Figure 9-11
Rail Versus Truck System Cost Comparison, 1990



Source: Previous tables.

The TRDF study demonstrates what happens when the full costs of transportation are not considered when investing public infrastructure resources. Public subsidies through improper user charges and fees create inefficient economic distortions. While the TRDF cross-modal comparison provides important information for analyzing intercity freight traffic, it is only a beginning. The terminal costs of freight operations must also be analyzed, as well as other social costs, as identified in the WRI study.

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[24] Robert Harrison and Mark Euritt, Truck to Rail Diversion Over the Conrail Network Using Pennsylvania I-80 Corridor Data, Texas Research and Development Foundation, Austin, Texas, October 1, 1992.

Case Study 3: Canada National Passenger Transportation Study

The Royal Commission on National Passenger Transportation began a three-year project in October 1989 to "inquire into and report upon a national integrated intercity passenger transportation system to meet the needs of Canada in the 21st century."[25] The fundamental premise of this inquiry is that transportation users pay for the full cost of the transportation system. This philosophy states:

> While a passenger transportation system heavily subsidized by the taxpayer may have been appropriate for Canada for the past 125 years, it is not the right one for Canada in the 21st century. Now, and in the decades ahead, Canada needs a system supported by the travellers who use it and not by government subsidies, departments and central controls. Passenger transportation should be treated more like a business.
>
> Instead of governments controlling who may carry passengers, we believe in a system controlled by consumers in the marketplace. Rather than governments providing most of the infrastructure, we believe the marketplace should do that job, with governments confining themselves to the roles of referee and policy maker. As a change from centralized and often remote jurisdictional arrangements, we believe transportation-related responsibilities should be moved to the level of government closest to the people that can most efficiently handle the responsibilities.
>
> In the past, passenger transportation has depended on major funding from general taxpayers, many of whom travel only a little or not at all. We believe that the system should now be self-sustaining; travellers should get what they pay for and pay for what they get.[26]

Based on this philosophy, the Royal Commission set out to develop a comprehensive, long-range, passenger transportation plan for the nation.

National Transportation Study Objectives

The Royal Commission identified four basic policy objectives to guide the development of their recommendations. They are

1) safety;

2) protection of the environment;

3) fairness to taxpayers, travellers and carriers; and

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[25] Directions: The Final Report of the Royal Commission on National Passenger Transportation: Summary, Ottawa, Canada, 1992, p. 1.
[26] Ibid., p. 5.

4) efficiency, so that services are provided only where benefits to the individual traveller equal or exceed the cost, and given levels of service are provided at the lowest possible cost.[27]

A number of other national objectives were explored, including "nation-building" and "regional development." Interestingly, these important objectives were determined to be inappropriate guides for transportation investment. It was recommended that these objectives be pursued through other national programs.

Long-Term Passenger Transportation Framework

The framework developed by the Royal Commission includes an in-depth study of transportation laws, regulations, and institutions. The analysis attempted to develop a more consistent and comprehensive approach to the transportation system. The process begins with identifying the components of the passenger transportation system. These transportation components, as shown in Figure 9-12, include terminals, links, and traffic control.

Figure 9-12
Components of Transportation System

		Infrastructure		
Mode	**Carrier**	**Terminals**	**Links**	**Traffic Control**
Road	Cars	Car Parking	Roads (including bridges)	Police, road signs and signals, traffic control laws and regulations
	Buses	Bus terminals		
Air	Airplanes	Airports (including runways)	Air navigation systems	Air traffic control
Rail	Trains	Stations	Railway tracks	Dispatch, signal systems
Water	Ferries	Ferry terminals (including wharves and ferry slips)	Waterways and canals (including navigational aids)	Vessel traffic services

Source: Directions: The Final Report of the Royal Commission on National Passenger Transportation: Summary, Ottawa, Canada, 1992, p. 9.

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27 Ibid. p. 6.

The Canada study follows the same basic approach outlined in Case Study 1, but on a modal basis. The system-wide, or social, costs of domestic intercity passenger travel in Canada are shown in Table 9-11. Special transportation taxes and fees are revenues generated by users but not used to finance transportation infrastructure or related items. As such, they are considered offsets to society costs. Like the U.S., Canada is dependent on highway-automobile transportation. This is a result of the large subsidies provided for highway users. The average travel cost per passenger is shown in Table 9-12. The information in Table 9-12 demonstrates that highway-automobile transportation is not the least-cost mode. Moreover, the table demonstrates that society costs for other non-highway modes are even more significant as a percentage of total passenger costs per distance travelled.

Recommendations

Based on the total systems cost philosophy and the stated objectives, the Royal Commission made a number of recommendations, including the following twelve:

1) Each traveller pay the full cost of his or her travel, and travellers, in total, pay the full cost of the passenger transportation system, including those costs related to protecting the environment, safety and accidents.

2) Travellers with physical or mental disabilities have opportunities similar to those enjoyed by all Canadians to use public passenger transportation.

3) Competition and market forces be the prime agents in providing viable and efficient carrier services.

4) Terminals, links and traffic control services be priced on a terminal-by-terminal, link-by-link and service-by-service basis.

5) Where there is sufficient competition, or where users are in a strong bargaining position with providers of terminals, links or traffic control services -- and so long as there are appropriate charges for environmental damage, safety and accidents -- competition and market forces determine prices and investment decisions for passenger transportation infrastructure.

6) Where regulations are required, they be designed to ensure that pricing and investment decisions will be similar to what would otherwise occur through competitive market forces.

7) Governments will be responsible for establishing policies in relation to the passenger transportation framework, setting and enforcing standards, gathering and reporting information to the public, ensuring

Table 9-11
System Costs of Domestic Intercity Travel, 1991
(Canada $ millions)

	Automobile (210 billion pass-km)			Bus (3.3 billion pass-km)			Airplane (25 billion pass-km)			Train (1.4 billion pass-km)			Ferry (0.85 billion pass-km)			All Intercity Travel (240 billion pass-km)		
Type of Cost	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total
Infrastructure	0	4,486	4,486	0	10	10	556	845	1,401	41	0	41	0	40	40	597	5,381	5,978
Environmental	0	1,211	1,211	0	8	8	0	247	247	0	9	9	0	17	17	0	1,492	1,492
Accident	7,874	172	8,046	13	0	13	25	0	25	3	0	3	1	0	1	7,916	172	8,088
Special Transp. Tax/Fee	2,461	-2,461	0	9	-9	0	149	-149	0	6	-6	0	7	-7	0	2,632	-2,632	0
Vehicle/Carrier Operating	22,817	0	22,817	277	8	285	3,595	0	3,595	104	459	563	205	98	303	26,998	565	27,563
Total	33,152	3,408	36,560	299	17	316	4,325	943	5,268	154	462	616	213	148	361	38,143	4,978	43,121

Source: Directions: The Final Report of the Royal Commission on National Passenger Transportation: Summary, Ottawa, Canada, 1992, p. 11.

Table 9-12
System Costs of Domestic Intercity Travel, 1991
(Average costs: ¢ per passenger-km)

	Automobile			Bus			Airplane			Train			Ferry			All Intercity Travel		
Type of Cost	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total
Infrastructure	0.0	2.1	2.1	0.0	0.3	0.3	2.2	3.4	5.6	2.9	0.0	2.9	0.0	4.7	4.7	0.2	2.2	2.4
Environmental	0.0	0.6	0.6	0.0	0.2	0.2	0.0	1.0	1.0	0.0	0.6	0.6	0.0	2.0	2.0	0.0	0.6	0.6
Accident	3.7	0.1	3.8	0.4	0.0	0.4	0.1	0.0	0.1	0.2	0.0	0.2	0.1	0.0	0.1	3.3	0.2	3.5
Special Transp. Tax/Fee	1.2	-1.2	0.0	0.3	-0.3	0.0	0.6	-0.6	0.0	0.4	-0.4	0.0	0.9	-0.9	0.0	1.1	-1.1	0.0
Vehicle/Carrier Operating	10.9	0.0	10.9	8.4	0.2	8.6	14.4	0.1	14.5	7.4	32.8	40.2	24.1	11.6	35.7	11.2	0.2	11.4
Total	15.8	1.6	17.4	9.1	0.4	9.5	17.3	3.9	21.2	10.9	33.0	43.9	25.1	17.4	42.5	15.8	2.1	17.9

Source: Directions: The Final Report of the Royal Commission on National Passenger Transportation: Summary, Ottawa, Canada, 1992, p. 10.

a sufficient level of research, maintaining competition and regulating monopolies.

8) Decision-making authority of governments be assigned to the level of government that is both closest to the people and most able to efficiently exercise such authority.

9) Governments tax and regulate all modes equally.

10) Decision-making be transparent so that Canadians can understand why governments or their agencies make the passenger transportation choices they make, and so that those making decisions can be held accountable.

11) In cases where time is required to ease the problems caused by steep price adjustments, or where a carrier, a particular carrier service, a terminal or a link is to be given another chance to survive within the new framework, financial assistance be designed to encourage adjustment.

12) If a carrier, a particular carrier service, a terminal or a link cannot survive despite a reasonable period of time for adjustment, the terminal or link be closed or the service discontinued.[28]

All the recommendations are consistent with a user-pay philosophy except the provision for persons with disabilities. These additional costs required by transportation providers are typically shared costs for all transportation users. If mobility-impaired persons must pay for the full costs of this accessibility, they may be priced out of the system. The most appropriate method would be for these mobility-impaired persons to receive general subsidies that are then used to pay for the real cost of their transportation decision. This would allow complete cost recovery for transportation providers, albeit somewhat inefficient.

Additionally, the recommendations provide for a period of transition while transportation providers adjust to the new approach. The subsidies recommended in number 11 are guided by the following:

1) Where possible, the subsidy should move people in the most efficient way, regardless of mode.

2) The subsidy should be borne by taxpayers in the jurisdiction that makes the decision, not by other transportation users.

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[28] Ibid., pp. 8-27.

3) The subsidy should be on a declining basis, for a reasonable adjustment period, and then terminated.[29]

The Royal Commission study included a projection of the change in transportation costs if these recommendations are adopted. Table 9-13 presents a year 2000 scenario assuming that no changes are made in the current policies for transportation. This baseline projection can be compared to Table 9-14, which illustrates the effect of implementing these recommendations. Finally, Table 9-15 illustrates the difference between the baseline scenario and the recommendations scenario. Based on these recommendations, users will pay an additional $3.871 billion. However, society costs will decline by $5.32 billion, representing a major savings to taxpayers. Overall, total intercity transportation costs will decline by $1.449 billion.

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[29] Ibid., p. 27.

Table 9-13
System Costs of Domestic Intercity Travel with Status Quo, Year 2000
(Canada 1991 $ millions)

	Automobile (210 billion pass-km)			Bus (3.3 billion pass-km)			Airplane (25 billion pass-km)			Train (1.4 billion pass-km)			Ferry (0.85 billion pass-km)			All Intercity Travel (240 billion pass-km)		
Type of Cost	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total
Infrastructure	0	5,769	5,769	0	10	10	723	701	1,424	45	0	45	0	52	52	768	6,532	7,300
Environmental	0	1,247	1,247	0	8	8	0	266	266	0	9	9	0	22	22	0	1,552	1,552
Accident	9,213	202	9,415	12	0	12	33	0	33	3	0	3	1	0	1	9,262	202	9,464
Special Transp. Tax/Fee	3,199	-3,199	0	9	-9	0	165	-165	0	6	-6	0	10	-10	0	3,389	-3,389	0
Vehicle/Carrier Operating	28,954	0	28,954	277	8	285	4,127	0	4,127	99	435	534	264	113	377	33,721	556	34,277
Total	41,366	4,019	45,385	298	17	315	5,048	802	5,850	153	438	591	275	177	452	47,140	5,453	52,593

Source: Directions: The Final Report of the Royal Commission on National Passenger Transportation: Summary, Ottawa, Canada, 1992, p. 30.

Table 9-14
System Costs of Domestic Intercity Travel with Recommendations, Year 2000
(Canada 1991 $ millions)

	Automobile (210 billion pass-km)			Bus (3.3 billion pass-km)			Airplane (25 billion pass-km)			Train (1.4 billion pass-km)			Ferry (0.85 billion pass-km)			All Intercity Travel (240 billion pass-km)		
Type of Cost	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total
Infrastructure	5,491	0	5,491	9	0	9	1,133	40	1,173	32	0	32	47	0	47	6,725	40	6,765
Environmental	1,122	0	1,122	6	0	6	253	0	253	4	0	4	17	0	17	1,405	0	1,405
Accident	9,414	0	9,414	12	0	12	33	0	33	1	0	1	1	0	1	9,470	0	9,470
Special Transp. Tax/Fee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vehicle/Carrier Operating	28,480	0	28,480	237	5	242	4,127	0	4,127	181	60	241	320	28	348	33,411	93	33,504
Total	44,507	0	44,507	264	5	269	5,546	40	5,586	218	60	278	385	28	413	51,011	133	51,144

Note: Costs for means of travel do not sum to costs for all intercity travel. The latter includes allowance for costs of increased car, bus, and airplane travel to replace assumed reduction in rail travel between the status quo and recommendations scenarios.

Source: Directions: The Final Report of the Royal Commission on National Passenger Transportation: Summary, Ottawa, Canada, 1992, p. 31.

Table 9-15

Change in System Costs of Domestic Intercity Travel Between Status Quo and Recommendations, Year 2000

(Canada 1991 $ millions)

	Automobile (210 billion pass-km)			Bus (3.3 billion pass-km)			Airplane (25 billion pass-km)			Train (1.4 billion pass-km)			Ferry (0.85 billion pass-km)			All Intercity Travel (240 billion pass-km)		
Type of Cost	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total	Users	Society	Total
Infrastructure	+5,491	-5,769	-278	+9	-10	-1	+410	-661	-251	-13	0	-13	+47	-52	-5	+5,957	-6,492	-535
Environmental	+1,122	-1,247	-125	+6	-8	-2	+253	-266	-13	+4	-9	-5	+17	-22	-5	+1,405	-1,552	-147
Accident	+201	-202	-1	0	0	0	0	0	0	-2	0	-2	0	0	0	+208	-202	+6
Special Transp. Tax/Fee	-3,199	+3,199	0	-9	+9	0	-165	+165	0	-6	+6	0	-10	+10	0	-3,389	+3,389	0
Vehicle/Carrier Operating	-474	0	-474	-40	-3	-43	0	0	0	+82	-375	-293	+56	-85	-29	-310	-463	-773
Total	+3,141	-4,019	-878	-34	-12	-46	+498	-762	-264	+65	-378	-313	+110	-149	-39	+3,871	-5,320	-1,449

Note: Costs for means of travel do not sum to costs for all intercity travel. The latter includes allowance for costs of increased car, bus, and airplane travel to replace assumed reduction in rail travel between the status quo and recommendations scenarios.

Source: Directions: The Final Report of the Royal Commission on National Passenger Transportation: Summary, Ottawa, Canada, 1992, p. 32.

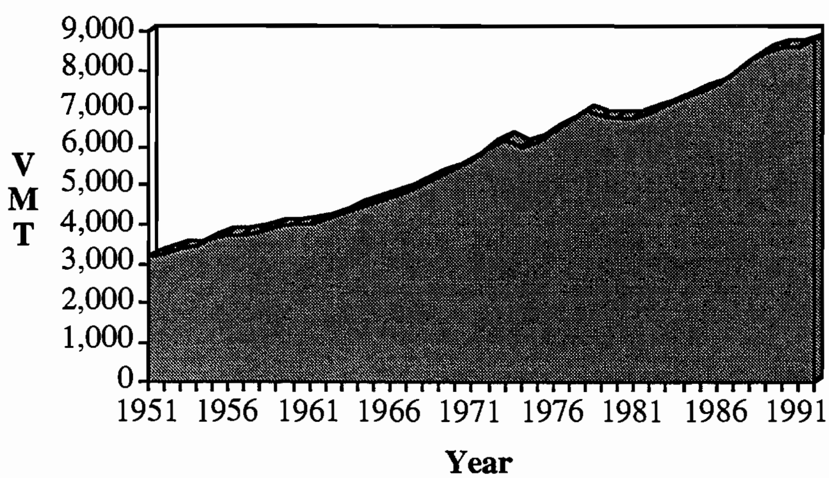
RECOMMENDATIONS FOR MULTIMODAL INVESTMENT

The case studies presented in the previous section demonstrate the development of multi-disciplinary system evaluations in the area of transportation investment. In the 1990's, the need to both address intermodal investments equitably from a national perspective and incorporate social externalities like accident rates and air quality into modal choice, dictates the widespread adoption of such evaluation frameworks.

Currently, the U.S. has a distorted modal transportation pattern resulting from historic subsidies, particularly those associated with highway use and cost recovery. Unfortunately, it is not easy to correct such distortions, particularly in the area of freight movement where the truck-freight industry wields powerful political influence. Highway use and dependence has grown throughout the last decade and has produced a social dependence on highways with attendant problems and costs.

Inefficient transportation investment has resulted in a growing demand for highway infrastructure. As shown in Figure 9-13, U.S. per capita travel has increased from 3,171 miles (5,102 km) per year in 1951 to 8,781 miles (14,129 km) per year in 1992. The dependence on highway-automobile transportation is unlike that of most other

Figure 9-13
U.S. Per Capita Vehicle Miles of Travel



Source: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, Washington, D.C., various years.

developed countries. As shown in Figure 9-14, U.S. passengers travel farther by automobile than passengers in any of the countries presented, and rely more on automobile transportation as a percent of total travel. Related to this is a major difference in vehicle operating costs as reflected in fuel prices.[30] As illustrated in Figure 9-15, fuel prices, which include government taxes, are signficantly lower in the U.S.

In order to change this highway emphasis and develop an effective multimodal transportation system, a multi-dimensional framework must be developed to evaluate the economic consequences of various transportation alternatives. A systems perspective for addressing mobility problems focuses on the total social costs of transportation decisions. Social costs consist of infrastructure and related support costs, modal ownership and operating costs, and the costs of externalities. Investment of public dollars for transportation must be made to maximize public gain. This can be done only if overall system costs are minimized. Using a systems, or social, cost approach will change, fundamentally, the evaluation of transportation alternatives. The case studies demonstrate the significance of these other costs. Failure to utilize a social, or total system, cost approach will only exacerbate future mobility problems. ISTEA provides a legislative imperative to develop a multimodal transportation plan and central to the success of this legislation is a new framework for analyzing transportation investment of a type presented in this chapter.

Finally, two observations can be made concerning the analysis procedures used in a total system, or social, cost approach. First, at the macro-level it may be useful to consider a multi-attribute methodology utilizing non-monetary inputs for decision-making. Traditionally, evaluation efforts have concentrated on attributing monetary values to all system outputs, including social items. Multi-attribute methodologies incorporate both the physical or actual units of attributes (i.e., number of accidents, tons of pollutant) and monetary values of attributes (i.e., operating costs) in order to avoid the difficult process of valuing externalities. This valuation problem is a consequence of utilizing cost-benefit methods for planning purposes.

Second, at the micro-level, additional work is needed in marginal cost analysis, particularly determining the price or cost values for subsequent economic evaluation. Again, traditional investment decisions have been based on average costs (typically long

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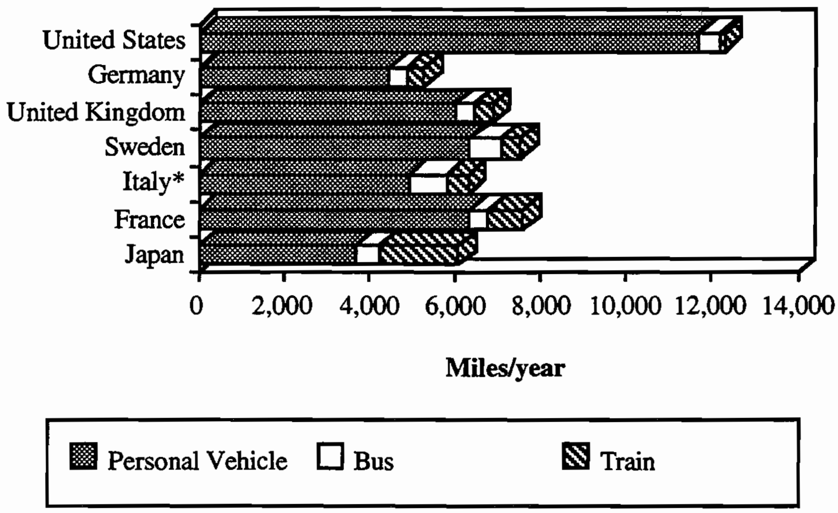
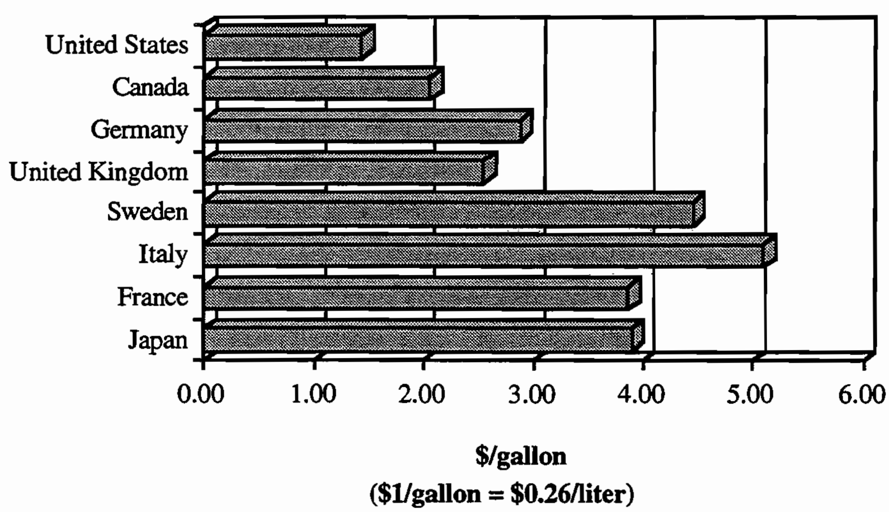
[30] While not the major vehicle operating cost component, fuel prices do represent a significant variable cost, accounting for more than 50 percent of the variable costs of vehicle ownership.

Figure 9-14
Passenger Travel Per Capita, 1989



Source: Stacy C. Davis and Sonja G. Strange. Transportation Energy Data Book: Edition 13. Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 1993, pp. 1-20 to 1-24; U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census. Statistical Abstract of the United States, 1991: The National Data Book. 111th edition, Washington, D.C., 1991, pp. 830-832.

Figure 9-15
Gasoline Prices, 1991
(includes taxes)



Source: Stacy C. Davis and Sonja G. Strange. Transportation Energy Data Book: Edition 13. Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 1993, p. 1-9.

run). Both for social welfare optimization and implementing efficient operating practices for transportation facilities, short run marginal cost analysis is essential. These two observations, if implemented, should strengthen the case for adopting a total system, or social, cost methodology, as recommended in this study, for transportation decision-making.

CHAPTER 10. SUMMARY

OVERVIEW

This report began with a conceptual discussion of intermodal and multimodal transportation. Intermodal transportation focuses on connecting several different modes into a seamless transportation system. Multimodal transportation focuses on transportation system links and providing users with a choice of modes along those links. The first two parts of this report documented current activities related to multimodal and intermodal transportation as well as the catalysts driving the move towards multimodal and intermodal transportation systems and major issues that confront its successful implementation. Parts I and II address the first three goals of this report, listed below; Part III addresses the fourth goal, and the appendices (Part IV) address the fifth goal.

1) Define terminology uniformly and synthesize a definition of a "transportation center" in keeping with current national policy.

2) Perform an in-depth literature review and contact appropriate federal, state, and local officials outside of Texas to identify experiences with multimodal planning and transportation centers.

3) Identify key issues affecting the implementation of multimodal planning and transportation centers.

4) Develop investment decision methodologies that will aid engineers, planners, and decision-makers.

5) Inventory the status of non-highway transportation systems in Texas.

Initially, this research project focused on the development of multimodal transportation centers. Following the first year of research and the writing of the interim report, the project focus was shifted to develop a more meaningful approach to multimodal transportation analysis. Based on an extensive review of transportation centers, it became apparent that their development hinged on the development of new methodologies for evaluating transportation alternatives. The second year effort focused on an examination of modal activities in the state and the development of a new framework for evaluating multimodal transportation.

CONCLUSIONS

Over the years, a number of approaches have been developed to assist decision-makers in analyzing and evaluating transportation alternatives. While important progress has been made in broadening the evaluation of alternatives -- including consideration of organizational and community standards and priorities, impacts on development both commercial and residential, impact on user costs, etc. -- they remain insufficient to address long-term transportation investment needs. Fundamental to the evaluation of transportation alternatives is the most basic of questions: What is the true, or social, cost of transportation? The social cost of transportation is more inclusive than what is generally considered by policy-makers. It includes not only the infrastructure and related support costs, but also user costs and externalities.

Multimodal transportation planning is couched between two basic problems: first, the efficient use of the transportation system, and second, the promotion of social policies, such as clean air, energy security, etc. Central to both of these concerns is an accurate reflection of all costs on the users. Failure to include all costs in an analysis of transportation alternatives, can result in the selection of unproductive or inefficient alternatives. Moreover, given the user-pay philosophy of transportation, i.e., users of transportation pay for the full costs of transportation, it is important that the facility costs and externalities become communicated and internalized to users. Failure to adequately reflect these costs results in serious system inefficiency. In economic parlance, users will over-consume a resource that is undervalued because elements considered as free goods carry, in fact, a social cost.

Historically, transportation alternatives are presented for investment approval with limited information. When examining transportation alternatives, decision-makers are generally provided with information only on the facility and related maintenance costs of a particular infrastructure investment. The decision-maker must subjectively incorporate the impact of other social costs into this investment. The Intermodal Surface Transportation Efficiency Act (ISTEA) attempts to move in this direction by encouraging a broader evaluation of transportation investment opportunities, but, as discussed in previous sections, falls short in promoting a true multimodal transportation system.

The major recommendation of this report is that transportation planners and decision-makers consider the full range of transportation costs when analyzing multimodal opportunities and strategies. Public resources are limited and demand efficient use. The framework presented in Chapter 9 provides a basis for efficient and rational investment of public transportation dollars. The adoption of a National Highway System (NHS) under ISTEA will result in the need to evaluate high priority corridors, super highways, new links between the interstate and state highway systems and intermodal connectivities to airports, rail intermodal yards, and seaports. Based on the information presented in this report, we argue that such investments should be analyzed using inter-disciplinary, multimodal full-cost systems. Therefore, the Texas Department of Transportation will maximize benefits to the Texas consumer by integrating a total system, or social, cost approach into its planning process. Current work on highway cost allocation should be expanded to develop a true program of transportation cost recovery. More modal data will be needed to complete this effort and the data in the appendices provide a good starting point. This data collection should be undertaken in conjunction with major state transportation providers. In the end, successful development of a multimodal transportation system will require the joint efforts of both the public and private sectors through an on-going process and a long-term commitment.

PART IV

APPENDICES

MODAL INVENTORY

As part of the background data developed for this project, a detailed inventory of transportation facilities in Texas, by mode, was conducted. This appendix presents the results of the modal inventory. The inventory includes information on routes, traffic volume, operational characteristics, and costs for each transportation mode. This appendix is a description of the statewide transportation system. Four subsections describe the rail, air, water, and highway transportation system components in the state of Texas. The data presented represent the most recent information available at the time these sections were written (mid-1993).

