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Foreword

The Lyndon B. Johnson School of Public Affairs has established interdisciplinary research on policy problems as the core of its educational program. A major part of this program is the nine-month policy research project, in the course of which two or three faculty members direct the research of graduate students of diverse backgrounds on a policy issue of concern to a government agency. This "client orientation" brings students face to face with administrators, legislators, and other officials active in the policy process and demonstrates the occasional difficulties of relating research findings to the world of political realities.

This report supplements the findings of policy research projects conducted in the 1992-93 and 1993-94 academic years with funding from the Texas Department of Transportation and the Federal Highway Administration. This study is part of a three-year project coordinated by the LBJ School and the UT-Austin Center for Transportation Research to investigate public policy issues related to Texas-Mexico multimodal transportation.

The curriculum of the LBJ School is intended not only to develop effective public servants but also to produce research that will enlighten and inform those already engaged in the policy process. The project that resulted in this report has helped to accomplish the first task. It is our hope and expectation that the report itself will contribute to the second.

Finally, it should be noted that neither the LBJ School nor The University of Texas at Austin necessarily endorses the views and findings of this study.

Max Sherman
Dean

Preface and Acknowledgements

The policy research project that produced this report was conducted during the 1994-95 academic year as a cooperative effort between the LBJ School of Public Affairs and the UT-Austin Center for Transportation Research, with funding by the Texas Department of Transportation and the Federal Highway Administration.

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Chapter 1. Executive Summary

Introduction

The efficiency of bilateral trade flows between the United States and Mexico depends upon the interactivity and mutually reinforcing nature of both nations' physical and technological infrastructure. Technological infrastructure, in turn, comprises the systems and techniques of advanced logistics management. These systems and techniques allow firms to overcome to a certain extent the constraints that physical infrastructure often represents, and they also allow for the efficient and cost-effective transportation and distribution of commodities from origin to destination. However, logistics management techniques can only go so far in compensating for inadequate infrastructure development, investment, and maintenance, and can only be used on a limited basis if the technologies needed for their implementation are inadequate or do not exist.

As the third in a three-report series, this report explores in detail the development and evolution of logistics management techniques in both the United States and Mexico via partnerships and strategic alliances. It serves as a more detailed exploration of the concepts touched upon in the second, 1994 report, *Logistics Management and U.S.-Mexico Transportation Systems: A Preliminary Investigation*, which began a preliminary investigation into the ways in which growing transportation needs in the context of U.S.-Mexico trade were driving changes in infrastructure, modal agreements, and regulatory harmonization. In addition, the report briefly touched on how shippers and carriers on both sides of the U.S.-Mexico border were challenged to seek out nontraditional transportation arrangements to overcome the obstacles originating from disparate infrastructural, technological, and regulatory environments between the two nations.

The first, 1993 report, *Texas-Mexico Multimodal Transportation*, examined the binational transportation systems already in place and described current plans for improvement or expansion and the opportunities and constraints faced by each mode. It included specific chapters on highway, rail, maritime, and air transportation modes, together with information on customs.

This report provides a detailed investigation into the ways in which U.S. and Mexican firms are attempting to overcome the difficulties of cross-border transportation and distribution. In great part, this is occurring via partnerships, strategic alliances, and other kinds of business ventures designed to facilitate cross-border transfers of technology, capital, and expertise. Through a case-study approach, we explore how several firms involved in cross-border transportation and distribution are using these types of cooperative ventures to expand effectively and profitably into the markets opened in Mexico by the North American Free Trade Agreement (NAFTA).

Contents

This report is composed of six chapters, including this first chapter, the executive summary. A review of trade patterns and logistics management trends are provided in Chapters 2 and 3, followed by an examination of these trends vis-à-vis four case studies which comprise Chapter 4. Information technologies and modal planning techniques are addressed in the remaining chapters. A brief summary of each of these chapters follows below.

Chapter 2. U.S.-Mexico Bilateral Trade and Transportation Systems

This opening chapter describes U.S.-Mexico trade flows and infrastructure development. The interrelationship between commodity type, commodity origin/destination, and physical infrastructure is examined in detail. Moreover, the concept of transportation corridors is applied with an emphasis on assessing how the existence or non-existence of these corridors on both sides of the border can facilitate or hinder U.S.-Mexico trade.

Most every firm, unless it is located adjacent to both its raw materials and its market, will need to transport its product from one point to another. In doing so, firms must make a variety of important decisions regarding how to transport these goods in an efficient and cost-effective manner. The efficiency and cost of a particular mode of transportation is affected by a variety of factors, the most important of which appears to be the existence of infrastructure in place along corridors which facilitate trade movements. The development and maintenance of this physical infrastructure, particularly between centers of population and centers of production and also along certain heavily traveled corridors, are of great importance to the continued smooth operation of U.S.-Mexico trade. However, the mere existence of physical infrastructure is not enough by itself to generate trade and transportation efficiencies. There must also exist a technological infrastructure designed to support the physical infrastructure. This technological infrastructure is a central component of logistics management.

Chapter 3. Evolution of Logistics Practices and Intermodal Partnerships in the United States and Mexico

This chapter examines the pattern and process of U.S.-Mexico trade from the viewpoint of technological infrastructure which, in great part, comprises the systems that facilitate logistics management and practice. Logistics is important to trade because it expedites and simplifies a firm's ability to transport its product(s) from origin to destination and makes a variety of other production and distribution-related tasks, such as warehousing, inventory management, and customer service, much simpler and more efficient. The transportation function, linked by information technology to the production function, becomes an integral part of the manufacturing process, thereby allowing firms to respond quickly to changes in customer demand. As transportation services become more important to productivity and competitiveness, firms are increasingly required to reevaluate transportation alternatives and, in some cases, take a variety of innovative steps in the shipment of their goods. As a consequence, many U.S. firms that wish to conduct business with Mexico are developing strategic alliances and other cooperative business ventures designed to support the transfer of capital and technology, and also encouraging the application of logistics management technologies to cross-border trade. This often occurs via third-party logistics providers, or logistics subsidiaries. Lastly, this chapter provides a context for the more detailed examination of these trends in subsequent case studies.

Chapter 4. Case Studies

The case studies provide current examples of joint ventures and cooperative partnerships between U.S. and Mexican transportation firms to facilitate cross-border trade, encourage intermodalism, and increase the use of logistics management techniques and related technologies. Each case study attempts to describe and analyze how a firm is coping with the challenges that cross-border trade represents, and also how it is taking advantage of opportunities for growth and expansion. The four companies that comprise the case studies are J.B. Hunt Transport (U.S.

truckload motor carrier), Southern Pacific Lines (U.S. Class 1 railroad), Transportación Marítima Mexicana (Mexico's largest maritime shipping company), and Almacenes Nacionales de Depósito, S.A. (Mexico's national warehousing concern).

Chapter 5. The Role of Technological Innovation

Each case study points to the increasingly important role technology is presently playing and will play in the future within the field of transportation, distribution, and logistics management. Given the limitations of physical infrastructure and transportation modes to dramatically increase efficiency and decrease costs, information technologies have become the most effective tool at the disposal of logistics managers and transportation professionals to make their organizations more competitive in the global marketplace. Through advanced information technologies, firms can meet the complex demands of a rapidly changing transportation environment. However, the disparity of levels of technological development and use between the United States and Mexico has placed U.S. firms that wish to do business across the border in an awkward position. If the seamless shipping envisioned by logistics professionals in the United States continues to move in the direction of becoming a necessity for competitiveness, Mexico will be required to make huge investments in infrastructure, especially in its telecommunications and power networks; Mexican firms will need to invest in and learn to use advanced information technologies or be left behind. U.S. firms must decide if it continues to make financial sense to facilitate the transfer of their technology and expertise in to Mexico via partnerships and alliances in the face of a regulatory environment which does not allow them to compete effectively.

Chapter 6. Forecasting Freight Demand and Modal Choice

Because resources are scarce, investments in the development and maintenance of physical infrastructure and technological infrastructure must be made carefully. In this sense, the myriad changes to transportation and distribution systems caused by advances in technology and the pervasive use of logistics management practices have dramatically changed the nature of trade flows. This, in turn, has necessitated a change in the way transportation professionals in both the public and private sector forecast freight demand and modal choice. This chapter examines several traditional freight forecasting and modal choice models, assesses their ability to capture the various characteristics of U.S.-Mexico trade as described in this and the previous two reports, and applies these characteristics meaningfully to obtain an accurate forecast of modal choice and demand.

Major Findings

Changes taking place in the global economy, industrial practices, technological applications, and the continuing process of transportation deregulation are all bringing forces to bear on the structure and functions of logistics systems and shipping practices. These changes include the following: increased use of flexible manufacturing strategies and production methods to enable firms to adjust quickly to shifts in consumer preferences and supplier needs; increased reliance on multimodal partnerships and joint ventures to reduce operating costs, enhance quality of service, and provide seamless transportation networks; and the outsourcing of transportation and logistics management functions so that firms can concentrate on their core competencies. Advanced information and telecommunications systems enable the coordination of complex activities. With the cost of information and telecommunications systems decreasing relative to the cost of vehicles, labor, and fuel, electronic data interchange (EDI) systems will have an increasingly significant part to play in the improvement of logistics management functions.

The same trends are taking place in Mexico. Mexico deregulated its domestic motor carrier industry in 1989; and, in the intervening years, the deregulatory process was extended to other transportation modes. This liberalization of Mexico's transportation sector legally enabled the formation of multimodal partnerships and joint ventures which, after the passage of NAFTA, gained momentum in the form of U.S.-Mexico transportation alliances. These alliances included agreements between U.S. rail carriers and the Mexican National Railways (Ferrocarriles Nacionales de Mexico, or FNM), between U.S. and Mexican motor carriers, between U.S. and Mexican maritime shipping companies, and even the advent of logistics subsidiaries and companies that lease new and used vehicles in Mexico. The latter two developments have established the basis for outsourcing the operations of private carrier fleets.

Perhaps the most interesting examples of alliances in Mexico involve partnerships in information technologies. For example, the Scott Paper Company hired Schneider Logistics to manage its North American cargo movements. Schneider is using a computer model to analyze costs, routes, schedules, transportation modes, raw material shipments, and finished-good shipments, as well as other data. The model provides information to dispatchers on the lowest-cost carriers serving a particular region and on the most direct route through that region. More importantly, the model uses Schneider's satellite monitoring capabilities to advise Scott of any potential problems with their trucks while they are en route between plants in Mexico, Canada and the United States.

Skyway Freight entered into a partnership with Vidales Hermanos of Monterrey, Mexico, to provide tracking information to its customers in both the United States and Mexico. Vidales Hermanos employs a private communications system to overcome Mexico's poor telecommunications infrastructure so that companies will not lose track of their shipments after they cross the Mexican border. Customers such as Computerland can track shipments all the way from the United States to its retail operations in Mexico City.

Carolina Freight expanded its EDI network into Mexico by installing its computer systems in the offices of its Mexican partner, Tresguerres, S.A. de C.V. This system provides a paperless environment, one bill of lading, door-to-door tracking, and direct telephone access into the computer. Moreover, Yellow Freight has accomplished similar results with the establishment of its own Mexican trucking firm, Yellow Freight Mexicana. Yellow is able to provide single-source surface transport using its information technology which allows for minute-by-minute tracking with direct telephone access.

Despite these advancements, Mexico will be required to make huge investments in its telecommunications and advanced information technology infrastructure if technology is to play the same role in logistics management functions in Mexico that it does in the United States. Today, for instance, the only EDI networks in Mexico are the internal networks of private companies. In order to realize the efficiencies of EDI technology, it will be necessary for Mexico, in conjunction with private firms, to develop an adequate and accessible telecommunications infrastructure which can support this endeavor. Expanded implementation of equipment tracking and monitoring technologies will also be necessary to provide reliable logistics information to support any expanded EDI capabilities.

The continual process of technological development is likely to accelerate in years to come as powerful logistics technologies and systems become available to small firms in the developing world. Given the probability of ever-increasing competition, it is in the interests of U.S. and Mexican businesses to push aggressively for the implementation of improved transportation technologies and logistics management systems throughout North America.

Chapter 2. U.S.-Mexico Bilateral Trade and Transportation Systems

Introduction

Whether transported over land, by sea, or by air, traded commodities will typically move from centers of production and manufacturing to centers of consumption and population (markets). Most every firm, unless it is located adjacent to both its raw materials and its market, must incur some kind of transportation expenses. These costs are incurred by firms when they must transport raw materials and other supplies needed for production, and when they are ready to distribute their final product to its intended market. Most every firm, then, must make a variety of decisions regarding transportation: what mode of transportation will the firm use to move a given product or material; how much will it cost the firm to use a particular mode of transportation; and how efficient this mode of transportation is when compared to other modes. These answers often depend on the type of commodity being shipped.

Different kinds of goods have different transportation requirements. For example, perishable goods, such as fruits and vegetables, need to be transported quickly, perhaps in refrigerated containers, and with a minimum of handling. Petroleum products are heavy and usually shipped in large quantities. Computer equipment or automobiles are expensive, require gentler handling, and also may attract the attention of thieves (so they may need to be tracked and watched carefully). When a firm needs to ship a product, these requirements, along with general cost and quality-of-service considerations, are important factors in its modal choice. In addition, the firm and the carrier it chooses will need to take into account the logistics requirements for moving the goods from origin to destination.

The logistics of trade is greatly affected by the existence of, or lack of, adequate infrastructure on the way to or in the market area. The ease with which trade between the United States and Mexico does (or does not) occur is, then, a direct consequence of the interaction of the nature and quantity of the commodities that move across the border, the origin and destination of these commodities, the infrastructure presently in place to facilitate the movement of these commodities, and the level of shippers' and carriers' logistics development.

U.S.-Mexico Bilateral Trade Flows

As a result of Mexico's 1982 debt crisis and the subsequent imposition of austerity programs requested by the International Monetary Fund, U.S.-Mexico bilateral trade stagnated over the period from 1982 to 1986. Total bilateral trade amounted to US$27.59 billion for 1982 and US$29.95 billion for 1986.[1] A major turning point occurred in August 1986 when Mexico joined the General Agreement on Tariffs and Trade (GATT). Beginning in late 1987, Mexico reduced its highest tariffs (100 percent in 1986) to 20 percent, eliminated a 5-percent tax on imports, and significantly reduced the number of products subject to import licensing. This trade liberalizing process continues with the North American Free Trade Agreement (NAFTA) that became effective January 1, 1994. NAFTA primarily deals with the reduction of tariff and nontariff barriers to trade. A number of tariffs were eliminated when the agreement went into effect; other tariffs will be phased out over a period of fifteen years.[2]

The volume of U.S.-Mexico trade grew 336 percent over the period from 1986 to 1994. Table 2.1 indicates that trade steadily increased from US$29.95 billion in 1986, to US$100.78 billion in 1994. Moreover, the annual trade surpluses that Mexico was able to register in the years following the debt crisis were replaced by deficits from 1991 through 1994. And, until the December 20, 1994 peso devaluation, Mexico experienced a buildup in foreign-exchange reserves because inflows of foreign funds, especially foreign direct investment, more than compensated for the trade deficits.

Table 2.2 contains a list of the top-ten commodity groups, by two-digit Standard Industrial Classification (SIC) code for U.S. exports to Mexico and U.S. imports from Mexico in 1993. Exports and imports in electrical machinery, transport equipment (vehicles and parts), mechanical machinery, and precision instruments (optical, photographical, and surgical instruments) dominate U.S.-Mexico trade. However, oil and refined petroleum, iron and steel, agriculture, apparel, and paper products are also important commodities in terms of their export/import dollar values.

Table 2.1
U.S.-Mexico Trade
(billions of $US)

Year	U.S. Exports to Mexico	U.S. Imports from Mexico
1986	$12.39	$17.56
1987	14.58	20.52
1988	20.47	23.53
1989	24.97	27.59
1990	28.38	30.80
1991	33.28	31.89
1992	40.60	35.19
1993	41.58	39.92
1994	50.84	49.94

Source: U.S. Customs data distributed by U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division.

Table 2.2
Top-Ten U.S.-Mexico Exports and Imports by Commodity Groups, 1993
(millions of $US)

U.S. EXPORTS TO MEXICO

SIC Code	Value of Trade	Rank	Commodity-Group Description
85	$8,111.4	1	Electrical Machinery
84	5,678.9	2	Mechanical Machinery
87	4,512.1	3	Transport Equipment
39	2,078.1	4	Plastics
90	1,706.3	5	Precision Instruments
48	1,105.1	6	Paper and Paperboard
27	1,042.8	7	Mineral Fuels (oil, bitumen.)
29	890.8	8	Organic Chemicals
73	705.9	9	Iron & Steel Articles
10	670.1	10	Cereals

U.S. IMPORTS FROM MEXICO

SIC Code	Value of Trade	Rank	Commodity-Group Description
85	$9,992.6	1	Electrical Machinery
87	6,812.6	2	Transport Equipment
27	4,741,0	3	Mineral Fuels
84	3.116.3	4	Mechanical Machinery
90	1,210.3	5	Precision Instruments
94	1,041.2	6	Furniture
62	1,012.2	7	Apparel
7	949.8	8	Vegetables
73	481.8	9	Iron & Steel Articles
1	432.3	10	Live Animals

Source: U.S. Customs data distributed by U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division.

These bilateral trade flows move between centers of production and consumption by means of air, sea, and land (highway and rail) transportation. Table 2.3 shows that 90.6 percent of the 1993 value of U.S. exports to Mexico moved by ground transportation, 4.1 percent by sea, and 5.3 percent by air. In terms of their respective shares of U.S. imports from Mexico, 84.9 percent moved by ground transportation, 13.2 percent by sea, and 2.2 percent by air. The relatively large percentage of seaborne shipments coming from Mexico primarily involves oil-related products being transported from the Mexican Gulf coast to the Texas Gulf coast.

Table 2.3
Modal Share of U.S.-Mexico Trade, 1993

	U.S. EXPORTS TO MEXICO		U.S. IMPORTS FROM MEXICO	
	Value of Trade (millions of $US)	Modal Share (percent)	Value of Trade (millions of $US)	Modal Share (percent)
Ground	$37,732	90.6	$33,782	84.9
Sea	1,691	4.1	5,268	13.2
Air	2,213	5.3	880	2.2

Source: U.S. Customs data distributed by U.S. Department of Commerce, Foreign Trade Division.

Maquiladora versus Traditional Trade

All modes of transportation move both *maquiladora* and traditional trade. *Maquiladora* operations are manufacturing and assembling plants located in Mexico that produce goods primarily with U.S. components. These goods are mostly intended for the U.S. market and become U.S. imports. A large percentage of these goods consists of automobiles, electrical components, and consumer products. Most *maquiladora* operations are located just south of the border, although an increasing number, with government encouragement, have established operations in the interior of Mexico. By contrast, traditional trade has more diverse origins and destinations, is shipped throughout Mexico, and tends to consist of components for Mexican manufacturers and goods sold to the Mexican consumer.

In 1992, m*aquiladora* operations in Mexico accounted for 41 percent of U.S. exports to Mexico and 52 percent of U.S. imports from Mexico. By the end of the first quarter of 1992, the number of *maquiladora* plants had risen to 2,117, and the number of Mexicans employed had risen to 471,814. Over 90 percent of these plants are located within the six northern Mexican border states: Baja California Norte has 932 *maquiladora* plants (44 percent of the nation's total), employing over 102,000 workers; Chihuahua has 391 (18 percent), employing 164,482 workers; Coahuila has 129 (6 percent), employing 30,113; Nuevo Leon has 83 (4 percent), employing 15,881; Sonora has 158 (7.4 percent), employing 39,884; and, finally, Tamaulipas has 333 (19 percent), employing 89,268.[3]

Centers of Manufacturing and Population

The six northern Mexican border states collectively possessed 16 percent of Mexico's 1990 population and 22 percent of Mexico's 1990 manufacturing employment. In 1992, these six states were responsible for 15 percent of Mexico's traditional-trade exports and 96 percent of *maquiladora* exports, as well as 23 percent of its traditional-trade imports and 96 percent of *maquiladora* imports. The primary concentration of population (one-quarter of the total) and manufacturing employment is located in the center of the country in the Distrito Federal and the State of Mexico. Other highly populated states are Veracruz (along Mexico's Gulf coast) and Jalisco (along the Pacific coast).[4]

The four southern U.S. border states collectively possessed 21 percent of the 1990 U.S. population and 18 percent of the 1990 U.S. manufacturing employment. The primary concentration of population and manufacturing along the border is in California (17 percent of population and 5 percent of manufacturing employment). Other major centers of population and manufacturing are located in the northeast, north central, and southeast regions of the United States. The states of Michigan, Illinois, Ohio, New York, and Pennsylvania individually accounted for at least 4 percent of the 1990 U.S. population and at least 5 percent of 1990 U.S. manufacturing employment.[5]

Impact of the Devaluation on Trade

The devaluation of the Mexcian peso in December 1994 led to a collapse of the Mexican currency, which, at its worst, resulted in the peso trading at 8 to US$1.00 -- prior to the devaluation, the peso traded at about 3.4 to US$1.00. Although the peso's value has steadied and is now leveling off at around 6 to US$1.00, the loss of close to 50 percent of the peso's value has had a variety of consequences for U.S.-Mexico trade.

Prior to the devaluation, the peso was traded on a programmed basis, rising and falling within a prescribed narrow band. Although the Mexican government attempted to devalue the currency within this band, it was forced to allow the peso to float freely as both foreign and domestic investors fled from the market and emptied foreign currency reserves.[6]

When a currency floats freely, its value is extremely volatile. For importers and exporters, this volatility causes a variety of problems. For example, importers and exporters of goods to and from points in Mexico cannot predict how much they will have to pay, or how much they will be paid, for shipments of goods. This uncertainty can discourage trade, particularly for the smaller businesses engaging in cross-border transactions. In addition, the financing of various transactions, including warehousing and inventory management, customs fees, and business loans, becomes exceedingly risky and expensive.