APPENDIX A

RAIL TRANSPORTATION IN THE STATE OF TEXAS

This subsection presents information regarding rail transportation in the state of Texas, the majority of which was gathered from data provided by Amtrak, Texas TGV, TxDOT reports, and State Supplements to the ICC R-1 Reports as submitted to the Railroad Commission of Texas. The most recent year for which data were available was 1991.

A.1 RAIL PASSENGER SERVICE

At the present time, rail passenger service in Texas is provided by Amtrak and a number of small tourist-oriented operations. A number of urban rail systems are in the planning stages (light rail transit in Dallas is under construction), as is the proposed high-speed rail project linking Dallas-Fort Worth, Houston and San Antonio.

A.1.1 Intercity System

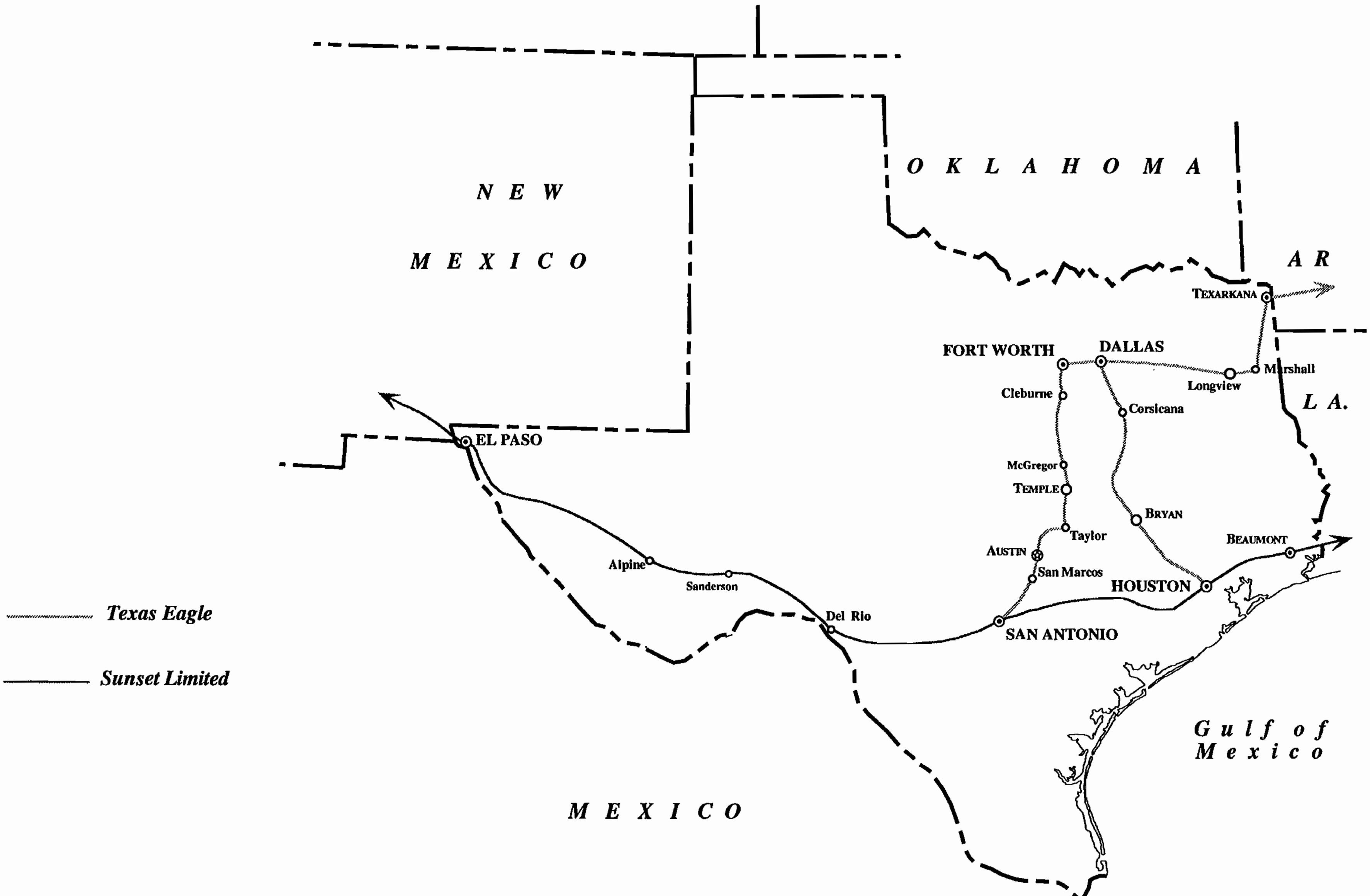
A.1.1.1 Amtrak (National Railroad Passenger Corporation)

In the past eight years, Amtrak service in the State of Texas has expanded to include additional routes and has also become more frequent. Amtrak operates two trains through Texas, the *Texas Eagle* and the *Sunset Limited* (see Figure A-1).

Prior to 1990, the *Texas Eagle* operated on a tri-weekly schedule, serving the following Texas cities: Marshall, Longview, Dallas, Fort Worth, Cleburne, MacGregor (Waco), Temple(Fort Hood, Killeen), Taylor, Austin, San Marcos, and San Antonio. Through service is provided on this train to Little Rock, Saint Louis, and Chicago. Beginning January 19, 1990, Amtrak began daily operation of the *Texas Eagle* service from Chicago. The train splits into two sections in Dallas, with new service to Corsicana, College Station/Bryan, and Houston (Galveston). Three days a week the *Texas Eagle* combines with the *Sunset Limited* in San Antonio for through service to El Paso, Tucson, and Los Angeles. The *Texas Eagle* provides coach seating, sleeping car accommodations, and cafe service using Amtrak Superliner equipment. In addition, a dining/lounge car is available Chicago-Dallas-San Antonio.

The *Sunset Limited* operates on a tri-weekly schedule, serving the following Texas cities: Beaumont (Port Arthur), Houston (Galveston), San Antonio, Del Rio, Sanderson, Alpine (Big Bend National Park), and El Paso. Through service is provided on this train to New Orleans, Tucson, Phoenix, and Los Angeles. Amtrak Superliner coaches, sleeping cars, a dining/lounge car, and a Sightseer lounge are the accommodations provided on the *Sunset Limited*.

Figure A-1: Map of Amtrak Passenger Routes in Texas, 1992



SOURCE: *State of Texas Amtrak Facts*, National Railroad Passenger Corp., Washington D.C., 1992.

Ridership at Texas station stops for fiscal years 1984 to 1991 is shown below in Table A-1. Total Amtrak ridership during this period has risen from 150,367 passengers in 1984 to 305,449 passengers in 1991, an increase of over 100 percent. Figure A-2 shows the total ridership trend for this period. Figure A-3 shows the ridership trend for the major Texas cities of Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio.

Table A-2 provides a summary of Amtrak monetary outlays for goods and services in the state of Texas for fiscal years 1984 to 1991. The table is separated into three parts. The first section lists procurements and contracts made by Amtrak in the state of Texas. It is further divided into those cities where significant expenditures were made. The majority of expenditures occurred in Dallas. The second part shows Texas resident Amtrak employment and those employees' annualized earnings. In addition, Amtrak has contracted in some years with private railroads who employ Texas residents involved in the provision of rail passenger services. A summary of the expenditures for these services and the number of contract employees is contained in the third section of the table.

A.1.1.2 Texas High-Speed Rail Corporation (Texas TGV)

In May 1989 the Texas legislature passed the Texas High-Speed Rail Act which created the Texas High-Speed Rail Authority. This agency was directed under the act to receive applications from the private sector for a franchise to construct, operate, maintain, and finance a high-speed rail facility. Then, the agency was to review the applications to determine whether it was in the public interest to grant the franchise, and subsequently to select the most qualified applicant.

Two applicants responded by the deadline of January 16, 1991, to the Request for Proposals and submitted the application fee: one representing German technology and one the French technology. The Board of the Texas High-Speed Rail Authority found the project in the public interest and awarded the franchise to Texas TGV Consortium. The franchisee is now incorporated as the Texas High-Speed Rail Corporation (THSRC), a company whose major players include Morrison-Knudsen Corporation, Wilbur Smith & Associates, GEC Alsthom/Bombardier, and Rail Transportation Systems (a French National Railways, SNCF, subsidiary) among others. No state tax money is to be spent on the project under the franchise agreement.

Table A-1: Amtrak Passenger Boardings/Deboardings Fiscal Years 1984 - 1991

Station	FY-1984	FY-1985	FY-1986	FY-1987	FY-1988	FY-1989	FY-1990	FY-1991
Alpine	1,907	1,667	1,947	1,955	1,720	2,008	1,754	1,719
Austin	13,302	15,106	14,277	14,483	15,621	11,973	18,913	22,795
Beaumont	3,724	3,566	4,099	3,963	5,010	4,058	3,677	3,026
Cleburne	2,687	1,829	1,826	2,059	2,302	1,939	3,279	2,845
College Station/Bryan	-	-	-	-	-	7,090[1]	8,370	10,582
Corsicana	-	-	-	-	-	3,143[1]	2,380	2,141
Dallas	26,474	24,304	25,119	27,614	33,035	54,892[1]	64,350	76,695
Del Rio	1,304	1,201	1,238	1,386	1,598	1,745	1,235	1,136
El Paso	15,855	17,130	17,536	18,930	26,516	22,656	19,676	18,591
Fort Worth	12,636	12,226	12,171	14,354	15,565	14,049	23,623	23,926
Houston	17,055	15,115	17,101	16,970	22,151	45,370[1]	47,514	55,297
Longview	5,612	5,376	5,607	5,976	6,759	7,069	9,519	11,431
McGregor	1,865	1,904	1,904	2,261	4,203	1,955	6,901	8,349
Marshall	4,527	3,884	4,163	3,815	2,308	4,537	3,099	3,202
San Antonio	31,128[2]	31,505[2]	30,640[2]	31,678[2]	31,272	22,691	46,186	48,557
San Marcos	2,346	3,027	2,445	3,027	2,652	1,621	2,211	2,541
Sanderson	577	582	522	660	665	952	413	380
Taylor	3,722	3,772	3,505	4,186	4,732	3,723	4,626	4,596
Temple	5,647	5,239	5,133	5,894	5,958	5,191	7,495	7,478
TOTAL	150,367	147,433[3]	148,233	159,211	182,067	216,752	272,391[4]	305,449

[1]Reflects the addition of Dallas - Corsicana - Bryan/College Station - Houston section to the Texas Eagle service during FY1988.
[2]FY1984 - FY1987 San Antonio ridership is the sum of two separate stations in the city.
[3]Total does not include ridership of 360 for Laredo in FY1985. Extension of Texas Eagle service offered only this year.
[4]Total does not include ridership of 130 San Antonio - Houston Inaugural trip in FY1990.

SOURCE: *State of Texas Amtrak Facts*, National Railroad Passenger Corp., Washington D.C., 1984 - 1991.

Figure A-2: Total Amtrak Ridership in Texas 1984 - 1991

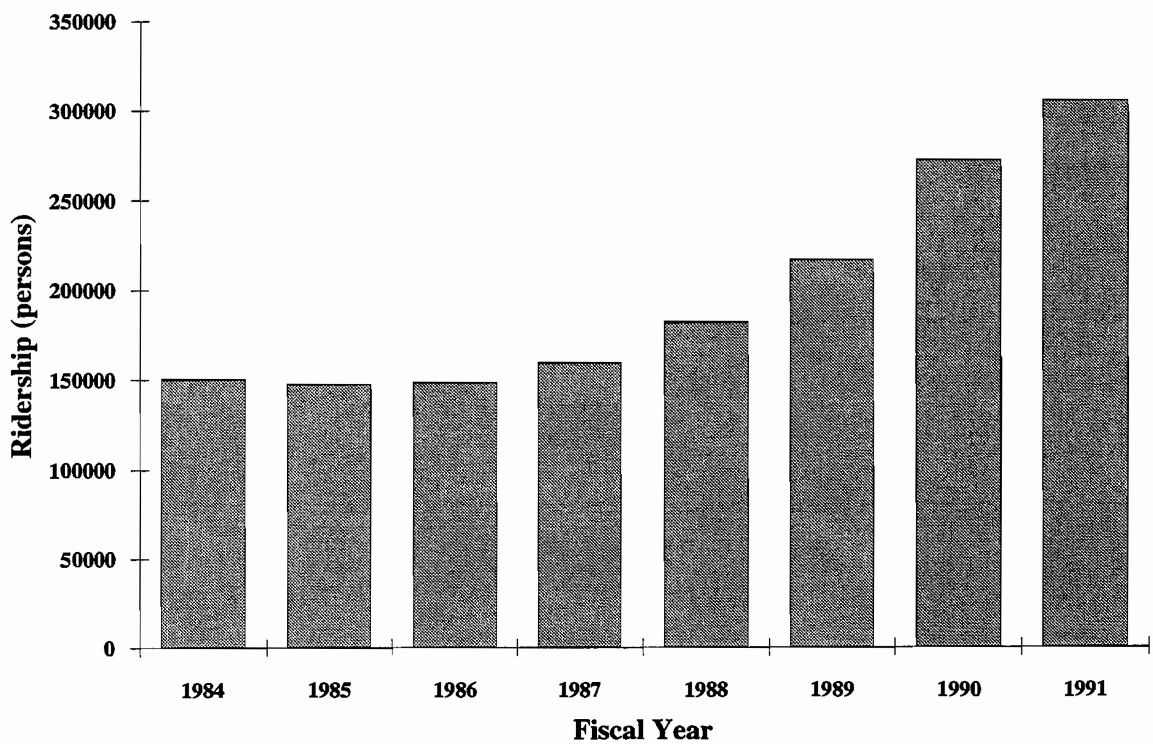


Figure A-3: Amtrak Ridership In Major Texas Cities 1984 - 1991

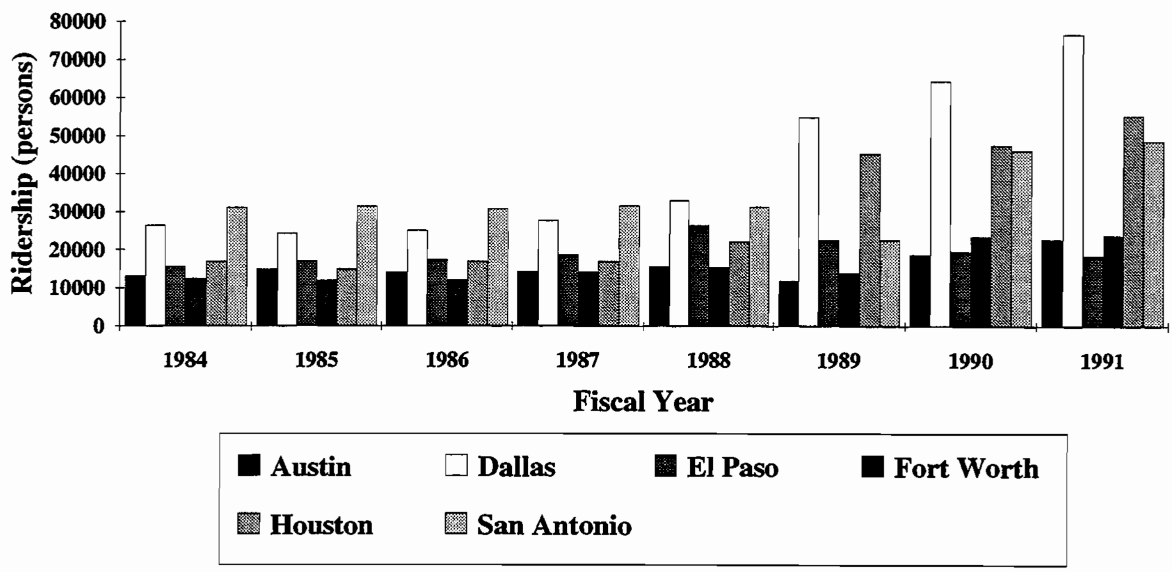


Table A-2: Amtrak Monetary Outlays in Texas Fiscal Years, 1984 - 1991

	FY-1984	FY-1985	FY-1986	FY-1987	FY-1988	FY-1989	FY-1990	FY-1991
I. Procurements/Contracts								
State of Texas ($)	1,370,000	4,076,843	2,800,000	2,500,000	2,300,000	1,600,000	4,600,000	4,500,000
Dallas ($)	941,103	1,231,976	1,038,710	1,330,804	1,421,999	633,248	2,000,000	908,000
Farmers Branch ($)	-	-	213,037	304,921	-	-	-	-
Fort Worth ($)	-	300,148	503,822	394,000	-	-	-	-
Houston ($)	-	2,420,609	988,768	269,667	-	-	-	-
II. Amtrak Employees								
Texas residents	67	70	84	59	56	112	169	175
Annualized total earnings ($)	1,500,000	1,823,000	1,700,000	1,600,000	1,700,000	3,380,000	5,110,000	4,120,000
III. Private Railroads								
Contract employees	-	83	81	77	85	34	-	-
Annualized total earnings ($)	-	about 5,500,000	about 5,300,000	over 5,400,000	over 5,710,000	over 3,090,000	-	-

SOURCE: *State of Texas Amtrak Facts*, National Railroad Passenger Corp., Washington, D.C.

Service is to be provided by 200-mph (322-km/h) steel-wheel on steel-rail electric passenger trains consisting of two power cars, a first-class car, a business-class car, five coaches, and a food service car. High-speed rail is being presented by the THSRC as an alternative to local airline travel by intrastate business travelers. The service is to provide convenient connections to national and international airline carriers. Another potential market being investigated is tourism and induced travel on the part of people who would not have otherwise traveled in the corridors to be served.[1]

When the entire project is completed, high-speed trains will connect the major cities of the "Texas Triangle." The east leg of the route, serving Houston, Dallas, and Fort Worth, will be placed in service first, with a projected completion date of 1998. The west leg, providing service from San Antonio and Austin to Dallas and Fort Worth, will begin service in 1999. The proposed southern leg is at this time being limited to concept development. Alternative alignment studies are investigating the feasibility of adding service to Waco and College Station/Bryan. Figure A-4 shows the most current route alternatives for the facility. Initial plans call for 34 round trips on each of the east and west legs, half-hour service during the day and 15-minute service during peak periods. Estimated travel time from Dallas to Houston is 90 minutes, from San Antonio to Dallas is 104 minutes, and from Austin to Dallas is 69 minutes.[2]

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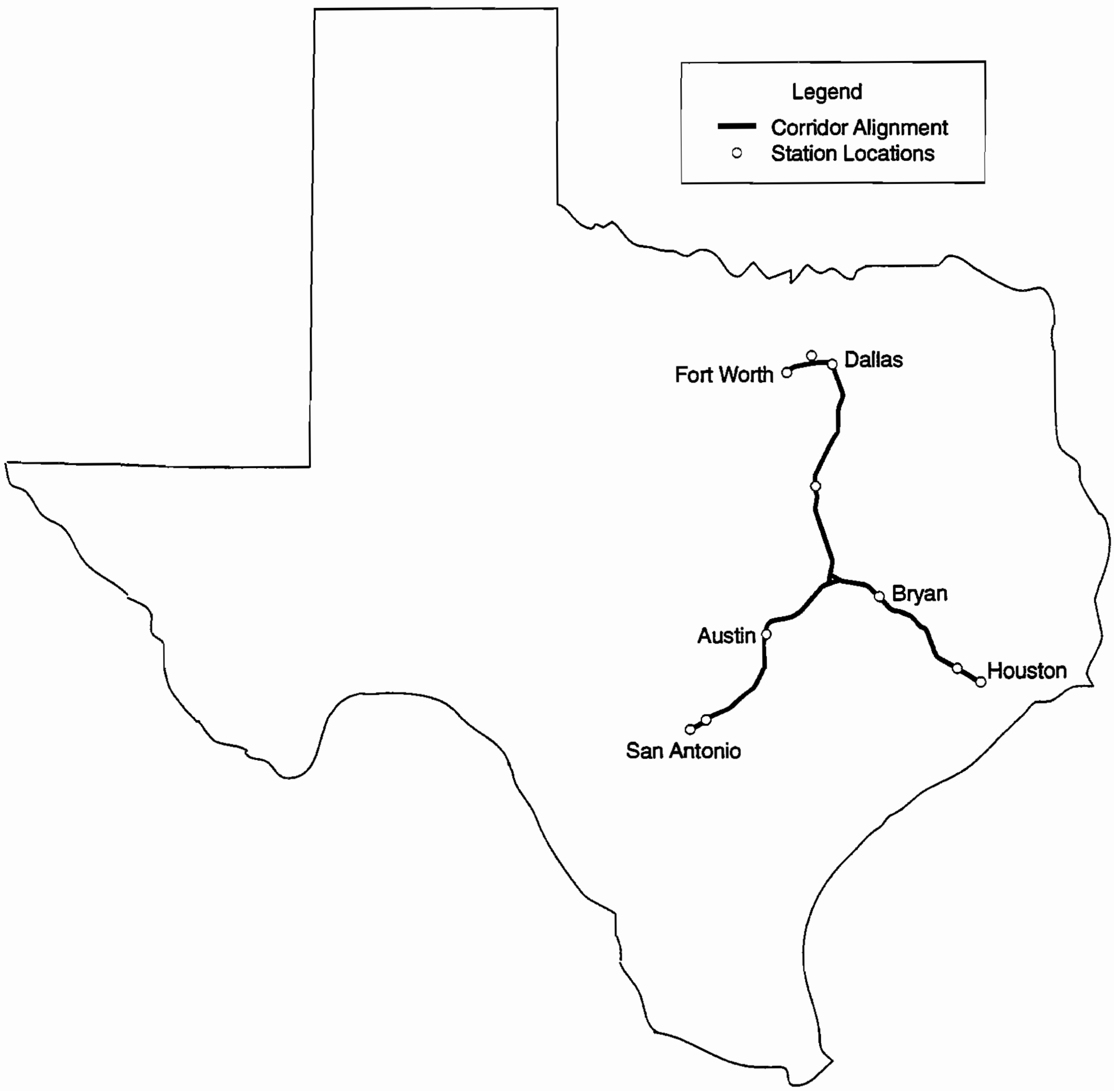
[1] Texas High-Speed Rail: A Project Summary (Austin, TX: Texas High-Speed Rail Corporation, 1992), 4.
[2] Ibid., 6.

Figure A-4: Texas High-Speed Rail Route Alternatives



SOURCE: Texas High-Speed Rail Corporation, Austin, Tx, 1993.

The potential economic impact on the state of Texas reported by the THSRC is expected to be significant.[3] During the development period which extends through 1994, an estimated $167 million will be spent on design, environmental services, and professional services for the project. Direct construction expenditures are expected to contribute $3.8 billion to the Texas economy. Employees associated with the project will earn approximately $2.5 billion in wages. The state, counties, and other taxing entities will benefit from an estimated $100 million in sales taxes to be paid by THSRC. The estimated fiscal impact of operating the system from 1998 and beyond includes 1,800 persons permanently employed by THSRC. In addition, a total of 9,000 jobs will be supported by the $560 million in direct and indirect expenditures for products and services purchased in Texas. Furthermore, the 18 counties on the final alignment will receive an estimated annual increase of $90 million in property taxes. The system should have a positive impact on air quality by reducing the emissions from mobile sources such as cars and airplanes through its substitution for these other modes. The electricity for the passenger trains and their support systems is readily available from the commercial power grid. There are also unspecified impacts of increased tourism resulting from high-speed rail. Preliminary estimated intercity ridership is expected to be approximately 2.8 million trips. This figure includes neither interstate and international trips nor those resulting from induced travel and diversion from autos; including these sources of ridership increases the total to an estimated 8.7 million trips.[4]

The project is now in the development phase, during which the project's transportation consultants are conducting public hearings to obtain input for the design process. In addition, the THSRC is preparing detailed ridership projections and finalizing the route alignment. Because of the delays in this process and the expectation of potential investors that they have detailed ridership estimates, an extension of the December 1992 financing milestone was requested and approved by the Texas High-Speed Rail Authority.

A.1.2 Regional and Urban Systems

Rail-based urban and regional transportation disappeared from Texas during the 1950's and 1960's. The status of various projects in Texas will be described in this section. First is a brief overview of the different types of rail service available to metropolitan areas. Rail passenger transportation in the regional and urban setting generally consists of four distinct types. Commuter rail is characterized by the operation of conventional diesel-electric or of all-electric-powered trains on standard railroad lines, intermixed with local and/or through freight service. This type of service often has highly peaked demand, directional travel, long average

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[3]"Texas Supertrain Fact Sheets" (Austin, TX: Texas Supertrain News Bureau, 1992).

[4]Texas High-Speed Rail: A Project Summary (Austin, TX: Texas High-Speed Rail Corporation, 1992), 8.

trip length, and long station spacing. Commuter rail has been operated continuously for many years in large cities in the U.S. and Canada, including New York, Chicago, San Francisco, and Toronto.

Heavy rail transit is the current name used to describe advanced subway systems. It is characterized by fully controlled right-of-way (e.g., full grade separation, either elevated or subway), electric traction, and fail-safe signal control. These systems feature higher performance and normally use car-floor-level platforms and operate long, frequent, high-capacity trains. There is no operation of this type in Texas. It has never existed here, nor are any systems being planned. Newer examples of heavy rail transit are Washington, D.C., and Atlanta, while older systems operate in Chicago, New York, and Boston.

Light rail transit (LRT) has been described as a metropolitan electric railway. Light rail may use a variety of different rights-of-way: subway, elevated, in-street, in a roadway median, or combined (a combination of all of the above). Power is supplied through overhead wire, and systems may use car-floor-level platforms or have steps for ground-level loading on the light rail vehicles (LRV's). Modern LRT systems are in operation in a number of U.S. cities, including Portland, Sacramento, and San Diego. Heritage trolley service is operated in many cities. To be defined as such, it must meet three of four following criteria[5]:

1) Genuine historic or accurate facsimile electric railway equipment in a setting recalling the area's own electric railway heritage;

2) Electric operation on rails from overhead wire or coupled generator;

3) Operation independent of an established trolley museum or transit operation, in or close to the heart of the urban area; and

4) Service directed primarily toward tourists or other non-regular riders.

Recently, planning for new rail systems in major urban areas of the state has experienced a rebirth. A number of Texas cities are planning rail systems or have begun construction. The following is an overview of the status of rail systems in Texas cities.

A.1.2.1 Austin

The Capital Metropolitan Transportation Authority (Capital Metro) is currently involved in the planning stages for a light rail system. The agency is working on a route alignment and preliminary design study with consultants, including community input. A non-binding

[5]North American Light Rail Annual and User's Guide for 1992, (Glendale, CA: The Interurban Press, 1992), 19.

referendum on the project has been tentatively scheduled for the fall of 1994. The City of Austin and Capital Metro jointly purchased the Southern Pacific Transportation Company railroad line from Giddings to Llano in August 1986 (see Austin & Northwestern). The proposed LRT starter line will extend from Pleasant Valley Road and Fifth Street to Parmer Lane in North Austin (see Figure A-5). It will run through downtown, then north on Guadalupe Street and Lamar Boulevard past the state Capitol, The University of Texas, and various state offices. At Airport Boulevard it will join the railroad right-of-way and continue to its terminus at Parmer Lane, a total of 14.5 miles (23 km). The proposed route will make use of both street and rail right-of-way. The estimated capital cost of the project is $174.6 million, or approximately $12 million per mile ($7.5 million per kilometer).[6] Capital Metro expects the line to be completed and operational in the 1996 to 1999 time frame.