In order to ease these problems, the Mexican government, in late April 1995, allowed the development of a futures market for pesos on the Chicago Mercantile Exchange so that banks and larger financial institutions could attempt to hedge their exchange rate risks for certain products. For the trading community, the Mexican government also allowed the creation of "forward contracts," which allow a firm to sign a contract with a bank to exchange pesos for dollars at a specific rate on a specific date, thereby protecting the firm against currency fluctuations.[7] The test of Mexico's floating exchange rate policies -- strong futures and a forward market -- will come at the end of the summer of 1995 when Mexico will be expected to have retired the bulk of its *tesobonos*, the short-term debt instruments at the heart of Mexico's crisis that are denominated in dollars and paid in pesos.[8]

Imports and Exports

All is not bleak for Mexico's economy as a result of the devaluation, however. The weakened peso boosted Mexican exports and discouraged nonessential (commercial, retail) imports, leaving the country with a US$620 million surplus in its trade balance for April 1995. The weakened peso has made Mexican exports more competitive worldwide, and these export sales are helping to ease many of the post-devaluation problems.

According to statistics compiled by the Mexican Secretariat of Finance and Public Credit (Secretaría de Hacienda y Crédito Público), these figures compare favorably to the US$1.4 billion trade deficit that Mexico posted in April 1994, and marks the fourth consecutive month of trade surpluses for Mexico. Last year's huge trade deficits and an over-reliance on short-term debt instruments (the *tesobonos*) combined to throw Mexico into severe economic crisis after last December's peso devaluation.[9]

For the first four months of 1995, Mexico ran a surplus in its commercial balance of US$1.16 billion, compared to a deficit of US$5.7 billion over the same period in 1994.[10] In December 1994, Mexico registered a trade deficit of almost US$1.7 billion. By January 1995, after the collapse of the peso, it had a negative balance of only US$530 million. By February 1995, Mexico had a trade surplus of approximately US$240 million. Exports for February were valued at US$5.83 billion -- a 28.7 percent increase over the same period in 1994; imports for February were valued at US$5.59 billion -- a 7.3 percent decrease in imports over the same period last year.[11]

Our most recent trade figures for April 1995 indicate that exports in that month alone totaled US$5.76 billion, which is an increase of over 23 percent from the same period last year. Manufactured goods accounted for approximately US$4.6 billion of total exports for April, 52.6 percent of which represented exports of non-*maquiladora* goods. Exports of agricultural goods were valued at US$415 million (a 63 percent increase from last April) and petroleum exports were valued at US$686 million. The Mexican Secretariat of Finance and Public Credit indicated that the weaker peso has also led to export gains in textiles, clothing, paper, chemicals, and minerals.[12]

Meanwhile, also in April 1995, import levels by value fell 15.4 percent compared to the previous year, and 3.4 percent over the first quarter when compared to last year.

Imports of capital goods in the first quarter fell 28.3 percent and consumer goods 34.4 percent compared to the same quarter of last year.[13] In fact, Mexico's first quarter exports for 1995 were estimated at US$6.82 billion while imports hovered around US$6.3 billion. Although this means that Mexico only has a surplus of approximately US$460 million for the first quarter, at least it is partially on its way toward obtaining the US$10 billion it needs annually to service its debt.[14]

Domestic manufacturers have increased their exports by more than 30 percent while reducing their imports by almost half, in many cases. However, many companies have had to not only trim their payrolls, but have had to cancel orders for new machinery to achieve this favorable trade balance.[15]

Unemployment

The unemployment rate in Mexico in the post-devaluation period reached one of its highest official rates ever - 5.7 percent - in March 1995, up from 3.2 percent in December 1994. The actual jobless rate may be worse, however, because of the way the Mexican government compiles its unemployment statistics. For example, a person is counted as employed even if that person only works for a few hours a week. The dramatic increase in unemployment is expected to rise even further in the second quarter of 1995 as the Gross Domestic Product (GDP) contracts. GDP estimates indicate that the contraction could be as much as 4 percent for the second quarter.[16]

Rising levels of unemployment also mean that individuals have much less disposable income with which to purchase imports from the United States. And, as the unemployment benefits of individuals laid off as a result of the devaluation run out (severance pay covers only two months), the Mexican economy may slow down even further and import levels may fall even more, thereby compounding the problem.

Gross Domestic Product

Leading analysts inside Mexico have projected a 4 percent drop in GDP in 1995, which was less than expected. Although GDP was only down by 2.8 percent in the first quarter, the construction industry experienced a huge slowdown, with output reduced by almost half. Many expect the second and third quarters' GDP to drop below 4 percent, and admit that 4 percent, as an average for the year, may be optimistic.[17]

In order to boost production as much as possible, the Secretariat of Commerce and Industrial Development and the Banco Mexicano de Comercio Exterior (the foreign trade bank) plan to select certain industries and assist them in boosting sales and production levels. The Mexican government plans to cut paperwork drastically and is abolishing part of the cumbersome quota system in the textile industry. Exports of linens, canvas, cotton cloth, wool knits, jackets, and synthetic sportswear will experience free trading on international markets. Quotas on wool suits and overcoats, shirts, and cloth made from artificial fibers, however, will continue to be regulated. Other sectors that will receive special attention from the government include auto parts and mining, particularly for those materials and metals useful for the auto industry.[18]

The Austerity Program

The austerity program announced in March caused the Mexcian government to immediately raise fuel prices by 35 percent and prices for electricity by 20 percent. Prices are scheduled to rise 0.8 percent each month through the end of 1995. The biggest price jump includes April's 50 percent increase in the value-added tax (VAT) to 15 percent.[19] As a result of the VAT increase, and in combination with the other effects of the economic crisis, inflation in Mexico has seen its greatest increase in seven years - an estimated 8 percent in many of the most densely populated urban areas.

This sharp increase in consumer prices brought accumulated levels of inflation for the first four months of 1995 to over 23 percent (14.5 percent for the quarter); this represents more than half of the Mexican government's goal of 42 percent for the entire year. The Banco de México reported that the cost of the "basic basket" of consumer items and services rose 10.4 percent with major price increases in transportation (11.9 percent), housing (8.5 percent), health and personal care (7.5 percent) and food, drink and tobacco (6.8 percent).[20]

Many economists believe, however, that the worst is still to come with regard to the economy. According to Jorge Mariscal, director of the Latin American equity research group for Goldman Sachs & Co. in New York, "the economy has not yet bottomed out, and I think [this will occur] sometime in the second quarter."[21] Because many consumers rushed to buy goods ahead of inflation, some inventory was created which was used in the first quarter; now, in the second quarter, inventories and stocks purchased before inflation are depleted and replacing them will be quite costly. In addition, each laid-off employee who has been living on severance pay will be running out of cash in the near future. This problem has required the Mexican government to bolster its socioeconomic safety net which is a costly proposition.

Lastly, GDP contraction is the inevitable result of the tight fiscal and monetary policy the government put in place as the main condition of the U.S.-led rescue package. Despite this, $10 billion in bailout money could be made available to the Mexican government at the beginning of July; meeting the strict conditions to receive this money is a top priority for Mexican officials.

Trade Corridors versus Transportation Corridors

A recent study by the Arizona Department of Transportation attempted to identify some of the key attributes of mature trading patterns and/or established trade corridors. The key elements that this study identified which comprise the creation of a trade corridor give insight into what is important in the development and continued maintenance of mature trading relationships between countries (or between other kinds of geographically distinct entities, such as states or cities): the existence of a well-developed physical infrastructure, including highway, rail, and sea linkages, and border ports of entry; the existence of an established, commercial infrastructure to encourage trade, which would include distribution and warehousing facilities, foreign trade zones and/or industrial parks, a harmonized regulatory environment, and other similar trade incentives; the existence of an integrated professional, technological, and communications infrastructure, which would not only include the existence and use of the actual technology of business (such as computers, advanced telecommunications networks, and other electronic media), but also the existence of a cadre of business professionals, which would include accountants, attorneys, consultants, customs brokers, freight forwarders, and a variety of other social, political, and business linkages.[22]

These elements, however, have been often used to describe transportation corridors. There obviously exists a great deal of uncertainty within the academic community and between transportation professionals concerning whether there are or are not actual and discernible differences between trade and transportation corridors, and, if so, what those differences actually are. To some, the essence of what differentiates these two types of corridors is the extent to which one or the other does or does not provide the opportunity for adding value to a commodity. Transportation corridors are sometimes described as routes which simply facilitate the movement of commodities (expressed in terms of tons, ton miles, or dollar/value miles). Trade corridors are sometimes defined as specific geographic routes and areas which facilitate trade (not only the movement of goods) and which add dollar value to the goods which travel along or within them.[23] Typically, trade corridors would necessarily include great concentrations of population and manufacturing employment, in addition to the physical, technological, and professional factors listed above.

For the purposes of this report, however, such differentiation may be unnecessary, and may indeed obfuscate the point -- that traded commodities often travel along certain typical routes from their origin to their destination, and that the commodities which are involved in U.S-Mexico trade in particular follow typical routes, depending upon what mode of transportation is used. In this sense, for the purposes of this report, the activity of "adding value" becomes secondary to the tracking of trade flows and describing the logistics used to keep these flows as smooth as possible. In this report, the term "transportation corridor" will be used to describe the routes over which commodities move from their origin to their destination, and we will temporarily push aside the issue of the existence of (or lack of) value added to those commodities while in transport. For the purposes of this report, the definition of a transportation corridor will include the physical infrastructure (such as highways and bridges) which is used most frequently by the businesses and industries conducting trade between two geographic areas; it forms the arteries of multimodal transportation systems that that connect truck, rail, and sea traffic.[24]

In this sense, these transportation corridors combine the use of the interstate highway systems, rail mainlines, air facilities, and port/waterway systems. These corridors can consist of major facilities for a single mode of transportation; but, within the context of a multimodal transportation system, they consist of the combined network of a variety of different transportation modes that carry large volumes of goods.[25]

There are three major types of transportation corridors: land (or surface) corridors, air corridors, and sea corridors. Land corridors are used by motor carriers and railroads; they are usually linked by networks of warehouses, truck terminals, rail yards and refueling stations. Air corridors are used by airlines to transport air-freight;

they are linked by networks of airports and general aviation facilities. Sea corridors are utilized by marine vessels (oceangoing ships as well as shallow-water barges); they are linked by other seaports and inland waterways. Whenever two different modes of transportation are used together in a particular corridor to move a commodity, the corridor is referred to as "intermodal."

Transportation Corridors in the United States

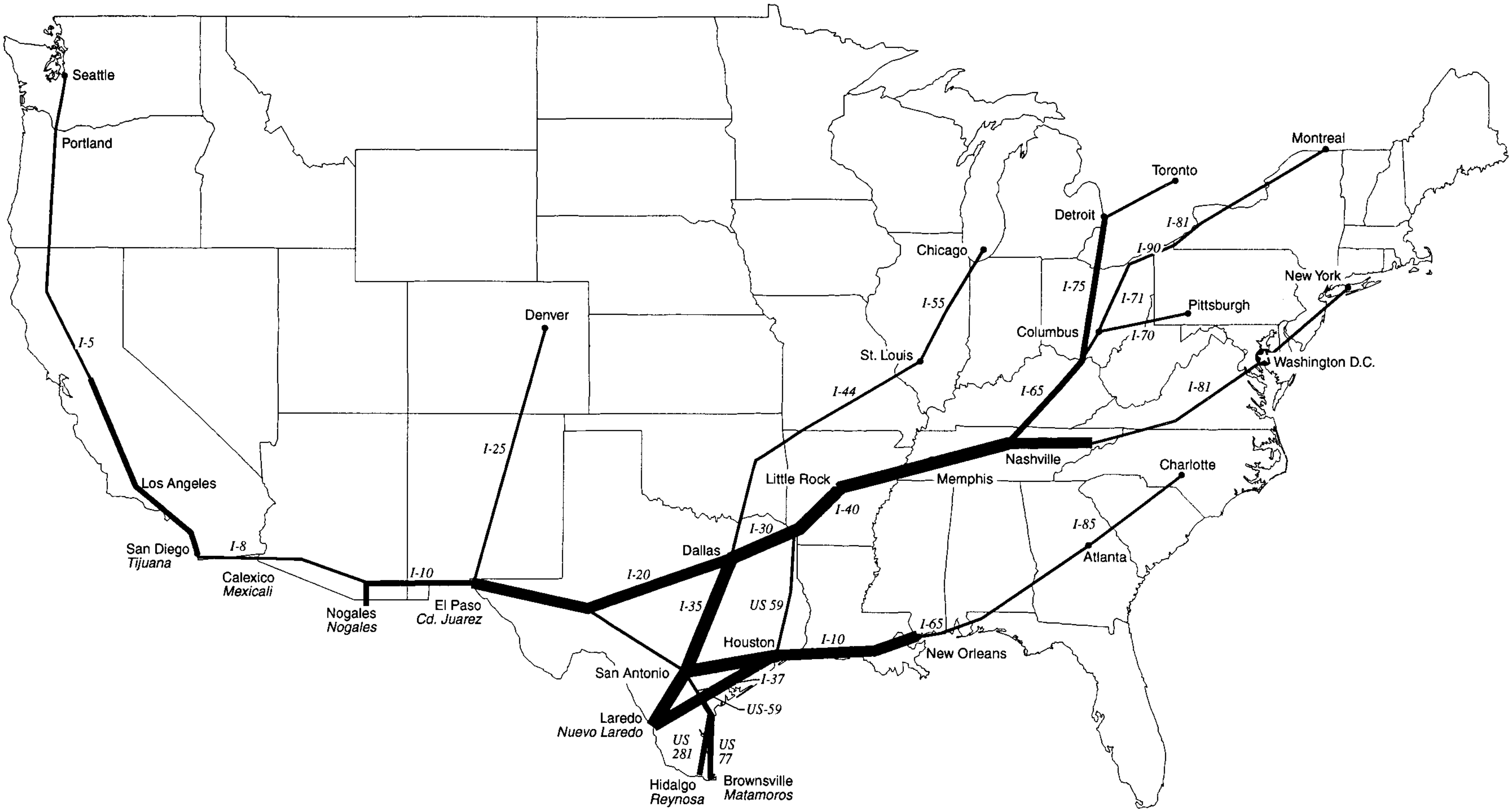
Overland trade between the United States and Mexico follows distinct routes, using both highway and railway rights-of-way. The pattern of flow of ground-transported exports is depicted in Map 2.1. Although the depicted transportation corridors are designated as specific interstate highways, both highway and rail transportation are implied.

One easily notices that the dominant export shipments consist of products originating in the northeast, north central, and southeast regions of the United States. The same general pattern applies to ground-transported imports destined to the same regions of the United States. Map 2.2 highlights these points by showing the amount of 1992 exports to Mexico originating in each state (the top figure) and the amount of 1992 imports from Mexico that are destined to each state (the lower figure). Texas plays a prominent position in these trade flows. Texas alone accounted for $17.4 billion in 1992 exports to Mexico and for $12.8 billion in imports from Mexico. Moreover, the great bulk of trade moving to and from other regions of the United States and Mexico transits Texas border gateways and transportation corridors.

Western Corridor

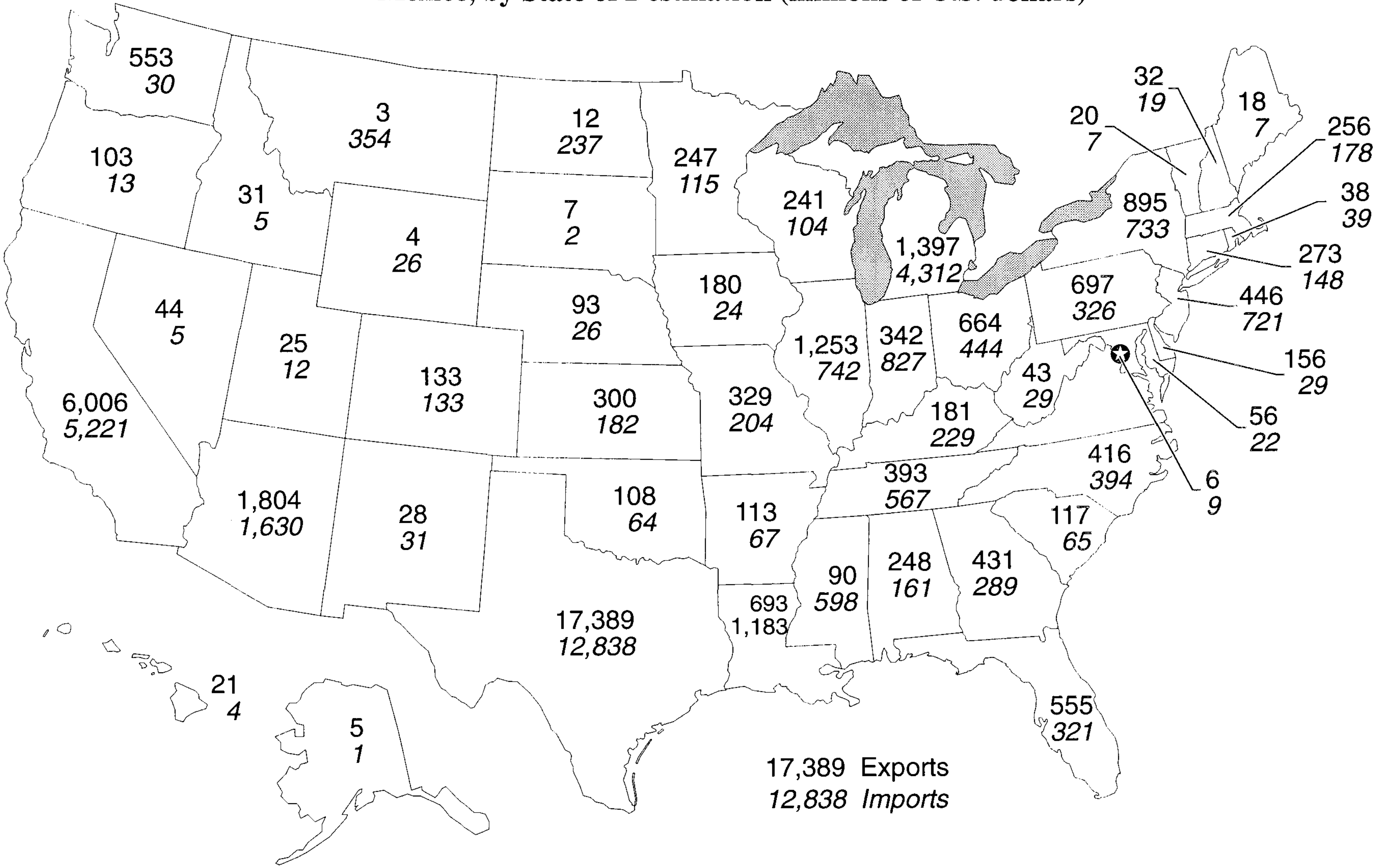
As shown in Map 2.1, the Western Corridor for U.S.-Mexico trade begins in Seattle, Washington. Traffic along this corridor follows Interstate 5 (I-5) from Seattle all the way into Southern California. Class 1 rail carriers which operate in this corridor are The Atchison, Topeka and Santa Fe Railway Company (ATSF), Burlington Northern Railroad Company (BN), Southern Pacific Lines (SP), and the Union Pacific Railroad Company (UP). In San Diego, I-5 divides, allowing a motor carrier to travel either directly to the border (crossing into Tijuana), or to connect with Interstate 8 (I-8) for access to Mexicali, Mexico, or to southern Arizona. In Tucson, Arizona, traffic along I-8 can either exit via Nogales into Mexico, or continue along Interstate 10 (I-10) for travel into El Paso and West Texas. A motor carrier also has the option of continuing a trip along I-10 to San Antonio. A spur of this Western Corridor begins in Denver, Colorado, and moves directly south along Interstate 25 (I-25) through New Mexico, where it intersects with I-10 in El Paso. Rail traffic moving from California to Texas travels over either SP or ATSF rail lines. Finally, as will be described later in greater detail, traffic entering Mexico through Tijuana, Mexicali, or Nogales connects with Mexico's Pacific Corridor, while traffic entering Mexico through Ciudad Juarez (the sister city of El Paso) connects with Mexico's Chihuahua Corridor.

Map 2.1
Major U.S. Trade Corridors with Mexico



Source: Adapted from information provided by McCray Research, San Antonio, Texas

Map 2.2
1992 U. S. Exports to Mexico, by State of Origin, and U.S. Imports from Mexico, by State of Destination (millions of U.S. dollars)



Source: Barton-Aschman Associates, Inc., *Transportation and Trade Expansion Between the U.S. and Mexico* (*Making Things Work: Transportation and Trade Expansion in North America*, Volume 3), performed under contract for the Federal Highway Administration, FHWA-PL-009-016 (Albuquerque, New Mexico: September 1993), Table 4, p.8.

Midwestern Corridor

The Midwestern Corridor links the north central region of the United States with Mexico. This particular transportation corridor begins in Chicago, Illinois. It extends south along Interstate 55 (I-55) to St. Louis, Missouri, where it connects with Interstate 44 (I-44) and continues southwest until it reaches Oklahoma City. In Oklahoma City, motor carriers travel south along Interstate 35 (I-35) and move into Texas, via Dallas, until they reach the Texas-Mexico border. The ATSF, BN, and UP all operate along this corridor. The SP also operates between Chicago and Texas, but its tracks more closely follow the Northeastern Corridor through Arkansas and Memphis, Tennessee.

Northeastern Corridor

The Northeastern Corridor has three spurs, of which two begin in Canada (Toronto and Montreal), and one begins in New York City. All three spurs converge in Nashville, Tennessee. The Toronto spur moves south through Detroit, Michigan, where it connects with Interstate 75 (I-75) until it reaches Cincinnati, Ohio. From that point, traffic moves along Interstate 71 (I-71) to Louisville, Kentucky, and then along Interstate 65 (I-65) into Nashville. The Montreal spur moves along Interstate 90 (I-90), I-71, and then I-65 into Nashville. Finally, the New York City spur begins on Interstate 80 (I-80) and then extends southwest along Interstate 81 (I-81) into Nashville.