A.1.2.2 Dallas

Dallas Railway and Terminal streetcars ran until 1956. The company was also Texas' only electric trolley bus operator until the streetcars were removed from service in 1966. A plan adopted by the Dallas Area Rapid Transit Authority (DART) in 1986 called for 93 miles (150 kilometers) of LRT by the year 2010, as a predecessor to a heavy rail transit-type system. A 1988 long-term bond issue for the design and construction of this system failed. One of the primary reasons for the defeat of the bond issue was the desire of the community for a less expensive solution. DART went back to work and created a new Regional Transit Service Plan in 1991. This plan (see Figure A-6) calls for a smaller light rail system than the 1986 plan, a High-Occupancy Vehicle Transitway system, commuter rail service, and expansion of bus and van services.

The initial 20-mile (32-kilometer) LRT starter line is the first step in the new plan. To expedite the process, the project was submitted under the Federal Transit Administration (FTA) Overmatch Initiative, which gives priority treatment to systems funded primarily locally. Only 20 percent of the $843 million system cost will be paid through federal grants; the balance will come from the fare box and from a sales tax. Under this FTA program, the alternatives analysis/draft environmental impact statement (AA/DEIS) and preliminary engineering and final environmental impact statements (PE/FEIS) were completed in 28 months.[7] This process can normally take from 32 to 72 months.

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[6]Public Transportation in Texas: Profiles and Projections 1994-1997 (Austin, TX: Texas Department of Transportation, December 1992), 28.

[7]Allen, Douglas A. and Keahey, William Kyle, "DART's ASAP EIS," *Civil Engineering*, 63, no. 8 (New York, NY: American Society of Civil Engineers, August 1993), 58.

Figure A-5: Proposed Light Rail Transit Route Alignment in Austin, 1994

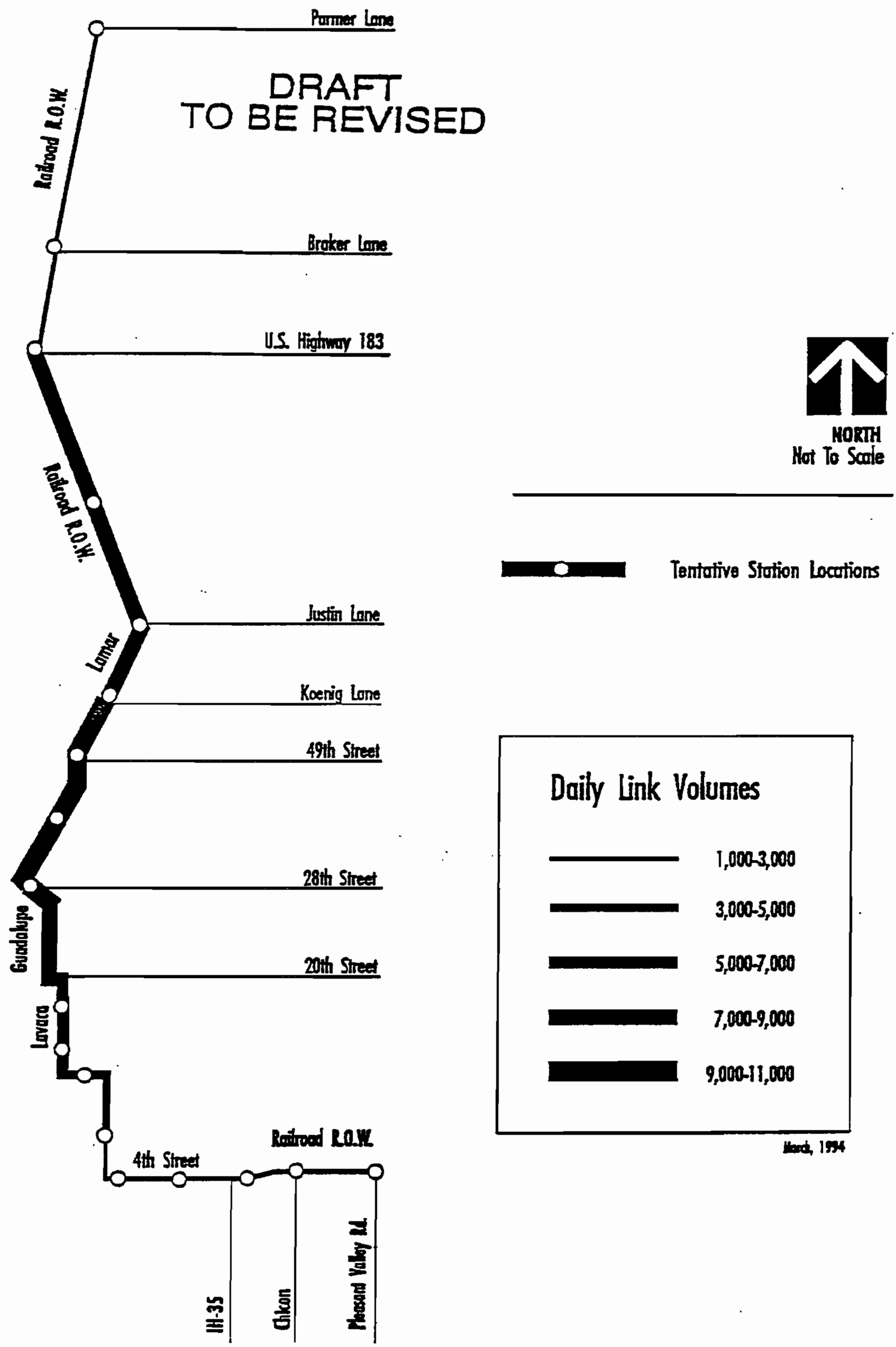
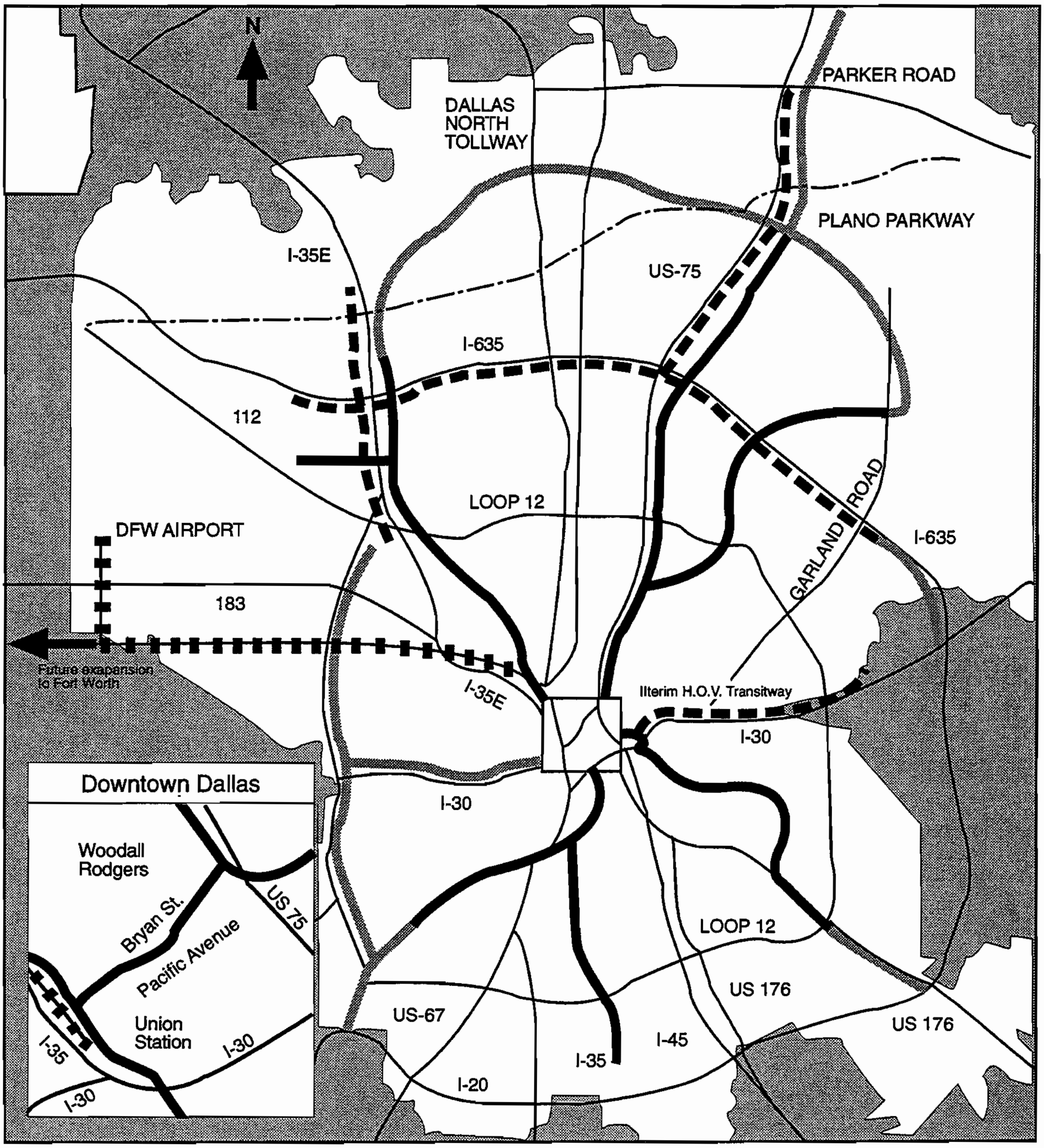


Figure A-6: Dart Transit System Plan, 1991



LEGEND

- Light Rail System (1990-2010)
- H.O.V. Transitway System (1990-2005)
- Light Rail System (1990-2010)
- H.O.V. Transitway System (1990-2005)

SOURCE: *Public Transportation in Texas: Profiles and Projections 1994-1997,* (Austin, TX: Texas Department of Transportation, December 1992), 40.

The light rail route has the shape of an inverted "Y," beginning north of the central business district and ending with two branches south of the Trinity River (see Figure A-7). Starting from the north, the route begins at Park Lane on DART-owned former Southern Pacific right-of-way and enters a subway under the North Central Expressway, emerging near downtown. DART decided to adopt a deep-bore, dual-tunnel option to allow construction independent of highway drainage improvements occurring concurrently. The expected completion of the tunnels in early 1995 has been delayed due to the discovery of gasoline pockets and methane gas in the tunnel bore. Work has resumed with additional detection equipment, and slow progress is being made. In the downtown area the line runs in a transit mall, then turns onto railroad right-of-way into Dallas Union Station. From there it heads south to a new crossing of the Trinity River. Once across the river, it branches to West Oak Cliff and South Oak Cliff. The west branch serves the Dallas Zoo before reaching its terminal at Westmoreland Avenue. The south branch serves the Veterans Administration hospital before terminating at Ledbetter Drive. The two branches serve predominantly middle-class blue-collar neighborhoods. The entire route will serve a total of 21 stations.

Construction is already well underway on some sections of the route. The current schedule calls for revenue service to begin between the West End station in the central business district to Westmoreland Avenue on the west branch and to Illinois Avenue on the south branch in June 1996. The remainder of the starter system is expected to be operational in December 1996. Ridership is predicted to reach 50,000 passengers per weekday by the year 2000.

In November of 1992, DART awarded the joint venture of Kinki Sharyo/Itochu International a $99 million contract for the construct of 40 light rail vehicles.[8] The cars will seat 76 passengers. They are required to be capable of operation at 65 mph (105 km/h) and in trains of up to three cars.

The planned 67-mile (108-kilometer) system in the Regional Transit Service Plan (see Figure A-7) includes the following additions to the system: an extension of the South Oak Cliff branch to I-635; an extension of the North Central line to Plano with a branch to Garland; and a new route running from the vicinity of Farmers Branch in the northwest through downtown to Pleasant Grove in southeast Dallas. Portions of all these routes will use railroad right-of-way purchased by DART. Completion of the entire light rail system would not occur until after the year 2010.

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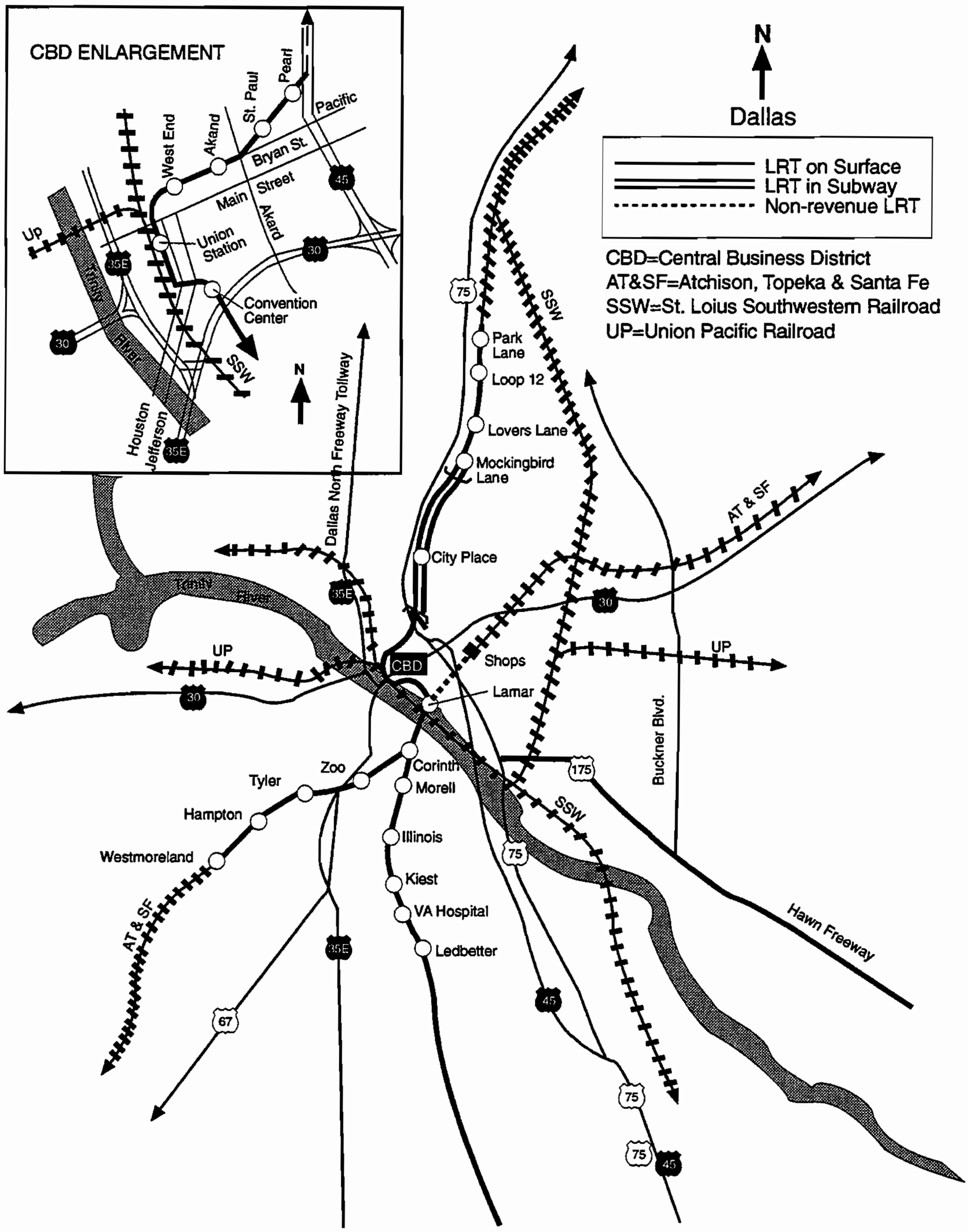
[8] Wilkins, Van, "Dallas Finally Does It: LRT Is Coming," *1993 North American Light Rail Annual and User's Guide*, (Glendale, CA: Interurban Press, 1993), 2-5.

Figure A-7: Dallas Light-Rail Transit Route Map



SOURCE: *1993 North American Light-Rail Annual and User's Guide* (Glendale, CA: The Interurban Press, 1993), 3.

Commuter rail service of 18 miles (29 kilometers) is planned between Dallas, Fort Worth, and the Dallas-Fort Worth International Airport. Initially, operation will be between Dallas and Irving; Fort Worth and the airport will be added before the year 2000. Agreements on the service have been approved by the city councils of Dallas and Fort Worth. This was necessary because the cities own the track and rail freight service operates in the same corridor. Additional agreements remain to be arranged between the Fort Worth Transit Authority and the two cities. DART recently approved the purchase and retrofitting of 13 Budd Rail Diesel Cars from Via Rail (Canada) for the commuter service at a cost of $1.9 million. Start-up of the commuter rail service is planned for 1995.

McKinney Avenue Transit Authority operates a heritage trolley operation through the city's arts and entertainment district on a re-excavated portion of the former street railway line.[9] There has been some limited discussion of an extension so the trolley can serve as a circulator connecting with the LRT.

A.1.2.3 Fort Worth

In Fort Worth, Tandy Corporation operates a 1.0-mile (1.6-kilometer) line from a remote parking lot to a station under its headquarters building. The line has five stations along a double-track private right-of-way. There are three crossings, one vehicular and two pedestrian, and two grade separations. The operation uses eight heavily rebuilt President's Conference Committee (PCC) streetcars equipped for only high platform loading. The cars have 60 seats and a total capacity of 83 passengers each. The cars are electrically powered from 600-volt D.C. overhead wire. The facility was opened in 1963 by Leonard's M & O to transport customers from the department store's remote parking lot to the downtown store. The store building was later purchased by Tandy Corporation for its headquarters. Recent operating statistics indicate that 5,900 passengers use the service each weekday.[10] The line was reconstructed in 1978 at a capital cost of approximately $1.0 million. The Tandy subway continues to function as an efficient connector between peripheral parking and the Fort Worth central business district.

A.1.2.4 Galveston

Diesel-powered heritage trolley replicas operate as a shuttle from downtown to the beaches.[11] Community concerns initially ruled out overhead wire electrification, but it remains as a future option.

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[9] North American Light Rail Annual and User's Guide for 1992, (Glendale, CA: The Interurban Press, 1992), 43.
[10] TRB Special Report 221.
[11] North American Light Rail Annual and User's Guide for 1992, (Glendale, CA: The Interurban Press, 1992), 43.

A.1.2.5 Houston

In January 1988, city voters approved the $2.6 Billion Phase 2 Mobility Plan for Houston's METRO, a key element of which was a 20-mile (32-kilometer) fixed-guideway system linking four major employers.[12] In 1991 METRO reversed course on a proposed monorail and chose instead an increased bus service alternative. This decision was due in part to a change in mayoral administration in 1992. The $300 million appropriated by Congress for the project was offered to Seattle instead.[13] METRO is currently discussing the commuter rail system which would involve a track-sharing arrangement with area freight railroads.[14] A final alignment is presently under study.

A.1.2.6 San Antonio

VIA metropolitan transit is currently involved in the assessment of light and commuter rail feasibility through a number of studies. VIA anticipates continuing the assessment of rail for the service areas during the 1994-1997 fiscal years.[15] A Request For Proposals issued by the San Antonio - Bexar County MPO for a transportation center to consolidate rail service at a location near the Alamo Dome, requires inclusion of commuter, light, and regional rail proposals (e.g., service to Laredo).

A.2 RAIL FREIGHT SERVICE

Railroads are grouped by annual gross operating revenues into three classes: Class 1, revenues exceeding $50 million; Class 2, revenues between $10 million and $50 million; and Class 3, income under $10 million. Operating statistics for Class 1 carriers operating in Texas are presented first, followed by those for Class 2 and Class 3 carriers. Class 2 and Class 3 railroads are characteristically regional railroads, short lines, or providers of terminal and switching services.

A.2.1 Class 1 Railroads

Six Class 1 Railroads operated over 9,800 route-miles (15,771 route-kilometers) in Texas during 1991. These railroads are the Atchison, Topeka & Santa Fe (ATSF), the Burlington Northern (BN), the Kansas City Southern (KCS), the Union Pacific (UP), the Southern Pacific (SP), and the Saint Louis-Southwestern (SSW). Their major routes in Texas are described below

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[12] TRB Special report 221

[13] North American Light Rail Annual and User's Guide for 1992, (Glendale, CA: The Interurban Press, 1992).

[14] Public Transportation in Texas: Profiles and Projections 1994-1997 (Austin, TX: Texas Department of Transportation, December 1992), 49.

[15] Public Transportation in Texas: Profiles and Projections 1994-1997 (Austin, TX: Texas Department of Transportation, December 1992), 56.

and are shown in Figure A-8. Because of the dynamic nature of the industry, this illustration may not include all line-hauls operated under trackage rights or haulage agreements with other railroads. Trackage rights are granted by one railroad to another to operate on the tracks of the first, usually for a rental fee and without rights to serve customers on that line. Haulage is the movement of one railroad's traffic by a second between specific points under the terms of a contract. The hauling railroad does not exercise any control over the traffic, is not shown on the route for the traffic, and receives no portion of the revenue.

The major routes through Texas of each Class 1 railroad are summarized in the descriptions of service that follow.

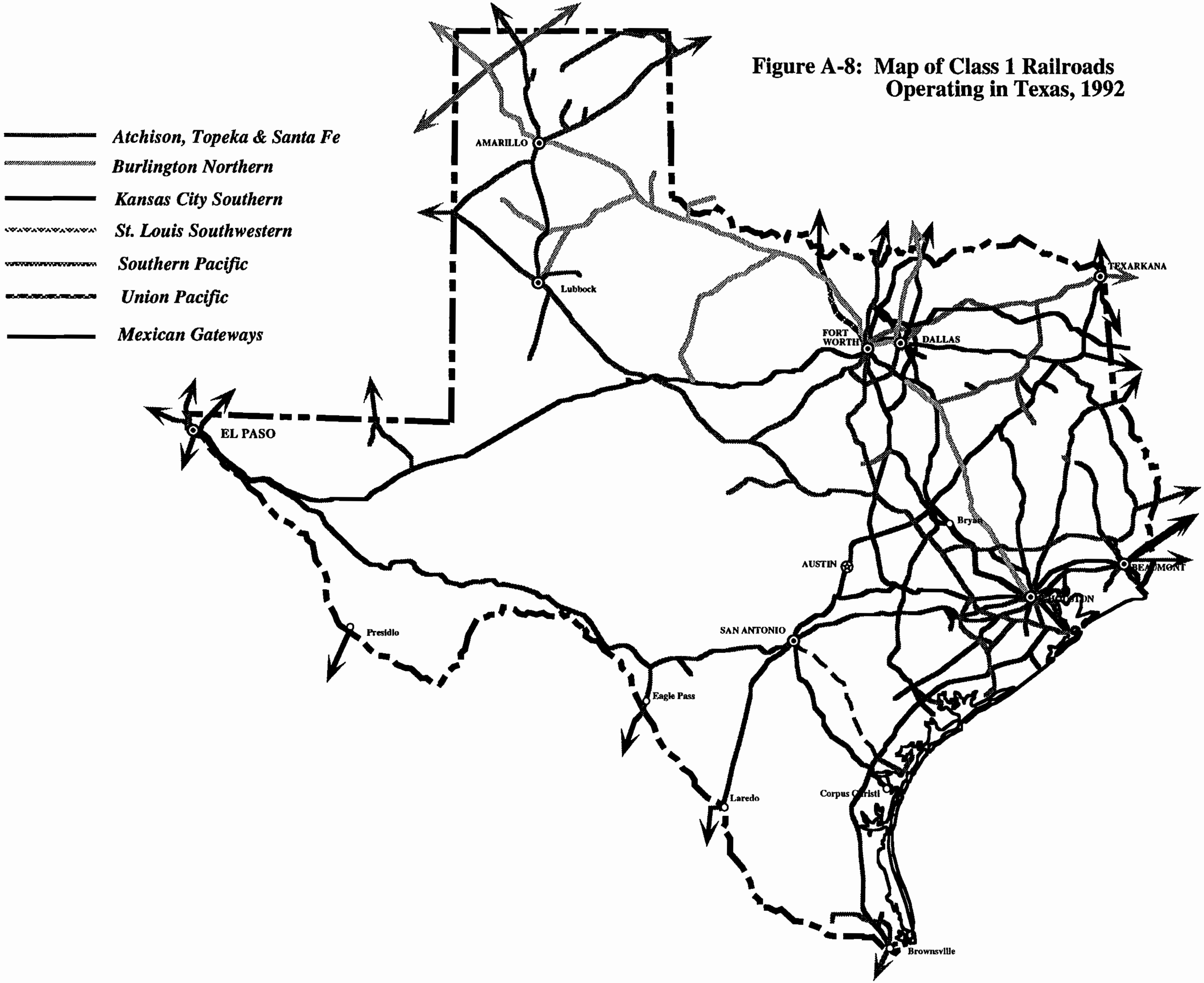
A.2.1.1 Atchison, Topeka & Santa Fe

The Santa Fe operates a line from the Houston/Galveston area to Temple, where one part splits to Fort Worth and Dallas (and north to Kansas City and Chicago). The second part of the line heads west to Brownwood and Lubbock, where it splits again. The one line proceeds north through Amarillo to a connection with the Chicago - Los Angeles main line through Raton Pass and continues north to Pueblo and Denver. The other line heads west to Clovis, New Mexico, and joins the railroad's second Chicago - Los Angeles main line. El Paso is reached by a line from Belen, New Mexico, where the line connects to both Chicago - Los Angeles main lines. Other routes include a line from Longview to Beaumont in East Texas, which connects to the Temple - Houston/Galveston segment at Somerville. From Brownwood there is a route to Fort Worth and Dallas on which the Burlington Northern and South Orient have trackage rights. To shorten movements between the West Coast and Dallas - Fort Worth, the Santa Fe has recently negotiated trackage rights on the Union Pacific between Sweetwater and Dallas. This routing is 50 miles (80 kilometers) shorter than the line via Brownwood and avoids several engineering problems on the Brownwood - Fort Worth segment.

A.2.1.2 Burlington Northern

The Burlington Northern operates a route from the Houston/Galveston area through Fort Worth, Wichita Falls, and Amarillo, and north to Pueblo and Denver. There are branches from this line to Abilene and Lubbock. The railroad operates a second route from Presidio to Fort Worth (under a haulage agreement with the South Orient and Santa Fe trackage rights), where it continues north to Tulsa and connects to Saint Louis and Kansas City.

Figure A-8: Map of Class 1 Railroads Operating in Texas, 1992



A.2.1.3 Kansas City Southern

The Kansas City Southern's main line from Kansas City to New Orleans runs through Texas between Texarkana and a point near Shreveport, Louisiana. A branch line runs from Shreveport to Farmersville and extends into Dallas by trackage rights on the Santa Fe.[16] The railroad has a petition before the Interstate Commerce Commission to merge with MidSouth Rail Corp., a regional railroad which operates many of the east-west former Illinois Central Gulf routes across Louisiana, Mississippi, and Alabama.

A.2.1.4 Southern Pacific

On September 12, 1988, the ICC approved the purchase of the Southern Pacific Transportation Co. and the Saint Louis Southwestern Railway Co. by the Rio Grande Industries, parent of the Denver & Rio Grande Western Railroad. The resulting corporate name is the Southern Pacific Transportation Company. Generally, little change will be noticed in the Texas operations of either railroad; the merger broadly reflects the corporate changes in rail transportation in the western United States. Southern Pacific operations in Texas can be split into three routes. One is from Los Angeles through El Paso, San Antonio, Houston/Galveston, and Beaumont, continuing to New Orleans. Another runs from Sherman through Dallas and Corsicana, south of which it splits; one line goes to Port Lavaca, the other to Houston/Galveston. The third route goes from Shreveport through Houston/Galveston and Victoria and continues to Brownsville (the Victoria - Brownsville segment is on Union Pacific trackage rights). A secondary line runs from San Antonio to Aransas Pass (Corpus Christi area), but the middle of the line is out of service. Also, a line runs from the Los Angeles - New Orleans mainline near Del Rio to the Eagle Pass/Piedras Negras border crossing. Recently, the Southern Pacific announced 322 miles (518 kilometers) of branches for sale in Texas.[17] These branches include 110 miles (177 kilometers) between Elmdorf and Sinton (on the San Antonio - Aransas Pass line); 96 miles (154 kilometers), Mount Pleasant to Wylie; 89 miles (143 kilometers), Rosenburg to Victoria; 14.5 miles (23.3 kilometers), Placedo to Port Lavaca; and 13 miles (21 kilometers), Wharton Junction to New Gulf.

A.2.1.5 Saint Louis Southwestern

Since 1932 the Southern Pacific has controlled the Saint Louis Southwestern Railway Co., and in recent years it has operated essentially as a division of the Southern Pacific. From Saint Louis and Memphis, its route enters Texas at Texarkana and runs to Dallas and Fort Worth.

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[16]Note: the Santa Fe is in the process of selling this line (the Dallas and Garland Subdivisions) to the Kansas City Southern.

[17]"SP cuts Oregon Milegage," Trains 53, no. 5 (May 1993), 19.

This line splits in Mount Pleasant and runs through Tyler to a connection with the Southern Pacific at Corsicana. A branch runs from Tyler to Lufkin. The Saint Louis Southwestern purchased the Tucumcari, New Mexico - Kansas City line of the Chicago, Rock Island & Pacific when that railroad, following labor unrest and bankruptcy, ceased operation in 1980. The line connects with the Southern Pacific in Tucumcari and joins the Los Angeles - New Orleans main line in El Paso.

A.2.1.6 Union Pacific

In 1985, the Missouri Pacific became a part of the Union Pacific Railroad even though its corporate identity remained unchanged. In a decision served on May 18, 1988, the Interstate Commerce Commission approved the merger of the Missouri-Kansas-Texas Railroad Co. (MKT or the Katy) into the Missouri Pacific Railroad Co., doing business as the Union Pacific Railroad Co. Operation of these railroads' lines in Texas is considered an integrated element of the Union Pacific system and will be referenced as Union Pacific. As a result of these mergers, some lines with marginal profitability have been sold or abandoned. Former Missouri Pacific lines extend from El Paso through Fort Worth and Dallas to Shreveport. Another line from Saint Louis runs through Texas from Texarkana through Austin and San Antonio (a branch goes to Corpus Christi), and continues to Laredo. Several lines radiate from the Houston/Galveston area. One joins the Texarkana - Laredo line in Palestine; another extends south along the coast to Brownsville and northeast to Beaumont, continuing to New Orleans; and a third runs to Waco. Generally, the former Missouri-Kansas-Texas Railroad Co. operated from Denison to Fort Worth and Dallas, on separate parallel routes, to Smithville, where the line extends easterly to the Houston/Galveston area and west to a connection in San Marcos with the north-south line through Austin. It is interesting to note the railroad's extensive use of trackage rights, about 25 percent of its total mileage.

Table A-3 below lists these carriers, along with total route-miles owned by each for the years 1986 to 1991. The number of total route-miles (route-kilometers) of Class 1 carriers continues a slow decline over the period. This demonstrates the continuing trend of major railroads to rationalize their physical plant so they can maximize their return on investment. This trend is the result of an ongoing examination of system maps and of eliminating routes with inadequate revenue or which are inconsistent with the rest of the system. Unwanted branch and secondary lines have been sold to short lines and regional railroads, or abandoned if an operator could not be found. Divestiture (downsizing) has been made simpler as a result of deregulation (the Staggers Act of 1980) and changes in Interstate Commerce Commission policies.

Table A-3: Route-Miles of Line Owned by Class 1 Railroads in Texas, 1986 - 1991

Railroad	1986	1987	1988	1989	1990	1991
Atchison, Topeka & Santa Fe (ATSF)	3,268	3,261	3,261	3,132	2,817	2,272
Burlington Northern (BN)	1,157	1,100	1,095	990	990	991
Kansas City Southern (KCS)	252	252	252	238	238	238
Missouri-Kansas-Texas (MKT)	796	796	- -[1]	- -	- -	- -
Southern Pacific (SP)	2477	2,453	2,421	2,421	2,563	2,532
Saint Louis Southwestern (SSW)	614	614	614	614	715	631
Union Pacific (UP)	2,816	2,787	3,562	3,505	3,213	3,193
TOTAL	11,380	11,263	11,205	10,869	10,147	9,857

[1] 1988 -1991 MKT figures reflected in UP data due to merger. This applies throughout this section.

1 mile = 1.61 kilometers

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1986-1991.

The top five Texas rail commodities by car-loadings are miscellaneous mixed shipments, nonmetallic minerals, chemicals and allied products, coal, and food and kindred products (see Table A-4). When ranked by tonnage, nonmetallic minerals drops from the list, farm products joins, and the order is rearranged, with chemicals and allied products the highest ranked (see Table A-5).

In terms of total traffic, the Class 1 railroads appear to be separated into three tiers (see Table A-6). The Union Pacific and Santa Fe are in the top group of over 65 million short tons (over 58,968,000 metric tons), with the Southern Pacific in a level slightly lower. The Burlington Northern, Kansas City Southern, and Saint Louis Southwestern are in the bottom grouping. When the affiliated operations of the Southern Pacific and the Saint Louis Southwestern operations are combined, traffic divides into two groupings. The order ranking by total traffic in carloads and tons (metric tons) roughly corresponds to the distance (miles/km) operated by each carrier.

The profitability of Class 1 railroad operations is shown in Table A-7. Two carriers, the Burlington Northern and the Saint Louis Southwestern, had a gross loss from railroad operation operations in the state of Texas during 1991. The values in Table A-7 are shown graphically in Figures A-9, A-10, and A-11.

Operating revenues, net ton-miles of freight hauled, and operating revenues per net ton-mile for each Class 1 railroad are contained in Table A-8. In 1991, the Kansas City Southern

Table A-4: Total for All Railroads Ranked by Carloads, 1991

STCC	Commodity	Carloads	Short Tons
46	Miscellaneous. mixed shipments, except forwarder & shipper associations	1,091,641	24.734,746
14	Nonmetallic minerals, except fuels	916,720	22.405,431
28	Chemicals & allied products	643,690	52.479,906
11	Coal	506,999	52.171,825
20	Food & kindred products	369,827	23.507,032

1 short ton = 0.91 metric ton

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

Table A-5: Top Five Commodities for All Railroads Ranked by Tons, 1991

STCC	Commodity	Carloads	Short Tons
28	Chemicals & allied products	643,690	52,479,906
11	Coal	506,999	52,171,825
1	Farm products	329,497	26,839,150
46	Miscellaneous. mixed shipments, except forwarder & shipper associations	1,091,641	24,734,746
20	Food & kindred products	369,827	23,507,032

1 short ton = 0.91 metric ton

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

Table A-6: Total Carload Traffic by Railroad, 1991

	Originating Freight		All Other Freight		Terminating Freight		Total Traffic	
Railroad	Carloads	Short Tons	Carloads	Short Tons	Carloads	Short Tons	Carloads	Short Tons
ATSF	285,023	15,795,527	1,161,584	49,497,443	480,620	33,972,330	1,446,607	65,292,970
BN	117,849	4,885,981	167,780	15,425,002	258,416	17,931,759	285,629	20,310,983
KCS	71,489	5,510,876	310,728	24,199,353	138,780	11,801,017	382,217	29,710,229
SP	321,212	21,544,808	569,290	30,936,575	327,724	22,642,474	890,502	52,484,383
SSW	14,503	733,851	316,850	14,201,951	32,524	1,781,661	331,353	14,935,802
UP	465,259	32,264,589	1,410,231	50,796,522	717,525	50,048,165	1,875,490	83,061,111
TOTAL	1,275,335	80,735,632	3,936,463	185,056,846	1,955,589	138,177,406	5,211,798	265,792,478

1 short ton = 0.91 metric ton

Note: Total traffic is the sum of originating plus all other for carloads, and tons

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

Table A-7: Profitability of Class 1 Railroad Operations in Texas During 1991 ($ x 1,000)

	Operating Expenses						Gross
	Transportation		Maintenance	General &		Operating	Profit
Railroad	Operations	Equipment	Of Way	Administration	TOTAL	Revenues	(Loss)
ATSF	180,711	115,253	61,738	39,114	396,816	525,040	128,224
BN	101,899	54,291	56,597	35,333	248,120	197,787	(50,333)
KCS	16,943	7,768	9,466	5,956	40,133	53,134	13,001
SP	230,711	133,365	122,139	78,230	564,445	584,475	20,030
SSW	32,944	20,192	17,968	7,447	78,551	51,611	(26,940)
UP	215,150	130,397	89,569	123,323	558,439	698,432	139,993
TOTAL	778,358	461,266	357,477	289,403	1,886,504	2,110,479	223,975

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

Figure A-9: Operating Revenues for Class 1 Railroads in Texas, 1991

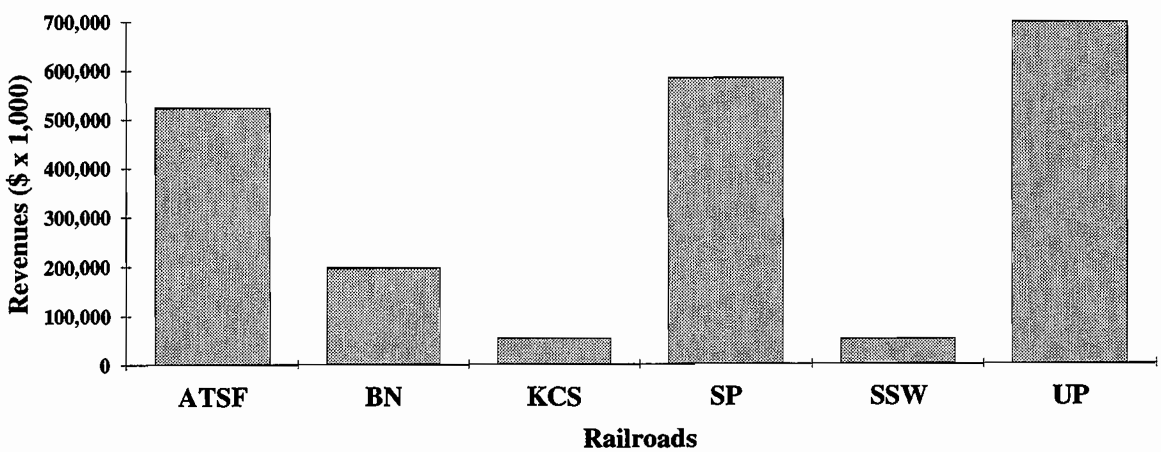


Figure A-10: Total Operating Expenses for Class 1 Railroads in Texas, 1991

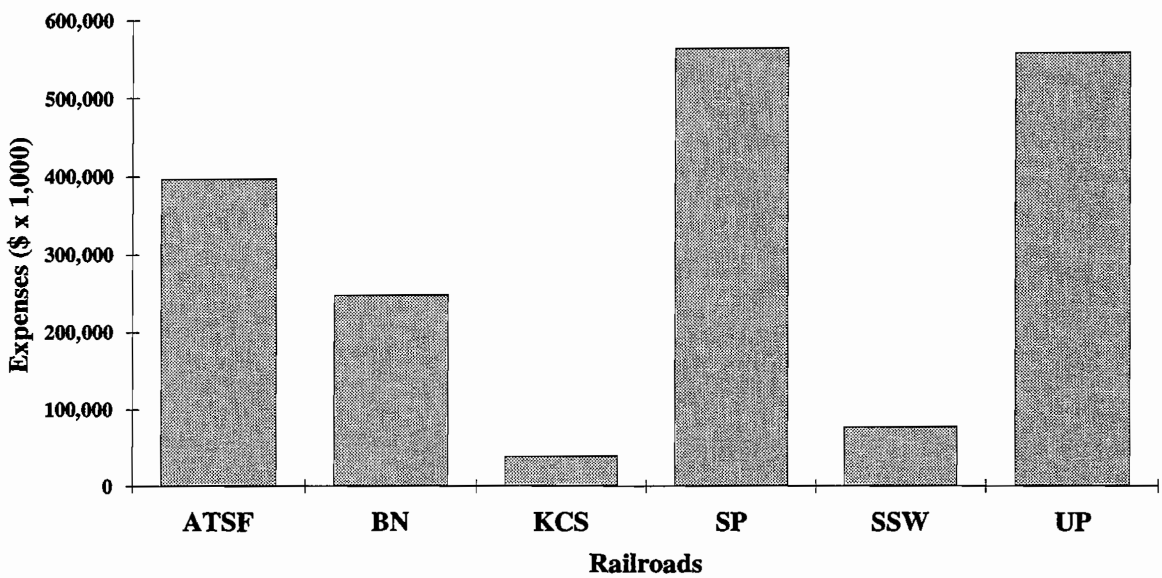


Figure A-11: Gross Profit (Loss) for Class 1 Railroads in Texas, 1991

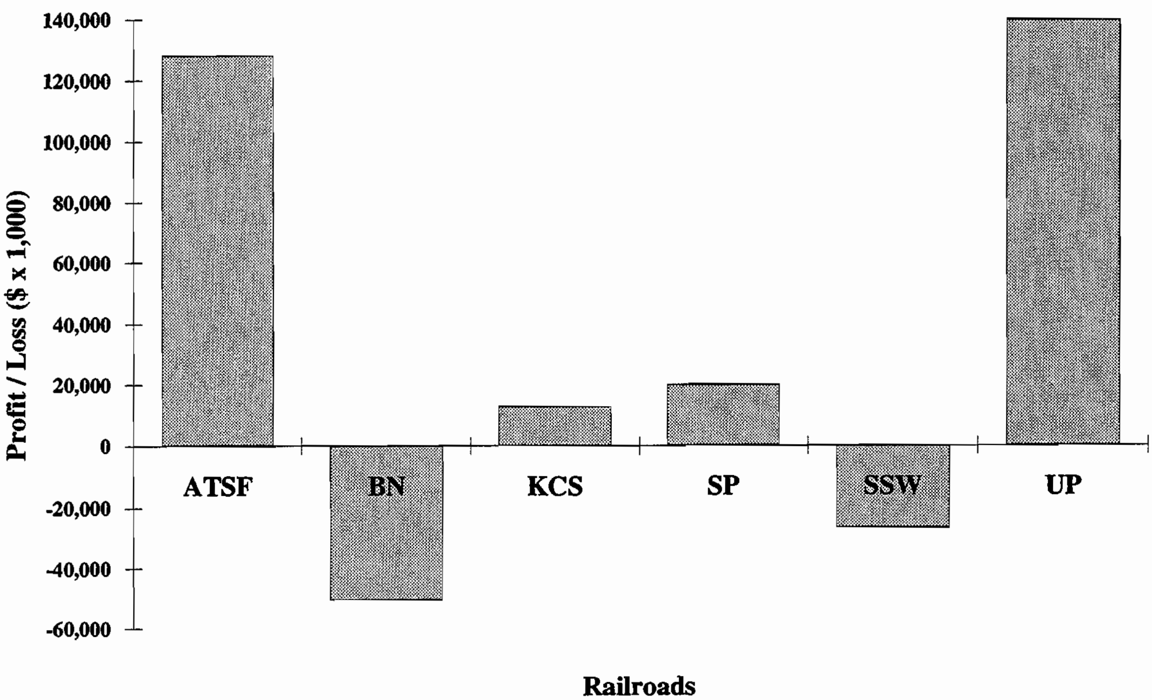


Table A-8: Operating Revenues Per Net Ton-Mile for Class 1 Railroads in Texas, 1991

Railroad	Operating Revenues ($ x 1,000)	Net Ton-Miles of Freight (1,000's)	Operating Revenues per Net Ton-Mile ($)
ATSF	525,040	19,500.178	0.0269
BN	197,787	11,091.067	0.0178
KCS	53,134	1,619.921	0.0328
SP	584,475	20,257.567	0.0289
SSW	51,611	2,141.706	0.0241
UP	698,432	24,237.672	0.0288

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

($.0328/net ton-mile) ($.0225/net metric ton-km) had the highest measure, followed by a virtual tie between the Union Pacific ($.0288/net ton-mile) ($.0197/net metric ton-km) and the Southern Pacific ($.0289/net ton-mile) (($.0198/net metric ton-km). The remainder were the Santa Fe ($.0269/net ton-mile) ($.0184/net metric ton-km), the Saint Louis Southwestern ($.0241/net ton-mile) ($.0165/net metric ton-km), and the Burlington Northern ($.0178/net ton-mile) ($.0122/net metric ton-km). These numbers are shown graphically in Figure A-12 for comparison.

Table A-9 is a summary of 1991 data for revenue and nonrevenue freight for each railroad. Amounts of 262,454,463 short tons (238,098,689 metric tons) of revenue freight and 3,336,222 short tons (3,026,621 metric tons) of nonrevenue freight, for a total of 265,820,685 short tons (241,152.525 metric tons), were carried on Texas railroads in 1991. The Union Pacific leads the Class 1 railroads, followed by the Santa Fe and the Southern Pacific. Total ton-miles of revenue freight is 77.9 billion short ton-miles (113.7 billion metric ton-km). Again, the Union Pacific is the leader, followed by the Southern Pacific and the Santa Fe third.

A comparison of locomotive miles by type of service, train miles, and ton-miles is presented in Table A-10. The Southern Pacific and the Saint Louis Southwestern do not count train switching in their statistics. As in Table A-9, the Union Pacific has the highest values in all categories. Following a similar trend, the Santa Fe has higher total locomotive unit miles and total train miles than the Southern Pacific, yet lower total ton-miles from operations.

As shown in Table A-11, the Burlington Northern and the Kansas City Southern average nearly 70 tons (64 metric tons) per carload, the Southern Pacific about 59 short tons (54 metric tons) per carload, and the other three carriers about 45 short tons (41 metric tons) per carload. These figures are somewhat descriptive of the type of lading carried by each carrier; the Burlington Northern and the Kansas City Southern transport those commodities with higher

Figure A-12: Operating Revenue Per Net Ton-Mile for Class 1 Railroads in Texas, 1991

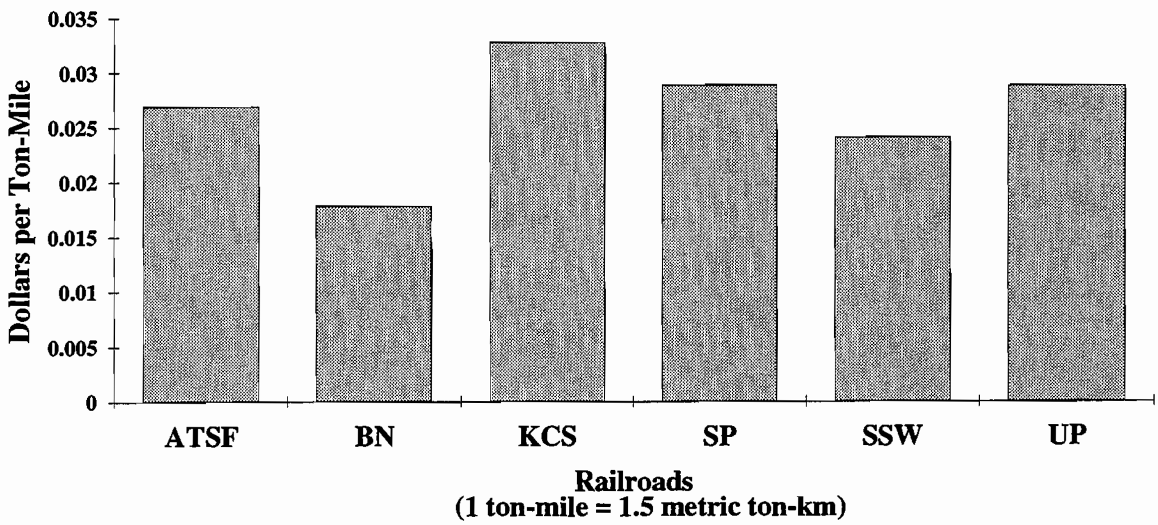


Table A-9: Revenue and Nonrevenue Freight for Class 1 Railroads in Texas, 1991

Railroads:	ATSF	BN	KCS	SP	SSW	UP	TOTAL
Tons of Revenue Freight	65,434,166	35.654.324	13,495,260	52,535,702	14,976,354	80,358,657	262.454.463
Tons of Nonrevenue Freight	1,425,550	310,446	52,651	79,972	17,779	1,449,824	3,336,222
Total Tons of Revenue and Nonrevenue Freight	66,889,716	35.964.770	13.547,911	52,615,674	14,994,133	81,808,481	265.820.685
Total Ton-Miles Revenue Freight (1,000's)	19,230,749	11.042.088	1,608,318	20,052,443	2.123,480	23,849,156	77,906,234
Total Ton-Miles Nonrevenue Freight (1.000's)	269.429	48,979	11,603	205,124	18,226	388.516	941,877
Net Ton-Miles Revenue and Nonrevenue Freight (1,000's)	19,500,178	11.091.067	1,619,921	20,257,567	2.141,706	24,237,672	78,848,111

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

Table A-10: Locomotive and Train Mile Information for Class 1 Railroads in Texas, 1991

	LOCOMOTIVE MILES				TRAIN MILES	TON-MILES (1,000's)
	Road Service	Train Switching	Yard Switching	Total Locomotive Unit Miles	Total Train Miles	Total Ton-Miles Freight
ATSF	27.728,018	471,972	1,383,792	29,583,782	7,795,127	19,500,178
BN	11.753,456	95,119	371,015	12,219,590	3,752,405	11,091,067
KCS	1.663,540	92,887	288,227	2,044.654	563,798	1,619,921
SP	24.277,541	0	4,850,484	29,128,025	7,366,783	20,257,567
SSW	3.580,532	0	12,546	3,593,078	1,316,208	2,141,706
UP	27.047.985	3.425.798	4.112.634	34.586.417	8.492.547	24.237.672
TOTAL	96.051,072	4.085,776	11,018,698	111,155.546	29,286,868	78,848,111

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

Table A-11: Average Weight Per Carload for Class 1 Railroads in Texas, 1991

	Carloads of Revenue Freight	Tons of Revenue Freight	Average Weight Per Carload (Tons)
ATSF	1,446,607	65,292,970	45.14
BN	285,629	20,310,983	71.11
KCS	382,217	29,710,229	77.73
SP	890,502	52,484,383	58.94
SSW	331,353	14,935,802	45.08
UP	1,875,490	83,061,111	44.29
TOTAL	5,211,798	265,792,478	57.05

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

weights per carload. Additionally, the numbers might point toward higher maintenance-of-the-way costs. Maintenance-of-the-way expense as a percentage of total operating expense, from Table A-7, shows that the Burlington Northern and the Kansas City Southern ratios are approximately 23 percent, versus the Santa Fe or the Union Pacific, each of which has a percentage of about 15 percent. This bears out the hypothesis. A final comparative measure is the average length of haul per carload. The Burlington Northern is far and away the leader in this category with a value of 477 miles (767 km), almost twice the second-best average length of haul, that of the Southern Pacific with 281 miles (452 km). It is interesting that the Burlington Northern was fourth in terms of loaded car miles, but carried the fewest total carloads of revenue freight, which resulted in Burlington Northern's leading figure. Average distance traveled per carloading are shown for all Class 1 carriers in Table A-12.

A.2.2 Class 2 and Class 3 Railroads

This section provides brief overviews of the operations of Class 2 and Class 3 railroads operating in the state of Texas. Class 2 railroads have a revenue range of $5 million to $19 million, and Class 3 railroads have revenues under $5 million. Figure A-13 is a map of the locations and routes of railroads falling into these two classes. The overviews are based on data from each railroad's 1991 annual operating report submitted to the Texas Railroad Commission,

Table A-12: Average Length of Haul Per Carload for Class 1 Railroads in Texas, 1991

	Loaded Car Miles	Total Carloads of Revenue Freight	Average Miles per Carload
ATSF	265,388,000	1,446,607	183.46
BN	136,295,000	285,629	477.18
KCS	21,524,000	382,217	56.31
SP	250,451,000	890,502	281.25
SSW	33,317,000	331,353	100.55
UP	333,758,996	1,875,490	177.96
TOTAL	1,040,733,996	5,211,798	212.79

SOURCE: State Statistics, R-1 Annual Reports to the ICC for the Years 1991.

unless otherwise noted. The descriptions include the route, route-miles (route-kilometers), predecessor railroads, corporate affiliation, traffic mix with STCC code, interchange railroads, number of employees, operating costs, and carloadings/tonnage data (if available).

A.2.2.1 Angelina & Neches River Railroad *(Est. 1900)*

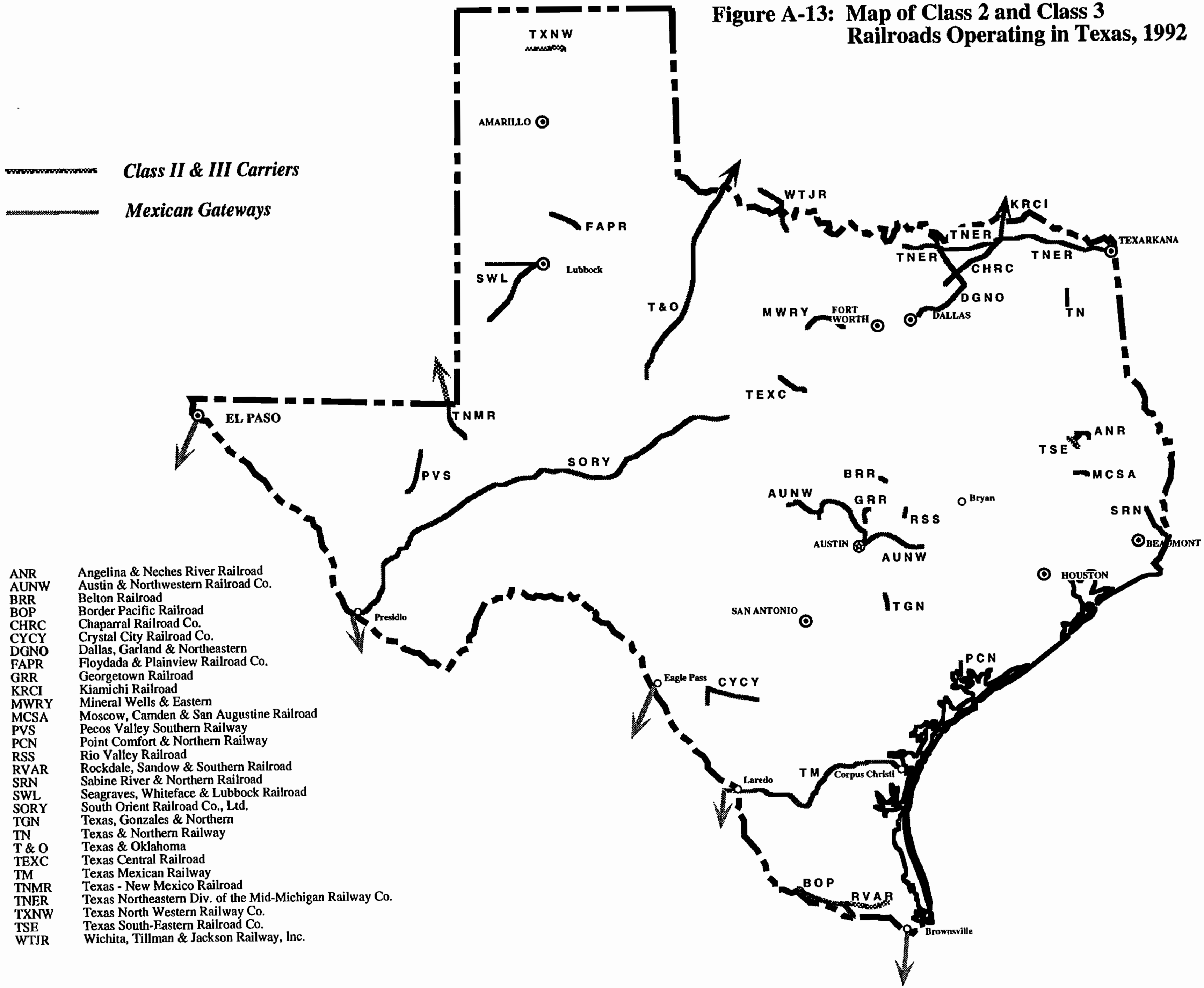
The railroad operates freight and TOFC service from Keltys to Lufkin and Buck Creek via Prosser, 22 miles (35 km). The load limit is 150 tons (136 metric tons). It connects with the Southern Pacific at Dunagen and Lufkin and with the Texas South-Eastern at Lufkin. Traffic is primarily Pulp & Paper Products (15), Chemicals & Allied Products (28), and Waste & Scrap Metals (40). Champion International owns 50 percent of company stock, with the balance owned by several other parties.