From Nashville, all three spurs follow Interstate 40 (I-40) through Memphis, Tennessee, to Little Rock, Arkansas. From Little Rock, traffic moves along Interstate 30 (I-30) into Texas, where it can take several alternative routes to reach the Texas-Mexico border. Traffic entering Mexico at Nuevo Laredo (the sister city of Laredo) connects with Mexico's Central Corridor, whereas traffic entering at Matamoros (the sister city of Brownsville) connects with Mexico's Gulf Corridor. No single rail carrier provides single-line service along the Northeastern Corridor extending from Canada through Texas. The three major eastern Class 1 rail carriers - ConRail, CSX Transportation, and Norfolk Southern Corporation - offer various combinations of interline connections with the four major western Class 1 rail carriers to provide through service to Mexico.

Southeastern Corridor

The Southeastern Corridor connects the southeast region of the United States with Mexico. In Charlotte, North Carolina, motor carriers can take Interstate 85 (I-85) through Atlanta, Georgia, to Montgomery, Alabama. At Montgomery, traffic moves along I-65 to New Orleans, Louisiana, where it connects with I-10 for travel through Houston, San Antonio, and El Paso. Again, while no rail carrier offers single-line service, CSX Transportation and Norfolk Southern Corporation offer interline connections with western Class 1 rail carriers.

Texas Transportation Corridors

The state of Texas has developed the most comprehensive highway system in the United States. Center-line miles, a measure of roadway length, and lane miles, roadway length multiplied by the number of lanes along each roadway segment, are two indicators of the magnitude of highway systems. In Texas, state-maintained highways total 76,856 center-line miles and 183,551 lane miles. State-maintained highways include those designated as interstate highways, U.S. highways, state highways, and farm-to-market or ranch-to-market roads. An additional 213,317 center-line miles of other roadways are maintained by Texas local governments.[26]

There are many important highway links in Texas which facilitate trade with Mexico - many of them were introduced in the previous paragraphs. Highway links to Mexican border crossings, then, are an important consideration in planning for the growth of U.S.-Mexico bilateral trade. There are currently 23 border crossings between Texas and Mexico. Twenty of these crossings are bridges, seventeen of which charge a user toll. Many of the bridges are over 50 years old and in need of improvement or repair. Almost all of the border crossings are served directly or indirectly by the Texas Trunk System.

The Texas Trunk System, adopted by the Texas Transportation Commission in 1990, is comprised of planned four-lane, divided roadways that include and complement segments of the interstate, U.S., and state highways systems. The intent is to provide each Texas city with a population over 20,000 with access to major ports, adjacent states, border crossings between Texas and Mexico, and recreational areas. The estimated completion time is 30 years. The Texas Department of Transportation has determined that it is critical to link highway and bridge development in the state with Mexican infrastructure development on the other side of the border.[27]

The state of Texas also ranks high among other states in terms of rail infrastructure. In 1992, Texas ranked first in the nation with 11,285 miles of rail. Texas ranked second in the nation in railroad employment, with over 16,000 people employed by rail carriers. In 1992, Texas ranked fifth in the nation in tons of freight handled by rail. Five Class 1 rail carriers operate in the state: The Atchison, Topeka and Santa Fe Railway Company (ATSF), Burlington Northern Railroad Company (BN), Kansas City Southern Railway Company (KCS), Southern Pacific Lines (SP), and Union Pacific Railroad Company (UP). There were a total of 46 rail carriers in operation throughout the state as of 1994.[28]

Intermodal facilities are crucial to the development of a binational multimodal transportation system because they allow freight transfer from one transportation corridor to another or one mode of transportation to another.[29] The use of intermodal freight-handling facilities has been increasing in recent years. The passage of NAFTA has increased the demand for intermodal transfer facilities in Texas, and especially trailer-on-flatcar (or TOFC) service between the United States and Mexico. Intrastate trucking deregulation is also likely to increase the demand for intermodal rail access, as large and small railroads and trucking companies increase price competition.

Highway access to intermodal facilities is an important issue facing the railroad industry in Texas. Tom Kelly, the Director of Intermodal Operations and Terminal Services for ATSF, indicated that the improvement and construction of feeder roads to intermodal facilities is a top priority for easing intermodal freight transfers, as well as decreasing intercity truck traffic.[30] Roads linking intermodal terminals, as well as intermodal transfer facilities themselves, may be eligible for federal funding under the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).[31] Table 2.4 provides information on rail intermodal facilities by location, and Table 2.5 lists major rail carriers serving individual Texas ports.

Table 2.4
Rail/Truck Intermodal Facilities By Location

LOCATION	RAILROAD *
Alliance Airport/Haslet, TX	ATSF
Amarillo	ATSF
"	BN
Dallas	KCS
"	SP
Dallas - Mesquite	UP
El Paso	ATSF
"	SP
Harlingen	UP
Houston	ATSF
"	SP
"	UP
Laredo	ATSF
"	UP
"	TM
Prosser	ANR
Marshall	UP
Texarkana	KCS
San Antonio	SP
"	UP

Source: Telephone communication by C. Toews, Texas Department of Transportation, with Texas Rail Carriers, October 27, 1994.

Table 2.5
Major Rail Carriers Serving
Texas Port Facilities

Port Facility	Rail Company
Beaumont	ATSF, KCS, SP, UP
Brownsville	MNR, SP, UP
Corpus Christi	SP, TM, UP
Freeport	UP
Galveston	ATSF, BN, SP, UP
Harlingen	SP
Houston	ATSF, SP, UP
Port Lavaca	SP, UP
Orange	SP, UP
Port Arthur	KCS, SP
Texas City	ATSF, BN, SP, UP

Source: Port interviews and port questionnaires, 1994.

* Note: Abbreviations for Railroads are as follows:

ANR:	Angelina & Neches River Railroad
ATSF:	Atchison, Topeka & Santa Fe Railway
BN:	Burlington Northern Railroad
KCS:	Kansas City Southern Railway
MNR:	Mexican National Railways
SP:	Southern Pacific Lines
TM:	Texas-Mexican Railway
UP:	Union Pacific Railroad

Rail connections with Mexico are an important link between transportation corridors in the United States and Mexico. There are currently five ports of entry for rail traffic to and from Mexico in the state of Texas: Brownsville, Laredo, Eagle Pass, Presidio, and El Paso. Most of these five ports of entry are at or near capacity. UP intends to complete an $85 million project to expedite rail car exchanges at the border, including a proposed new international rail bridge and rail yard. UP is also attempting to obtain a permit with the Mexican National Railways (Ferrocarriles Nacionales de Mexico, or FNM) to link international rail traffic. Improvement in rail facilities between the two countries is also underway at the Brownsville-Matamoros border crossing. New investment in the Texas border rail infrastructure depends on the growth in future demand for U.S.-Mexico bilateral trade.[32]

Texas is the most important link between transportation corridors in Mexico and transportation corridors throughout the rest of the United States.[33] The predominance of

Texas in the linkage of the U.S. and Mexican bilateral trade infrastructure is not solely based on geography. It is also a result of the quality of the transportation infrastructure within the state. Four roadways in Texas carry most of the southbound U.S. trade destined for Mexico - I-35, I-20, U.S. 59, and U.S. 77.

The Interstate 35 Corridor

The I-35 Corridor is the most utilized transportation corridor within the state of Texas. More trucks carrying goods between the United States and Mexico have traveled on I-35 than any other highway in the country.[34] The Interstate Highway 35 Corridor Coalition, an interest group organized to promote development and increase federal assistance for the I-35 corridor, has been lobbying to create a "super-highway" designation for I-35 under ISTEA.[35] Because I-35 connects the Laredo border crossing - the most heavily used border crossing for truck traffic - to Dallas, through San Antonio and Austin, and because I-35 represents the point of convergence of several major transportation corridors from the interior of the United States, it is extremely important. The UP also operates a rail line from Dallas that parallels this corridor.

The U.S. Highway 59 Corridor

Laredo is linked to the city of Houston, which contains Texas' largest seaport, via the U.S. Highway 59 (U.S. 59) corridor. However, unlike the I-35 Corridor, the U.S. 59 Corridor is not an interstate highway. Recently, under ISTEA, the U.S. Congress designated U.S. 59, from Laredo to Texarkana, a "high priority" transportation corridor. All corridors designated high priority under ISTEA are to be included in the National Highway System which is intended to supplement the existing interstate highway system.[36]

The Interstate 20 Corridor

The main transportation corridor that connects Dallas with El Paso is the Interstate 20 (I-20) Corridor. This is an important corridor because it connects the traffic moving east on I-10 from the Western Corridor to the traffic moving up to the Northeast Corridor via Dallas, and the traffic moving from the Northeast to the West. UP operates a rail line that parallels the I-20 Corridor from Dallas.

The U.S. Highway 77 Corridor

U.S. Highway 77 connects the U.S.-Mexico border at Brownsville-Matamoros with Victoria through Corpus Christi. In Victoria, U.S. Highway 77 intersects with U.S. 59 for traffic movements to Houston. The UP operates a rail line that connects Houston and Brownsville. The rail line parallels the U.S. Highway 77/59 corridor. U.S. Highway 77 also intersects Interstate 37 (I-37) in Corpus Christi. I-37 connects Corpus Christi and San Antonio. UP also operates a rail line connecting San Antonio and Corpus Christi.

Transportation Corridors in Mexico

Four transportation corridors in Mexico carry the bulk of its trade with the United States (see Map 2.3). These corridors developed as a consequence of historical trading patterns and the topographical characteristics of the country. Two major mountain ranges divide Mexico: the Sierra Madre Occidental and the Sierra Madre Oriental. The existence of these major north-south mountain ranges force highways and rail lines to operate in four distinct north-south corridors: the Pacific Corridor, the Chihuahua Corridor, the Central Corridor, and the Gulf Corridor. All four corridors link up in Mexico City, allowing relatively direct access between the United States and the most populous city in Mexico.[37]

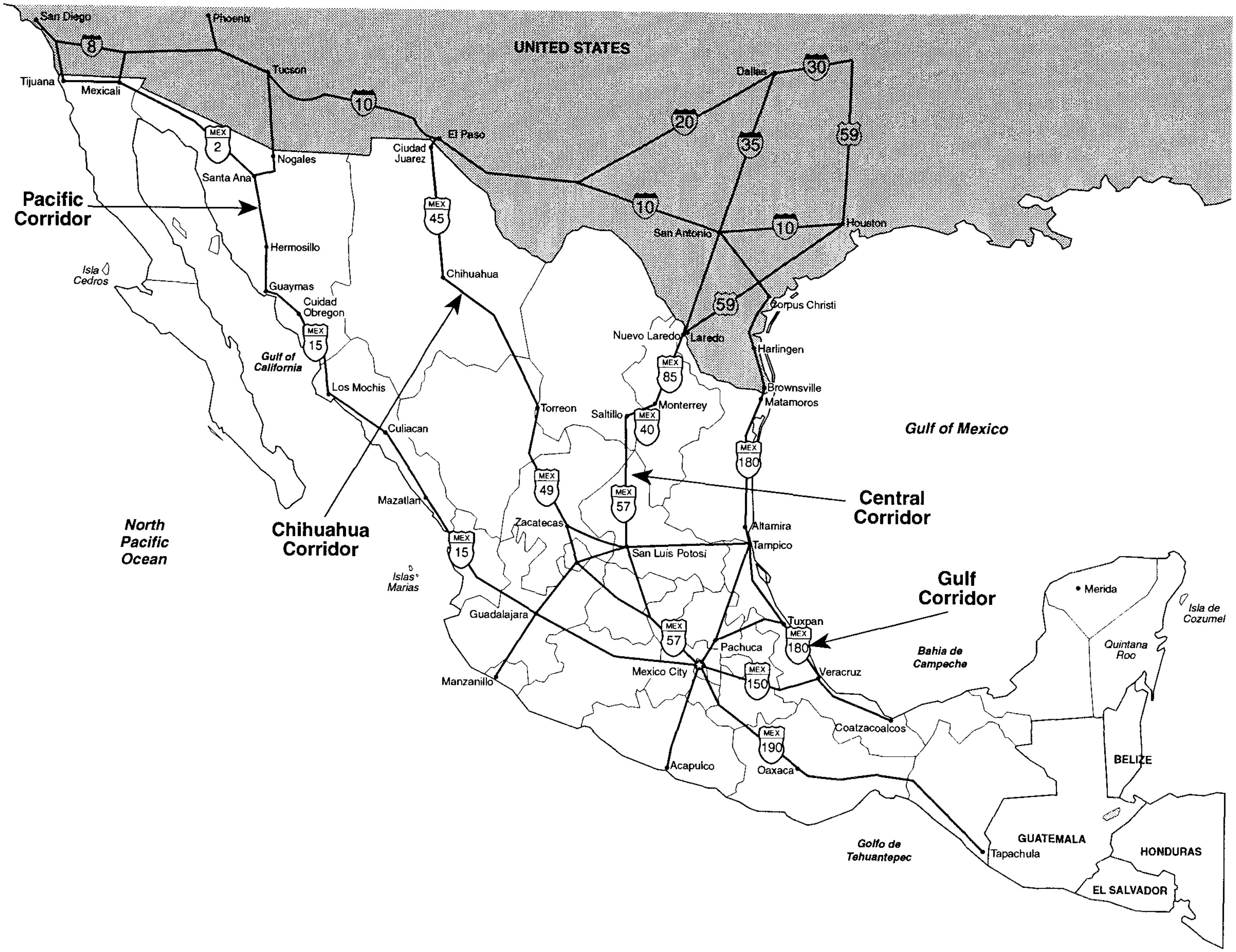
Much like U.S. overland trade corridors, two principal modes of transportation operate along Mexico's overland transportation corridors: motor carriers and rail carriers. As in the United States, Mexico's airport and seaport facilities are connected to these corridors by roadway or railway spurs. The highway system in Mexico covers over 243,000 kilometers and carries 60 percent of all shipments transported in Mexico (as well as 84 percent of all land-based shipments). There are approximately 155,000 kilometers of dirt roads, compared to only 88,000 kilometers of paved roads in Mexico; and, of the paved roads, 46,000 kilometers belong to the federal road network and 42,000 kilometers to either state or rural highway networks. Of the roads in the federal network, approximately 16,000 kilometers are considered part of a priority network of roads and highways which join the main cities of Mexico, all Mexican state capitals, and Mexican sea and border ports.[38]

The railway system in Mexico is managed by FNM, which operates over 26,000 kilometers of rail lines that link the country's main cities. The Mexican rail system also forms three major corridors running from north to south - one running along the Pacific Coast, another through the center of the country, and a third in the northwest. Another rail corridor links Mexico City with the Yucatán Peninsula. These rail lines converge in Mexico City.[39]

The Pacific Corridor

The major highway in the Pacific Corridor of Mexico is Federal Highway 15. However, the Pacific Corridor actually begins in Tijuana at Federal Highway 2. Federal Highway 2 intersects with Federal Highway 15 in Santa Anna, in the state of Sonora. Federal Highway 2 begins in Nogales at the U.S.-Mexico border. An FNM rail line parallels both Federal Highway 2 from Tijuana and Federal Highway 15 from Nogales to Mexico City. This rail line is authorized to carry up to 110 metric tons gross weight per four-axle rail car until it reaches Mazatlán on the Pacific Coast. From Mazatlán to Mexico City, the rail line is authorized up to 120 metric tons, per four-axle rail car.[40] In addition, an intermodal facility is operated in Hermosillo, Sonora, located on Federal Highway 15, by Ford Motor Company. Containers are off-loaded onto freight cars at Ford's assembly plant in Hermosillo.[41]

Map 2.3
Major Mexican Trade Corridors with the United States



The Chihuahua Corridor

The Chihuahua Corridor originates in Ciudad Juarez and terminates in Mexico City. This corridor facilitates more *maquiladora* trade between the United States and Mexico than do the other three Mexican corridors.[42] The highway that runs south from Juarez in this corridor is Federal Highway 45. In Torreon, in the state of Coahuila, the Chihuahua Corridor follows Federal Highway 49 until it again intersects with Federal Highway 5. In San Luis Potosí, the Chihuahua Corridor merges with the Central Corridor. FNM operates a rail line along the Chihuahua Corridor that is authorized to carry up to 120 metric tons per four-axle rail car.[43] This rail line does not directly follow the highway, but instead bypasses San Luis Potosí to the west. The Chihuahua Corridor is connected with the second largest city in Mexico, Guadalajara, by Federal Highway 54. An intermodal facility is operated by the ATSF in Ciudad Chihuahua.[44]

The Central Corridor

This corridor begins in Nuevo Laredo, terminates in Mexico City, and is the most important of the four Mexican corridors in terms of non-*maquiladora* trade. The Central Corridor carries almost 80 percent of all traditional trade.[45] Federal Highway 85 connects Nuevo Laredo with Monterrey, while Federal Highway 40 connects Monterrey with Saltillo, in the state of Coahuila. An intermodal facility is operated off this highway in Ramos Arizpe by General Motors. This facility is similar to the facility in Hermosillo operated by Ford Motor Company.[46] In Saltillo, the main artery of the Central Corridor becomes Federal Highway 57 which terminates in Mexico City. FNM operates a rail line in this corridor which is authorized to carry up to 127 metric tons per four-axle rail car between Nuevo Laredo and Monterrey and 120 metric tons between Monterrey and Mexico City.[47] An intermodal facility is in operation in Querétaro, connecting Federal Highway 57 motor carrier traffic with FNM rail traffic.

The Gulf Corridor

The Gulf Corridor links the Mexican border city of Matamoros with Mexico City. Federal Highway 180 links Matamoros with the port city of Veracruz. In Veracruz, Federal Highway 150 links with Mexico City. There is no rail linkage between Matamoros and Veracruz. FNM operates a rail line which is authorized to carry 120 metric tons per four-axle rail car between Veracruz and Mexico City.[48]

The Gulf Corridor is the least significant corridor of the four in terms of total tonnage and the dollar value of imports and exports to and from the United States. Recently, however, the Mexican government has expressed interest in developing the transportation infrastructure in the Gulf region. A new highway is being built connecting Mexico City to Pachuca to Tuxpan. This highway may make it more cost effective for some companies to move commodities from central Mexico by sea to Gulf ports in the United States, rather than relying on the traditional central highways and rail lines.[49]

Mexico City's Link to Central America

An intermodal facility is operated in Mexico City by FNM at the convergence of all four of the transportation corridors. This facility, known as Pantaco, is operated in a heavily congested area. Most of the freight off-loaded from rail cars at this facility is transported by truck within a 100-mile radius of Mexico City. Most of the commodities loaded at this facility are done on "team tracks," or public unloading-loading ramps.[50] Mexico City, therefore, represents the major traffic and trade hub in Mexico. In this sense, it not only is important to U.S.-Mexico trade, but is extremely important to Mexico's trade (and to some extent U.S. trade) with Central America.

There is a transportation corridor that links Mexico City with Central America. The main Federal Highway in this corridor is 190. A FNM rail line follows this corridor, but does not link with Guatemala because the two countries have different rail gauges. Commodities that are transported out of Mexico City to Central America must be off-loaded at Ciudad Hidalgo, on the Mexico-Guatemala border, and transported by motor carrier into Central America.[51]

Major Port Facilities in Mexico

Mexico's major ports - Veracruz, Tampico-Altamira, Manzanillo and Lazaro Cardenas - are connected to Mexico's transportation corridors by rail lines and federal highways. The Port of Veracruz, Mexico's oldest and most important seaport, facilitates the transportation of most of Mexico's seaborne agricultural and industrial products, accounting for 23.8 percent of Mexico's seaborne cargo.[52] The Port of Veracruz is linked to Mexico City by Federal Highway 150 and a rail line that is authorized to carry up to 120 metric tons per four-axle rail car.[53]

The ports of Tampico and Altamira are connected to the Gulf Corridor by Federal Highway 180. These two facilities handle 19.7 percent of Mexico's seaborne cargo and are connected to the Port of Manzanillo by a specialized rail link.[54] A rail line, authorized to carry up to 120 metric tons per four-axle rail car, connects Altamira with the Gulf Corridor and again with the Central Corridor at San Luis Potosí.[55]

The Pacific Port of Manzanillo is connected by Federal Highway 80 to the Pacific Corridor in Guadalajara. This facility handles 10.6 percent of Mexican seaborne cargo and has the potential for trade with the Pacific Rim, as well as the United States and Canada.[56] A rail line, authorized to carry up to 120 metric tons per four-axle rail car, connects Manzanillo with Guadalajara.[57] The Port of Lazaro Cardenas is connected to the Gulf Corridor by Federal Highway 37. This facility is the most important port on the Pacific, handling 14.1 percent of Mexico's seaborne cargo.[58] A rail line, authorized to carry up to 120 metric tons per four-axle rail car connects Lazaro Cardenas with the Pacific Corridor rail line in Penjamo.[59]

Table 2.6
Land Connections at Major Mexican Ports

Port	Destination	By Road	By Rail
Veracruz	Mexico City	443 km	419 km
Altamira	Monterrey	564 km	517 km
	Nuevo Leon	793 km	785 km
	Mexico City	576 km	1014 km
Manzanillo	Guadalajara	313 km	355 km
	Mexico City	804 km	1114 km
Lazaro Cardenas	Mexico City	688 km	799 km

Source: Puertos Mexicanos, Investment Opportunities in Container Terminals, March 14, 1994.

Planned Infrastructure Improvements in Mexico

Mexico has been addressing the pressing needs to improve its border facilities, roadways rail lines, seaports, and airports. The Mexican government has made an effort to encourage private-sector investment in infrastructure projects. Through its new investment law, U.S. and other foreign businesses are allowed to invest in rail services, warehousing operations, and various maritime activities, including port administration concessions. This next section provides a brief overview of infrastructure as it now exists in Mexico, and describes some of Mexico's plans for infrastructure investment.