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	3,303	233,903
Terminating	2,299	189,094
Bridge	0	0
Local	592	32,121
TOTAL	6,194	455,118

Operating Revenue	$2,598,057
Operating Expenses	$1,595,918
Gross Profit (Loss)	$4,193,975

Total Ton-Miles	1,620,621	Revenue Class	Under $5 Million
		Number of employees	28 (in 1988)

Figure A-13: Map of Class 2 and Class 3 Railroads Operating in Texas, 1992



ANR	Angelina & Neches River Railroad
AUNW	Austin & Northwestern Railroad Co.
BRR	Belton Railroad
BOP	Border Pacific Railroad
CHRC	Chaparral Railroad Co.
CYCY	Crystal City Railroad Co.
DGNO	Dallas, Garland & Northeastern
FAPR	Floydada & Plainview Railroad Co.
GRR	Georgetown Railroad
KRCI	Kiamichi Railroad
MWRY	Mineral Wells & Eastern
MCSA	Moscow, Camden & San Augustine Railroad
PVS	Pecos Valley Southern Railway
PCN	Point Comfort & Northern Railway
RSS	Rio Valley Railroad
RVAR	Rockdale, Sandow & Southern Railroad
SRN	Sabine River & Northern Railroad
SWL	Seagraves, Whiteface & Lubbock Railroad
SORY	South Orient Railroad Co., Ltd.
TGN	Texas, Gonzales & Northern
TN	Texas & Northern Railway
T & O	Texas & Oklahoma
TEXC	Texas Central Railroad
TM	Texas Mexican Railway
TNMR	Texas - New Mexico Railroad
TNER	Texas Northeastern Div. of the Mid-Michigan Railway Co.
TXNW	Texas North Western Railway Co.
TSE	Texas South-Eastern Railroad Co.
WTJR	Wichita, Tillman & Jackson Railway, Inc.

A.2.2.2 Austin Railroad Co. doing business as Austin & Northwestern Railroad Co. *(Est. 1986)*

The railroad operates freight services from a connection with the Southern Pacific at Giddings through Austin to Llano, 156.7 miles (252 km). A 6.2-mile (10-km) branch extends from Fairland to Marble Falls. Connections are also made with the Union Pacific at McNeil and Elgin. The load limit is 131.5 tons (119 metric tons). Traffic is Nonmetallic Minerals except Fuels (14) and Lumber & Wood Products except Furniture (24). These lines were acquired from the Southern Pacific by Capital Metro and the City of Austin. The railroad is operated by a subsidiary of RailTex, Inc., of San Antonio. Portions of the line in the Austin metropolitan area are under consideration for the route of a proposed light rail transit line.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	N/A	N/A	Operating Revenue	$2,889,222
Terminating	N/A	N/A	Operating Expenses	$2,718,358
Bridge	N/A	N/A	Gross Profit (Loss)	$170,864
Local	N/A	N/A		
TOTAL	N/A	N/A		

Total Ton-Miles	N/A	Revenue Class	Under $5 Million
		Number of employees	18 (in 1988)

A.2.2.3 Belton Railroad *(Est. 1961)*

This railway owns a line extending from a connection with the Union Pacific at Smith to Belton, 6.21 miles (10 km). It was incorporated to purchase a Missouri-Kansas-Texas branch. Traffic is Pulp, Paper & Allied Products (26). The company was owned by F. H. Guffy and others. The Georgetown Railroad purchased the assets of the company in 1992.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	N/A	N/A	Operating Revenue	0
Terminating	N/A	N/A	Operating Expenses	$39,293
Bridge	N/A	N/A	Gross Profit (Loss)	($39,293)
Local	N/A	N/A		
TOTAL	38 (in 1988)	N/A		

Total Ton-Miles	N/A	Revenue Class	Under $5 Million
		Number of employees	4 (in 1988)

A.2.2.4 Border Pacific Railroad *(Est. 1984)*

The railroad operates freight service from Rio Grande City to Mission, 31.6 miles (51 km), where a connection is made with the Rio Valley Railroad. Traffic includes Waste & Scrap

Materials (40), Nonmetal Minerals except Fuels (14), and Farm Products (1). The line was purchased from the Missouri Pacific and is controlled by Rio Grande Materials.

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	N/A	N/A
Terminating	N/A	N/A
Bridge	N/A	N/A
Local	N/A	N/A
TOTAL	300 (in 1988)	N/A

Operating Revenue	$539,838
Operating Expenses	$586,681
Gross Profit (Loss)	($46,843)

Total Ton-Miles	N/A	Revenue Class	Under $5 Million
		Number of employees	N/A

A.2.2.5 *Brownsville & Rio Grande International Railroad* *(Est. 1984)*

This is the terminal switching railroad at the Port of Brownsville. It operates 33 miles (53 km) of track and connects with the Union Pacific and -- via the Union Pacific -- with the Southern Pacific and the National Railways of Mexico. Traffic is primarily Nonmetal Minerals except Fuels (14) and Primary Metal Products (33). The line was operated by the Missouri Pacific until 1984 when the owner, the Brownsville Navigation District, recovered the property and leased it to the current operator.

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	N/A	N/A
Terminating	N/A	N/A
Bridge	N/A	N/A
Local	N/A	N/A
TOTAL	4,884	(in 1988)

Operating Revenue	$69,313
Operating Expenses	$871,473
Gross Profit (Loss)	($802,160)

Total Ton-Miles	N/A	Revenue Class	Under $5 Million
		Number of employees	14 (in 1988)

A.2.2.6 *Chaparral Railroad Co.* •*(Est. 1990)*

The railroad operates a line extending from connections with the Kiamichi Railroad and the Union Pacific at Paris to Farmersville, 60.1 miles (97 km), and then 24.6 miles (40 km) of trackage rights on the Santa Fe to Garland, where connections are made with the Santa Fe and the Union Pacific. Traffic is Food & Kindred Products (20), Lumber & Wood Products except Furniture (24), Pulp, Paper & Allied Products (26), and overhead traffic from the Kiamichi Railroad. This includes canned foods, grain, and aggregates. The trackage is a former secondary line of the Santa Fe. The company is affiliated with the Kiamichi Railroad.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	96	5,760		Operating Revenue	$255,569
Terminating	292	17,466		Operating Expenses	$604,467
Bridge	357	21,412		Gross Profit (Loss)	($348,898)
Local	0	0			
TOTAL	745	44,638			
Total Ton-Miles	5,261,280		Revenue Class	Under $5 Million	
			Number of employees	N/A	

A.2.2.7 Crystal City Railroad Co. *(Est. 1990)*

The railroad provides freight service from a connection with the Union Pacific at Gardendale to Crystal City and a branch from Crystal City to Carrizo Springs, 55 miles (88 km) in total. Traffic is Food & Kindred Products (20), Nonmetallic Minerals except Fuel (14), and Farm Products (1). This includes canned foods, tinplate, LP gas, and salt. The line is a former Missouri Pacific branch now operated by the Texas Railroad Switching Co., a subsidiary of Ironhorse Resources, Inc.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	275	19,250		Operating Revenue	$535,999
Terminating	796	60,730		Operating Expenses	$535,235
Bridge	0	0		Gross Profit (Loss)	$764
Local	0	0			
TOTAL	1,071	79,980			
Total Ton-Miles	N/A		Revenue Class	Under $5 Million	
			Number of employees	N/A	

A.2.2.8 Dallas, Garland & Northeastern *(Est. 1992)*

This railroad began service in February 1992. The railroad operates freight service on the former Missouri-Kansas-Texas main line between Garland, Greenville, and Trenton, 62 miles (100 km). The railroad interchanges with the Texas Northeastern at Trenton and with the Union Pacific at Garland. The railroad is operated by RailTex of San Antonio.[18] Operating costs and carload information are not yet available.

A.2.2.9 Floydada & Plainview Railroad Co. *(Est. 1990)*

The railroad operates freight service on this former Santa Fe line from a connection with the Santa Fe at Floydada Junction (Plainview) to Floydada, 26.9 miles (43 km). Traffic is Farm

[18] Robert Gallegos, "Short Lines: New RailTex Operation in Texas," Pacific Rail News, no. 341 (April 1992), 45.

Products (1) and Chemicals & Allied Products (28) including cotton, grain, and fertilizer. The company is a subsidiary of American Railway Corp. (Temco Corp.).

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	787	59,025	Operating Revenue	$179,679
Terminating	40	4,600	Operating Expenses	$207,314
Bridge	0	0	Gross Profit (Loss)	($27,635)
Local	0	0		
TOTAL	827	63,625		
Total Ton-Miles	299,130		Revenue Class	Under $5 Million
			Number of employees	N/A

A.2.2.10 Fort Worth & Dallas Railroad *(Est. 1988)*

Fort Worth & Western Railroad *(Est. 1988)*

Fort Worth & Western Railroad operates 6.5 miles (10 km) of former Burlington Northern trackage in Fort Worth. The Fort Worth & Dallas Railroad is 1.25 miles (2 km) of ex-Union Pacific trackage. Connections are made with the Santa Fe, the Burlington Northern, and the Union Pacific. Traffic is Food & Kindred Products (20), Pulp, Paper & Allied Products (26), and fabricated Metal Products (34). Both railroads are jointly operated and controlled by the Tarantula Corporation.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	0	N/A	Operating Revenue	$792,851
Terminating	0	N/A	Operating Expenses	$1,211,373
Bridge	0	N/A	Gross Profit (Loss)	($418,522)
Local	3,307	N/A		
TOTAL	3,307	N/A		
Total Ton-Miles	N/A		Revenue Class	Under $5 Million
			Number of employees	5 (in 1988)

A.2.2.11 Galveston Railway, Inc. *(Est. 1987)*

The railroad operates 43.3 miles (70 km), and connections are made with the Santa Fe, the Burlington Northern, the Southern Pacific, and the Union Pacific. The line began operation in 1900 as the Galveston Wharves Railway and is owned by the City of Galveston. Traffic is primarily farm and food products. The present operator is affiliated with Rail Switching Services of Dothan, Alabama, operating under a lease from the city since November 1987.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	N/A	N/A		Operating Revenue	$3,525,716
Terminating	N/A	N/A		Operating Expenses	$2,044,536
Bridge	N/A	N/A		Gross Profit (Loss)	$1,481,180
Local	N/A	N/A			
TOTAL	92,000	(in 1988)			
Total Ton-Miles	N/A		Revenue Class	$5 - 9 Million	
			Number of employees	17 (in 1988)	

A.2.2.12 Georgetown Railroad *(Est. 1958)*

The railroad operates freight service from connections with the Union Pacific and the Southern Pacific at Kerr to another connection with Union Pacific at Georgetown. The load limit is 150 tons (136 metric tons). Traffic is Stone, Clay, Glass & Concrete Products (32), Chemicals & Allied Products (28), and Transportation Equipment (10). The line was originally the Missouri Pacific's Georgetown branch. The railroad is independent.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	35,106	3,417,018		Operating Revenue	$10,582,195
Terminating	138	13,062		Operating Expenses	$8,163,040
Bridge	0	0		Gross Profit (Loss)	$2,419,155
Local	0	0			
TOTAL	35,244	3,430,080			
Total Ton-Miles	13,118,907		Revenue Class	Under $5 Million	
			Number of employees	34 (in 1988)	

A.2.2.13 Houston Belt & Terminal Railroad *(Est. 1905)*

This is the terminal and switching railroad in the Houston metropolitan area, operating 55 miles (88 km) of track. It is jointly owned by the Santa Fe, the Burlington Northern, the Union Pacific, and the Maytag Corporation. The owners pay the net cost of operation, listed as Gross Profit (Loss) in the table below, based on a joint facility operating agreement. The net profit from operations is reported as zero to the Railroad Commission of Texas.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	N/A	N/A		Operating Revenue	$2,998,756
Terminating	N/A	N/A		Operating Expenses	$39,824,449
Bridge	N/A	N/A		Gross Profit (Loss)	($36,825,693)
Local	N/A	N/A			
TOTAL	N/A	N/A			
Total Ton-Miles	N/A		Revenue Class	Under $5 Million	
			Number of employees	517 (in 1988)	

A.2.2.14 Jaxport Terminal Railway Co., Inc. *(Est. 1992)*

This railroad began service at Victoria in 1992. Operating costs and carload information are not yet available.

A.2.2.15 Kiamichi Railroad *(Est. 1987)*

The railroad operates freight service from a connection with the Louisiana & Arkansas (KCS) and the Union Pacific at Hope, Arkansas, 186 miles (299 km) to Lakeside, Oklahoma. From Lakeside, Oklahoma, 20 miles (32 km) of trackage rights on the Burlington Northern are used to reach an interchange location with the Burlington Northern at Madill, Oklahoma. A branch runs 45 miles (72 km) from Antlers, Oklahoma through Hugo, Oklahoma to Paris (20 miles (32 km) of this line are in Texas, from Arthur City to Paris). It connects at Paris with the Chaparral Railroad and the Union Pacific. Traffic is primarily Primary Metal Products (33) and Pulp, Paper & Allied Products (26) and includes coal, lumber, paper, chemicals, cement, pulpwood, feed, and food stuffs. The line is a former Saint Louis - San Francisco route made redundant when the Burlington Northern purchased that railroad. It is owned by Jack Hadley and others. (Operating revenues and expenses presented below are system totals.)

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	138	11,040
Terminating	1,129	90,320
Bridge	220	17,600
Local	0	0
TOTAL	1,487	118,960

Operating Revenue	$9,877,696
Operating Expenses	$7,645,929
Gross Profit (Loss)	$2,231,767

Total Ton-Miles	3,291,634
Revenue Class	$5 - 9 Million
Number of employees	53 (in 1988)

A.2.2.16 Mineral Wells & Eastern *(Est. 1989)*

The railroad operated freight service from a connection with the Union Pacific at Weatherford, 22 miles (35 km) to Mineral Wells. Traffic included minerals, forest products, plastics, beer, and bricks. The line was sold to the City of Mineral Wells in the fall of 1989 and was operated under contract by Transportation Consultants, Inc. The railroad ceased operations in October 1992, and local groups are advocating that the right-of-way be preserved under the "rails to trails" program.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	N/A	N/A		Operating Revenue	$350,849
Terminating	N/A	N/A		Operating Expenses	$345,544
Bridge	N/A	N/A		Gross Profit (Loss)	$5,305
Local	N/A	N/A			
TOTAL	351	N/A			
Total Ton-Miles	N/A		Revenue Class	Under $5 Million	
			Number of employees	18 (in 1988)	

A.2.2.17 Moscow, Camden & San Augustine Railroad *(Est. 1898)*

The railroad operates freight service 6.87 miles (11 km) from a connection with the Southern Pacific at Moscow to Camden. Traffic is outbound lumber and forest products (STCC 24). Chartered in 1898 to build a line from Moscow to San Augustine, it was built to Camden in that year but never extended. Champion International acquired the company in 1969.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	3,122	249,006		Operating Revenue	$563,856
Terminating	0	0		Operating Expenses	$388,771
Bridge	0	0		Gross Profit (Loss)	$175,085
Local	0	0			
TOTAL	3,122	249,006			
Total Ton-Miles	3,986,084		Revenue Class	Under $5 Million	
			Number of employees	7 (in 1988)	

A.2.2.18 Pecos Valley Southern Railway *(Est. 1911)*

The railway operates freight service from a connection with the Union Pacific at Pecos to Saragosa, 29.3 miles (47 km). Traffic is Nonmetallic Minerals except Fuels (14) and Chemicals & Allied Products (38). This includes farm products and supplies, barite, sand, and gravel. From 1927 to 1946, the railroad was controlled by the Texas & Pacific, but it is now owned by Trans-Pecos Materials.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	951	91,842		Operating Revenue	$184,538
Terminating	42	3,965		Operating Expenses	$169,122
Bridge	0	0		Gross Profit (Loss)	$15,416
Local	0	0			
TOTAL	993	95,807			
Total Ton-Miles	1,619,138		Revenue Class	Under $5 Million	
			Number of employees	6 (in 1988)	

A.2.2.19 Point Comfort & Northern Railway *(Est. 1948)*

The railroad operates freight service from a connection with the Union Pacific at Lolita to Point Comfort, 12.71 miles (20 km). Traffic is Metallic Ores (10), Chemicals & Allied Products (28), and Primary Metal Products (33), primarily aluminum and plastics. The railroad has always been owned by the Aluminum Company of America.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	16,525	1,549,153	Operating Revenue	$11,322,620
Terminating	5,211	444,165	Operating Expenses	$25.63.649
Bridge	0	0	Gross Profit (Loss)	$8,759,271
Local	0	0		
TOTAL	21,736	1,993,318		

Total Ton-Miles	25,913,134	Revenue Class	$5 - $9 Million
		Number of employees	N/A

A.2.2.20 Port Terminal Railroad Association *(Est. 1924)*

The railroad operates 32 miles (51 km) of line as an association for the benefit of the member railroads: the Santa Fe, the Burlington Northern, the Southern Pacific, the Union Pacific, and the Houston Belt and Terminal. The member railroads pay the net cost of operation based on car counts. The profit or loss from operations is reported as zero because costs are absorbed by the member railroads. Traffic is farm products, together with chemicals and allied products.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	N/A	N/A	Operating Revenue	$6,331,011
Terminating	N/A	N/A	Operating Expenses	$32,488,026
Bridge	N/A	N/A	Gross Profit (Loss)	($26,157,015)
Local	N/A	N/A		
TOTAL	239,000 (in 1988)	N/A		

Total Ton-Miles	N/A	Revenue Class	Under $5 Million
		Number of employees	400 (in 1988)

A.2.2.21 Rio Valley Railroad *(Est. 1993)*

The railroad operates lines from Harlingen to Mission, 42 miles (68 km), and from Mission to Hidalgo, 8 miles (13 km). Connections are made with the Border Pacific at Mission and with the Union Pacific at Harlingen. The railroad leases these lines from the Union Pacific and operates them under contract.[19] The railroad is a subsidiary of Ironhorse Resources, Inc. Operating costs and carload information are not yet available.

A.2.2.22 Rockdale, Sandow & Southern Railroad *(Est. 1923)*

The railroad operates freight service from a connection with the Union Pacific at Marjorie to Sandow, 5.87 miles (9 km). Traffic is Metallic Ores (10), Primary Metal Products (33), and Petroleum & Coal Products (29). The company was incorporated to purchase the railway from the Standard Coal Company. It changed to common carrier status in 1952 and is owned by the Aluminum Company of America.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	4,068	353,282	Operating Revenue	$4,422,011
Terminating	10,772	963,213	Operating Expenses	$1,375,012
Bridge	0	0	Gross Profit (Loss)	$3,046,999
Local	0	0		
TOTAL	14,840	1,316,495		

Total Ton-Miles	7,898,970	Revenue Class	Under $5 Million
		Number of employees	N/A

A.2.2.23 Sabine River & Northern Railroad *(Est. 1966)*

The railroad operates 31.5 miles (51 km) for freight service from Bessmay to Echo (Orange), with a 9-mile (14-km) branch to Evadale. Connections are made with the Santa Fe at Bessmay, the Kansas City Southern at Lemonville, the Union Pacific at Mauriceville, and the Southern Pacific at Echo. Traffic is Pulp, Paper & Allied Products (26), Lumber & Wood Products except Furniture (24), and Chemicals & Allied Products (28). The company is owned by Inland-Orange Inc.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	9,709	556,930	Operating Revenue	$5,295,300
Terminating	6,703	496,573	Operating Expenses	$3,628,700
Bridge	0	0	Gross Profit (Loss)	$1,666,600
Local	2,836	189,074		
TOTAL	19,248	1,242,577		

Total Ton-Miles	19,133,251	Revenue Class	Under $5 Million
		Number of employees	23 (in 1988)

[19]Wayne Monger, "Union Pacific: More Texas Branch Lines Leased," Pacific Rail News, no.354 (May 1993), 13.

A.2.2.24 Seagraves, Whiteface & Lubbock Railroad *(Est. 1990)*

The railroad operates freight service from a connection with the Santa Fe at Lubbock southwest to Seagraves, 65 miles (105 km). A 39.8-mile (64-km) branch runs west from Doud to Whiteface and Coble. This trackage was formerly operated by the Santa Fe. Traffic is Farm Products (1), Chemicals & Allied Products (28), and Nonmetallic Minerals except Fuels (14), which includes salt cake, chemicals, fertilizer, grain, cotton, and LP gas. The company is owned by American Railway Corporation (Temco Corporation).

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	3,605	354,460
Terminating	771	88,065
Bridge	0	0
Local	0	0
TOTAL	4,376	442,525

Operating Revenue	$2,387,164
Operating Expenses	$2,223,157
Gross Profit (Loss)	$164,007

Total Ton-Miles	13,541,763
Revenue Class	Under $5 Million
Number of employees	N/A

A.2.2.25 South Orient Railroad Co., Ltd. *(Est. 1992)*

This railroad operates a 386-mile (621-km) former Santa Fe line from Coleman to the border crossing of Presidio, with trackage rights on the Santa Fe to reach San Angelo. The railroad also uses 11 miles (18 km) of trackage rights on the Southern Pacific near Alpine. The line is owned by the South Orient Rural Railroad Transportation District and is operated under contract by the Kiamichi Railroad. Between the start of service on January 1, 1992 and March 1, 1992, the company moved 139 cars. Effective September 18, 1992, a haulage agreement had been negotiated with the Burlington Northern. The company's goal is to handle livestock, auto parts, and other commodities moving from Fort Worth and San Angelo to Chihuahua, Mexico, and the Gulf of California.[20] Historically, this line was the southern end of the Kansas City, Mexico and Orient, built in the late 1800's as a link between Kansas City and Gulf of California. The Santa Fe purchased the U.S. portion of the line in 1928; the Mexican portion is now operated by the National Railways of Mexico.

A.2.2.26 Texas & Northern Railway *(Est. 1948)*

The railway operates freight service from a connection with the Louisiana & Arkansas (KCS) at Daingerfield to Lone Star, 7.6 miles (12 km). Traffic is steel and related commodities:

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[20]Paul D. Schneider, "The Mexican Connection," Trains 53, no. 1 (January 1993), 50.

Primary Metals (33), Waste & Scrap Materials (40), and Coal (11). The company was incorporated to take over operation of the Lone Star Steel Company's private railroad.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	1,290	116,708		Operating Revenue	$6,402,083
Terminating	4,351	370,972		Operating Expenses	$4,492,327
Bridge	0	0		Gross Profit (Loss)	$1,909,756
Local	15,892	539,980			
TOTAL	21,533	1,027,660			
Total Ton-Miles	6,890,956		Revenue Class	Under $5 Million	
			Number of employees	46 (in 1988)	

A.2.2.27 Texas & Oklahoma *(Est. 1991)*

The railroad owns and operates the former Santa Fe line between Maryneal and Thomas, Oklahoma, 282 miles (454 km).[21] Historically, this line was part of the Kansas City, Mexico, and Orient built in the late 1800's as a link between Kansas City and Gulf of California. The Santa Fe purchased the U.S. portion of the line in 1928; the Mexican portion is now operated by the National Railways of Mexico.

A.2.2.28 Texas Central Railroad *(Est. 1967)*

The railroad operates 24.2 miles (39 km) for freight service from a connection with the Santa Fe at Dublin to Gorman. Traffic is primarily Farm Products (1). The company was incorporated in 1892, under the same name as it has today, and at one time operated 267 miles (430 km) of track from Waco extending northwest to Rotan. The company was leased by the Missouri-Kansas-Texas Railroad from 1914 to 1967, when remaining line was sold to Texas Central Enterprises, Inc..

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	455	36,400		Operating Revenue	$484,157
Terminating	59	7,087		Operating Expenses	$450,348
Bridge	0	0		Gross Profit (Loss)	$33,809
Local	1,263	43,345			
TOTAL	1,777	86,832			
Total Ton-Miles	1,476,144		Revenue Class	Under $5 Million	
			Number of employees	5 (in 1988)	

A.2.2.29 Texas City Terminal Railway *(Est. 1921)*

This is a terminal switching railroad in Texas City that operates 30 miles (48 km) of track and provides interchange with the Santa Fe, the Burlington Northern, the Southern Pacific, and

[21]Elson Rush, "Santa Fe: Line Sale Update," Pacific Rail News, no. 340 (March 1992), 11.

the Union Pacific. Traffic consists of chemicals, potash, and petroleum and coal products. The company was incorporated as a successor to Texas City Transportation Co., and is jointly owned by the Santa Fe and the Union Pacific.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	N/A	N/A	Operating Revenue	$7,715,759
Terminating	N/A	N/A	Operating Expenses	$4,531,300
Bridge	N/A	N/A	Gross Profit (Loss)	$3,184,459
Local	N/A	N/A		
TOTAL	29,600	N/A		

Total Ton-Miles	N/A	Revenue Class	Under $5 Million
		Number of employees	68 (in 1988)

A.2.2.30 Texas, Gonzales & Northern *(Est. 1992)*

This railroad began service in November 1992 on a 12-mile (19-km) former Southern Pacific branch line, between Gonzales and a connection with the Southern Pacific at Harwood.[22] Operating costs and carload information are not yet available.

A.2.2.31 Texas Mexican Railway *(Est. 1881)*

The railroad operates freight service from the international border at Laredo to Corpus Christi and Flour Bluff, 172.9 miles (278 km). Connections are made with the National Railways of Mexico, the Southern Pacific, and the Union Pacific. Traffic includes Farm Products (1), Waste & Scrap Materials, and Stone, Clay, Glass, & Concrete (32), much of it moving between the United States and Mexico. The company stock was controlled in a trust by the National Railways of Mexico until 1982, when it became independent.

TRAFFIC TYPE	CARLOADS	TONNAGE		
Originating	6,304	489,772	Operating Revenue	$19,820,432
Terminating	668	53,777	Operating Expenses	$19,954,805
Bridge	27,151	2,022,763	Gross Profit (Loss)	($134,373)
Local	3,972	361,299		
TOTAL	38,095	2,927,611		

Total Ton-Miles	422,443,146	Revenue Class	$5 - $19 Million
		Number of employees	240 (in 1988)

[22] Wayne Monger and Bob Thompson, "Short Lines: Lone Star Extras," Pacific Rail News, no. 353 (April 1993), 43.

A.2.2.32 Texas - New Mexico Railroad *(Est. 1989)*

The railroad operates 107 miles (172 km) for freight service from a connection with the Union Pacific at Monahans to Lovington, New Mexico. Traffic includes salt cake, cotton, and scrap metal. The railroad was operated for many years under lease to the Missouri Pacific (Texas & Pacific). The Union Pacific did not seek to renew the lease, and a new operator was found. It is now operated as a division of the Austin and Northwestern Railroad, a subsidiary of RailTex, Inc. of San Antonio.

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	864	N/A
Terminating	575	N/A
Bridge	0	N/A
Local	0	N/A
TOTAL	1,439	N/A

Operating Revenue	$129,870
Operating Expenses	$141,319
Gross Profit (Loss)	($11,449)

Total Ton-Miles	N/A
Revenue Class	Under $5 Million
Number of employees	N/A

A.2.2.33 Texas North Western Railway Co. *(Est. 1982)*

The railroad operates freight service from an Etter Junction connection with the Santa Fe east to Morse, 32 miles (51 km). The railroad is a former Chicago, Rock Island & Pacific branch. The company initially offered service from Etter Junction to Liberal, Kansas, but in 1987 the line was cut back to its present length. Traffic is Farm Products (1), Chemicals & Allied Products (28), and Petroleum & Coal Products (29). The company is controlled by TNW Corporation of Dallas, Texas.

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	1,001	77,837
Terminating	418	33,506
Bridge	0	0
Local	0	0
TOTAL	1,419	111,343

Operating Revenue	$652,991
Operating Expenses	$512,312
Gross Profit (Loss)	$140,679

Total Ton-Miles	1,412,538
Revenue Class	Under $5 Million
Number of employees	7 (in 1988)

A.2.2.34 Texas North-Eastern Div. of the Mid Michigan Railway, Inc. (Est. 1990)

The railroad operates a total of 184 miles (296 km) for freight service. The main line runs from a connection with the Union Pacific at Texarkana to Sherman, 154 miles (248 km). A 13-mile (21-km) branch extends from Bells south to Trenton, where a connection is made with the Dallas, Garland & Northeastern. The railroad operates between Sherman and near Denison, 13 miles, on trackage rights from the Southern Pacific. A sale of this line to the Burlington Northern is pending, and the agreement is expected to be renegotiated.[23] In addition, 4 miles of track are operated to enter Denison, where connection is made with the Union Pacific. Interchange with the Burlington Northern and the Southern Pacific occurs at Sherman, and interchange with the Kiamichi and the Chaparral is made at Paris. The railroad was a former Missouri Pacific (Texas & Pacific) line. Traffic includes Food & Kindred Products (20), Farm Products (1), and Nonmetallic Minerals except Fuels (14). The trackage is operated under a 20-year lease from the Union Pacific with options for additional 20-year leases. The company is owned by RailTex, Inc., of San Antonio.[24]

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	5,706	487,510		Operating Revenue	$2,886,579
Terminating	9,390	855,910		Operating Expenses	$2,271,658
Bridge	23	2,300		Gross Profit (Loss)	$614,921
Local	0	0			
TOTAL	15,119	1,345,720			
Total Ton-Miles	5,884,090		Revenue Class	Under $5 Million	
			Number of employees	N/A	

A.2.2.35 Texas South-Eastern Railroad Co. (Est. 1900)

The railroad operates freight and TOFC service from Diboll to Lufkin, 10.3 miles (17 km), plus a 7.2-mile (12-km) branch from Blix to Vair. It connects with the Southern Pacific at Diboll and Lufkin and with the Angelina & Neches River in Lufkin. Traffic is Nonmetal Minerals (7), Lumber & Wood Products except Furniture (34), and Chemicals & Allied Products (28).

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23 Karl Rasmussen, "Burlington Northern: BN purchases SP trackage in Texas," Pacific Rail News, no. 353 (April 1993), 7.

24 Wayne Monger and Bob Thompson, "Short Lines: Texas Northeastern Corrections," Pacific Rail News, no. 352 (March 1993), 47.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	712	55,890		Operating Revenue	$646,695
Terminating	1,248	110,860		Operating Expenses	$479,340
Bridge	0	0		Gross Profit (Loss)	$167,355
Local	0	0			
TOTAL	1,960	166,750			
Total Ton-Miles	N/A		Revenue Class	Under $5 Million	
			Number of employees	12 (in 1988)	

A.2.2.36 Texas Transportation Company *(Est. 1932)*

This is an electrically operated 1.1-mile (2-km) switching line in San Antonio connecting with the Southern Pacific. It was built in 1889, and designated as a common carrier in 1932. Traffic is Food & Kindred Products (20). The railroad is owned by the Pearl Brewing Company.

TRAFFIC TYPE	CARLOADS	TONNAGE			
Originating	0	0		Operating Revenue	$38,980
Terminating	0	0		Operating Expenses	$93,440
Bridge	0	0		Gross Profit (Loss)	($54,460)
Local	487	25,333			
TOTAL	487	25,333			
Total Ton-Miles	N/A		Revenue Class	Under $5 Million	
			Number of employees	4 (in 1988)	

A.2.2.37 Trancisco Texas Railway, Inc. *(Est. 1990)*

This railroad is the operator of the ***Texan*** dinner train service on a 50-mile (80-km) round-trip route between Houston and Galveston by trackage rights on the Union Pacific (ex-Missouri Pacific). The operation ran a deficit of $583,304 on operating revenues of $2,321,041 and operating expenses of $2,904,345. The company is a wholly owned subsidiary of Trancisco Tours of San Francisco.

A.2.2.38 Western Rail Road Company *(Est. 1975)*

This railroad operates a 1.95-mile (3-km) line extending from a connection with the Union Pacific at Dittlinger to another connection with the Union Pacific at Solms (near New Braunfels). Traffic is Nonmetallic Minerals (14), Stone, Clay, Glass, & Concrete (32), and Petroleum & Coal Products (29). The railroad is controlled by Duncan Gage.

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	21,963	2,215,896
Terminating	1,294	116,430
Bridge	0	0
Local	0	0
TOTAL	23,257	2,332,326

Operating Revenue	$4,404,509
Operating Expenses	$1,459,911
Gross Profit (Loss)	$2,944,598

Total Ton-Miles	3,498,489	Revenue Class	$5 - $9 Million
		Number of employees	33 (in 1988)

A.2.2.39 Wichita, Tillman, & Jackson Railway, Inc. *(Est. 1991)*

The railroad operates freight service on a former Missouri-Kansas-Texas line from Wichita Falls to Altus, Oklahoma, 77.6 miles (125 km) (18 miles (29 km) in Texas). It connects with the Burlington Northern at Wichita Falls and Altus, with the Grainbelt at Fredrick, Oklahoma, with the Santa Fe at Altus, and with the Union Pacific at Wichita Falls via the Burlington Northern. A second disconnected 24-mile (39-km) segment (ex-Chicago, Rock Island & Pacific) is operated from a connection with the Union Pacific at Waurika, Oklahoma to Walters, Oklahoma. Trackage in Oklahoma is owned by the State of Oklahoma. Traffic is primarily Nonmetallic Minerals (14), Farm Products (1), and Waste & Scrap Metals (40). The railroad carries primarily grain; additionally, fertilizer, gypsum board, sand, soda ash, and chemicals used in glass manufacture are hauled. The railroad is a joint venture of the Rio Grande Pacific Corporation and the Minnesota Valley Railroad (incorporated as MNVA Railroad).

TRAFFIC TYPE	CARLOADS	TONNAGE
Originating	3,504	N/A
Terminating	3,214	N/A
Bridge	0	N/A
Local	0	N/A
TOTAL	6,718	N/A

Operating Revenue	$1,446,369
Operating Expenses	$1,385,696
Gross Profit (Loss)	$60,673

Total Ton-Miles	7,179,496	Revenue Class	Under $5 Million
		Number of employees	18 (in 1988)

APPENDIX B

AIR TRANSPORTATION IN THE STATE OF TEXAS

In Texas, there are 28 major airports, generally located in or near the largest cities. Figure B-1, on the following page, illustrates where these airports are located. This chapter will examine this mode of travel in an effort to advance understanding of intermodal transit.

B.1 AIRPORT FACILITIES

Much in the way that automobiles must have entrances and exits to the roads on which they travel, aircraft must have runway facilities in order to access their travel medium, the sky. Very often, cities have several runways clustered together near the edge of town to form that community's airport.

B.1.1 Cities with Multiple Airports

In large cities, there may be more than one airport, the result of a large population, a large number of flights, or both. Two examples of this phenomenon in Texas are Dallas and Houston. Dallas has an airport of its own, Love Field, as well as one it shares with Fort Worth, Dallas/Fort Worth International (DFW). Houston has three airports of its own, namely Ellington Field, William P. Hobby (Hobby), and Houston Intercontinental (Intercontinental).

B.1.1.1 Competition

In these two cases, the size and location of the airport generally indicates its age (see Figure B-2). Hobby and Love Field, for example, are smaller and located closer to the city centers. Originally, these were the primary airports for Houston and Dallas, respectively. They continue to operate, but serve secondary and/or supporting roles to Intercontinental and DFW . Most carriers serve only one of the airports. Southwest Airlines is a good example, serving only Hobby and Love Field.

B.1.1.2 Cooperation

In many cities, the airport is a department or agency of the municipal government. Its budget is part and parcel of that of the city in general. In Houston, for example, the city's

Department of Aviation manages all three airports with central authority. This may be problematic, when one considers that the other municipalities in the region, which benefit or suffer as a result of the airport(s), may not have a say in its operation.

B.1.2 Conventional Metropolitan Airports

In most Texas cities, there is one airport that serves the community and it is usually a major component of the city's transportation infrastructure. DFW processes over 50 million passengers annually, or over 135,000 per day. Table B-1 provides a listing of each airport and its passenger totals. The highest totals -- 25,981,866 enplanements and 25,961,701 deplanements -- occur at DFW.

Table B-2 illustrates how enplanements have increased in the last four years. The large airports had moderate increases from 1989 to 1992 (23.9 percent for DFW and 33.9 percent for Intercontinental). Several airports, mostly in the southern portion of the state, had much more significant increases: 78.3 percent for Victoria, 86.6 percent for McAllen, and 294.1 percent for Laredo. (Note that McAllen, most of whose passengers originate in the Rio Grande Valley, appears to have usurped trip ends from Brownsville, whose airport shows a 69.8 percent drop in enplanements.)

It is interesting to correlate passenger totals with other city characteristics. One would expect passenger totals to be proportional to the city's population, but this is not always the case (see Table B-3). DFW, for example, serves as a hub for many major airlines, and there are numerous transferring passengers who are not actually originating from the Dallas metroplex. This fact most likely accounts for the high enplanements per capita of 13.79. Most medium- to large-size cities have per capita enplanements from 2 to 8. In the Rio Grande Valley, Harlingen has much higher per capita enplanements (10.40) compared to McAllen (3.26) and Brownsville (0.03). This is most likely due to the fact that some airlines, such as Southwest, serve only one of the three airports -- in this case, Harlingen.

B.1.3 Links Between Cities

One major task of evaluating transportation is ascertaining not only where people go, but how they get there. It is, therefore, important to identify the major traveled routes. Unfortunately, airports are not too concerned with where flights are headed for, or arriving from, as long as they can process the planes, passengers, and cargo efficiently. Airlines are usually unwilling to disclose how many passengers fly a particular route for proprietary reasons. It is possible to see what routes are served (see Figure B-3 for Southwest Airlines as an example), but not how busy they are.

It can be argued, however, that transportation agencies are not in the business of allocating the actual air space between cities, only the departures and arrivals at the airports. In contemplating a study of a city and how its airport functions, it is important to note that the vast majority of all air travel takes place between only a few of the available airports. As shown in Figure B-4, 94 percent of the passenger movements occur between seven of the 28 airports. DFW, alone, accounts for nearly one-half of all passenger trip-ends in Texas. DFW, Love Field, Intercontinental, and Hobby together account for over 80 percent of the Texas air travel.

B.2 FREIGHT SERVICES

In addition to passenger transport, airports also handle cargo. Table B-4 shows how much freight and mail is handled in Texas airports. Again, the largest volumes occur at DFW, which handles almost 750,000 tons (680,581 metric tons) of freight yearly, and Intercontinental, which handles nearly half a billion tons (454 metric tons).

There are some cargo-only airlines, such as the aircraft fleets owned by United Parcel Service and Federal Express, but most air cargo is transported on passenger flights. In addition to the normal quantity of cargo carried on each commercial flight, there exist courier services who will issue a free or less expensive airline ticket to any passenger who agrees to let them use the space allowed for his/her luggage to transport packages instead.

B.3 AIRPORT FINANCES

B.3.1 Income from Airlines

Landing Fees (charges to airlines by airports for the use of runways) are usually a major source of income. Some airports do not charge landing fees, relying instead on hangar rental, terminal concessions, parking fees, or other sources for their income. Table B-5 identifies the importance of landing fees for Texas airports. Note that Brownwood and Victoria charge no landing fees at all. Generally, the percentage of revenue derived from landing fees seems to be proportional to the size of the airport.

B.3.2 Other Income

As was stated, there are many possible sources of income for an airport. This is illustrated for DFW in Table B-6 which itemizes DFW revenues and expenditures. Note that parking provides nearly 20 percent of the revenue, with another 17 percent coming from the terminal buildings.

B.3.3 Operating Costs

Table B-7 show the revenues and expenses for Texas airports. While the revenues and expenditures are generally proportional to the size of the airport, size is not a good indicator of profitability. A number of airports operate at a loss, meaning the costs of the airport facilities are subsidized by general taxpayers and not paid by air travelers.

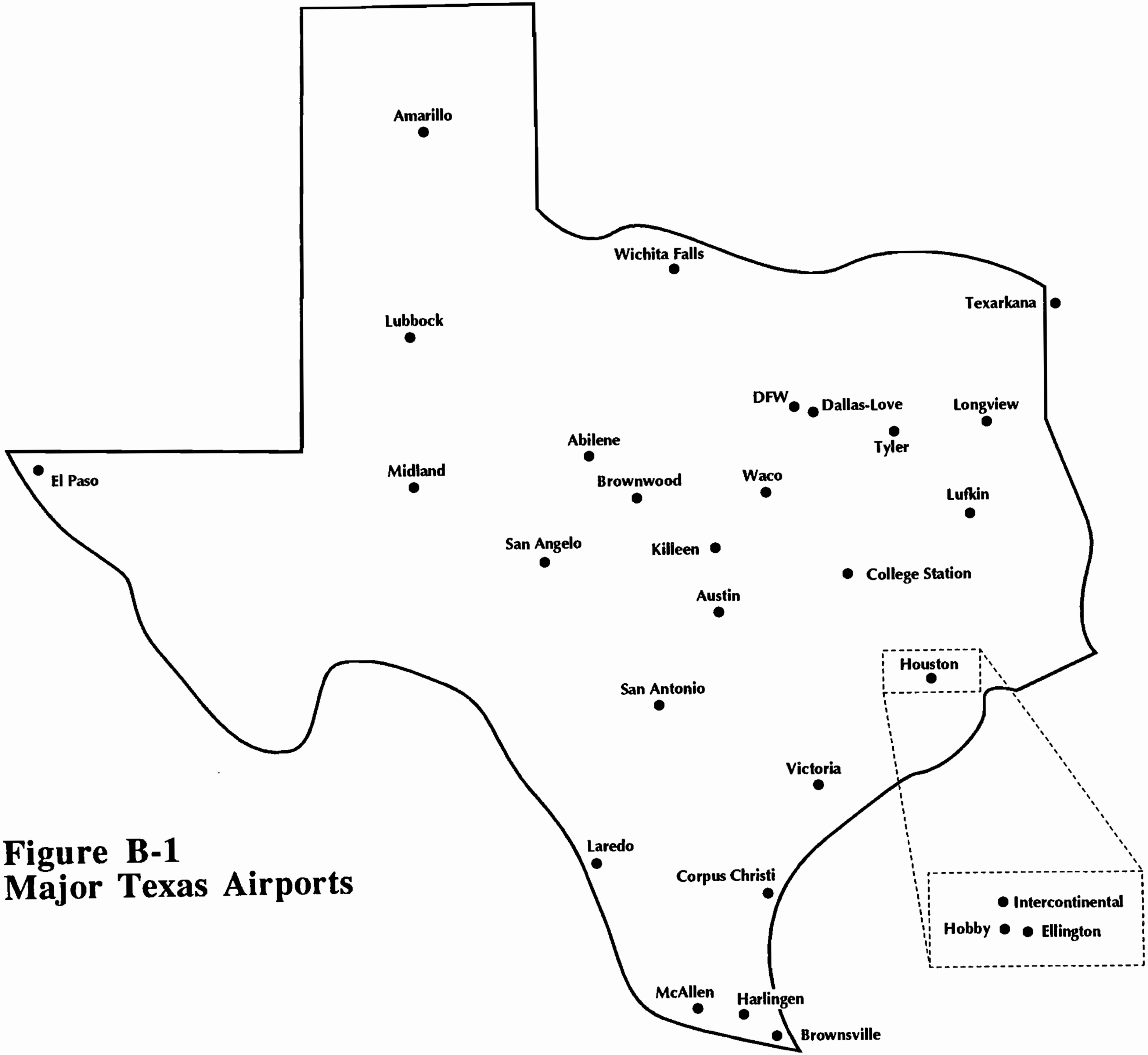


Figure B-1
Major Texas Airports

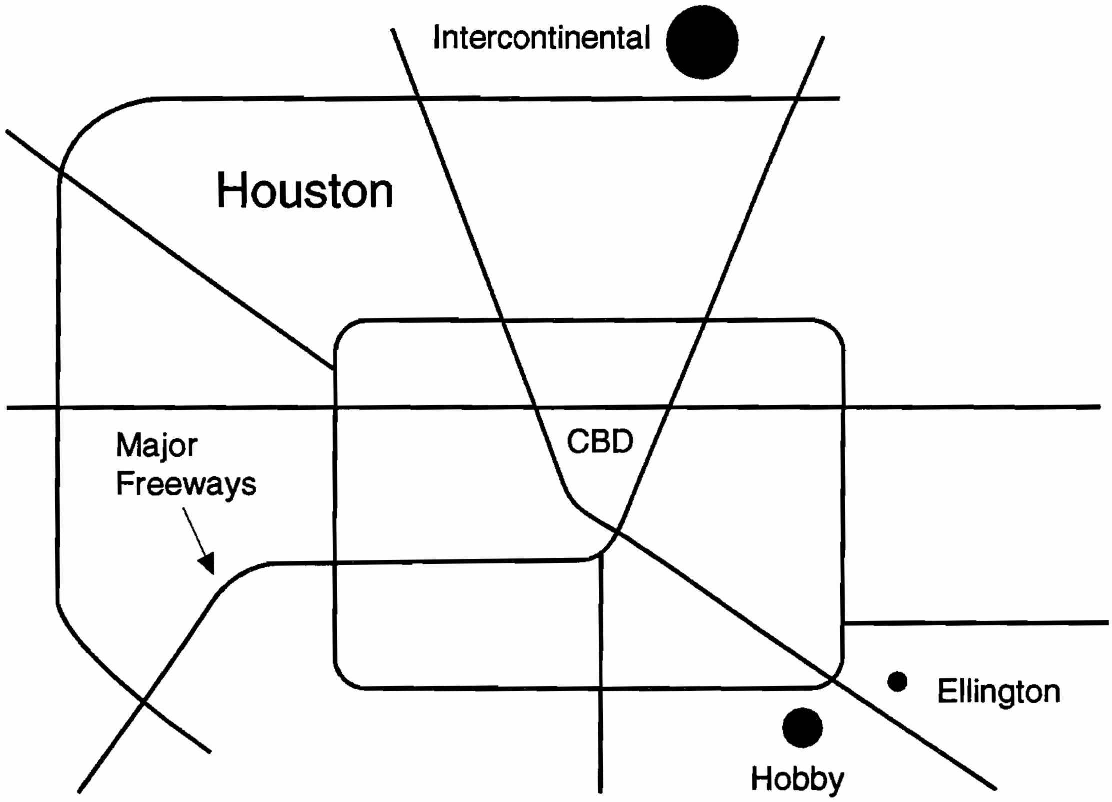
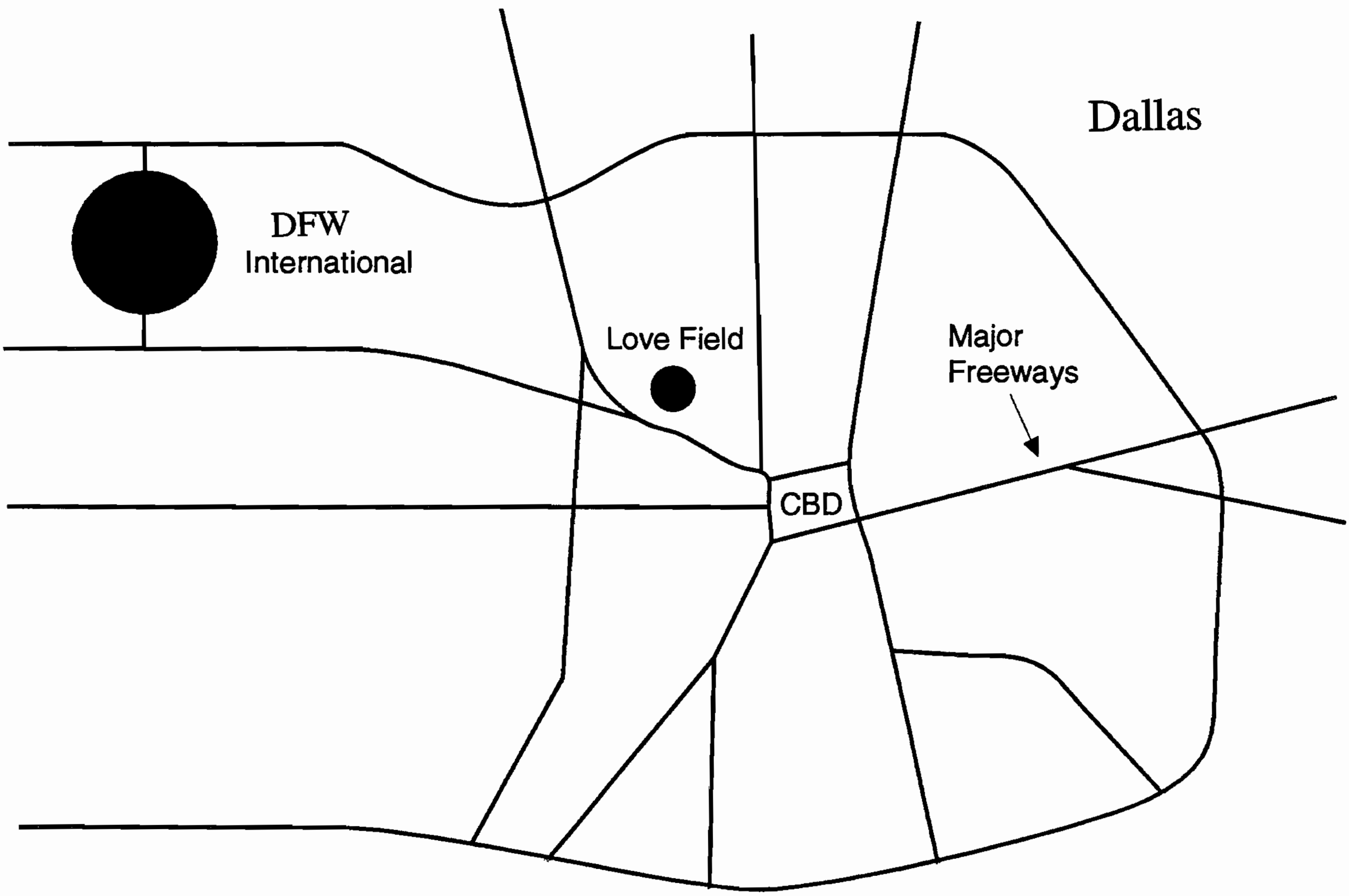


Figure B-2
Houston and Dallas Airport Locations



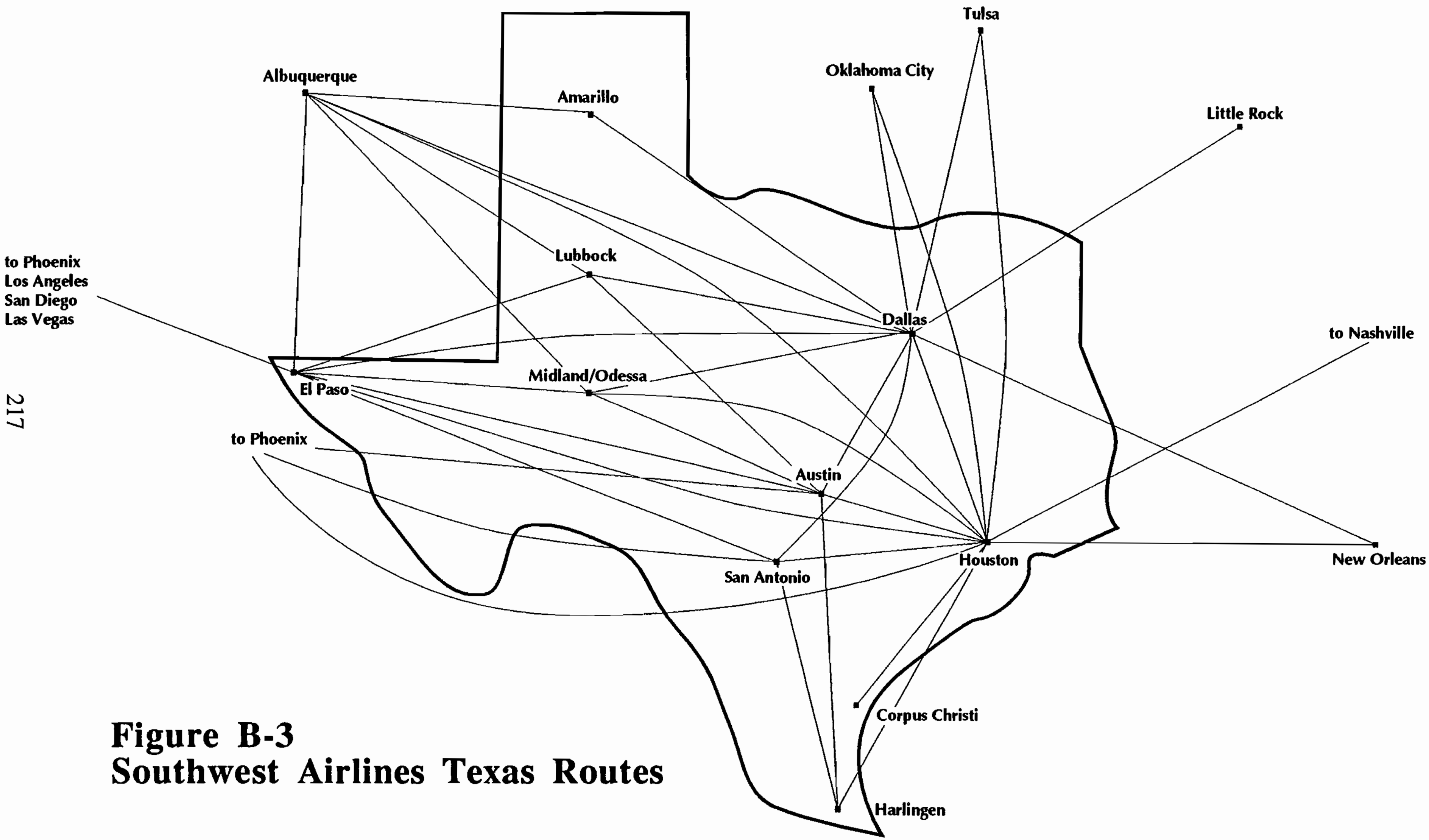


Figure B-3
Southwest Airlines Texas Routes

Figure B-4
Distribution of Airport Travel

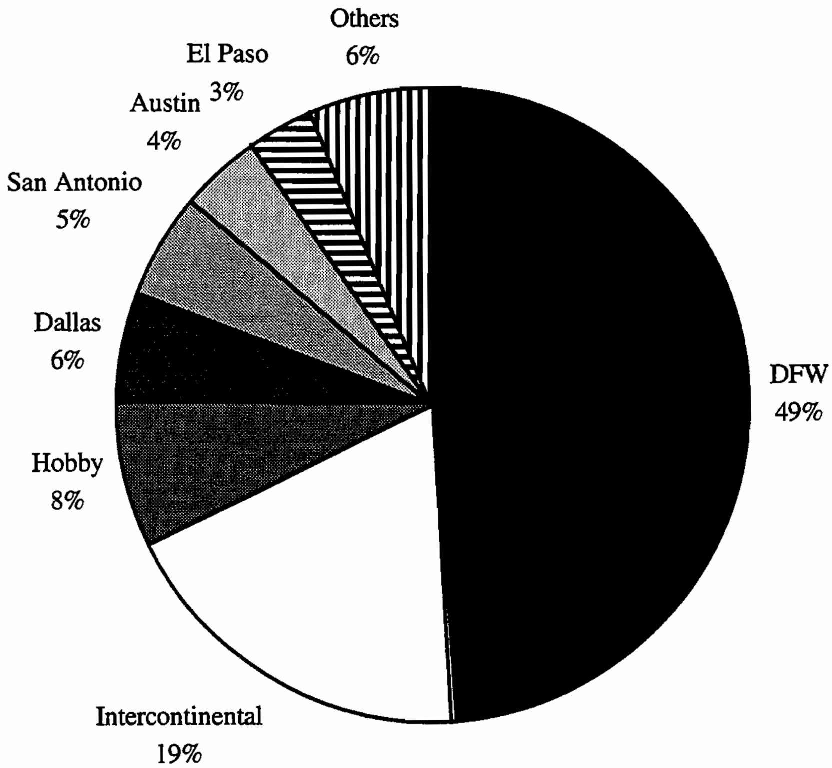


Table B-1
Passenger Movements (1992)