Highways and Toll Roads

From 1989 to February 1994, almost 4,100 kilometers of new four-lane highways were constructed in Mexico, with 1,800 additional kilometers scheduled to be completed. Seven new national and international bridges are also expected to be constructed over the next few years. Almost 90 percent of the construction costs of these roads, highways, and bridges (an estimated US$15 billion) was provided by the private sector. Through the Secretariat of Communications and Transportation (Secretaría de Comunicaciones y Transportes, or SCT), the Mexican government has granted private investors the right to construct, operate, and maintain toll-highways. The SCT provides the specifications and construction requirements, supervises the construction process, and assists the private sector in operation and maintenance.[60] The private sector also has become more involved in the operation and maintenance of the federal highway network, investing an estimated US$300 million in 1992, and US$500 million in 1993.[61]

According to a report released in 1994 by the former Undersecretary of Infrastructure at the SCT, Dr. Rogelio Gasca Neri, Mexico plans to build approximately 6,000 kilometers of new highways between 1995 and 2000, requiring an estimated investment of US$15 billion. The Mexican government intends to award concessions to the private sector for a large portion of this development and investment. It is the opinion of SCT that, while the design of new highways should remain a government responsibility, the private sector could better perform the engineering design tasks and construction.[62]

SCT also believes that investments of approximately US$700 million will be needed over the next 15 years to upgrade and maintain the federal highway network, with a significant portion of these costs to be spread throughout the public and private sectors.

According to the Programa Nacionál de Autopistas, 1989-1994, the Mexican government has estimated that Mexico will need more than 16,000 kilometers of highways by the year 2000. Land transportation already accounts for 60 percent of the total tonnage of cargo shipped within Mexico, and this percentage is projected to increase as Mexico's economy continues to develop; there will be a definite need for more and better roads and bridges in the future. The Mexican government decided to incorporate private financing into its transportation plans through a series of long-term concessions to private companies which have built and operated toll roads and bridges.[63]

During the Salinas Administration, the number of concessions granted for toll roads and bridges increased dramatically. In the two years prior to President Salinas, only four concessions were granted for 304 kilometers of highway. As of October 1994, the Salinas Administration had issued 48 concessions for highways and bridges (representing 5,093 kilometers of new roads) at a cost of US$12.5 billion. The vast majority of the concessions are for 20 years or more. At the end of the concessionary period, the toll roads will be turned over to the government.[64] Mexico has advanced its toll road development at an incredible pace. In just six years, Mexico has built five times as many kilometers of toll roads as it had in the previous 40 years combined.

In addition to private toll roads, the government has also constructed 732 kilometers of free federal highways, 272 kilometers of state-owned toll roads, 68 kilometers of free state highways, and 96 kilometers of other federal highways in the past few years. All of these highways consist of four or more lanes.[65] In total, the Mexican highway program has directly employed more than 270,000 workers, not including technical and professional personnel.[66]

Despite these achievements, the privatization program has been under fire. Faced with short concession periods (some originally under ten years) in which to recoup their investments, toll-road operators charged some of the most expensive tolls in the world - an average of 18 cents per kilometer, second only to Japan at 20.5 cents per kilometer. As a result, very few Mexican toll roads are generating much traffic. The situation grew into a financial crisis betwen 1992 and 1993, when banks and contruction companies desperately sought to renegotiate the terms of their concessions with the government.

Beginning in 1993, the SCT extended concession lengths on major projects, supposedly to enable a lowering of tolls. For example, the Cuernavaca-Acapulco roadway concession was extended from 14 to 30 years, and the Mazatlán-Culiacán roadway concession was extended from 17 to 30 years. Even so, tolls remain at extraordinarily high rates and traffic levels are far below those needed to generate revenues that are sufficient to cover costs.[67]

Railways

Limited investment has been made in Mexico's rail system over the past 40 years. However, Mexico's economic expansion, combined with the cost effectiveness of rail for shipping goods over long distances, has made investment in rail infrastructure an important part of Mexico's infrastructure development plan. According to a report by the SCT, over 50 percent of rail shipments in Mexico move along three rail routes which represent only 9 percent of the entire Mexican rail network: Mexico City-Veracruz; Mexico City-Nuevo Laredo; and Querétaro-Guadalajara-Manzanillo. While improvement is still needed on these rail routes, they have received much of the previous investment designated for rail infrastructure. Other rail corridors in Mexico, therefore, have suffered from lack of attention. It is SCT's opinion that, by concentrating investment in the other 91 percent of Mexico's rail routes, the rail system could dramatically increase its system-wide cargo handling ability. As a result, Mexican rail lines could increase cost effectiveness by moving a wider variety of goods to a wider variety of places.[68]

The Mexican government is planning to privatize parts of FNM and allow investment by the private sector. The privatization of FNM will grant up to 50-year concessions to private investors, but will hold the percentage of foreign ownership below 50 percent. Mexican officials expect that the plan will be a major step in improving the U.S.-Mexico transportation system. Because FNM has been slow to modernize, the Mexican government hopes that private ownership of the railroad will increase its current share of U.S.-Mexico traffic.[69]

The privatization of FNM is expected to result in the separation of the railroad into two or more pieces. The rail corridor between Nuevo Laredo and Mexico City is of special interest to potential investors, as it is FNM's most profitable rail section, and also one of the most modern tracks in the country.[70] U.S. rail executives expect the private concessions to also include the rail lines operating in the Pacific, Chihuahua, and Central Corridors, and possibly a private railroad operating in the Mexico City metropolitan area.[71] FNM has solicited input for their privatization efforts from the four principal U.S. rail companies: UP, SP, BN, and ATSF.[72]

As mentioned in the previous section, the Mexican rail system has been experiencing a steady decline in market share with respect to the volume of freight it hauls. This is presumed to have been caused by poor service quality, noncompetitive pricing, and poorly maintained track and equipment.[73] To reverse this trend, FNM has encouraged the private sector to help improve and maintain about 800 kilometers of track throughout Mexico. FNM has also relied upon private-sector financing to service several intermodal cargo facilities in order to expand container handling capacity. Private investors are also now allowed to lease and maintain certain kinds of equipment and telecommunications systems used by the railway.

FNM estimates that investments, totaling almost US$2.3 billion, will be necessary to modernize the rail network over the next five years, and anticipates almost 50 percent of these investments will come from the private sector. However, private-sector investment remains restricted. For example, investors may participate in marketing cargo and passenger services, and also in the construction and operation of intermodal cargo terminals. Private-sector investors may also lease locomotives from FNM, provide maintenance and support, and aid in the development of traffic control systems.[74]

In December 1993, a consortium, comprised of three foreign groups and three Mexican firms, committed to making investments in locomotive and railcar maintenance projects and repair centers totaling more than US$102.1 million. Each pair of firms is responsible for three separate regions within the country. Two of the foreign firms are from the United States (Morrison Knudsen Corporation and VMV). The other foreign firm, GEG Alsthom, is a Spanish subsidiary of the French energy and transportation group of the same name.[75] Shippers into and within Mexico will eventually expect to pay lower rates and experience increased service as a result of the private participation.[76] This increased service capacity may result in wider geographical coverage and will require Mexico to further develop its intermodal transportation capacity and services, as well as its logistics management capabilities.

Without private investment, however, FNM has attempted to focus on improving those sections of rail which account for most of Mexico's rail shipments, with emphasis on the construction of effective inland cargo and intermodal facilities. As mentioned previously, intermodal facilities currently exist in the three largest Mexican cities - Monterrey, Guadalajara and Mexico City - with another intermodal facility under construction in Celaya, Guanajuato.[77] All of these facilities are operated by FNM.

Lastly, FNM spent approximately US$10.3 million in 1994 to expand Mexico's largest intermodal facility, Pantaco, which is located in Mexico City. The expansion will allow the facility to handle a much higher volume of double-stack container trains by moving nonintermodal activities, which take up about half of the facility, to a nearby area. Investments are expected to be made in new cranes, yard equipment, and chassis. This effort follows FNM's securing governmental permission to allow UP to move TOFC's inbound to Pantaco and thus bypass delays at the border in Laredo.[78]

Airports

In the area of air transport, Mexico has begun to make large investments in infrastructure.[79] In October 1993, the state-run agency for airports, Airport and Support Services (Aeropuertos y Servicios Auxiliares, or ASA), announced plans to spend US$68.6 million for expansion, maintenance, and repair of Mexico's busiest air terminals. The Deputy Director of ASA, Jorge de la Madrid Virgen, said these funds will be provided to airports in Cancún, Puerto Vallarta, Tijuana, Guadalajara, Monterrey, and Mexico City. Of the total funds, approximately US$44 million will be allocated for construction projects such as the lengthening of runways and the expansion of airplane parking areas, while another US$25 million will be used for maintenance and conservation purposes.

Because of high passenger and cargo traffic in the largest cities, new airports have been proposed for Guadalajara (Jalisco) and for Linares (Nuevo León). In Guadalajara, city authorities have petitioned the SCT to allow construction of a new facility to replace the Miguel Hidalgo Airport. According to Francisco Martinez, President of the Tourism Development Council in Guadalajara, the current airport is overcrowded and located in an area where industrial pollution and fog combine to reduce visibility.[80]

Conclusion

As we described in the beginning of this chapter, most every firm, unless it is located adjacent to both its raw materials and its market, will need to transport its product from one point to another. In doing so, firms must make a variety of important decisions regarding how to transport these goods in an efficient and cost-effective manner. These decisions usually take into account the type of commodity being shipped, where it needs to go, what the preferred mode of transportation will be, how much the use of this preferred mode of transportation will cost, and how efficient this mode of transportation is when compared to other modes.

Often, the efficiency and cost of a particular mode of transportation is greatly affected by a variety of factors, the most important of which appear to be the existence of transportation corridors and the infrastructure in place along these corridors which facilitates the movement of commodities from their origin to their destination. The development and maintenance of this physical infrastructure - whether it is infrastructure designed to facilitate overland trade, such as roadways and rail lines, or facilitate trade over sea and by air, such as seaport facilities and aviation terminals - is of great importance to the continued smooth operation of trade, particularly trade which occurs over great distances or over international borders.

The existence or absence of bilateral trade with Mexico is, then, a direct consequence of the interaction of the nature and quantity of the commodities that move across the border, the origin and destination of these commodities, and the infrastructure presently in place to facilitate the movement of these commodities. In the next chapter, we will explore the fourth component of this trade equation which is the existence and level of development of a technological infrastructure designed to support the physical infrastructure. This technological infrastructure is a central component of logistics management: the art and science of moving goods and people over space and time.

Notes

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Chapter 3. Evolution of Logistics Practices and Multimodal Partnerships in the United States and Mexico

Introduction

In the previous chapter, we closely examined trade patterns and flows between the United States and Mexico. We concluded that one of the most important factors in trade between the two nations is the existence, continued development, and maintenance of a physical infrastructure designed to allow efficient and smooth trade flows. This chapter will examine the pattern and process of U.S.-Mexico trade from the viewpoint of technological infrastructure which, in great part, comprises the systems that facilitate logistics management and practices. Logistics is important to trade because it expedites and simplifies a firm's ability to move its product(s) from origin to destination, and makes a variety of other production and distribution-related tasks much simpler and more efficient, such as warehousing, inventory management, and customer service.

Increasing levels of competition in an expanding world market are forcing firms to reduce their costs and streamline production and distribution practices. Success depends on the ability to efficiently deliver products at the right time, to the right place, and in the proper condition. To meet these new demands on firms and the shipping services they use, the processes of production and distribution are changing as well. These changes include increased use of flexible production and manufacturing strategies, such as Just-In-Time (JIT) production and delivery, the trend toward partnerships and joint ventures designed to create seamless distribution and transportation networks, the use of advanced information exchange and tracking technologies, efforts at economic deregulation, and the increased use of logistics management techniques (either in-house or outside contractors). As a consequence of these shifts in industry operating standards and practices, patterns of shipment volume, shipment size, frequency of shipments, and other characteristics of freight transport are also changing.[1]

In order to respond quickly and with flexibility to these changing demands on production and distribution, firms are taking advantage of "new" or "advanced" logistics management practices. Advanced logistics is the activity of synchronizing the activities of multiple actors in the logistics chain and feeding back necessary information to actors in the production and physical distribution sectors by fully utilizing information technology and digital communication networks.[2] The transportation function, linked by information technology to the production function, then becomes an integral part of the manufacturing process, allowing firms to respond quickly to changes in customer demand. As transportation services become more important to a firm's productivity and competitiveness, firms are increasingly required to reevaluate transportation alternatives and, in some cases, take a variety of innovative steps in the shipment of their goods. For U.S. firms that transport goods into Mexico, the existence of viable and cost-effective transportation alternatives represents an important issue.

Changes in logistics management practices are taking place within an atmosphere of global competition, a changing regulatory environment, technological innovation, and more flexible forms of manufacturing. This chapter serves as a framework for exploring the development of new logistics and shipping practices within the context of U.S.-Mexico trade. After taking a brief look at the components of physical distribution (production and order processing, inventory management, warehousing, and transportation), this chapter examines some of the forces that are presently causing changes in the practice of logistics management, such as the increased use of flexible manufacturing strategies and production methods, the increased application of advanced information technologies, the effect of intermodalism and transportation deregulation, and the increased use of third-party logistics providers, otherwise known as outsourcing. By describing the dimensions of current trends in logistics and transportation partnerships in both the United States and Mexico, the chapter also provides a reference for the more detailed examination of these trends in subsequent case studies. These case studies provide current examples of joint ventures and partnerships between U.S. and Mexican transportation firms to facilitate cross-border trade, encourage multimodalism, and increase the use of logistics management techniques and related technologies.

Physical Distribution and Logistics Management

Although systems of physical distribution and logistics have changed substantially in recent years, the basic nature of physical distribution has remained the same.[3] The tasks involved in physical distribution involve the movement, storage, and handling of goods for various segments of a firm's production process and, eventually, to a firm's customers. Physical distribution also entails the planning and control of the flow of production materials and finished goods from the points of origin to the points of utilization. The main elements of physical distribution are production, order processing, transportation, warehousing, inventory management, and customer service. In general, the costs to a firm of the various elements of physical distribution are quite high. Of all the facets of the distribution function the most expensive (as a percentage of total distribution costs) is transportation, followed by inventory, warehousing, and order processing. Large cost savings can be realized in these areas, however, through the application of advanced logistics management practices and technologies.

The objective of a logistics management system is to maximize customer service while minimizing distribution costs. No logistics system can both maximize and minimize these two factors, but the design of a physical distribution system should attempt to achieve a balance between these objectives. Because logistics costs and services involve tradeoffs, decisions must be made by each individual firm regarding the benefit accrued by their logistics systems as compared to the cost of these systems to the firm. These cost-benefit criteria are especially important to Mexican firms seeking to do business in the United States because start-up costs are high and the learning curve is long but the payoffs may indeed be large.

Production and Order Processing

More flexible styles of manufacturing have made production a more complex activity intimately linked to transportation. The ability of a company to deliver made-to-order goods in the required amount, at the right time, and to the right place, is becoming a crucial factor in a firm's profitability and competitiveness. Greater flexibility in production and manufacturing, however, demands that a firm's supply of parts and raw materials also be flexible, thus making the order processing, transportation, and inventory/warehousing aspects of distribution crucial.[4]

After production, physical distribution actually begins with order processing; firms must decide how to handle customer orders quickly and accurately. Briefly, an order-shipping-billing cycle is established, to which a number of firm activities may also be peripherally linked, such as invoicing, back ordering, tracking, inventory control, warehousing, and production ordering. This web of interrelated functions illustrates the central role logistics management plays in production, but, even more importantly, the central role that technology plays within the firm. In this sense, the level of technological advancement a firm possesses is directly related to its ability to continue to be competitive and respond to both market and customer needs. With respect to Mexican firms, the level of technological advancement correlates strongly with the future ability to enter the U.S. market or conduct cross-border joint ventures with U.S. firms. Our case studies explore in more detail how Mexican firms are or are not dealing with these pressures.

Inventory Management

Firms carry inventory for a variety of reasons. They may, for example, store spare machines and/or parts for those machines. They may store the raw materials they need for production. They may store goods awaiting sale. Inventory levels involve a variety of trade-offs, usually involving the cost of storage (or warehousing) versus the cost of production down time (due to broken machines with no spare parts or a shortage of raw materials) or the cost of customer dissatisfaction. Ideally, a firm would prefer to never have its machinery in disrepair or experience material shortages, and certainly would like to be able to fill every customer order immediately. To do all these things, however, a firm would require huge on-hand inventories of a variety of products and materials. Storage space is quite expensive, and holding items in inventory increases the risk of their loss through obsolescence, theft, or damage. In addition, inventory represents capital tied up in stock. A firm, when deciding when and how much to order of a certain material or good, must take these costs into consideration.

Important trade-offs also exist between transportation costs and inventory carrying costs. Logistics has been described as the art and science of moving items over time and space. Transportation costs represent the costs of moving items over space, and inventory expenses have been described as the costs of keeping/moving items over time.[5] The shift away from maintaining large inventories has required the movement of smaller shipments on a more frequent basis. Savings in transportation costs, then, generally result in higher inventory costs and vice versa.

Problems in inventory control (such as tracking) created by the storage and more frequent movement of smaller shipments have been given greater attention in recent years and have resulted in improved inventory management practices and increased use of information management and transfer technologies.[6] For example, the use of electronic point-of-sale terminals in many retail outlets has allowed companies to utilize real-time information on sales to monitor and adjust their inventory levels. With more accurate sales information, retailers can then cut costs by reducing in-store inventories. However, this benefit inevitably pressures suppliers and manufacturers to adjust their practices to make more frequent and smaller deliveries.

Warehousing

Because production and consumption cycles are not synchronous, firms must store goods to await sale. Storage warehouses and distribution centers often function as way-stations for goods between the production and delivery phases of the physical distribution chain. The costs involved in maintaining goods in storage and distribution facilities must be balanced against the desired level of customer service, that is, the ability to move products as quickly as demand requires. Advances in automated warehousing equipment, technology, and computerization have improved the efficiency of warehousing and distribution facilities in recent years. Firms are also reexamining their storage and distribution systems as improved efficiencies in transportation and communications change the way inventory decisions are made.

Old-style warehouses, with an emphasis on long-term storage in multiple facilities, are becoming a thing of the past. Major changes in the way products move from manufacturer to retailer, and the changing identity of the warehouse itself, have caused warehouse volumes overall to decrease steadily over the past few years. Many warehouses, for example, are evolving into cross-dock centers, where products come in one door and almost immediately go out another. This change is indicative of the trend toward more flexible manufacturing and distribution strategies, where the traditional warehouse becomes a shipper's last resort. New-style warehouses can move a larger number of smaller-sized orders more quickly, placing new demands on efficiency and also requiring additional labor and larger facilities. Flexible manufacturing strategies also require closer and more detailed monitoring of production and distribution levels to manage faster and more complex product movements between transportation modes.[7]

The faster a product moves, the more difficult it becomes to track. As a result, new methods and systems to aid in the identification, distribution, and tracking of products are being developed and implemented in warehouses. Such technology allows for lower inventory levels and faster order-cycle times. According to one third-party distribution provider, "warehouses that don't have radio frequency and bar code capabilities in five years will be dinosaurs."[8] Mike Jenkins, president of the American Warehouse Association (AWA), predicts that most warehouses in the public and contract industry will need to be automated in the areas of inventory management systems, locator systems, and electronic interface systems which allow for real-time contact between the customer (shipper), the warehouse, and the carrier.[9] Automation for information and product handling can offer a less expensive cost-cutting option to million-dollar mechanical systems. In our case study of Almacenes Nacionales de Depósito, S.A. de C.V. (ANDSA), the largest Mexican warehousing company, we examine how the Mexican warehousing industry is attempting to develop, integrate, and manage the new technological and infrastructural requirements of modern-day warehousing.

The trend toward large, centralized storage points serving expansive geographic areas in which large retail outlets are supplied has created a need for fast and reliable transportation systems to and from these central points. In this manner, economies of scale can be achieved by multiple firms' sharing of distribution locations, warehousing space, and various technological systems for order processing and tracking.[10] This is the basis for the hub-and-spoke distribution system.

With the passage of the North American Free Trade Agreement (NAFTA), finding the proper location for a hub-and-spoke transportation and warehousing system has become more important. Companies must look not only to the north, east and west to determine the proper geographic location for their distribution centers, but also to the south in consideration of proximity to the Mexican market.[11] Due to its advantageous geographic location, Texas in general, and the Dallas-Fort Worth (DFW) Metroplex in particular, are poised to become the center of North American distribution. Until recently, however, intrastate trucking regulations and high intrastate trucking rates restricted the development of the DFW Metroplex into a distribution center, despite its geographic advantages.

On January 1, 1995, the federal Trucking Industry Regulatory Reform Act deregulated intrastate trucking nationwide. According to Clifford F. Lynch, president of Clifford F. Lynch & Associates, a Dallas logistics management firm, "with intrastate deregulation a reality, logistics planners are discovering that, geographically, the [DFW] Metroplex is at the center of North American distribution." In fact, of an estimated 615 million square feet of private and public warehousing space in Texas, the DFW area already leads the state with 275 million square feet of warehousing space, followed by Houston with 225 million square feet. San Antonio and El Paso follow at a distant third and fourth with 55 million and 25 million square feet of warehousing space, respectively.[12] This has interesting implications for the state of Texas regarding the extent to which it has the potential to become the nexus of U.S.-Mexican trade.

Many larger firms for which the ease of distribution is of paramount importance have relocated to Texas. Nabisco, Inc. has announced its intention to relocate its Memphis, Tennessee distribution center to DFW to take advantage of its geographic location and the recent intrastate trucking reform. The company is moving into a 160,000-square-foot warehouse facility operated by Exel Logistics North America in Arlington, Texas. Exel's complex encompasses more than 450,000 square feet of space in five buildings. Federal Express decided in December 1994 to locate its newest hub at Alliance Airport, located north of Fort Worth. Alliance Development Corporation's 1,110-acre industrial center, which includes Alliance Airport, already has 1.1 million square feet of warehouse space and all but 39,000 square feet is leased. Ridell Athletic moved from Houston to Alliance Airport in DFW Metroplex in September 1994, to take advantage of Alliance's foreign trade zone and the 575-acre intermodal yard operated by The Atchison, Topeka and Santa Fe Railway Company (ATSF).[13]

As more firms which trade with Mexico relocate into Texas, Texas' physical transportation infrastructure, especially that which is located along the transportation corridors which handle most of the trade flows into Mexico, may indeed be taxed to its limit. In addition, Texas firms will begin to realize the importance, practicality, and perhaps the necessity, of entering into joint ventures and partnerships with Mexican firms to provide transportation, technology, and other logistics-related services designed to make cross-border trade more efficient and cost effective.

Because the size of warehouses has grown steadily, the contracting out of the physical distribution function, as well as a variety of other logistics functions, has also become more common. Products previously housed in the shippers' own distribution centers or retail outlets are now being consolidated in larger warehouses set up by outside contractors, many of whom also perform transportation functions.[14] We will discuss this outsourcing activity in a later section of this chapter.

Transportation and Modal Choice

As previously discussed, transportation is fast becoming one of the most central components of a physical distribution system, affecting the pricing of products, delivery performance, and the condition of shipped goods, all of which have an impact on customer satisfaction. Decisions regarding modes of transportation are therefore quite important to a firm's bottom line, and most often revolve around issues of cost, speed, reliability, availability, and compatibility with the needs of the firm.

Rail is one of the most cost-effective modes for shipping large volumes of bulk products and is the nation's largest carrier by volume. Recent innovations in containerization and intermodal technologies have expanded the type of products that can be shipped by rail and have increased the number of successful joint ventures between railroad and trucking firms. In fact, containerization has allowed shippers to combine various modes of transportation in the movement of products over long distances and allow modal changes to be cost effective. Three major rail carriers with direct overland connections to Mexican National Railway (Ferrocarriles Nacionales de Mexico, or FNM) lines experienced increases in their traffic flows into Mexico in the first half of 1994.[15]

Trucks have also steadily increased their share of the overall transportation market since deregulation. The flexibility in routing and scheduling offered by truck transportation makes trucks competitive with all other modes in terms of both cost and speed. Truck transportation accounts for the largest portion of intracity transportation, owing to the ability to ship door-to-door. Water transportation is a low-cost alternative for shipping bulky, low-value, non-perishable products. It is the slowest mode of transportation and is the most prone to interference from poor weather. This mode is both an intermodal link with rail and a competitor for north-south flow of goods between the United States and Mexico. Business innovations and infrastructure development on both sides of the border are currently taking place in the maritime industry.

In contrast to water transportation, air transport is the fastest and most expensive mode of transportation, and accounts for the smallest portion of total cargo shipped. High-value, low-bulk, and perishable products are among the most frequent air-freight items. The ability to reach distant markets very quickly sets air transportation apart from other modes. Air freight has grown quite rapidly in recent years as firms have sought to reduce inventory levels, warehouse numbers, and packaging costs. Table 3.1 illustrates the comparative advantages of each mode.

Table 3.1
Transportation Mode Advantages

ECONOMIC CHARACTERISTICS	Motor	Rail	Air	Water
Cost	moderate	low	high	low
Market Coverage	point-to-point	terminal-to-terminal	terminal-to-terminal	terminal-to-terminal
Competitors	many	moderate	moderate	few
Predominant Traffic	all	low/moderate value, moderate/high density	high value, low/moderate density	low value, high density
Average Length of Haul	515 miles	617 miles	885 miles	376 - 1,367 miles
Equipment Capacity (tons)	10 - 25	50 - 12,000	5 - 125	1,000 - 60,000
SERVICE CHARACTERISTICS				
Speed	moderate	slow	fast	slow
Availability	high	moderate	moderate	low
Consistency (delivery time)	high	moderate	high	low-moderate
Loss and Damage	low	moderate-high	low	low-moderate
Flexibility (to shipper's needs)	high	moderate	low-moderate	low

Source: Douglas M. Lambert and James R. Stock, *Strategic Logistics Management*, 3rd ed. (Homewood, Illinois: Irwin, 1993), p. 175.

Deregulation of the transportation industry, beginning in the late 1970s, caused rapid and substantial changes in the services provided by carriers to their customers. More flexible service, containerization, and increasing use of intermodal shipping practices have offered shippers new opportunities for savings but have also meant new challenges to traditional transportation planning and practices, and by extension, to logistics management systems. Shippers must consider a number of criteria concerning mode of transportation (cost, speed, availability, reliability, and compatibility), as well as a variety of physical distribution components (inventory, warehousing, order processing, and customer service) in order to design a logistics system that is efficient and effective in accomplishing the movement of goods over time and space. Physical distribution is an area of potentially high-cost savings and improved customer satisfaction when decisions are made within a unified logistical framework.

Transport Alliances

As logistics management has developed, shipping firms have formed strategic alliances combining modes of transportation to improve their competitive position in rapidly evolving markets. In an effort to both streamline physical distribution and compete effectively in the long-haul freight market, several railroad and trucking firms have formed strategic alliances. These rail/truckload alliances offer major potential advantages for rail carriers. First, truckload carriers tend to have highly developed marketing and sales forces with better training programs, and better shipper access than rail. Second, truckload carriers have a proven systems and management focus on over-the-road (OTR) trucking to maximize usage of trailers (and containers) which should be transferable to intermodal service. Third, at its most efficient, double-stack intermodal service offers lower line-haul costs than longer combination vehicles (LCV) on long-haul trips.

These alliances also offer advantages for truckload carriers. In addition to providing drivers more predictable work schedules and more time at home, thus improving morale and job satisfaction, the partnerships also enable truckload carriers to penetrate new markets serviced by rail with minimal investment and risk. Finally, both rail and truck firms benefit because they offer shippers a diverse menu of transportation options.[16]

In 1990, J.B. Hunt initiated one of the first large-scale intermodal rail-truckload partnerships with ATSF. This venture, initially known as Quantum, became so successful in its first few months that J.B. Hunt integrated the intermodal service into its core service options. Other truckload and rail carriers soon formed their own strategic alliances. By the end of 1992, at least six major rail/truckload partnership initiatives had become operational. Table 3.2 summarizes the principal features in the six major alliances. In general, marketing, sales, and pricing are controlled by the trucking firm. In none of the alliances does the railroad have significant contact with the shipper. In fact, in most cases, the trucking firm provides the trailers or containers. In the end, these alliances rely more heavily on the truck carrier to provide the customers and the railroad contracts for the rail portion of the service. Thus, the trucking firm, not the railroad, assumes most of the risk associated with the project and reaps most of the rewards.[17]

Table 3.2
Rail/Truckload Alliances

	J.B. Hunt/ATSF Quantum	Hunt/BN SP-UP-FEC	Schneider National/SP	KLLM/ATSF	Conquest
Marketing/Sales	Trucker	Trucker	Trucker	Trucker	Trucker
Pricing/Line Haul	Partnership	Contract	Contract	Contract	Contract
Pricing/Door-to-Door	Trucker	Trucker	Trucker	Trucker	Trucker
Equipment Type	Trailers	Trailers	Container	Reefers	Container
Equipment Supplier	Trucker	Trucker	Railroad	Trucker	Trucker
Train Type	Existing	Existing	New Dedicated	Existing	Existing

Source: Dan Smith, "Mercer Management Study of Rail/Truckload Initiatives Part II: Evolution of Partnerships," *Intermodal Trends,* Volume IV, Number 14, October 9, 1992.

Driving Forces Behind Changes in Logistics Management

Changes taking place in the global economy, industrial practices, technology, and public policy are all bringing forces to bear on the structure and function of logistics systems.[18] These forces will continue to place new demands on the freight transportation sector. As mentioned previously, they will also generate a variety of changes in the operation of industry in general, including increased use of flexible manufacturing strategies and production methods, the use of partnerships and joint ventures to reduce operating costs, the more pervasive use of advanced information technologies, the increasing levels of intermodalism to achieve seamless transportation networks, the deregulation of the transportation industry, and the outsourcing of transportation and logistics management functions.

The recent attention paid to logistics management and its related technologies is the result of the need for companies to implement new and innovative practices in order to remain competitive, and the ability of advanced logistics to answer that need. In a world where consumers are shifting between suppliers and product lines with much greater frequency, the businesses which can anticipate and adjust to such changes quickly have the advantage over their competitors. Companies are looking to logistics for ways to offset this kind of profit margin erosion.[19] Customers are likely to want more frequent shipments of goods, in smaller lot sizes, and with greater mixtures of commodities in each shipment. This is likely to mean greater use of containerization for domestic as well as international movements, and transportation providers need to be prepared to respond to that need.[20]

Industry Practices

Manufacturing processes become more decentralized as firms draw on labor and material resources from an ever-widening geographic area. Combined with flexible production strategies emphasizing smaller production facilities, shorter product life cycles, and niche marketing, decentralization requires significant adjustments to be made in logistics systems and services and how they are used by different kinds of firms. Often, rather than make these adjustments from within the firm, many companies are contracting out those services which require advanced logistics technology and expertise. These services often include some aspects of production and assembly, transportation, order processing, data management, tracking and various aspects of customer service. The act of subcontracting these activities, however, increases the demands placed on technological and transportation arrangements/partnerships and their accurate coordination with the production and distribution cycles remaining within the firm. The firm's logistics manager will often perform this liaison function.

The trend toward long-term cooperative relationships between shippers and carriers, as well as between producers and customers, will require logistics managers to work in close proximity with business partners and logistics partners in order to tailor specific services to the needs of the partnership and to the customer base it serves. To maintain precise coordination between and among such a wide variety of participants, almost instantaneous communication of information to production and warehousing facilities, as well as to transportation providers and data processors, will be required.[21] Since three of the most important goals for transportation operations are coordination, responsiveness, and resource utilization, reaching these goals in the current business atmosphere will only be possible where companies quickly and effectively apply recent innovations in the area of information exchange technologies.[22]

Information Technologies

A variety of cost-saving opportunities accrue via improvements in computer networking and distribution database management. The use of advanced information technologies has been key to the expansion in intermodalism in recent years. Reliance on computers and electronic data communication is anticipated to increase significantly in the near future as transportation services increase in complexity. Electronic data interchange (EDI) and Automatic Equipment Identification (AEI) are two currently functioning technologies that will change the way that the transportation business is conducted. Table 3.3 provides examples of these and other innovations.

Briefly, EDI facilitates the interchange of business data between computers, even where incompatible software and hardware systems are involved. EDI can link systems that are separated by very long distances. Its ability to transfer information to all parties simultaneously in standardized formats make it a powerful management tool which can eliminate paperwork.[23] Customer pressure for all aspects of EDI, from order entry to shipment tracing to billing, is on the rise. Attractive EDI capabilities include computerized traffic control and electronic status check programs, such as electronic bar coding which allows every item to be instantly checked for quantity, location, and pickup status.[24] AEI involves the use of Radio Frequency Identification (RFID) technology to track vehicle and container movement out on the roadway or railway. Stationary readers located at key points can pick up the signal of a passing piece of equipment fitted with an electronic tag. The tag identifies the equipment to the reader, which then relays the information to the central database. In this way, periodic updates on equipment location and progress can be accessed by the home office. An entire fleet or container stock could conceivably be tracked to aid in the efficient management of the system for money savings, time savings, and improved efficiency.[25]

Table 3.3
Innovations in Logistics and Information Technology

INNOVATION	FUNCTION	USES
Automatic Equipment Identification (AEI)	*Transmit vehicle information* (Identification, size and weight, Vehicle type/class, automatic toll collection)	Traffic counting and vehicle classification, comply with regulatory requirements
Bar Coding	*Provide product and packing information* (identification, size and weight, origin and destination)	Sales and inventory, verify shipments and check status
Electronic Data Interchange (EDI)	*Transmit business data and provide electronic documents* (purchase order, bill of lading, packing slip, invoice, electronic funds transfer)	Electronic ordering and billing, verify pick-up and delivery
In-vehicle Navigation Systems	*Provide driver information* (highway and traffic conditions, location of vehicle, destination, alternate routes, automatic vehicle spacing, blind spot warning, crash avoidance)	Identify most direct route, avoid road hazards especially during bad weather, avoid congestion and delay
On-board Computer Information	*Monitor vehicle and driver* (vehicle speed, engine r.p.m., idle time, oil pressure/temperature, stop time, distance, driver braking habits)	Decide when maintenance is necessary, diagnose/prevent major breakdowns, evaluate driver performance
Two-way Communication System	*Exchange messages between driver and dispatcher* (trip and shipment information, location of vehicle, repair shops, lodging)	Manage logistics while in transit, arrange repairs, respond to emergencies

Source: Organization for Economic Cooperation and Development (OECD), Road Transport Research, *Advanced Logistics and Road Freight Transport* (Paris, 1992), p. 112.

With the cost of information decreasing relative to the costs of vehicles, labor, and fuel, electronic data systems will have a significant part to play in the improvement of logistics operations.[26] The fact that these technologies have demonstrated that they can enhance the quality and efficiency of logistics operations by aiding in the quest for the elimination of defects, reduction of delays, minimization of inventory, and reduction of red tape is certainly one of the reasons the transportation industry is seeking to develop advanced information and telecommunications systems.[27] In this emerging high-tech world, transportation providers who want to remain viable will have to make investments in technology.[28] Chapter 5 examines in more detail various new technologies and their impact on logistics decisionmaking processes, with a particular emphasis on the effects of technological development of U.S.-Mexico trade.

Intermodalism and Deregulation

Deregulation of the transportation sector has already had a profound effect on logistics systems. The concept of an integrated, tightly knit (or seamless) system of transportation, first described in 1991 in the Intermodal Surface Transportation Efficiency Act (ISTEA), views individual modes not as isolated or competing entities, but rather as part of an articulated transportation system designed to serve the needs of the shipper. ISTEA requirements, coupled with the aggressive way in which logistics planners are seeking new ways to move goods more efficiently, should result in expanded intermodal opportunities and new service offerings.

A dramatic increase in intermodal traffic took place during the 1980s. The railroad industry experienced the largest gain with an 87 percent increase in the numbers of trailers and containers (5.7 million vs. 3.1 million) carried by American railroads over the period from 1980 to 1988.[29] This growth in intermodal traffic can be attributed, in large part, to the loosening of regulatory restraints brought about by the Motor Carriers Act and the Staggers Rail Act of 1980, key changes in the U.S. economy and trade patterns, and new technological developments such as double-stack rail cars.[30] In a deregulated environment, improved transportation planning becomes necessary if firms are to take full advantage of new opportunities in the changing transportation market.[31] Intermodal growth is expected to continue as transportation firms aggressively market their services. Recent figures show that intermodal container volume for the first half of 1994 totaled approximately three million units - 12.9 percent above the previous year during the same period.[32] Rail intermodal traffic grew by 17 percent in the period from June 1993 to June 1994.[33]

A new type of transportation company has emerged during this growth in intermodalism, offering a new type of service: door-to-door transportation services through fully integrated intermodal networks. By gathering the management expertise and technology to coordinate complex international movements of containerized cargo, these multimodal transportation companies have created a system that links together the ocean, rail, and highway modes.[34] This development is part of a trend toward increased usage of containers facilitated by new rail cars designed for improved container handling.[35]

Burlington Northern Worldwide (BN Worldwide), a subsidiary of the Burlington Northern Railroad, is one firm which offers its customers worldwide door-to-door service using a single bill of lading without operating any vehicles. The company is able to offer its clients the same frequency of service as any large firm that operates its own equipment. BN Worldwide achieves this feat by working with customs brokers, freight forwarders, overseas agents, consolidators, truckers, railroads, steamship lines, and nonvessel-operating common carriers (NVOCCs). Besides various kinds of full and partial load shipping services by truck, rail, and ocean vessel, BN Worldwide is also involved in international air freight; consolidation, distribution, and warehousing; and logistics management.[36]

J.B. Hunt Transport and Schneider National, both truckload motor carriers, provide another example of intermodal partnerships. The successful participation of J.B. Hunt and Schneider in intermodal transportation has led other major truckload motor carriers to take an interest in using railroads. In their respective arrangements, J.B. Hunt and Schneider are able to offer shippers a lower-cost alternative to highway long-hauls.[37]

Logistics Operating Practices, Outsourcing, and Third-Party Logistics

The need for firms to continuously create breakthroughs in operational efficiency to remain competitive, combined with the potential for the use of logistics management techniques to reduce operating costs, have not only brought greater attention to the logistics function within firms, but have also encouraged firms to look to outside providers for expert service. Studies show logistics costs have represent more than 11 percent of total U.S. gross domestic product, typically account for 10 to 35 percent of gross company sales, and often are a company's single largest operating cost.[38] As a result, logistics management plays a leading role in the general management of many firms and is now recognized as a key source of profitability and growth.

Many firms, recognizing the central role that logistics now plays in their operations, have sought out the expertise and services of third-party logistics providers. This outsourcing of logistics functions often allows a firm to reap the benefits of advanced logistics without the added expense and long learning curve if hiring individuals and providing in-house services. Often the need to outsource a particular activity - such as transportation, inventory management, data processing, or warehousing - leads to the development of strategic alliances and other kinds of partnerships between firms. However, decisions on warehousing, inventory, and transportation usually fit into a broader scheme of in-house logistics and strategic planning functions.[39]

Responding to changes in the transportation industry has required more sophisticated tools than most firms can readily provide. Many firms, therefore, look to third-party logistics providers for help in designing, managing, and operating logistics systems. Outsourcing of logistics functions can take numerous forms: contracting out the entire physical distribution system; the use of customs brokers who can facilitate cross-border transactions; and/or the use of consultants who can instruct firms about the latest communication technologies. All of these third-party services, however, are aimed at increasing profitability and customer satisfaction, while holding costs to a minimum. In fact, many firms will be able to lower distribution costs and avoid additional investments in transportation equipment and warehouse facilities by using a third-party logistics firm.[40] In this manner, a firm can then focus on the primary functions of production and customer service.[41]

The third-party logistics industry, having experienced huge growth in the 1980s, has developed a full range of transportation and distribution services for clients including truck brokering, consolidating, freight bill auditing, and payment services.[42] For many of these third-party logistics firms, the ability to offer a full range of services gives the logistics customer a place to conduct one-stop shopping for logistics needs. Participants in the third-party logistics market include transportation brokers, railroad companies, total logistics companies, contract companies, small-package shipment firms, intermodal companies, steamship companies, packaging services, consultants to the industry, and all the potential suppliers to the industry.[43]

Third-party logistics firms have greatly increased the utilization of intermodal transportation and have had a positive impact on reducing the amount of empty container/trailer backhauls. In addition, third-party firms are highly competitive - this competition encourages shippers to take advantage of intermodal arrangements, negotiate contracts where the most efficient system is chosen, and form partnerships with carriers.[44] It also creates a situation where the third-party logistics providers have learned to tailor different levels, bundles, and pricing based on a menu of services, as opposed to volume of services, that customers want and need.[45] These services are generally centered around inventory management, transportation, and other distribution functions, but also include strategic market planning, market research, and research and development (R & D).[46] Third-party firms are becoming increasingly involved with the provision of these kinds of value-added services.[47] Firms such as The Hub Group and GATX Logistics offer value-added services via a menu of related logistical services such as national distribution, transportation, warehousing, systems, and consulting services. They also contract with a large number of carriers across modes, and can achieve economies of scale that are not possible for shippers operating individually. Customers will benefit from the greater availability of equipment, more competitive pricing, quicker service, and goods that arrive in better condition.[48]

Warehousing firms and freight forwarders also provide logistics services on a contract basis. As transportation choices grow, it often becomes more efficient for firms, large and small, to turn to companies who specialize in storing, packaging, shipping, and tracking goods. For firms that want to continue to perform part of their own physical distribution activities, yet achieve greater efficiency, third-party providers of communications and transaction processing services, inventory management services, and logistics management guidance are available. With shippers demanding more functions from fewer firms, warehousers, with their expertise in inventory control, are in a unique position to become third-party service providers.[49] Several major warehousers also offer a wide range of distribution services that include storage, cross-docking, trucking, consolidation, and assembly. Mike Jenkins, president of the AWA, reported that warehouse membership, in terms of total square footage, has grown 15 percent per year since 1980, and that he expects that pace to continue in 1994.[50]

Carriers themselves have entered the logistics business in search of expanded market share and increased profitability. Both Federal Express and United Parcel Service offer logistics management services in addition to their more well known LTL (less-than-truckload) trucking businesses. Federal Express recently won a contract with a California-based computer chip manufacturer to manage its physical distribution system worldwide, including warehousing, inventory, and transportation elements. Two of the largest TL (truckload) carriers, Schneider and J.B. Hunt, have recently established third-party subsidiaries, Schneider Logistics and Dedicated Contract Services Group, respectively. Both subsidiaries focus on supplying equipment in cases where customers want to replace their own private fleet or develop certain markets without incurring the costs of fixed transportation assets.[51] Lastly, partnerships between shippers and their transportation companies are another way firms are outsourcing logistics functions. The partnership between CF Motor Freight and Ford Motor Company's Parts and Services Division is one example. CF has dedicated an entire terminal to handle parts shipments to Ford dealers nationwide, allowing CF (and its sister air freight company, Emery Worldwide) to become Ford's primary carrier. Ford now has a dedicated distribution center, a guarantee of three-day transit time anywhere in the United States, and a reduction in damages and claims.

U.S.-Mexico Transportation Partnerships and Logistics Management Strategies in Mexico

Several U.S. and Mexican firms have begun to position themselves for increased trade opportunities resulting from NAFTA and the trend toward greater north-south trade. NAFTA has caused not only a rise in trade volumes between these two countries, but changes in patterns of distribution as well. As NAFTA provisions are phased in and firms locate their operations further into the Mexican interior, longer hauls and increases in distribution costs are expected. These circumstances should favor the use of rail/truck intermodal combinations that are popular in the United States. Many of the trends taking place in the United States in shipping practices, such as hub-and-spoke warehousing, information exchange technology, and strategic alliances, are taking place in Mexico as well.

According to Steven Baquet, former Managing Director of Strategic Initiatives for the Southern Pacific Lines' Mexico Division, the combination of increased trade and increased multimodal needs has led the North American shipping public to demand quality seamless transportation and advanced logistics services into Mexico.[52] In recent years, the Mexican government has shown its commitment to these requirements by modernizing and expanding its transportation infrastructure. The more frequent use of logistics management strategies to facilitate long-term planning and short-term transportation needs, as well as the modernization of logistics management systems are not far behind. However, as many U.S. businesses are beginning to realize, there is a great difference between building and maintaining a physical infrastructure and building and maintaining a technological infrastructure. The following section will explore how Mexico is looking to partnerships and other kinds of relationships with U.S. firms for help and guidance in the development of its technological future. Although our case studies will examine these cross-border business relationships in more detail, we will briefly describe some of them here.