	Passenger Totals	
Airport Name	**Enplaned**	**Deplaned**
DFW	25,981,866	25,961,701
Houston Intercontinental	9,908,401	9,445,612
William P. Hobby	4,065,542	4,054,267
Dallas Love Field	2,948,535	2,939,224
San Antonio International	2,751,043	2,774,218
Austin- Robert Mueller	2,187,790	2,181,962
El Paso International	1,713,244	1,657,761
Lubbock International	576,886	NA
Midland Regional	541,171	533,624
Corpus Christi International	527,425	524,549
Harlingen- Rio Grande Valley	506,907	495,910
Amarillo International	439,502	NA
McAllen- Miller International	274,058	267,542
Laredo International	99,000	84,500
Abilene Municipal	65,473	65,619
Houston- Ellington Field	56,745	51,734
San Angelo- Mathis Field	52,620	52,534
Waco Regional	48,226	48,080
Tyler- Pounds Field	46,810	46,523
Texarkana Regional	44,661	43,223
Longview- Gregg County	39,922	39,781
Victoria Regional	20,790	20,208
Brownsville / S. Padre Island	3,036	R/R
Brownwood Municipal	R/R	R/R
College Station- Easterwood	R/R	R/R
Killeen Municipal	R/R	R/R
Lufkin- Angelina County	R/R	R/R
Wichita Falls- Sheppard	R/R	R/R

N.A. - not available
R/R - requested, but not received

Table B-2
Enplaned Movements (1989-1992)

	Enplaned Passengers		
Airport Name	**1989**	**1992**	**% Increase**
DFW	20,973,462	25,981,866	23.88%
Houston Intercontinental	7,399,010	9,908,401	33.92%
William P. Hobby	3,934,383	4,065,542	3.33%
San Antonio International	2,513,870	2,751,043	9.43%
Dallas Love Field	2,438,372	2,948,535	20.92%
Austin- Robert Mueller	1,933,752	2,187,790	13.14%
El Paso International	1,337,792	1,713,244	28.07%
Midland Regional	579,620	541,171	-6.63%
Lubbock International	527,433	576,886	9.38%
Harlingen- Rio Grande Valley	479,945	506,907	5.62%
Amarillo International	456,920	439,502	-3.81%
Corpus Christi International	430,173	527,425	22.61%
McAllen- Miller International	146,860	274,058	86.61%
Abilene Municipal	61,427	65,473	6.59%
San Angelo- Mathis Field	47,508	52,620	10.76%
Tyler- Pounds Field	40,529	46,810	15.50%
Waco Regional	34,309	48,226	40.56%
Longview- Gregg County	26,018	39,922	53.44%
Laredo International	25,120	99,000	294.11%
Victoria Regional	11,660	20,790	78.30%
Brownsville / S. Padre Island	10,038	3,036	-69.75%

Table B-3
Enplanements vs. Population

Airport Name	Passengers Enplaned	Population (1990 census)		Enplanements per Capita
DFW	25,981,866			
Dallas Love Field	2,948,535			
Total for Dallas/Fort Worth	28,930,401	2,097,967	*	13.79
Houston Intercontinental	9,908,401			
William P. Hobby	4,065,542			
Houston- Ellington Field	56,745			
Total for Houston	14,030,688	1,813,766	**	7.74
San Antonio International	2,751,043	935,933		2.94
Austin- Robert Mueller	2,187,790	465,622		4.70
El Paso International	1,713,244	515,342		3.32
Lubbock International	576,886	186,206		3.10
Midland Regional	541,171	179,142	†	3.02
Corpus Christi International	527,425	257,453		2.05
Harlingen- Rio Grande Valley	506,907	48,735		10.40
Amarillo International	439,502	157,615		2.79
McAllen- Miller International	274,058	84,021		3.26
Laredo International	99,000	122,899		0.81
Abilene Municipal	65,473	106,654		0.61
San Angelo- Mathis Field	52,620	84,474		0.62
Waco Regional	48,226			0.47
Tyler- Pounds Field	46,810	75,450		0.62
Texarkana Regional	44,661	54,287	††	0.82
Longview- Gregg County	39,922	70,311		0.57
Victoria Regional	20,790	55,076		0.38
Brownsville / S. Padre Island	3,036	98,962		0.03

* Includes Dallas, Fort Worth, Arlington, Grand Prairie, Garland, and Mesquite
** Includes Houston, Baytown and Pasadena
† Includes Midland and Odessa
†† Includes Arkansas and Texas portions of Texarkana

Table B-4
Freight and Mail Operations (1992)

	Pounds of Freight		Pounds of Mail	
Airport Name	**Enplaned**	**Deplaned**	**Enplaned**	**Deplaned**
DFW	467,004,800	472,823,600	203,009,600	205,539,000
Houston Intercontinental	274,937,000	242,262,000	N.A.	N.A.
William P. Hobby	N.A.	N.A.	N.A.	N.A.
Dallas Love Field	N.A.	N.A.	N.A.	N.A.
San Antonio International	44,420,590	N.A.	21,738,195	N.A.
Austin- Robert Mueller	37,893,886	41,032,581	7,895,448	9,235,672
El Paso International	37,536,800	49,045,000	3,683,600	3,696,200
Lubbock International	N.A.	N.A.	N.A.	N.A.
Midland Regional	2,034,000	R/R	880,000	R/R
Corpus Christi International	105,621	228,036	124,983	121,590
Harlingen- Rio Grande Valley	298,048	1,937,403	N.A.	N.A.
Amarillo International	N.A.	N.A.	N.A.	N.A.
McAllen- Miller International	1,610,482	1,453,752	1,258,727	107,104
Laredo International	N.A.	N.A.	N.A.	N.A.
Abilene Municipal	25,898	117,843	12,103	27,078
Houston- Ellington Field	N.A.	N.A.	N.A.	N.A.
San Angelo- Mathis Field	N.A.	N.A.	N.A.	N.A.
Waco Regional	52,975	88,165	Combined with	freight
Tyler- Pounds Field	18,863	64,660	5,854	2,117
Texarkana Regional	37,852	32,666	Combined with	freight
Longview- Gregg County	16,110	37,371	N.A.	N.A.
Victoria Regional	24,391	N.A.	N.A.	N.A.
Brownsville / S. Padre Island	R/R	R/R	R/R	R/R
Brownwood Municipal	R/R	R/R	R/R	R/R
College Station- Easterwood	R/R	R/R	R/R	R/R
Killeen Municipal	R/R	R/R	R/R	R/R
Lufkin- Angelina County	R/R	R/R	R/R	R/R
Wichita Falls- Sheppard	R/R	R/R	R/R	R/R

N.A. - not available
R/R - requested, but not received

Table B-5
Landing Fees vs. Total Revenues

		Landing Fees	
Airport Name	**Revenues**	**Total**	**As % of Revenues**
DFW	$218,443,000	$82,445,000	37.74%
Austin- Robert Mueller	$18,671,000	$4,200,000	22.49%
Corpus Christi International	$4,197,706	$867,475	20.67%
Lubbock International	$4,130,467	$665,653	16.12%
Dallas Love Field	$15,665,498	$2,131,440	13.61%
Midland Regional	$3,834,062	$487,803	12.72%
Tyler- Pounds Field	$352,400	$31,269	8.87%
El Paso International	$13,008,482	$1,147,892	8.82%
Harlingen- Rio Grande Valley	$4,346,776	$374,502	8.62%
Amarillo International	$3,264,969	$200,450	6.14%
Abilene Municipal	$650,970	$35,534	5.46%
San Angelo- Mathis Field	$578,340	$29,372	5.08%
Longview- Gregg County	$797,000	$12,000	1.51%
Brownsville / S. Padre Island	$1,565,956	$15,496	0.99%
Brownwood Municipal	$258,260	$0	0.00%
Victoria Regional	$1,663,854	$0	0.00%

Table B-6
Revenues and Expenses for DFW (1992)

Airport Area	Revenues	% of Total	Expenditures	% of Total
Landing Operations	$84,797,000	38.82%	$40,341,000	43.22%
Terminal Buildings	$37,255,000	17.05%	$10,250,000	10.98%
Parking Complex	$42,324,000	19.38%	$11,185,000	11.98%
Grounds and Concessions	$15,884,000	7.27%	$4,600,000	4.93%
Utility Systems	$11,777,000	5.39%	$9,193,000	9.85%
Hotel/Recreation Complex	$4,278,000	1.96%	$3,265,000	3.50%
Transit System	$6,088,000	2.79%	$9,233,000	9.89%
Fueling Systems	$3,120,000	1.43%	$1,573,000	1.69%
East Cargo Area	$1,495,000	0.68%	$804,000	0.86%
Anti-Air Piracy	$2,450,000	1.12%	$2,450,000	2.62%
Other	$1,091,000	0.50%	$443,000	0.47%
Interest	$7,884,000	3.61%	$0	0.00%
TOTAL	$218,443,000		$93,337,000	

Table B-7
Airport Revenues and Expenditures

Airport Name	Expenditures	Revenues	Profit (Loss)
DFW	$93,337,000	$218,443,000	$125,106,000
Dallas Love Field	N.A.	$15,665,498	
San Antonio International	$28,377,559	$29,476,477	$1,098,918
Austin- Robert Mueller	$19,806,147	$18,671,000	($1,135,147)
El Paso International	$10,193,973	$13,008,482	$2,814,509
Lubbock International	$5,007,673	$4,130,467	($877,206)
Midland Regional	$6,233,557	$3,834,062	($2,399,495)
Corpus Christi International	$4,758,488	$4,197,706	($560,782)
Harlingen- Rio Grande Valley	$3,914,093	$4,346,776	$432,683
Amarillo International	$5,156,753	$3,264,969	($1,891,784)
Laredo International	$2,397,695	$2,733,892	$336,197
Abilene Municipal	$636,925	$650,970	$14,045
San Angelo- Mathis Field	$866,050	$578,340	($287,710)
Tyler- Pounds Field	$367,614	$352,400	($15,214)
Longview- Gregg County	$778,000	$797,000	$19,000
Victoria Regional	$1,678,330	$1,663,854	($14,476)
Brownsville / S. Padre Island	$2,122,002	$1,565,956	($556,046)
Brownwood Municipal	$370,185	$258,260	($111,925)

APPENDIX C

MARITIME TRANSPORTATION IN THE STATE OF TEXAS

C.1 FERRY SERVICE

C.1.1 Los Ebanos Ferry

The Los Ebanos ferry is the only hand-operated ferry in Texas. Located near Mission, Texas, this state-recognized, historical landmark is used to hand-pull vehicles across the Rio Grande River. The service can be found 14 miles (23 km) west of Mission on U.S. 83, 3 miles (5 km) south of F.M. 886.[1]

C.1.2 Lynchburg Ferry in Houston

The Lynchburg ferry is operated by Harris County to shuttle travelers across the San Jacinto River. The service is offered seven days a week.[2,3]

C.1.3 Port Aransas/Aransas Pass Ferry

This state-operated ferry service provides passengers with a connection 0.25 miles (5 km) in length between Port Aransas and Aransas Pass. The free service is provided 24 hours a day, every day of the year. It operates on a demand basis with a trip time of approximately 3 minutes across the waterway. There are five boats available for use. Four of the boats have a capacity of 20 vehicles, and the other boat handles 9 vehicles. The ferry line extends from State Highway 361.

C.1.4 Galveston Ferry

The Galveston Ferry is operated by the Texas Department of Transportation (TxDOT). The service provides passage between Galveston Island and Port Bolivar on Texas Highway 87. The trip is 2.5 miles (4 km) in length and usually takes 15 to 20 minutes to traverse. A round trip takes 50 minutes, allowing time for boarding and deboarding. The service operates 24 hours a day every day of the year on a fixed schedule and is free to the public. There are five boats each with a capacity to carry 70 vehicles.

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[1] Texas Department of Transportation, Travel and Information Division, Austin, Texas.

[2] Ibid.

[3] Phone conversation with Clark Titus, Texas Department of Transportation, Construction and Maintenance Division, Austin, Texas.

C.2 WATERWAYS

Maritime transportation in the state of Texas occurs along the Gulf of Mexico. The major waterborne traffic is concentrated along the Gulf Intracoastal Waterway (GIWW) and the many channels which link into it. Most shipments are freight movements; however, the waterway also handles passenger travel by ferries and cruise ships, as well as other recreational activities. The Gulf Intracoastal Waterway supports the commercial and sport fishing industry.

C.2.1 Gulf Intracoastal Waterway

Transportation of goods and people by water in Texas occurs along the GIWW. This human-made channel parallels the Gulf of Mexico's coastline from the southernmost tip of Texas at Brownsville to Saint Marks, Florida, a distance totaling 426 miles (685 km) in length. The waterway has a bottom-width of 125 feet (38 meters) and a minimum depth of 25 feet (8 meters). The waterway is classified as an "inland" waterway because the majority of its length is protected by natural barrier islands. Two main rivers flow into the GIWW from Texas: the Colorado and the Brazos. The waterway serves an important role in the Texas economy by providing service to various industries, recreational activities, and fishing markets.[4]

The U.S. Corps of Engineers maintains the GIWW and the many channels which connect with it. The Corps also compiles statistics on the tonnage moved on the GIWW and channels each year, which are published in the *Waterborne Commerce of the United States*. According to a recent publication of *The Gulf Intracoastal Waterway in Texas*, 82.3 million short tons (74.7 million metric tons) of goods were transferred on the waterway in 1990. These goods amounted to over $23.9 billion. The GIWW is most efficiently used by barge traffic, and, according to 1990 records, barged goods averaged 70.8 million short tons (64 million metric tons) per year for the last ten years. "Petroleum products, chemicals and crude petroleum account for approximately 90 percent of the 1990 average tonnage moved on the waterway. Other bulk materials such as minerals, metals, grains, shell, and miscellaneous materials accounted for the remaining annual percentage."[5] Texas handled approximately 70 percent of the 1990 total short tons moved on the GIWW between Brownsville, Texas, and Saint Marks, Florida.[6]

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[4]Texas Department of Transportation, *The Gulf Intracoastal Waterway in Texas*, 1992, Texas Department of Transportation, Austin, Texas, 1992.

[5]Ibid.

[6]Ibid.

C.2.2 Channels and Waterways of the GIWW

The *Waterborne Commerce Statistics* records tonnage volumes for individual sections of the GIWW. The following are descriptions of the included areas of study, as taken from the *Waterborne Commerce of the United States, Part 2*. For each section of waterway, the publication provides data on the foreign and domestic tonnage volumes moved, including the volumes occurring at the ports and harbors. Thus, the tonnages represent the cargo that originates, terminates, or flows through that particular waterway section. Therefore, total tonnages cannot be reconciled by summing the individual waterway figures, since double counting would result.[7]

Sabine-Neches Waterway - This section includes the Gulf of Mexico to the turning basins at West Port Arthur, Beaumont, and Orange, Texas; Adams Bayou Channel; and Cow Bayou. The waterway's tonnage for 1990 was 90,815,000 short tons (82,387,368 metric tons).

Orange - The area covered by this section ranges from the mouth of the Neches River to the mouth of the Sabine River; Adams Bayou; and Cow Bayou. The Orange section of the waterway handled 709,000 short tons (643,205 metric tons) in 1990.

Beaumont - The Beaumont section stretches from the mouth of the Neches River to the Bethlehem Steel Company. The total tonnage for 1990 was 26,729,000 short tons (24,248,549 metric tons).

Port Arthur - This section includes Sabine Pass Harbor to the Neches River. The tonnage for 1990 was 30,680,000 short tons (27,832,896 metric tons).

Sabine Pass Harbor - This sections extends from the Gulf of Mexico to the upper end of Sabine Pass. The total tonnage from 1990 was 630,000 short tons (571,536 metric tons).

Houston Ship Channel - Covered in this area are the Galveston Harbor to the Houston turning Basin, including a light draft extension; Turkey Bend Channel; Goose Creek; Barbours Terminal Channel; Five Mile Cut Channel; and Greens Bayou. This area moves the most tonnage volume for Texas. For 1990 there was a total of 126,178,000 short tons (114,468,682 metric tons) moved in this region.

Dickinson Bayou - This section covers Galveston Bay to Dickinson, Texas, and in 1990 moved 556,000 short tons (504,403 metric tons).

Texas City Channel - This channel includes the area from Galveston Harbor to the turning basin at Texas City, Texas, and in 1990 moved 48,071,000 short tons (43,610,011 metric tons).

[7]Maritime Administration Office of Port and Intermodal Development, *A Report to Congress on the Status of the Public Ports of the United States 1990-1991,* December 1992.

Galveston Channel - This channel, including Galveston Harbor, moved 9,619,000 short tons (8,726,357 metric tons) in 1990.

Chocolate Bayou - This section includes the Gulf Intracoastal Waterway to near Liverpool, Texas, and moved 3,463,000 short tons (3,141,634 metric tons) in 1990.

Freeport Harbor - This section covers Gulf of Mexico to the Diversion Dam at Freeport, Texas, on Old Brazos River.

Colorado River and Flood Discharge Channels - This region extends along the Colorado River from its junction with the GIWW upstream approximately 15.6 miles (25.1 km) to the turning basin. In 1990, 476,000 short tons (431,827 metric tons) were moved.

Matagorda Ship Channel - Included is the Gulf of Mexico to Point Comfort; to Port Lavaca; to Lynn Bayou; and to Red Bluff. In 1990, 5,097,000 short tons (4,623,998 metric tons) moved on this section of the waterway.

Channel to Victoria - This section extends from the Gulf of Mexico to the vicinity of Victoria, including Tributary Channel to Seadrift, Texas. The total tonnage moved in 1990 was 3,740,000 short tons (3,392,928 metric tons).

Corpus Christi - This section covers the Humble Oil Basin to the turning basins at Corpus Christi, at Avery Point, near Tule Lake, and at Viola, including the branch channel to La Quinta.

Harbor Island - This section stretches from the Gulf of Mexico to the west end of the Humble Oil Basin, Harbor Island, including the channel to Port Aransas. The total tonnage moved in 1990 was 1,899,000 short tons (1,722,773 metric tons).

Corpus Christi Ship Channel - This section ranges from the Gulf of Mexico to the turning basins at Corpus Christi, at Avery Point, near Tule Lake, and at Viola, including the branch channel to La Quinta; and the channel to Port Aransas. The total tonnage moved in 1990 was 62,020,000 short tons (56,264,544 metric tons).

Tributary Arroyo Colorado - This section extends from the Gulf of Mexico to Port Harlingen, Texas, and moved 765,000 short tons (694,008 metric tons) in 1990.

Port Isabel - Included in this region are the Gulf of Mexico to Port Isabel, Gulf Intracoastal Waterway side channels, and a small boat harbor. In 1990, a total of 269,000 short tons (244,037 metric tons) was moved on this section of waterway.

Brownsville - This section extends from the Gulf of Mexico to near Brownsville, including the Brownsville Fishing Boat Harbor. In 1990, 1,372,000 short tons (1,244,678 metric tons) of volume were moved on this section of waterway.

Cedar Bayou - The total tonnage moved on this channel was 219,000 short tons (198,677 metric tons) in 1990.

Channel to Aransas Pass - The tonnage moved on this section of the waterway was 18,000 short tons (16,330 metric tons) for 1990.

Port Mansfield - The section produced only fish as a commodity in 1990.

The remaining harbors and waterways did not report any commerce for the year 1990. They included: Anahuac Channel, Channel to Palacios, Channel to Port Bolivar, Clear Creek, Double Bayou, Rockport, and Trinity River Channel to Liberty.

C.3 PORTS

C.3.1 Port of Orange

The Port of Orange is an industrial deep water port located 42 miles (68 km) inland at the junction of the Sabine-Neches Channel and the Gulf Intracoastal Waterway. The public Port of Orange Alabama Street Terminal Wharf, Berths 1-4, is owned and operated by the Orange County Navigational & Port District. It handles both foreign and domestic general cargo. The terminal has 2,300 feet (701 meters) of berthing space and 8 transit sheds, which totals 256,312 square feet (23,811 square meters) of storage space. The Southern Pacific Transportation Company and the Union Pacific Railroad both have connections to the port. There are also links to area highways.[8]

	Fiscal Year (October 1 through September 31)				
	88/89	**89/90**	**90/91**	**91/92**	**92/93***
Metric Tonnage	87,685	140,904	67,776	76,291	18,370
Vessels	11	28	15	10	5
Barges	5	38	19	8	8
Cars	978	1,455	1,658	799	241
Trucks	577	2,361	455	103	5

* Note: Accounts for volumes only from October 1, 1992, through March 31, 1993.[9]

[8]United States Army Corps of Engineers, *Port Series No. 22, The Ports of Port Arthur, Beaumont, and Orange, Texas*, Water Resources Support Center, Fort Belvoir, Virginia, 1985.

[9]Information obtained from the Orange County Navigational and Port District.

Financial Data[10]	1989	1990	1991	1992
TOTAL ASSETS	$18,687,635	$19,132,581	$19,096,481	$18,761,073
Operating Revenues	$2,088,105	$2,148,667	$1,549,599	$1,618,301
Operating Expenses	$1,566,109	$1,820,707	$1,661,614	$1,488,969
Non-Operating Expenses	$514,508	$2,480,154	$1,639,762	$104,993
NET INCOME	$7,487	($2,152,195)	($1,751,777)	$24,339

C.3.2 Port of Beaumont

The Port of Beaumont can receive foreign and domestic shipments. Conventional, containerized, and roll-on/roll-off general cargo are handled. The port is served by several railroads including the Atchison, Topeka, & Santa Fe Railroad, the Kansas City Southern Railroad, the Union Pacific Railroad, and the Southern Pacific Transportation Company.[11]

C.3.3 Port of Port Arthur

The Port of Port Arthur's Public Ocean Terminal Wharf handles conventional and containerized general cargo, both foreign and domestic. No passenger services are available at the port. The port has 130,000 square feet (12,077 square meters) of open surfaced storage area, almost 200,000 square feet (18,580 square meters) of transit shed, and a railroad storage yard with a 140-car capacity. There are both rail and highway connections to this location. The port is served by the Kansas City Southern Railroad and the Southern Pacific railroad. Port Arthur also operates apron tracks, which accommodate 60 rail cars. State Highways 73 and 87 link the port to the cities of Houston and Orange.[12]

For 1990-1991, the port handled 562,535 short tons (510,332 metric tons). For the calendar year of 1991, ship cargo movements amounted to 494,499 short tons (448,609 metric tons) and barge cargo moved 15,598 short tons (14,154 metric tons). The main imports were steels slabs and guar gum; the main exports were plywood, linerboard, and wood pulp. Vessels handled by the port amount to an average of 65 vessels and 49 barges per year. The shipping lines include Star Shipping, Zim-American Israeli Shipping, and The Jugooceanija Line. The average annual expenditure per vessel was $11,882.76.[13]

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[10]Orange County Navigation and Port District, *Audited Financial Statements*, 1989, 1990, 1991, 1992.

[11]United States Army corps of Engineers, *Port Series No. 22, The Ports of Port Arthur, Beaumont, and Orange, Texas*, Water Resources Support Center, Fort Belvoir, Virginia, 1985.

[12]Ibid.

[13]Information obtained from the Port of Port Arthur.

C.3.4 Port of Houston

The Port of Houston is a deep draft port, located in Harris County along the Houston Channel. Its public facilities are owned and operated by the Port of Houston Authority. The port is one of the ten largest ports in the world, ranked third in the United States in foreign waterborne commerce, fourth in domestic commerce, and third in total tonnage.[14] The public facilities include the Turning Basin Terminal, the Bulk Materials Handling Plant, the Fentress Bracewell Barbours Cut Container terminal, and the Jacintoport Terminal.[15]

Four major railroads and more than 120 trucking lines connect the port to the continental United States, Canada, and Mexico. Air service is within easy access at the two public airports in the city of Houston and many other private terminals.[16]

The port area includes the Houston Ship Channel and its tributary channels and basins, including the turning basin located within Houston's city limits. Also included in the port area is Buffalo Bayou and the facilities at Bayport.[17]

"The Turning Basin Terminal includes 37 public wharves, each offering between 428 feet (130 meters) and 800 feet (244 meters) of quay. The terminal has more than 2.3 million square feet (213,670 square meters) of short-term storage and 2.4 million square feet (222,960 square meters) of open storage."[18]

C.3.5 Port of Texas City

The Port of Texas City is located on the west side of Galveston Bay and serves deep-draft vessels. "The Texas City Terminal Railway Co., jointly owned by the Atchison, Topeka, & Santa Fe Railway Co., Missouri-Kansas-Texas Railroad Co., and Missouri Pacific Railroad Co., operates all terminal and switching service at the port. In addition to connecting with the above-mentioned carriers, direct interchanges are also made with Burlington Northern Railroad Co.; Galveston, Houston, and Henderson Railroad Co.; [and] Southern Pacific Transportation Co."[19]

C.3.6 Port of Galveston

The Port of Galveston is located approximately 50 miles (80 km) south of Houston. The principal waterfront facilities for the Port of Galveston are located along the north side of the

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[14]Maritime Administration Office of Port and Intermodal Development, *A Report to Congress on the Status of the Public Ports of the United States 1990-1991*, December 1992.

[15]Port of Houston Authority, *1991 Annual Report*, Port of Houston Authority, Houston, Texas, 1992.

[16]Port of Houston Authority, *The Port of Houston Handbook and Industrial Guide, Volume 7, 1992-1993*, Port of Houston Authority, Houston, Texas, 1993.

[17]Ibid.

[18]Ibid.

[19]United States Army Corps of Engineers, *Port Series No. 23, The Ports of Galveston and Texas City, Texas*, Water Resources Support Center, Fort Belvoir, Virginia, 1985.

eastern portion of Galveston Island and on the south side of Pelican Island. The two islands are separated and served by the Galveston Channel.[20]

All of the publicly owned waterfront facilities are served by a terminal railroad. The Galveston Railway, Inc. (GRI) leases track and other rail property. The terminal rail line has 43.3 miles (70 km) of track, and GRI provides connections to the following railroads: The Atchison, Topeka, & Santa Fe Railway Co.; Burlington Northern Railroad Co.; Union Pacific System; and the Southern Pacific Lines.[21]

There are 30 piers, wharves, and docks in the port. Break-bulk facilities include 20 berths with approximately 1.8 million square feet (167,220 square meters) of dockside warehouse space. The port also has facilities to handle general cargo, grain cargo, bulk cargo, containerization cargo, special project cargo, and cruise ships.[22]

C.3.7 Port of Freeport

The Port of Freeport is operated by the Brazos River Harbor Navigation District. The port serves deep-draft vessels. There are has connections to Union Pacific Railroad lines, which parallel the Texas Gulf Coast between Galveston and Brownsville.[23]

There are four general cargo wharves in the inner harbor area, which have approximately 641,000 square feet (59,549 square meters) of adjacent covered storage served by rail and trucking. Two liquid bulk storage terminals are operated in the main channel area. The containerization yard is 6.5 acres (2.6 hectares/26,000 square meters), which can handle 320 trailers on chassis, of which 150 spaces are for refrigerated containers. A 5.7-acre (2.3-hectare/23,000-square-meter) area is leased for the receiving and processing of seafood products and boat supplies and service. The District also owns approximately 9,300 acres (3,674 hectares/36,740,000 square meters) of property within the Port's vicinity, of which 1,952 acres (771 hectares/7,710,000 square meters) are eligible to be "activated" in the Port of Freeport's Foreign-Trade Zone.[24]

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[20]Ibid.

[21]Ibid.

[22]Information obtained from the Port of Galveston.

[23]United States Army Corps of Engineers, *Port Series No. 26, Ports of Freeport, Point Comfort/Port Lavaca, Brownsville, and Ports Along Gulf Intracoastal Waterway, Texas*, Water Resources Support Center, Fort Belvoir, Virgina, 1991.

[24]Brazos River Harbor Navigation District, *Comprehensive Annual Report for the Year Ended December 31, 1991*, Freeport, Texas, 1992.

Financial Data[25]	1990	1991
TOTAL ASSETS	$80,133,902	$80,804,292
Operating Revenues	$6,352,702	$6,218,073
Operating Expenses	$9,347,050	$9,895,996
Other Expenses	$599	$0
NET INCOME	($2,994,947)	($3,677,923)

C.3.8 Port Lavaca / Point Comfort

Port Lavaca and Point Comfort are operated by the Calhoun County Navigational District. Point Comfort has 25,000 square feet (2,323 square meters) of cargo space and 64 acres (25 hectares/253,000 square meters) of open storage space. The Point Comfort Industrial Complex is served by the Point Comfort and Northern Railway, which has connections at Lolita with the Union Pacific Railroad. Port Lavaca is served by the Southern Pacific Transportation Co.[26]

C.3.9 Port Aransas

Aransas Pass is served by the Southern Pacific Transportation Company.

C.3.10 Port of Corpus Christi

The Port of Corpus Christi is made up of more than 40 public and private docks which handle a variety of cargo, including general, bulk, liquid, and container cargo. The port is divided into four parts - the Inner Harbor, La Quinta, Ingleside, and Harbor Island. In 1991, petroleum accounted for almost 80 percent of the 70.4 short tons (64 metric tons) that moved through the port.[27]

The port facilities at Corpus Christi Inner Harbor are located along a 9-mile (14-km) stretch of dredged channels and basins. The Inner Harbor has five turning basins and is the largest division of the port. Operated in this area are the public oil and general cargo docks, an export public elevator, and a bulk terminal.[28] There are five locations which provide a total of

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[25]Ibid.

[26]United States Army Corps of Engineers, *Port Series No. 26, Ports of Freeport, Point Comfort/Port Lavaca, Brownsville, and Ports Along Gulf Intracoastal Waterway, Texas*, Water Resources Support Center, Fort Belvoir, Virginia, 1991.

[27]Port of Corpus Christi, *1991 Annual Report*, Corpus Christi, Texas, 1991.

[28]Ibid.

45.6 acres (18 hectares/180,000 square meters) of open storage. Transit sheds allow 416,030 square feet (38,649 square meters) of cargo space.[29]

The Port of Corpus Christi has proposed to build Safeharbor -- a deepwater, inshore oil terminal to handle deep-draft oil tankers. The project is supported as a safe and reliable method of transporting crude oil to the Texas Coast.[30]

Additionally, the Port of Corpus Christi has constructed a new multi-purpose cargo dock, which will increase capacity with the 163,000-square-foot (15,143-square-meter) area. Studies were underway for a new 65,000-square-foot (6,039-square-meters) warehouse adjacent to the container yard.[31]

"All of the publicly-owned, as well as some of the privately-owned, waterfront terminals at the Port of Corpus Christi are served by terminal trackage owned by the Port of Corpus Christi Authority. This trackage is operated in turn by the Missouri Pacific Railroad Company, the Southern Pacific Transportation Company, and the Texas Mexican Railway Company, under an agreement which provides for the rotation of the operation among the participating railroads, with the operating railroad furnishing necessary motive power, switching crews, and yard personnel to maintain an efficient switching service. These three carriers and the Port of Corpus Christi Authority form the Corpus Christi Terminal Association."[32]

Financial Data[33]	1990	1991
TOTAL ASSETS	$149,371,165	$161,863,219
Operating Revenues	$22,085,606	$23,234,781
Operating Expenses	$18,699,631	$19,507,554
Non-Operating Revenues (Expenses)	$2,337,833	$1,953,456
NET INCOME	$5,723,808	$5,680,683

C.3.11 Port Mansfield

Port Mansfield is operated by the Willacy County Navigation District/Sea Terminal and has 10,000 square feet (929 square meters) of cargo space and an additional 0.5 acre (0.20 hectare/2,000 square meters) of open storage.

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[29]United States Army Corps of Engineers, *Port Series No. 25, The Port of Corpus Christi, Texas*, Water Resources Support Center, Fort Belvoir, Virginia, 1983.
[30]Port of Corpus Christi, *1991 Annual Report*, Corpus Christi, Texas, 1991.
[31]Ibid.
[32]United States Army Corps of Engineers, Port Series No. 25, *The Port of Corpus Christi, Texas*, Water Resources Support Center, Fort Belvoir, Virginia, 1983.
[33]Port of Corpus Christi, *1991 Annual Report*, Corpus Christi, Texas, 1991.

C.3.12 Port of Harlingen

The Port of Harlingen is located in southern Texas, 4 miles (6 km) east of Harlingen on State Highway 106. The port is an important link in the comprehensive transportation network of the Rio Grande Valley. Rail connections are available for Southern Pacific and Union Pacific Railroads, which move products on through the United States as well as into Mexico. Facilities available at the Port of Harlingen include a 650-foot (198-meter) concrete general dry cargo wharf, 100-foot (30-meter) dry bulk wharf, 10,800-square-foot (1,003-square-meter) transit shed, and unlimited acres (hectares/square meters) of open storage. There are five smaller docks located near the turning basin and extending down the Harlingen Channel. The port's main commodities are petroleum products and sand and gravel.[34]

Metric Tonnage Report	1991	1992
Port of Harlingen	594,937	578,105
Harlingen Channel	723,322	723,069

Port Traffic	1991	1992
Barges	247	237
Trucks	695	497
Rail Cars	70	52

Financial Data	Sept 1992	Dec 1991
Fixed Assets		
Land & ROW	$677,367	$677,367
Channel & Turning Basin	$325,468	$325,468
Buildings	$178,716	$178,716
Improvements	$787,944	$787,944
Machinery & Equipment	$60,661	$56,035
Subtotal	$2,030,156	$2,025,530
Depreciation	($741,673)	($760,384)
Total Fixed Assets	$1,269,772	$1,283,857
TOTAL ASSETS	$3,928,659	$3,662,422
Operating Revenue	$221,542	$287,381
Operating Expense	($154,877)	($187,501)
Non-operating Revenue	$692,101	$927,131
Non-operating Expense	-0-	($10,000)
NET INCOME	$537,224	$729,630

[34] Information obtained from the Port of Harlingen Authority.

C.3.13 Port Isabel

Port Isabel is operated by the Port Isabel-San Benito Navigation District of Cameron County. There are 31,375 square feet (2,915 square meters) of cargo space in the transit shed and an additional 92,000 square feet (8,547 square meters) of storage.[35] Approximately 115 acres (45 hectares/450,000 square meters) of land are available for long-term lease. Port Isabel has a total of 726 acres (287 hectares/2,870,000 square meters) of waterfront land. The port is located on 4 acres (1.6 hectares/160 square meters) of land and has deep-water frontage on the GIWW. Currently, construction is underway on a new liquid products dock. Additionally, the main cargo dock has recently been renovated.[36]

Financial Data[37]	1990	1991	1992
Operating Revenues	$314,024	$336,687	$375,275
Operating Expenses	$260,192	$294,525	$323,282
Non-Operating Revenues	$152,319	$123,989	$35,517
NET INCOME	$206,151	$166,151	$87,510

C.3.14 Port of Brownsville

The Port of Brownsville is owned and operated by the Brownsville Navigation District. The location has 415,300 square feet (38,581 square meters) of cargo space and 37.3 acres (14.7 hectares/147,000 square meters) of open storage. Connections to the Union Pacific Railroad are made at Brownsville by the Brownsville and Rio Grande International Railroad, which serves the port area. The National Railways of Mexico connects with the Union Pacific Railroad and Southern Pacific Transportation Co. trunk lines to provide for the international connection between Matamoros, Mexico, and Brownsville, Texas.[38]

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[35]United States Army Corps of Engineers, *Port Series No. 26, Ports of Freeport, Point Comfort/Port Lavaca, Brownsville, and Ports Along Gulf Intracoastal Waterway, Texas*, Water Resources Support Center, Fort Belvoir, Virginia, 1991.

[36]Information obtained from the Port Isabel-San Benito Navigation District.

[37]Ibid.

[38]United States Army Corps of Engineers, *Port Series No. 26, Ports of Freeport, Point Comfort/Port Lavaca, Brownsville, and Ports Along Gulf Intracoastal Waterway, Texas*, Water Resources Support Center, Fort Belvoir, Virginia, 1991.

APPENDIX D

HIGHWAY TRANSPORTATION IN THE STATE OF TEXAS

D.1 HIGHWAY TRANSPORTATION STATISTICS FOR TEXAS

D.1.1 Roadway

As of 1991, there were 293,509 miles (472,256 km) of public roadway in the state of Texas. This represents 7.5 percent of the nation's total roadway system. Table D-1 classifies the distance (miles/kilometers) in Texas by function. "Functional classification defines the role that a particular road or street plays in serving the flow of trips through a highway network. The functional systems are: 1) arterial highways, which generally handle the long trips; 2) collector facilities, which collect and disperse traffic between the arterials and the bottom level; and 3) local roads and streets, which serve the residential areas, individual farms, and other local areas." [1]

Table D-1: Public Road and Street Distance Traveled (miles/km) for Texas, 1991

Roadway Classification	Rural	Urban	Total
Interstate Roadway	2,286/3,678	943/1,517	3,229/5,195
Freeways and Expressways	N/A	855/1,376	855/1,376
Other Principal Arterials	7,915/12,735	3,997/6,431	11,912/19,166
Minor Arterials	6,914/11,125	5,588/8,991	12,502/20,116
Collectors	56,909/91,567	6,895/11,094	63,804/102,661
Local	143,270/230,521	57,937/93,221	201,207/323,742
TOTAL	217,294/349,626	76,215/122,630	293,509/472,256

Table D-2 presents the total rural and urban distance traveled from the years 1990 and 1991. It can be seen that there has been a slight increase in rural roadway distance traveled and a decrease in urban roadway distance traveled. According to *Highway Statistics*, produced by the U.S. Department of Transportation (U.S. DOT), increases in distance traveled are usually small and due to roadway improvements. Decreases in public road distance traveled have more recently been attributed to the removal of timber and forest roads from public use.

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[1] *Highway Statistics 1991*. Washington, D.C.: Federal Highway Administration, 1991.

Table D-2: Roadway Distance Traveled (miles/km) in Texas, 1990-1991

Roadway Classification	1990	1991
Total Rural	217,175/349,435	217,294/349,626
Total Urban	88,776/142,841	76,215/122,630
Total	305,951/492,275	293,509/472,256

Nearly 8 percent of the nation's bridges are in Texas. The U.S. DOT lists the number of highway bridges wider than or equal to 20 feet (6 meters). Table D-3 provides a breakdown of the bridges in Texas.[2]

Table D-3: Texas Bridges (≥ 20 feet [6 meters]), 1991

Bridge Classification	1991
Rural	33,089
Urban	12,671
Unclassified	722
Total Bridges	46,482

The roadway system in Texas is highly utilized. Table D-4 shows the annual distance (miles/km) of travel throughout the state for 1990 and 1991.

Table D-4: Annual Distance (miles/km) of Travel for Texas, 1990-1991

	Distance (miles/km) (millions)	
Roadway	1990	1991
Rural Interstate	11,645/18,737	12,134/19,524
Urban Interstate	23,075/37,128	23,311/37,507
Total Rural	54,660/87,948	55,529/89,346
Total Urban	107,527/173,011	103,227/166,092
Total Distance (miles/km) Traveled	162,232/261,031	158,756/255,438

2 Ibid.

D.1.2 Vehicles

Motor vehicle registration methods vary among the states. Most states use a "staggered" basis for registering vehicles, which permits the renewal workload to be distributed throughout the year. "In order to present vehicle registration data uniformly for all States, the information is shown as nearly as possible on a calendar-year basis. Insofar as possible, the registrations reported exclude transfers and reregistrations and any other factors that could otherwise result in duplication in the vehicle counts."[3] There are several major vehicle classes: automobiles, buses, and trucks. "The truck category includes light trucks to the extent [that] they can be identified and separated from automobiles."[4] Data on trucks, trailers, and semitrailers will be discussed in a later section of this report. A summary of all motor vehicles registered in Texas for 1990 and 1991 is shown in Table D-5.[5,6]

Table D-5: Motor Vehicle Registrations, 1990-1991

Classification	1990	1991
Automobiles	8,714,154	8,666,111
Buses	61,286	61,732
Trucks	4,024,375	3,968,697
Total Motor Vehicles	12,799,815	12,696,549

D.1.3 Drivers

All states require drivers to be licensed before operating a motor vehicle. To obtain a license, drivers must pass a state examination covering the laws and practices of driving and tests of vision and driving proficiency. Table D-6 shows the number of learner permits and driver's licenses issued and in force by class for Texas at the end of 1991.[7]

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[3] Ibid.
[4] Ibid.
[5] Ibid.
[6] Motor Vehicle Manufacturers Association of the United States, Inc. *MVMA Motor Vehicle Facts & Figures '92.* Detroit, MI: Motor Vehicle Manufacturers Association of the United States, Inc., 1992.
[7] *Highway Statistics 1991.*

Table D-6: Driver's Licenses in Texas, 1991

License Classification	Number Issued	Estimated Total In Force
Learner Permits	200,803	N/A
Class A	114,843	1,076,905
Class B	47,066	125,591
Class C	2,964,067	10,093,751
Class M	647	975
Occupational	4,293	3,424

In 1991, the population of Texas was 17,349,000, of which number 11,293,184 persons were licensed drivers. Thus, nearly 65 percent of Texas residents can drive motor vehicles. Table D-7 presents the numbers of male, female, and total licensed drivers.[8]

Table D-7: Licensed Drivers in Texas, 1991

Drivers	Number Licensed
Male	5,818,311
Female	5,474,873
Total Drivers	11,293,184

D.1.4 Traffic Fatalities

Of all motor vehicle fatalities, 7 percent occur in Texas. Table D-8 shows 1989 and 1990 data for the number of motor vehicle traffic deaths and traffic death rates for Texas and for the United States.[9]

Table D-8: Traffic Deaths and Traffic Death Rates, 1989 and 1990

Location	1989 Traffic Deaths	1989 Traffic Deaths per 100 million vehicle-miles (vehicle-km)	1990 Traffic Deaths	1990 Traffic Deaths per 100 million vehicle-miles (vehicle-km)
Texas	3,361	2.10/3.38	3,243	2.00/3.22
U.S.	47,575	2.30/3.70	46,800	2.20/3.54

[8] Ibid.
[9] Motor Vehicle Manufacturers Association of the United States, Inc., 1992.

D.2 PASSENGER TRANSPORTATION

D.2.1 Personal Transportation Methods

By far the most popular method of travel is the private automobile. Automobiles include all cars and small trucks for individual use. In Texas, automobiles comprise 68 percent of all registered motor vehicles, as can be seen in Table D-5 in the preceding section.

In addition to motor vehicles, many people use motorcycles to travel throughout Texas. In 1991, there were 185,167 motorcycles registered in the state. Motorcycles are not included in the automobile count.[10]

D.2.2 Mass Transportation Methods

As reported by the U.S. Department of Transportation in its annual report, *Highway Statistics*, a total of 61,732 buses were registered in Texas in 1991. This accounts for less than 0.5 percent of all motor vehicles registered in the state, as shown previously in Table D-5. This count includes all private, commercial, and publicly owned buses, such as school buses and public transit buses.

In 1991, Texas' public transportation services included 21 urbanized transit systems, 40 non-urbanized transit systems, and over 200 private nonprofit transportation agencies for the elderly and disabled. These operators provided nearly 240 million one-way passenger trips to persons in Texas. Table D-9 provides a look at statewide ridership for Texas in 1991.[11]

Table D-9: Statewide Ridership, 1991

Public Transportation	Passengers	Percentage
Urbanized	232,938,671	97.20
Non-Urbanized	3,601,334	1.50
Elderly and Disabled	3,051,740	1.30
Total Ridership	239,591,745	100.0

Table D-10 shows the average number of vehicles and distance (miles/kilometers) traveled for each classification in 1991.[12]

10 *Highway Statistics 1991*.

11 Texas Department of Transportation. *1991 Texas Transit Statistics*. Austin, Texas: Texas Department of Transportation, 1991.

12 Ibid.

Table D-10: Vehicles and Distance (miles/km) Traveled, 1991

Public Transportation	Vehicles	Distance (miles/km)
Urbanized	3,016	143,874,409/231,493,924
Non-Urbanized	844	13,209,274/21,253,722
Elderly and Disabled	779	10,703,564/17,222,034
Total	4,649	167,787,247/269,969,680

D.3 FREIGHT TRANSPORTATION

Highway transportation of freight is handled by the trucking industry. In 1990, intercity freight movement for the entire United States by motor truck was listed at 735 billion ton-miles (1,073 billion metric ton-km). Therefore, truck transport accounted for 26 percent of all freight ton-miles (ton-km).[13] Owing to the competitive nature of the trucking industry, actual figures for each state and trucking company are unavailable at this time.

The number of motor trucks registered in Texas for 1989, 1990, and 1991 is given in Table D-11.[14,15]

Table D-11: Motor Truck Registrations, 1989-1991

Truck Classification	1989	1990	1991
Private and Commercial	3,754,010	3,822,877	3,763,496
Publicly Owned	188,864	201,498	205,201
Total	3,942,874	4,024,375	3,968,697

Table D-12 provides a partial classification of all private and commercial trucks registered in Texas in 1991. These counts may not add up to equal the total registered private and commercial trucks because a vehicle may be included more than once if it was used for multiple purposes. As defined in *Highway Statistics*, "truck tractors may include some large trucks used regularly in combination with full trailers," and the light truck category "includes pickups, panels, and delivery vans generally of 10,000 pounds or less [4,540 kg or less] gross vehicle weight".[16]

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[13] Motor Vehicle Manufacturers Association of the United States, Inc., 1992.
[14] *Highway Statistics 1991.*
[15] Motor Vehicle Manufacturers Association of the United States, Inc., 1992.
[16] *Highway Statistics 1991.*

Table D-12: Partial Classification of Private and Commercial Trucks Registered in Texas, 1991

Private and Commercial Trucks	Number of Trucks
Truck Tractors	118,289
Light Trucks	3,548,472
Farm Trucks	185,440

Texas private and commercial trailer and semitrailer registrations for 1990 and 1991 are shown in Table D-13. Commercial trailers include those trailers and semitrailers in private or for-hire use. House trailers are not registered separately in Texas. Therefore, house trailers are included with light car trailers .[17]

Table D-13: Trailer and Semitrailer Registrations, 1990-1991

Trailers	1990	1991
Commercial	194,214	184,531
Light Farm and Car	1,152,981	1,221,480
House	N/A	N/A
Total	1,347,195	1,406,011

A study in 1987 found that the major uses of motor trucks in Texas were for personal (68%), agriculture (8%), construction (10%), manufacturing (1.5%), wholesale and retail (5%), utilities (1.5%), services (3%), for-hire (1.5%), and other (1.5%) purposes such as forestry, lumbering, mining, and rental.[18]

D.4 HIGHWAY FINANCE

This section summarizes the highway receipts and disbursements for Texas as reported in *Highway Statistics 1991*. Assistance to highway, road, and street programs is provided by federal, state, and local funding sources. Often, expenditures of one level of government may be transferred to another level. These intergovernmental payments must be carefully identified to avoid duplication of income and expenditures when combining all financial information. For this reason, as reported in *Highway Statistics 1991*, Tables D-14 and D-15 provide a combined summary of Texas highway finances for all levels of government in net amounts for 1990.

[17] Ibid.

[18] Motor Vehicle Manufacturers Association of the United States, Inc., 1992.

Table D-14: Total Receipts for Texas Highways, All Units of Government, 1990

Receipt	$ thousands
Highway-User Tax Revenues	2,743,380
Road and Crossing Tolls	95,938
Appropriations from General Funds	1,157,632
Property Taxes	811,607
Other Imposts	35,633
Miscellaneous Receipts	465,718
Bond Proceeds	367,159
Total	5,677,067

Table D-15: Total Disbursements for Texas Highways, All Units of Government, 1990

Disbursement	$thousands
Capital Outlay	2,305,478
Maintenance	1,434,236
Administration and Miscellaneous	541,303
Highway Law Enforcement/Safety	760,993
Interest	438,627
Bond Retirement	239,624
Total	5,720,261

Texas highway users pay motor-fuel, motor-vehicle, and motor-carrier taxes. These taxes make up the total state imposts, which are distributed as shown in Table D-16.[19]

The motor fuel tax rate in Texas was 15¢/gallon (4¢/liter) until October 1, 1991, when a new tax rate of 20¢/gallon (5¢/liter) went into effect. The motor fuel tax rate applies to gasoline, diesel, liquefied petroleum gas, and gasohol. To fuels which are not taxed and are exempt under other laws, a sales tax of 6.25 percent is applied.[20]

Motor vehicle and motor carrier tax receipts include registration fees and other fees. Registration fees apply to all motor vehicles (automobiles, buses, and trucks) and to trailers and motorcycles. Additional fees are collected from driver's licenses, certificate of title fees, special title taxes, fines and penalties, weighted and flat-rate special license fees and franchise taxes, certificate or permit fees, and miscellaneous receipts .[21]

19 *Highway Statistics 1991.*

20 Ibid.

21 Ibid.

Table D-16: Distribution of State Imposts, 1991

	Taxes ($ thousands)		
	Motor Fuel Taxes	Motor-Vehicle & Motor-Carrier Taxes	Total State Imposts
Total Receipts	1,503,865	1,964,393	3,468,258
Distribution Purposes:			
- Collection of Taxation	15,556	146,120	161,676
- State Administered Highways	1,087,106	670,035	1,757,141
- Local Roads and Streets	7,956	84,212	92,165
- Mass Transportation	17,551	10,818	28,369
- Non-Highway Purposes	375,699	1,053,208	1,428,907
Total Distributed	1,503,865	1,964,393	3,468,258

Table D-17 outlines the state, local, and total highway-user revenues and other receipts for Texas in 1991. The revenues include the previously mentioned motor-fuel, motor-vehicle, and motor-carrier taxes. Additional receipts are received from tolls, other state taxes, miscellaneous sources, and payments from other governments. The values in the "State" and "Local" columns may not sum to equal the total values as a result of rounding.

Table D-17: Highway-User Revenues and Other Receipts for Highways, 1991

	Revenues ($ thousands)		
Revenue Source	State	Local	Total
Motor Fuel Taxes	1,087,106	7,953	1,095,059
Motor-Vehicle and Motor-Carrier Taxes	670,035	84,212	754,247
Road and Crossing Tolls	41,785	0	41,785
Other State Imposts	32,107	0	32,107
Miscellaneous	84,683	0	84,683
Payments from Other Governments:			
- Federal Fund: FHWA	942,108	0	942,108
- Federal Fund: Other	29,409	1,196	30,605
- Counties and Townships	11,708	6,158	17,865
- Municipalities	22,988	2,040	25,028
Total	2,921,929	101,559	3,023,487

The disbursement of the total receipts for Texas highways is shown in Table D-18.

Table D-18: Disbursements of Total Receipts, 1991

Disbursement Source	$ thousands
Capital Outlay	1,824,186
Maintenance and Traffic Services	575,779
Administration and Highway Police	523,933
Interest	19,532
Bond Retirement	2,430
Grants-In-Aid to Local Governments	93,360
Total	3,039,220

The receipts and disbursements for mass transportation in Texas are shown in Table D-19.

Table D-19: State Receipts and Disbursements for Mass Transportation, 1991

	$ thousands
Receipts:	
- Highway-User Taxes	23,369
- Miscellaneous	1,902
Total Receipts	30,271
Disbursements	
- Capital Outlay	8,513
- Administration	550
- Transfer	18,635
Total Disbursements	27,697

Information on the various public transportation services available throughout Texas is the topic of two Texas Department of Transportation publications: *1991 Texas Transit Statistics* and *Public Transportation in Texas -- Profiles and Projections 1992-1995*. The latter publication provides information on each Transportation Authority's services, ridership, properties, special projects, and funding needs. The many routes and operating characteristics offered are also discussed.[22] Table D-20 summarizes the operating expenses incurred in 1990 and 1991 for the major public transportation classifications.[23] The urbanized transit systems

[22] Texas State Department of Highways and Public Transportation. *Public Transportation in Texas -- Profiles and Projections 1992-1995*. Austin, Texas: Texas State Department of Highways and Public Transportation, 1991.

[23] Texas Department of Transportation. *1991 Texas Transit Statistics.* Austin, Texas: Texas Department of Transportation, 1991.

reportedly received $204,437,664 in operating revenue and recovered $96,106,671 from the farebox in 1991.[24] Operating revenue and farebox recoveries were unavailable for the nonurbanized services and those for the elderly and disabled.

Table D-20: Public Transportation Operating Expenses, 1990 and 1991

Public Transportation	1990	1991
Urbanized	430,752,669	462,437,359
Non-Urbanized	18,048,800	20,157,940
Elderly and Disabled	7,691,729	9,345,715
Total	456,493,198	491,941,014

24 Ibid.

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