Warehousing in Mexico

For those U.S. firms moving goods into the interior of Mexico, warehousing and storage are important factors in the cost of doing business. However, many U.S. firms seeking storage space or a hub from which to distribute their goods run into a variety of barriers to efficiency. Mexico's warehousing and distribution system has been described by a leading import-export publication as the antithesis of a seamless operation.[53]

While warehousing operations have improved in Mexico since the 1980s, high-quality facilities are still limited. The shortage of storage space is estimated at about three million square meters. Currently, Mexico has just under two million square meters of storage capacity, compared to 515 million square meters in the United States[54] Mexico also suffers from high levels of market concentration. Of the 33 warehousing firms in Mexico, the ten largest control 90 percent of the available space in Mexico; ANDSA alone controls 62 percent of the industry. A case study of ANDSA and Mexican warehousing appears in Chapter 4.

Four underlying market fundamentals have made Mexican warehousing and distribution ripe for change. First, as noted above, quality warehousing space is extremely limited. Second, Mexico has undergone a state of real growth from 1985 to 1993, especially in imports which grew by over 310 percent during the period. While exports grew at a lesser rate of 78.1 percent, the bulk of growth was in *maquiladora* exports which require advanced warehousing and distribution technologies. Third, Mexican consumption and supply patterns have changed dramatically during this period. The movement into Mexico and rising popularity of large-scale department stores likes Sears, the introduction of warehouse clubs like Sam's Club and Price Club, and the growth of discount operations like K-Mart have dramatically changed the demands placed on the distribution system in Mexico. These operations require rapid movement of goods and frequent shipments - this is a new way of doing business in Mexico. Fourth, the high cost of real estate has limited speculative warehouse development which means that quality warehouse space is limited and operating costs are much higher.[55]

The shortage of new warehouse space in recent years, especially in Mexico City, combined with the increasing cost of industrial land, has raised rents for warehouse space throughout the country. Rents now range between 50 and 60 cents ($US) per square foot per month.[56] In addition, Mexican economic growth has provided more middle class jobs, leaving more Mexicans with more discretionary income which they are using to buy more foreign and domestic goods. This increase in consumption has increased demand for warehouse space. The devaluation of the peso, of course, has had an effect on warehousing and distribution activities. Even though demand for new warehousing and distribution hubs is high, financing for speculative real estate projects in Mexico is limited and expensive, and financing for inventory stocks is extremely expensive - particularly so after the devaluation.[57] In addition, much of the warehouse construction in recent years has been by individual companies building for their own needs; with the dramatic increase in trade since NAFTA, even those larger companies that planned five or six years ahead have run into warehousing shortages.

Site selection is also problematic for warehouse space in Mexico. Because access to distribution channels and support services is critical for a viable warehouse facility, many U.S. firms new to Mexico locate in existing industrial parks despite higher start-up costs. In these areas, they know that utilities will be easily available and that they will not need to contend with the zoning and title problems which often slow Mexican commercial real estate development. However, corporations are beginning to avoid the crowded industrial parks and overpopulation of Mexico City by relocating to the northern areas. Many firms have decided to store their goods at their own manufacturing facilities and then distribute from this central point to smaller, local warehouses in the city to efficiently serve customers there.[58]

U.S. logistics companies and their warehousing subdivisions are moving into Mexico to assist U.S. companies that need to distribute goods and store inventory in Mexico. GATX, a contract warehouse company and third-party logistics services provider, has developed an 80,000-square-foot warehouse facility which is used by several clients and serviced by 50 employees. The new GATX facility is located in Cuatitlan Izcali, 30 miles north of Mexico City. By using a logistics partner such as GATX, companies unfamiliar with Mexico can test the waters to see if their product is doing well before making significant investments in distribution facilities.

Warehousing plays an important role in the development of logistics management in North America. Mexico-based warehousing companies are aware of this trend and are actively improving their warehousing systems at the same time as their U.S.-based competitors. Mexico's largest private agricultural warehousing company, Abasto Corporation, has opened the largest agricultural warehouse along the U.S.-Mexico border in McAllen, Texas. The 352,000-square-foot facility built for $20 million is located at the largest point of entry for fruits, vegetables and perishables moving by land from Mexico and Central America. The complex includes 210 separate warehouses as small as 1,400 square feet. Eighty of the warehouses have refrigeration.[59] Abasto believes its facility will allow Mexican producers to sell directly to the North American market without using U.S. brokers. McAllen Tropic Pak Inc., for example, plans to import lemons from the state of Veracruz and sell them directly to grocery chains from Abasto's facility.[60]

An example of a U.S. company expanding its warehousing capabilities in Mexico is Mattel Toys. Before acquiring Fisher Price in December 1993, Mattel had decided to increase its 20,000-square-foot warehouse capacity in Monterrey. Now, the company manages 80,000 square feet of total storage space for both its Mattel and Fisher Price lines of toys. After its 500,000-square-foot facility in Ft. Worth reached capacity, Mattel decided to ship items directly from its Monterrey facility to customers in the United States to cut distribution time and save money.[61]

Another company to develop partnerships for warehousing and distribution functions in Mexico is USCO Distribution Services, Inc. In 1994, USCO formed a joint venture with InverMexico, a large Mexican financial group. The new company, InverMexico USCO, was the first third-party logistics provider in Mexico to have the ability to service clients and markets throughout Mexico. Lic. Fernando Saenz Jiménez, National Sales Manager for InverMexico USCO, believes this joint venture will provide their Mexican clients with a new way of managing their inventory - USCO's expertise in warehousing and logistics and InverMexico's financial services and knowledge of the Mexican market and culture can provide clients with a combination of services that will make their businesses more efficient. Lic. Fernando Saenz Jiménez suggests that this added understanding of the Mexican market and culture will provide InverMexico USCO an edge over other U.S. companies who do not plan to use a Mexican partner.[62]

Exel Logistics is one U.S. third-party logistics provider which does not plan to use a Mexican partner as it develops its Mexican business. According to Richard J. Jackson, Vice President of Exel Logistics, his company will not directly use a Mexican partner and will not heavily invest in high-tech warehouses because the current market does not demand a high-tech solution. Thus, the majority of their costs will be the implementation of an information-tracking system which has already been developed for the United States.[63] In contrast, two InverMexico USCO management teams have completed six months of training on USCO's warehouse operations and business management approach in order to facilitate the transfer of USCO's services to Mexico. Two more groups will travel to the United States soon for similar training.

Grupo Crisoba, Scott Paper Co.'s official Mexican partner, is one company that has overcome many of the limitations of Mexico's warehouse and distribution system. With sales of US$480 million per year, Grupo Crisoba has built a series of warehouses and distribution centers across Mexico to facilitate movement of Scott Paper's products. Grupo Crisoba's experience in handling their own products within Mexico, combined with the use of Scott Paper's own customs brokers, facilitate the distribution of Scott's products in a cost-effective manner throughout Mexico. Grupo Crisoba has also been able to provide high-quality logistics services to many U.S. companies that need to develop an efficient distribution system that covers all of Mexico. For example, when Wal-Mart began shipping bar-coded products into Mexico, Grupo Crisoba was one of a handful of companies able to help. Grupo Crisoba set up a multi-functional team of representatives from their sales, logistics, credit, and manufacturing departments to facilitate Wal-Mart's shipping needs and allow them to learn how to operate a complex distribution system within Mexico. This team is currently developing electronic links to facilitate the sending of advance shipment notices to Wal-Mart.

Deregulation of the Mexican trucking industry by President Salinas in 1989 provided Grupo Crisoba much more flexibility in choosing its land carriers. This was especially important for since they do not rely heavily on FNM rail service. In fact, only about 10 percent of all their freight moves by rail, and that portion primarily involves the shuttling of products between manufacturing plants. Currently, Grupo Crisoba uses over 100 different trucking companies throughout Mexico. In the future, as Mexican trucking develops further, the company would like to reduce its carrier base, although they are limited due to the structure of the Mexican trucking industry. According to Angel De la Puente, Grupo Crisoba's logistics manager: "In Mexico, truckers tend to be specialized into truckload or less-than-truckload, but the main difference is in the routes they serve. They go to Mexico City, Guadalajara and back and that's it."[64]

Distribution in Mexico City

Mexico City has many physical (infrastructural) problems which hinder rapid distribution of products and services. Most urban bridges are dangerously low which restricts routing alternatives for distributors. Congestion is a serious problem; trucks share the road with three million other vehicles. Because Mexico City is subject to two to three marches or demonstrations every day, delivery is slow on a regular basis, especially downtown. Also, trucks must negotiate low-quality roads where they frequently encounter "burms" or speed bumps. Finally, street names change without warning, making deliveries an adventure. Adrian de Lope, Marketing Director of Multi-Pack ADO, points out that finding a delivery address can be a serious problem because of changing names and nonexistent street signs. When signs do exist, he claims they could represent several different things: the street's name, the street's former name, the point of origin, the destination, or none of the above. And, with 225 streets named Benito Juarez in Mexico City, it can be difficult to find an unfamiliar destination.

A number of hidden costs also affect distribution. Lack of parking at delivery sites often means vehicles need two employees, one driver and one delivery person. Also, security is a big issue - robberies are a daily occurrence and many neighborhoods are to be avoided at night and others should always be avoided. Due to the size of the town, driving time can often be more than an hour before delivery can take place and routes are often widespread to cover the whole city, further increasing delivery time. Distribution is also slowed because most retail chains have stringent delivery times and often take deliveries from multiple carriers one at a time, meaning trucks must wait in line before discharging their goods. Finally, the 5-digit zip code system has not dramatically helped speed delivery because it has not been widely implemented.

Multi-Pack ADO solved many of these problems by developing special agreements with many of the major retail chains in Mexico. In fact, they handle distribution for Comercial Mexicana, Price Club, Gigante-Fleming, Chedraui, and Casa Ley. They consolidate deliveries from suppliers for each retail chain and make a single delivery to the store instead of 12 different ones. The retailers can also use Multi-Pak ADO for returned merchandise to suppliers. In exchange for the service, the retail chains allow their trucks immediate access to the delivery docks instead of waiting in line. While Multi-Pak ADO has developed a more sophisticated distribution system, it does not use multiple modes of transportation - it does not use FNM because of lack of control, lack of punctuality, and low security levels; sea transportation has been found impractical because the majority of Mexico's population does not live on the coastline or nearby major rivers.[65]

Devaluation and the Trucking Industry in Mexico

Imports and Exports

The devaluation of the peso has hit U.S. trucking firms hard. For those companies which transport goods into Mexico, shipment levels have dropped dramatically. For those firms with Mexican partners or subsidiaries, northbound business has expanded, balancing out some of their losses. Further, shipments to and from points in Mexico have also dropped dramatically as Mexicans have less disposable income, and firms have cut back on orders. J.B. Hunt Transport of Lowell, Arkansas, for example, indicated that the company's operating income from Mexican operations was reduced by US$700,000 in the first quarter of 1995, with company figures indicating that freight volume was half of what it was prior to the devaluation. The company has even decided not to place truck orders planned for its Mexican fleet. M.S. Carriers, another large U.S. motor carrier, has managed to increase its revenue and profit margins on southbound trade by offering discounts on southbound rates. Still, the company has put on hold plans to spend $3.5 million on new trucks and trailers. Instead, it will buy only half the number it planned to acquire for its Mexican joint venture with Transportes Easo.[66]

Most transportation companies doing business south of the border understand that, although the devaluation has made business difficult, now that the situation is stabilizing, companies will again be able to price their goods for sale in Mexico and freight will move with greater ease across the border. In other words, the issue does not necessarily concern the peso's value, but its instability - that instability is what is affecting trade transport most. In addition, those firms which transport large amounts of consumer and retail goods are being hit very hard - these items were among the first to experience cuts in production and sales. Goods for manufacturing and assembly fared better, as did raw materials. However, the consumer and retail shipments are the smaller, more frequent, and higher paying shipments for the motor carriers.[67]

Most transportation firms have also seen sharp changes in the mix of goods they ship. After the devaluation, for example, M.S. Carriers saw its freight mix shift from 50 percent of its southbound trade being consumer and retail goods to only about 20 percent. Until the company was able to get more nonconsumer freight, it was scrambling to send empty trucks south ("deadheading") to meet prior northbound commitments. This empty hauling is quite expensive, and now, also quite common. In response, many motor carriers have decreased the rates for their southbound shipments while increasing the rates for their northbound shipments in order to compensate for deadheading.[68]

Fuel Costs

As described in Chapter 2, after the devaluation of the peso and the economic collapse that followed, the Mexican government put into place a fiscal austerity program. This program, among other things, imposed immediate diesel fuel price increases of up to 35 percent at the pump, with monthly increases of 0.8 percent through the end of 1995. In May, however, the Secretaría de Communicaciones y Transportes (SCT) met with representatives of the Mexican national trucking association, the Cámara Nacional del Autotransporte del Carga (CANACAR), who were concerned that the increased costs of trucking caused by the increase in fuel prices would adversely affect commerce in all of Mexico's economic sectors, leading to price increases for firms and consumers who would now have to pay more to get their products to the market.[69]

In June 1995, in response to the concerns of CANACAR members, the SCT encouraged the Mexican Secretariat of Finance and Public Credit (the Secretaría de Hacienda y Crédito Publico), to announce a diesel-fuel tax credit. According to Hacienda officials, truckers and bus lines can seek a tax credit of 0.05 pesos per liter of diesel fuel through the end of December (when fuel price increases imposed by the government expire). The credit will count against taxes for rent, trucking activities, and aggregate value of cargo. To get the tax credit, however, a trucker must be on a federal highway. This provision is important because it serves as a quasi-guarantee that the government will continue to collect tolls which would offset monies lost to the treasury in tax credits.[70]

NAFTA

In December 1995, NAFTA regulations require that the U.S.-Mexican border states open themselves up to international trucking. This impending event, poorly timed with the peso devaluation, prompted CANACAR to ask the Mexican government to delay, or disregard completely, the scheduled opening. Mexican truckers are actively lobbying the SCT for this delay in fear that their market will be decimated. Apparently, Mexican truckers, unlike truckers in the United States and Canada, are struggling with lending rates as high as 80-100 percent, new size and weight rules that require extensive equipment upgrades, and an estimated 40 percent drop in consumer and import purchasing power as a consequence of the devaluation.[71]

Truckers want the Mexican government to lower and then freeze tolls on the newly concessioned highways. Studies show that tolls on the new highways would have to drop an estimated 75 percent before it would be cost effective for truckers to use those roads. In addition, truckers complain that deregulation has dramatically increased the number of forms - from a total of 103 forms to 207- they must submit for authorization to operate, and has also increased license fees and maintenance costs.[72] CANACAR's president, Bernardo Lijtszain Bimstein, even called for, then called off, a national work stoppage, and is openly feuding over the delay with CANACAR's past president, Francisco Davila, who has criticized Lijtszain for trying to "escape" NAFTA mandates. Lijtszain is also in disagreement with Mexican Transportation Secretary Carlos Ruiz Sacristán, who rebuffed him on delaying the border opening as well.[73]

U.S. and Canadian truckers are incensed at these events, and insist that such actions would "further dampen Mexico's credibility, which has dwindled since last December's surprise peso devaluation...". The president of the American Trucking Association, Mr. Thomas J. Donohue, indicated that it would be in the interests of Mexico to keep their multilateral trade agreements in both spirit and letter, and that Mexico's failure to do so would create many doubts in the minds of those providing financing or financing protection as to whether Mexico will live up to its commitments in the financial markets as well.[74] Mr. Donohue added that since the North American Transportation Alliance was formed over a year ago, Mexico's truckers have continued their restrictive package carrier rules, have failed to grant U.S. carriers the immediate, short-distance access given to Canadian truckers, and have continued to waffle over size and weight regulations.[75] Gilles Belanger, the president of the Canadian Trucking Association, was also against the delays, noting that Canada's uncompetitive tax structure also placed his truckers in a disadvantageous position with U.S. truckers, but that delaying the NAFTA start date would not change the situation for Mexico dramatically.[76]

Equipment Shortages

Ironically, while CANACAR is fighting to keep foreign trucking companies out of the market, Mexico is experiencing acute shortages of transport equipment. Because the devaluation has made Mexican exports cheaper for buyers in the United States and other countries, northbound export levels have increased. Larger manufacturers in Mexico, however, say that they have had to cut back production because there are not enough tractors and trailers to move their goods to market. Unable to find a sufficient number of trailers for export loads, these companies have had to turn to FNM to take their exports to the United States. The state rail line, however, is not as efficient with respect to the kind of fast and competitive, point-to-point service one receives when using motor carriers.[77]

Although there were equipment shortages in Mexico prior to the devaluation, the problem was manageable. There were an average of eight trucks going southbound into Mexico for every one truck going north. Many Mexican truckers, faced with extremely high finance charges for updating or increasing their fleets, relied on these southbound trailers to take their products north. But with the devaluation cutting down on the number of trucks coming south combined with increasing security risks for truckloads (because their goods are worth so much more), U.S. truckers and third party logistics providers are booking their outbound loads before taking freight into Mexico. This leaves Mexican truckers very limited equipment with which to haul freight, especially non-export freight.

Multimodal Agreements in Mexico

Railroads

In the spring of 1993, FNM reached an agreement with the Southern Pacific and Burlington Northern railroads to coordinate rail shipments between the state of Washington and the city of Monterrey, Mexico.[78] Under the agreement, Burlington Northern transports apples from Washington to Fort Worth, Texas. At that point, Southern Pacific picks up the shipments and moves them to the border crossing at Eagle Pass-Piedras Negras, where they are transferred to the FNM for shipment to a distribution center in Monterrey. As part of this arrangement, the FNM brings broccoli, frozen concentrated orange juice, and other produce to the Eagle Pass-Piedras Negras border crossing, where the U.S. railroads ship the products to northwestern markets. Mexican customs officials have agreed to perform the inspections of the apple shipments in Monterrey, rather than at the U.S.-Mexico border in order to simplify paperwork.

FNM also has an arrangement with the ATSF. It consists of a marketing agreement that allows the operation of a double-stack container train from Long Beach, California, to Mexico City. ATSF receives a number of inquiries from U.S. firms which are exploring the possibilities for expansion into the Mexican market; the company expects that many of these will translate into future business within two years.[79]

Trucking

In December 1994, M.S. Carriers began a 50-50 joint venture with Transportes Easo, a Mexican motor carrier based in Mexico City. The two carriers had begun cooperating three years earlier after being introduced to one another by Procter and Gamble. This informal partnership led to a three-year expansion plan which, according to Craig Coyan, director of international business development for M.S. Carriers, may make Transportes Easo the largest truckload carrier in Mexico.[80] To formalize the partnership, the two companies entered into a trust arrangement which makes M.S. Carriers a neutral 50 percent shareholder of Transportes Easo, while negotiations of NAFTA provisions concerning ownership of Mexican-based trucking firms continue.

M.S. Carriers developed marketing operations for northbound traffic from Mexico and created a logistics company in the industrial city of Monterrey to facilitate truck movement within Mexico and across the border. It is also planning to eventually bring its logistics operations into Mexico City and Guadalajara. M.S. Carriers also helped to arrange lower-cost financing for Transportes Easo to purchase more trailers, and spent several million dollars on telecommunications and computer equipment for the partnership. According to Mike Starnes, M.S. Carriers' president, conservative estimates call for net revenues of US$30 million to US$50 million by 1997.[81]

Since 1991, Yellow Freight Systems has been working to establish itself as a major player in Mexico's limited less-than-truckload (LTL) market through an exclusive arrangement with Mexican carrier Transportes Sierra. The result, Yellow Freight Mexicana, is Mexico's largest LTL carrier, with revenues of more than US$25 million and a growth rate estimated at 25 percent annually. Despite the current economic challenges in Mexico, Yellow Freight Mexicana remains successful in its relatively limited market. David Valdez, Yellow Freight's general sales manager for Mexico, credits his company's success in Mexico to its seamless transportation package, which includes extended coverage, tracing capabilities, consistent rate schedules, and simplified customs documentation.[82] Valdez also credits their success to the actions of Transportes Sierra, which allowed Yellow Freight to assume full control of the operation. Yellow Freight has also been successful pursuing intra-Mexico service as well as international service. Due to the company's rapid growth, in 1994 the company opened two new truck terminals, one in Otay

Mesa, California near San Diego and the other in Ciudad Juarez, Chihuahua near El Paso. The company already has terminals in Mexico City, Nuevo Laredo, Monterrey, Guadalajara, and San Luis Potosí.

Leasing

As a result of NAFTA, Mexico published regulations on November 22, 1994, which allow U.S. companies to lease new and used vehicles with a maximum age of five years to private, for-lease carriers in Mexico. Shortly thereafter, Ryder System Chairman, M. Anthony Burns, announced that the Miami-based leasing company would begin direct capital investment in Mexico of US$250 million. As a consequence of the new regulations, Ryder will not only be able to lease new equipment in Mexico, but will also be able to buy existing private fleets and lease them back to their companies - a form of transportation outsourcing which has become widely accepted in the United States and elsewhere. Ryder's initial strategy is to work with its current customers, primarily manufacturers in the United States, Canada, and Europe already established in Mexico. Ryder will also target large, progressive Mexican companies.[83]

While truck leasing is Ryder's core business, the company intends to provide additional logistics services for its Mexican customers. Randall West, Senior Vice President and General Manager of Ryder International, envisions its strategy in Mexico to include not only the leasing of trucks and trailers, but also providing drivers, warehousing space and facilities, cross-dock operations, and carrier management. For this reason, Ryder has committed $250 million over the next three to five years to buy 7,000 to 10,000 Mexican vehicles (both new and used), establish maintenance centers in major cities, and recruit and train Mexican workers, drivers, and executives.[84]

Transport International Pool (TIP), the largest trailer rental and leasing company in North America, has recently opened a location in Monterrey, Mexico, and plans to open a second facility in Mexico City. TIP de Mexico S.A. de C.V. is a wholly owned subsidiary of GE Capital, a financial branch of General Electric Co. As a consequence of NAFTA, TIP has been able to work with Mexican officials to make trailer rental and leasing options available for the first time in Mexico. TIP has commissioned Mexican trailer manufacturers to build the 48-foot vans, flatbeds, and reefer units which they will offer to Mexican carriers through flexible leasing plans of between one and ten years, with rentals as short as one day.[85]

Regulatory changes have also recently improved the leasing of railcars to Mexican firms. According to Kevin F. O'Gara, Jr., director of fleet management for Railcar Ltd., the company has perfected a lien on a group of boxcars on lease to a Mexican shipper. This practice guarantees the lender, in this case First National Bank of Boston, that the equipment securing its loan cannot be seized by anyone else in case of financial problems. While this practice is easily accomplished in the United States by filing a form with the Interstate Commerce Commission, until now, the practice had never been recognized in Mexico at a national level. Given that many lessors and lenders restrict the movement of their railcars to Mexico because of this problem, the ability to protect the lender should allow for greater freedom of movement of leased railcars into Mexico.[86]

Marine Partnerships

Mexican ports also are of strategic importance for U.S. carriers. In 1994, Illinois-based Alliance Shippers announced plans to open offices at the ports of Tampico and Veracruz to handle an expected increase in its shipments through those locations. Alliance Shippers, which has operated offices in Mexico City and Monterrey for several years, also opened a new branch in Guadalajara to serve as a distribution and redistribution center.[87]

In early April 1994, Mexico's largest ocean carrier, Transportación Marítima Mexicana (TMM) moved its U.S. container shipping operations from the Port of Galveston, Texas, to the Port of Houston.[88] In conjunction with that transfer, TMM signed a vessel-sharing agreement with three other carriers to provide weekly container service between ports in Mexico and Europe via Houston. Those partners are Tecomar (which TMM owns in partnership with another Mexican firm, Grupo Hermes), Hapag Lloyd (Germany), and Atlantic Container Line (United States). A case study of TMM will appear later in this report.

American President Lines (APL) has introduced a delivery service for less-than-container-load (LCL) shipments moving from Asia to Mexico.[89] In a partnership with TMM, also known as the Mexican Line, the firms announced a plan in November 1993 to offer a direct, all-water container service between Asia and Mexico's Pacific Coast.[90] It was the first such service to link the two markets on a fixed-day-of-the-week basis. Both carriers have found that their customers benefit from faster, more reliable service made possible through a slot-exchange agreement which will allow APL and TMM to use space aboard each other's trans-Pacific container ships. The new service supports the needs of Mexican importers, retailers, and manufacturers who require partial or overflow shipments of merchandise or parts, or deliveries that include merchandise from multiple Asian points of origin.

Under the new system, cargo originating at virtually any major port in Asia moves by APL container ships to APL terminals in Japan and Korea. At these terminals, the cargo is relayed to one of six TMM vessels bound for the Mexican ports of Manzanillo and Lazaro Cardenas on the Pacific coast. APL's "through" LCL service is the first to deliver partial container loads directly to Mexican commercial centers intact, without the need for the customer to arrange for inland transportation. Pick-up and delivery, to or from these modern ports, is available for Mexico City, Guadalajara, León, Aguascalientes, Cuernavaca, Puebla, Querétaro, Toluca, and other interior points. APL is now studying stack-train service from Manzanillo to Mexico City. Other LCL services to Mexico require shipment to U.S. ports and trans-shipment across the U.S.-Mexico border and often encounter border delays for customs entry, payment of duties, and reconsolidation. Thus, the new APL-TMM system minimizes cargo rehandling and border delays.

According to APL, part of the attraction to Mexico's ports is the decentralization process which allows for more autonomous port authorities and the issuance of private terminal contracts. Also, customs brokers and freight forwarders at the ports have improved their services, especially in Manzanillo, to match the level and range of service provided on the border at competitive prices. And, cargo theft, a major problem on Mexican highways, is much less of a problem at Manzanillo. The success of the system has prompted APL to spend between US$15 million and US$20 million on equipment and offices in Guadalajara, Monterrey, and Mexico City. On

September 1, 1994, APL opened new offices in Mexico City - a clear signal of long term involvement.[91]

Multimodal Partnerships

Two transportation firms have joined to allow for the more efficient and faster transportation of perishable products food between the United States, Mexico, and Canada.[92] KLLM, the largest U.S. temperature-control refrigerated motor carrier, and CN North America, Canada's largest railway, announced in late November 1993 that they have joined forces to move fresh produce by rail from California, the Gulf Coast, and Mexico into Canada. The service will also carry processed food from Canada on the return journey.

CN handles all the logistics in door-to-door service in Canada and positions KLLM's equipment to take best advantage of return traffic. CN foresees considerable opportunity to increase its intermodal traffic between Canada, the United States, and Mexico. Traffic to and from Mexico is made possible by new Mexican Gulf Line container ships that run between seaports at Tuxpan, Veracruz, and Gulfport, Mississippi. Port facilities in Gulfport are so efficient that containers are cleared as fast as they can be landed at the dock. Shipments arriving at Tuxpan will then be moved to warehouses located at facilities in Mexico City or Guadalajara.

GATX Logistics, a third-party logistics supplier based in Jacksonville, Florida, has decided to enter the Mexican market without a Mexican partner and pioneer a logistics operation. Joseph A. Nicosia, president of GATX, notes there are abundant opportunities for growth but little prospect of quick paybacks. For example, due to the unreliability of telephone service in Mexico, GATX was forced to invest in a satellite link to serve its communications needs. Also, GATX has been forced to pay higher costs for scarce executive talent in Mexico, up to 25 percent higher than in the United States. Nevertheless, GATX handles logistics for Jockey International and Foot Locker in Mexico. They also consolidate less-than-truckload shipments from 240 suppliers for delivery to ten Price Club stores in Mexico.[93]

Ohio-based American Electric Power (AEP) provides “partnering” to numerous partner-customers throughout east-central states. AEP’s strategy is to create export markets for its customers and help guide them through Mexico’s maze of documentation rules, trade regulations, and contractual laws. Thus, although AEP is not in the business of exporting electricity to Mexico, AEP customers who export their products to Mexico will increase production, and their consumption of electricity will rise as well. AEP estimates that its partnering efforts have led to a US$3.2 million increase in sales for its partners over a period of three years. As partnership efforts continue to develop, AEP plans to develop cost-benefit analysis scenarios to justify their continued partnering ventures to shareholders.[94]

United Parcel Service’s (UPS) customer resource group also provides many of the same promotional functions as AEP. In a co-sponsorship arrangement with the Indiana Commerce Department, UPS sponsored representatives from five Indiana companies to attend Rep-Com ‘94, an annual trade show organized by the U.S. Embassy in Mexico City. Carlos Barbera, the Indiana Commerce Department’s international trade director, noted that UPS provides a great advantage both by giving export advice and by facilitating contacts between U.S. and Mexican companies.

For example, at Rep-Com '94, UPS set up six appointments in two days for Londonware, an Indiana-based producer of bathware accessories.[95]

Partnerships in Information Technologies

Several companies have formed partnerships to improve the use of information technologies (IT) in distribution throughout North America, not just within the United States. Scott Paper Company has hired Schneider Logistics to manage its North American cargo movements. Schneider is using a computer model to analyze costs, routes, schedules, transportation modes, raw-material, shipments, finished good shipments, as well as other data. The model provides dispatchers information on the lowest-cost carriers serving a particular region, and on the most direct route through the region. More importantly, the model uses Schneider's satellite monitoring data to advise Scott of any potential problems with their trucks, while they are en route between their plants in Mexico, Canada, and the United States. Scott paper credits Schneider for raising its on-time delivery rate from 90 percent to 98 percent.[96]

Skyway Freight has partnered with Vidales Hermanos of Monterrey to provide tracking information to its customers not only in the United States, but also in Mexico. Vidales Hermanos employs a private communications system to overcome Mexico's poor telecommunications infrastructure so that companies will not lose track of their shipments after they cross the Mexican border. Customers such as Computerland can track their shipments from the United States all the way to the company's Mexico City retail operations.[97]

Carolina Freight Carriers has expanded its EDI network into Mexico by installing their computer systems in the offices of their Mexican partner, Tresguerres, S.A. This system provides a paperless environment, one bill of lading, door-to-door tracing, and direct telephone access into the computer at any time.[98] Yellow Freight System Inc. has accomplished similar results by the establishment of its own Mexican trucking firm, Yellow Freight Mexicana. Thus, Yellow is able to provide single-source surface transport using Yellow's IT which allows for minute-by-minute tracking with direct telephone access.[99]

Conclusion

As mentioned at the beginning of this chapter, physical infrastructure and technological infrastructure have become closely interrelated; so much so that trade truly can no longer occur in an efficient manner without the simulatanous use and mutually reinforcing effects of both. Logistics management techniques have sought to intertwine these separate spheres, and in so doing have become an important part of doing business in the 1990s. The use of logistics management techniques to facilitate transportation and distribution functions is fairly commonplace within the United States, but Mexican firms are lagging a bit behind. As a consequence, many U.S. firms that wish to conduct business with Mexico are taking innovative steps in the development of strategic alliances and other business ventures which are designed to support the transfer of capital and technology, and also encourage the application of logistics management technologies to cross-border trade.

In describing the evolution of logistics management trechniques and partnerships between the United States and Mexico, it is apparent that these new cooperative ventures present a vast opportunity for growth and expansion, as well as a variety of challenges. Because manufacturing, transportation, and distribution are now so technologically oriented and technologically demanding, U.S. firms may be frustrated in their attempts to expand into Mexican markets. However, this frustration may be eased over time as more Mexican firms begin to adopt the production technologies and strategies that the global market requires.

This process begins with the development of partnerships and alliances between U.S. and Mexican firms. The next chapter represents a cross section of firms involved in the transportation and distribution of commodities on both sides of the U.S.-Mexican border. It will describe and analyze how these firms are coping with the challenges that cross-border trade poses, and how they are taking advantage of opportunities for growth in expanding markets.

Notes

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[2] OECD, *Advanced Logistics,* p. 6.

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[20] Turnquist, "Manufacturing Logistics," p. 134.

[21] OECD, *Advanced Logistics*, pp. 66-67.

[22] Turnquist, "Manufacturing Logistics," p. 133.

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[25] McKenzie et al, *Intermodal Transportation*, p. 244.

[26] Turnquist, "Manufacturing Logistics," pp. 133-134.

[27] OECD, *Advanced Logistics*, p. 63.

[28] McMahon, "The Future," p. 40.

[29] McKenzie et al, *Intermodal Transportation*, p. 55.

[30] Ibid., p. 57.

[31] Kotler and Armstrong, *Principles of Marketing*, p. 379.

[32] "Intermodal Traffic Sets Record Pace," *Journal of Commerce* (June 2, 1994), p. B-3.

[33] "Intermodal Traffic Breaks Record," *Journal of Commerce* (June 17, 1994), p. B-3.

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Chapter 4. Case Studies

Introduction

Using four case studies as examples, this chapter examines how firms involved in transportation and distribution in the United States and Mexico are responding to the challenges of cross-border trade. Each case study illustrates how a particular firm is attempting to diversify its operations in order to respond to increasing levels of competitiveness. Each firm has made, and is continuing to make, extensive investments in the Mexican market. These investments are not only financial - each firm has realized that one of the keys to a successful strategy in the Mexican market for transportation and distribution services is the ability to create and nurture innovative partnerships and alliances. Strategic alliances are identified and used to illustrate the difficulties that arise from bringing together two or more companies which may have different values or visions. Special emphasis is placed on the decisionmaking processes that characterize these partnerships and how these relationships have developed in response to the North American Free Trade Agreement (NAFTA) and to the Mexican economy in general. We begin this chapter with an examination of the operations of J.B. Hunt.

Case Study 1: J.B. Hunt Transport Services, Inc.

J.B. Hunt Transport Services, Inc., founded in 1962, is an irregular route, full-service transportation company. It provides a wide variety of road transportation services through a variety of subsidiaries that are listed below:

- **J.B. Hunt Transport, Inc**. is headquartered in Lowell, Arkansas, this business unit is the largest truckload, dry-van carrier in the United States. It provides both truck and intermodal services, and maintains hauling agreements and over 45 ramp locations with 9 railroads, including Burlington Northern, Southern Pacific, Union Pacific and Santa Fe. Its services cover all 48 contiguous states, and also provides service in Canada and access to Mexico.

- **J.B. Hunt Logistics, Inc**. provides dedicated transportation logistics management services including Dedicated Contract Services, or DCS. DCS concentrates on providing outsourced dedicated fleet management.

- **J.B. Hunt Special Commodities, Inc**. hauls hazardous wastes and materials.

- **J.B. Hunt Flatbed** hauls commodities on flatbed trailers (rather than containerized cargo).

- **J.B. Hunt Transport of Texas** is an intrastate trucking company headquartered in Dallas, Texas.

- **TMM/Hunt de Mexico** is a joint venture with Transportación Marítima Mexicana (TMM) Mexico's largest maritime shipping company, that offers seamless service between the United States and Mexico.

- **J.B Hunt Intermodal Service Division** is responsible for the joint agreements with railroads.

J.B. Hunt and its subsidiaries operate 18 terminals in the United States and seven sales offices outside the United States. By the end of 1993, J.B. Hunt's combined U.S. operations owned 6,775 tractors, 19,089 trailers and containers, and employed over 10,000 employees nationwide.[1]

Operating revenues for J.B. Hunt increased 24 percent from 1991 to 1992, and 12 percent from 1992 to 1993, when the company surpassed US$1 billion in revenues. These revenue increases were primarily a result of the continued growth of railroad (intermodal) volume and the development of specialized carrier operations. Revenue from specialized carrier operations (such as flatbed transport, hazardous commodities transport, and dedicated contract and logistics services) represented 14 percent of the total operating revenues in 1993. Of the US$1.02 billion in revenue generated by J.B. Hunt's operations in 1993,[2] US$70 million was generated from operations in Mexico.[3]

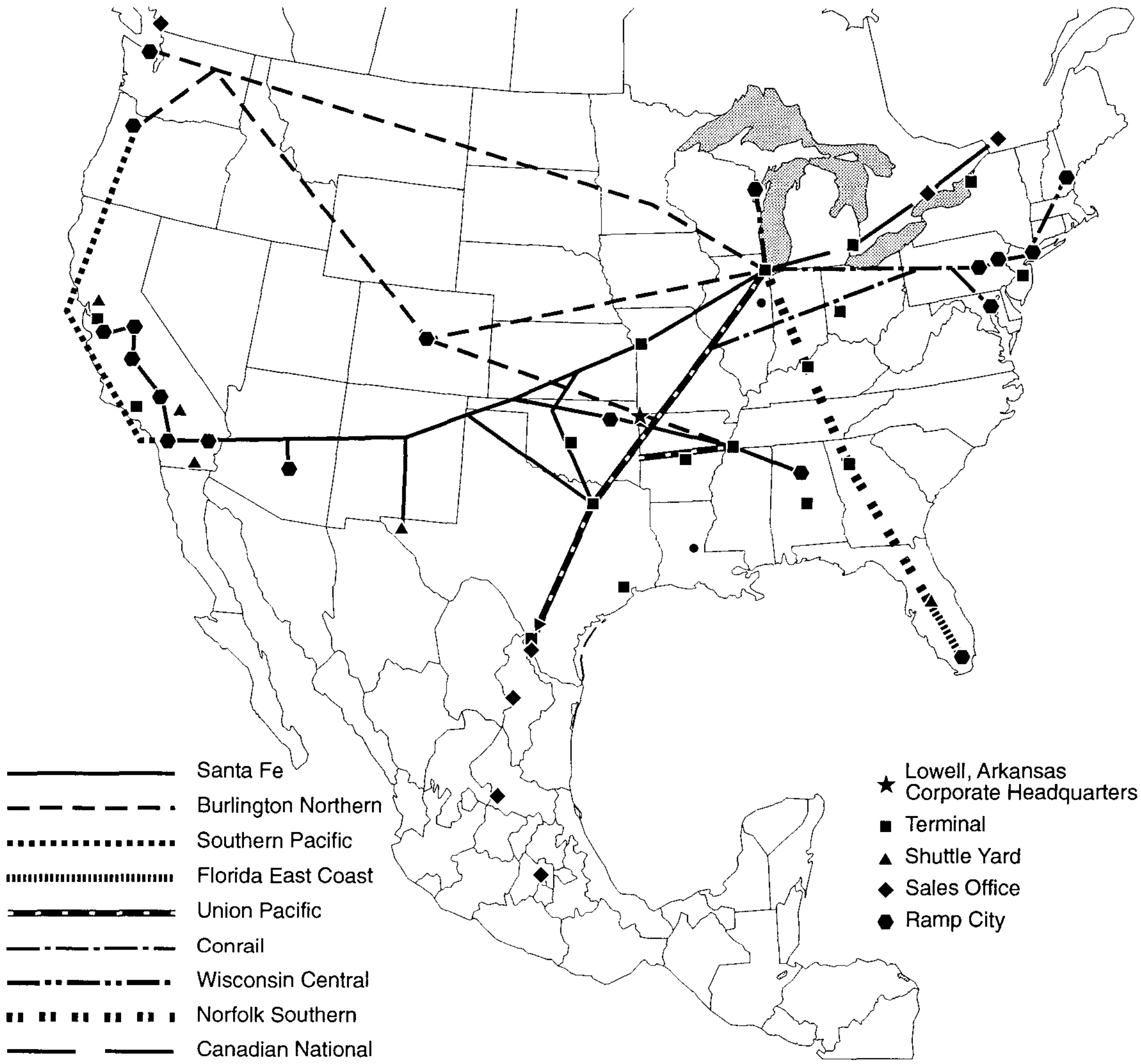
J.B. Hunt's clients ship a variety of commodities, from automotive parts to retail goods. A map of J.B. Hunt's primary routes can be found on the adjacent page (Map 4.1). The top commodities shipped by J.B. Hunt for these industries are included in Table 4.1.

Table 4.1
Percentage of Revenue for J.B. Hunt from Top 150 Shippers, 1993

COMMODITY	PERCENTAGE OF REVENUE
Food or Kindred Products	29%
Pulp Paper or Allied Products	24%
Transportation Equipment	15%
Clay, Concrete, Glass, and/or Stone	6%
Electrical Equipment	4%
Industrial Chemicals	3%
Primary Metal Products	3%
Rubber and Misc. Products	3%
Petroleum and Coal Products	1%
Other	12%

Source: J.B. Hunt Transport Services, Inc., 1993 Annual Report (Lowell, Arkansas, March, 1994), p. 16.

Map 4.1
J. B. Hunt Transport Network



SALES OFFICES

Mexico City, Toluca
Monterrey, Nuevo Leon
Montreal, Quebec
Nuevo Laredo, Tamaulipas
San Luis Potosi, San Luis Potosi
Toronto, Ontario
Vancouver, British Columbia

TERMINALS

Atlanta, GA
Chicago, IL
Dallas, TX
Detroit, MI
East Brunswick, NJ
Houston, TX
Hueytown, AL
Kansas City, MO
Laredo, TX
Lathrop, CA
Little Rock, AR
Louisville, KY
Lowell, AR
Memphis, TN
Oklahoma City, OK
South Gate, CA
Springfield, OH
Syracuse, NY

The top three revenue generating commodities shipped by J.B. Hunt comprise two-thirds of their total shipping. Food or kindred products, the top commodity in 1992 and 1993, had only a one percent fluctuation between those years. Pulp paper or allied products and transportation equipment make up the second and third highest percent commodities. J.B. Hunt is capable of shipping virtually any type of commodity as long as it can be hauled in a dry van (standard closed trailer), flatbed truck, multi-purpose van, or in the newly developed autorack (a fully enclosed automobile container/trailer).

J.B. Hunt's autorack is altering traditional finished automobile delivery. As mentioned several times in this report, trade in automobiles, automobile parts and related items is not only a big percentage of trade within the United States, but also a large percentage of U.S.-Mexico trade. The autorack, designed to transport finished automobiles from the factory to the dealership in fully enclosed containers and trailers, is a new technology/service that makes it easier and more efficient to transport assembled automobiles. It is currently being tested by a number of car manufacturers in the United States, Europe, and Asia.[4]

J.B. Hunt made substantial investments in 1993 in equipment and ventures designed to optimize freight-carrying capabilities and modal diversity. The investments centered around the purchase of 7,500 new containers, the establishment of several intermodal ramps, the creation of new businesses, and the implementation of a variety of new technologies, such as on-board computers.[5] In fact, 1993 was a pivotal year for J.B. Hunt, particularly with regard to its aggressiveness in responding to market changes caused by NAFTA. J.B. Hunt has long been a supporter of joint partnerships with railroads, its joint arrangements with nine of the largest U.S. railroad companies has allowed it to offer its customers a variety of service options. By being able to offer a variety of intermodal service choices, J.B. Hunt can provide its customers the efficiencies and cost savings on long hauls that are associated with rail movement while simultaneously providing the seamless door-to-door service associated with truck transport. Other specialized services provided through the Flatbed and Special Commodities groups give clients additional shipping options.[6]

In addition, J.B. Hunt has realized the importance of the trend toward using third-party logistics and outsourcing. Many of J.B. Hunt's clients are streamlining their operations through these arrangements to concentrate on their own core activities, and are seeking transportation providers to manage all of their transportation and distribution needs. Through Dedicated Contract Services, a unit of J.B. Hunt's logistics division created in the spring of 1993, J.B. Hunt can design a variety of custom-tailored logistical solutions that are suitable for client's distribution budget and precisely fit the client's transportation and distribution needs.[7]

In support of the trend toward the use of logistics management techniques and technologies, J.B. Hunt has provided its tractors with on-board computers and communications devices which facilitate tracking and repositioning. In addition, J.B. Hunt introduced the use of a new software program called Micromap,® which assists logistics managers in the difficult and complex process of matching loads to drivers. The program enables the computer to consider over 90 different assignment factors, well beyond the reasonable capacity of any one person to take into account at one time. According to J.B. Hunt, this program has been responsible for a more than 10 percent reduction in empty miles.[8]

Intermodal Agreements and Other Partnerships

Intermodal business agreements and partnerships give J.B. Hunt the capability of providing a variety of intermodal services to an ever-widening geographical market. As mentioned before, since 1989, J.B. Hunt has instituted intermodal hauling agreements with nine railroads, giving it access to over 47 ramp locations with railroads in the United States. In fact, the intermodal operations segment of J.B. Hunt's business is quite profitable and generates an estimated 30 percent of its total revenue. Because of the importance of these intermodal arrangements to J.B. Hunt's revenue stream, it has expanded the weight and cubic capacity of many of its containers, and plans to convert most of the fleet to containers in 1995. In addition, J.B. Hunt has also developed a new lifting system to allow the new containers to be doublestacked.[9] It is the partnership concept, however, that allows J.B. Hunt to serve such an extensive geographic market and variety of clients.

For example, an intermodal alliance with The Atchison, Topeka, and Santa Fe Railroad, initially called Quantum, was formed in 1990. This trailer-on-flatcar service initially involved service between Los Angeles and Chicago; now it offers expanded service to Kansas City, Dallas, and San Francisco. In 1992, approximately 2,000 Hunt trailers per week traveled intermodally using this type of partnership. In 1991, J.B. Hunt entered into an intermodal agreement with Burlington Northern Railroad. Unlike Quantum, no separate subsidiary was formed. This agreement services the Chicago to Seattle/Portland corridor. In February 1992, an agreement with Southern Pacific Lines was formed. It provided services on the Portland-Los Angeles corridor. In the same month, J.B. Hunt signed an intermodal agreement with Union Pacific Railroad for service from Chicago to Laredo, Texas.

In 1991, aware of the possible business to be generated from the Mexican market upon the passage of NAFTA, J.B. Hunt acquired Great Western Trucking, a Texas intrastate trucking company, to serve Texas and the *maquiladoras*. This venture is now known as J.B. Hunt Transport of Texas. In 1993, J.B. Hunt opened two terminals and two yards in Mexico. Linkages to many of these terminals or yards are made possible through agreements or partnerships with other companies involved in physical distribution.

Logistics Management Services

J.B. Hunt's drive toward greater productivity and efficiency has caused it to establish a business dedicated to outsourcing transportation logistics (defined by J.B. Hunt as the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from point of origin to point of consumption).[10] Dedicated Contract Services (DCS), a part of J.B. Hunt Logistics, Inc., is a comprehensive logistics management company that creates, manages, and coordinates customized logistics services and packages for clients that include single-source freight management, substitute service, transportation/logistics consulting, and customized Management Information Systems (MIS) development.

Most simply, DCS is designed to provide the client with the resources it needs to create, replace; or augment its motor carrier fleet, as well as improve its distribution capabilities. DCS's customized service options include:

- Just-In-Time (JIT) delivery support;
- International capabilities;
- On-site management;
- Routing and optimization software;
- Statistical Process Control analysis;
- On-board computers;
- EDI, electronic load tendering;
- Backhaul infusion;
- Surge capability; and
- Contract warehousing.

DCS custom-tailors each logistics distribution package for the customer. This package may include changing the service mix, redesigning routes, or meeting sudden changes in demand. The client receives the benefits of using a private fleet with dedicated equipment, drivers, and management, and also can avoid the capital outlays for purchase and maintenance of equipment. DCS also provides the client with information technologies the client may be unable to afford or unwilling to purchase - such as on-board computers, satellite tracking systems, EDI services, and a variety of routing and statistical packages. Through J.B. Hunt's partnership with Transportación Marítima Mexicana (TMM), DCS can provide clients access to Mexico's largest transportation provider. In addition, DCS hires, trains, and retains the drivers, which means the client saves the expense and time involved in the maintenance of drivers' logs, drug testing, payroll, benefits, and accident insurance. Lastly, DCS is eligible for fuel discounts its clients may not be able to obtain individually.[11]

One example of the possible variations of DCS packages is evident in the package designed for Mark III, a customized van-conversion business from Ocala, Florida, which uses three distinct areas of J.B. Hunt Logistics. They use a fleet of flatbeds to carry 125 loads per week; freight management services oversee 100 broker loads per week; and DCS hauls 335 loads per week. Rather than focus exclusively on its transportation needs, Mark III - as part of a high-growth market niche - is now able to better concentrate on meeting market demands.[12]

Another contract recently initiated with DCS is with IBM. Their primary need of DCS is to ship goods to Central America using JIT delivery service. The DCS contract with them, therefore, revolves around an on-board computer tracking system. This contract also marks the beginning efforts of J.B. Hunt' s expansion into Central and South America.[13]

J.B. Hunt's effort to employ this method of distribution involves all aspects of the manufacturing process from the procurement of materials to the delivery of the product to their customers. They use third-party logistics to perform all or part of a company's material or product distribution functions.

J.B. Hunt's Operations in Mexico

J.B.Hunt Transport Services, Inc. established operations in Mexico in 1989, and in 1990 formed a partnership with the Mexican trucking company, Fletes Soleto, to organize Hunt de Mexico, which was to provide trucking services between the United States and Mexico for *maquiladora* factories in the Ciudad Juarez/El Paso area.[14] After three years the relationship with Fletes Soleto dissolved as a result of dissimilar growth strategies.[15] Apparently, J.B. Hunt's plans to expand throughout Mexico clashed with Fletes Soleto's plan to remain a regional carrier.[16]

J.B. Hunt continued to seek out innovative ways of penetrating the Mexican market. Its initial goal was to find a Mexican partner with more expansive growth plans than Fletes Soleto. In 1992, the Hunt de Mexico subsidiary formed a joint partnership with TMM, which had similar plans for growth. TMM now owns 51 percent of TMM/Hunt de Mexico while J.B. Hunt Transport Services, Inc. owns the remaining 49 percent. This partnership allows J.B. Hunt to offer shipping services in Mexico by truck, steamship, or train. Offices for Hunt de Mexico are strategically located in Nuevo Laredo, Monterrey, Mexico City, Veracruz, Guadalajara, Lazaro Cárdenas, and San Luis Potosí.[17]

J.B. Hunt's revenues from its Mexican operations doubled in its first year. In 1994, revenue goals were US$100 million, which is about a fifty percent increase over 1993. They fell short of their goal with revenue of $80 million for the year, which was still a US$10 million increase from 1993.[18] However, these figures must be adjusted for the change in commodity mix that has occurred since the peso devaluation. There has been a decrease in shipments of almost 45-50 percent for the six months subsequent to the peso devaluation, with most of this decrease represented by retail and consumer goods.[19]

TMM/Hunt currently provides truckload services throughout Mexico, which allows J.B.Hunt to offer door-to-door service to and from Mexico. Despite their partnership, TMM/Hunt de Mexico shipments still cannot completely overcome border congestion, brokerage difficulties, and time delays. However, to facilitate door-to-door service, TMM/Hunt de Mexico is considering opening a location in the western trade corridor at Mexicali. It currently has three locations in the central trade corridor at Nuevo Laredo, Monterrey, and Mexico City, and two others in Guadalajara and San Luis Potosí. It should be noted, however, that TMM/Hunt de Mexico does not have a location in the Chihuahua *maquiladora* trade corridor.

In 1993, TMM/Hunt de Mexico began computerization of its Mexican operations. It provides computerized dispatch with Spanish language screens, computerized maintenance and driver payroll functions, as well as direct deposit for driver payroll, fuel accounts, and formal training. The installation of on-board computers in vehicles by Hunt de Mexico is planned for late 1995. It is expected that these systems will be integrated into operations once global satellite communications systems are in place. These computer screens will also be in the Spanish language, and J.B. Hunt plans to have a routing software program developed for Mexico.[20]

Finally, the significance of J.B. Hunt's partnership with TMM is emphasized by J. B. Hunt's decision to bring its DCS logistics unit into Mexico. Named Hunt DCS - Mexico (Servícios de Logísticos de México), it represents one of the largest and strongest dedicated contract logistics providers in Mexico. Because it, too, is allied with TMM, this business unit can take advantage of a variety of resources and facilities, and serve already existing, as well as new, clients. In addition, this partnership has allowed J.B. Hunt to better understand the business climate in Mexico, as well as the customers, culture, laws, and customs from an insider's perspective.[21] Without its history with TMM, J.B. Hunt could quite possibly have been left with a much smaller share of the Mexican market; instead, it now has the highest profile of any U.S. transportation company in Mexico. In return, J.B. Hunt supplied them their technological capability and industry experience.

In October 1994, Logistica (another name for the joint venture between J.B. Hunt's DCS subsidiary and TMM), entered into a five-year contract with Grupo Cifra, Mexico's largest retailer. Grupo Cifra, which owns Aurrera department stores, operates 276 outlets including supermarkets, discount warehouses, clothing stores, department stores, and a chain of restaurants, all located primarily in and around Mexico City. [22] Aurrera also has a partnership with U.S. retailers Wal-Mart and Sam's Club.

Under the agreement, TMM's land transport and logistics divisions are responsible for providing dedicated service in transporting goods for Grupo Cifra stores within Mexico, while J.B. Hunt handles the conglomerate's U.S.-Mexico traffic. More specifically, TMM handles the distribution to and from Aurrera warehouses throughout Mexico, while J.B. Hunt transports to and from the United States. The decision to have TMM/DCS handle Cifra's transport and distribution is due in part to the emerging trend in Mexico toward outsourcing.[23]

This trend allows the retail sector to rechannel its resources into its core business of selling. J.B. Hunt's DCS unit has a tailor-made contract to meet Cifra's needs. For example, Wal-Mart, the U.S. retail partner, did not want to bring trucks into Mexico because of union implications; therefore, DCS not only provided Wal-Mart with a fleet of trucks but also improved their routing technology. Prior to the contract, shipments were routed manually by Grupo Cifra every night. With the automated routing package, DCS logistics managers have increased the load capacity considerably, but without increasing capital from the client. Currently, DCS processes approximately 1,000 loads per week.[24] All of the roads traveled in Mexico are computerized, giving the logistics manager the capability of selecting the optimal route for delivery.[25] This system, the first of its kind in Mexico, is expected to draw many potential clients to Logistica.

J. B. Hunt's Future in Mexico

Three lines of business define J.B. Hunt Transport Services, Inc.'s vision for the future. First, the Logistics Division, primarily the DCS, is the obvious growth market.

J.B. Hunt's prescribed goals for DCS include doubling the size of its business in Mexico in 1995 to at least US$40 million,[26] and developing logistics managers within Mexico. DCS is shifting toward establishing "home-town" managers who know the culture and the informal Mexican market.[27] The impact of the peso devaluation may cause a delay in the implementation of these plans. Finally, J.B. Hunt is targeting the Mexican port business. With its TMM alliance, J.B. Hunt has an opportunity to expand its services to include seaborne cargo movements.

By exploring high-growth markets in Mexico, TMM/Hunt de Mexico has allowed J.B. Hunt to double its Mexico revenues since it began operating in 1992. Even after the drastic peso devaluation, TMM/Hunt de Mexico has only had to postpone expanding its fleet size. And, by forging recent innovative business arrangements through the DCS and establishing partnerships and agreements throughout the continent, J.B. Hunt has remained a leader in surface transportation in North America.

Case Study 2: Southern Pacific Lines

Southern Pacific Lines (SP) transports freight via an integrated rail network of its principal subsidiaries through 15 states located primarily in the midwestern, western, and southwestern regions of the United States. SP has five main routes that reach from the Pacific Coast across the Rockies and the Southwest toward the Mississippi River, and also along the U.S.-Mexico border from California through Texas all the way to the port of New Orleans.[28]

SP (and its predecessor lines) have been operating in the United States for over 140 years. As a consequence, the railroad has had the opportunity to develop its expertise in intermodal transportation. Its route structure serves many of the most populous and the most productive states in America, as well as top seaports and major gateways into Mexico. This rail carrier serves the Gulf Coast's petrochemical industry; the coal and copper mines of Arizona, Colorado, and Utah; the Pacific Northwest forests; the automotive and industrial regions of the northeast; the agricultural regions of the midwest; and trade with the Pacific Rim.[29] General SP financial and operating data can be found in Table 4.2 below.

Table 4.2
SP Financial and Operating Data, 1993 and 1994

(millions of $US, except where otherwise indicated)

	1994	1993
Operating Revenues	$3,142.6	$2,918.6
Operating Expenses	2,796.9	2,815.4
Operating Income	345.7	103.2
Total Carloads (thousands)	2,273.6	2,077.8
Route Miles (thousands)	14,559	14,829
Revenue ton-miles (billions)	139.1	123.6
Revenue per ton-mile	.021	.022

Source: Southern Pacific Rail Corporation, *1994 Annual Report* (San Francisco, CA, March, 1995), pp. 14,15.

Since its return to public ownership in 1993, SP has been aggressive in updating its facilities and consolidating its operations. It is currently upgrading its entire locomotive fleet and it overhauled or purchased more than 500 locomotives in 1994. This has made more units available and has reduced maintenance downtime. Its increased ability to handle a greater volume of traffic with greater efficiency has encouraged the rail carrier to develop and implement the technologies of intermodalism and logistics management; this would allow it to serve many different types of customers with different needs in many different markets.[30] SP is now ranked first in the intermodal container market; its 300-acre Intermodal Container Transfer Facility (ICTF), located four miles from the Port of Los Angeles/Long Beach, is ranked first among U.S. international container yards - an average of 18 SP trains arrived at this ICTF per day in 1994, serving an estimated 8,142 oceangoing vessels that year.[31]

In 1994, SP's geographic market and route structure, combined with its extensive use of intermodal technologies, were some of the major reasons it achieved such a high percentage increase in its freight volume when compared to other Class 1 railroads. In fact, the total freight volume carried by the rail carrier in 1994 rose by more than 195,000 carloads to an estimated 2.27 million carloads. Gross freight revenues also rose 10.7 percent in 1994 to an estimated US$3.25 billion.[32] SP's extensive route system can be separated into five main routes, or corridors that are similar to highway corridors (see Map 4.2):

- **The Mid-America Corridor**: Originating in St. Louis with a spur in Memphis, this corridor moves south through Arkansas and divides in Texas, with one spur going through Dallas, another going through Houston, and another going directly through Texas to meet with the SP rail lines that run parallel to the border. The Mid-America Corridor moves a great deal of grain, as well as chemical and petroleum products.

- **The Central Corridor**: One spur originates in Chicago, the other in St. Louis, with both sections converging in Kansas City and moving west through Denver and Salt Lake City. The line separates again in Nevada, with one spur going northwest to Portland and the other going southwest to Sacramento and San Francisco. This rail corridor handles primarily automobiles, construction materials, minerals, coal, metals, ore, and forest products.

- **The Golden State Corridor**: This Corridor moves in an east-west direction similar to the Central Corridor, except that where the Central Corridor moves west after Kansas City, this Corridor moves south through Texas and New Mexico to El Paso. It handles primarily grains and automobiles.

- **The I-5 Corridor**: Mirroring the I-5 roadway corridor, these rail lines move in a southerly direction from Portland to Los Angeles where they connect with SP's important Sunset Corridor, which moves along the U.S. border with Mexico. The I-5 Corridor typically transports forest products, metals, ores, minerals, and a variety of construction materials.

- **The Sunset Corridor**: SP's Sunset Corridor is extremely important to trade with Mexico because it moves through (generally parallel to the I-10 road corridor) and connects with all of SP's six points of entry into Mexico - Calexico, Nogales, El Paso, Eagle Pass, Laredo, and Brownsville.[33]

SP's diverse and extensive route structure, then, allows it to take advantage of market changes both in the short and long term. For example, as more companies comply with air quality standards, utility companies are switching to high-BTU, low-sulfur content coal - much of this type of coal is found in Colorado and Utah, states in which SP has excellent rail access. In addition, its rail intermodal facilities, located at or near seaports and other commercial centers, have allowed it to take advantage of the increasing demand for seamless transportation services. In fact, SP is the leader in U.S. container transport, increasing its revenues from intermodal transport linkages (which represented approximately 26 percent of 1994 gross revenues) by 16 percent.[34]

Lastly, the passage of the General Agreement on Tariffs and Trade (GATT) and NAFTA has increased SP's position in transporting commodities from the Pacific Rim and into and out of Mexico. As a consequence of its route locations along the U.S.-Mexico border, in 1994 SP recorded double-digit growth in freight volume to and from Mexico.[35] Figure 4.1 shows SP's percentage increases in gross freight revenues by commodity group for 1994; Figure 4.2 shows the carload comparisons between 1993 and 1994 for various commodity groups.

Map 4.2
Southern Pacific Lines Network

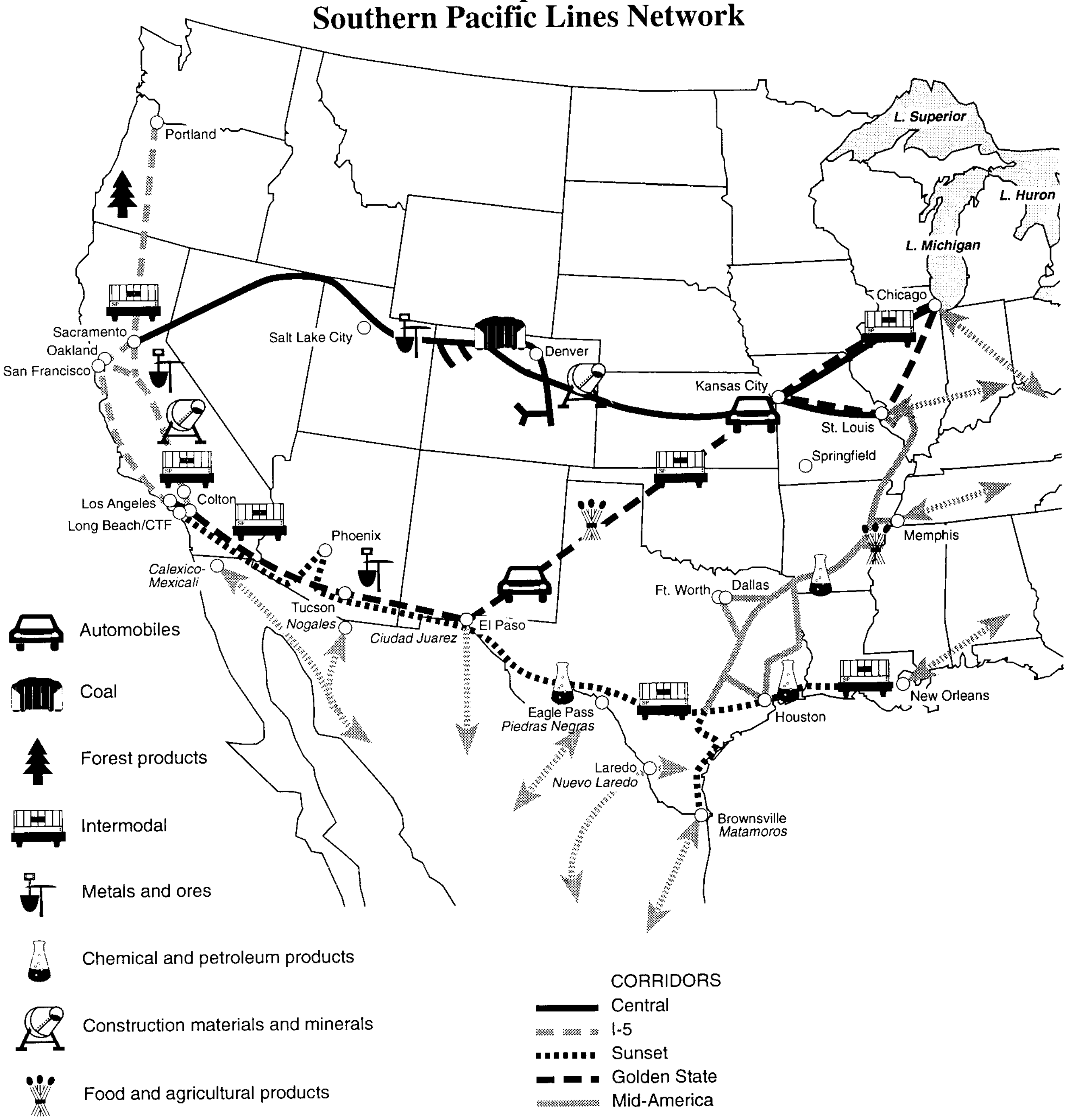
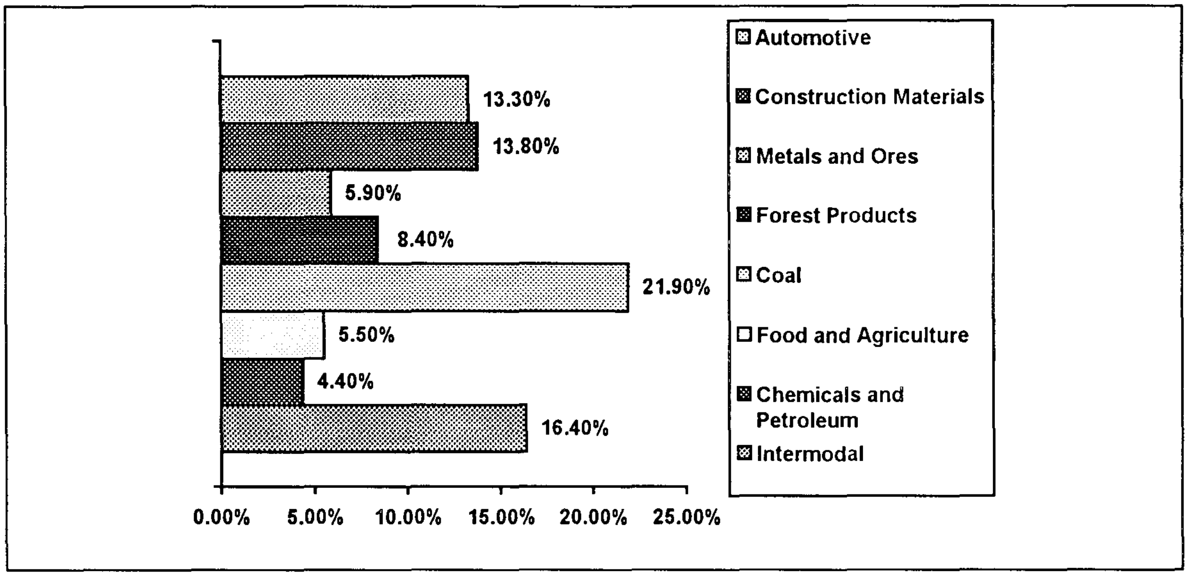
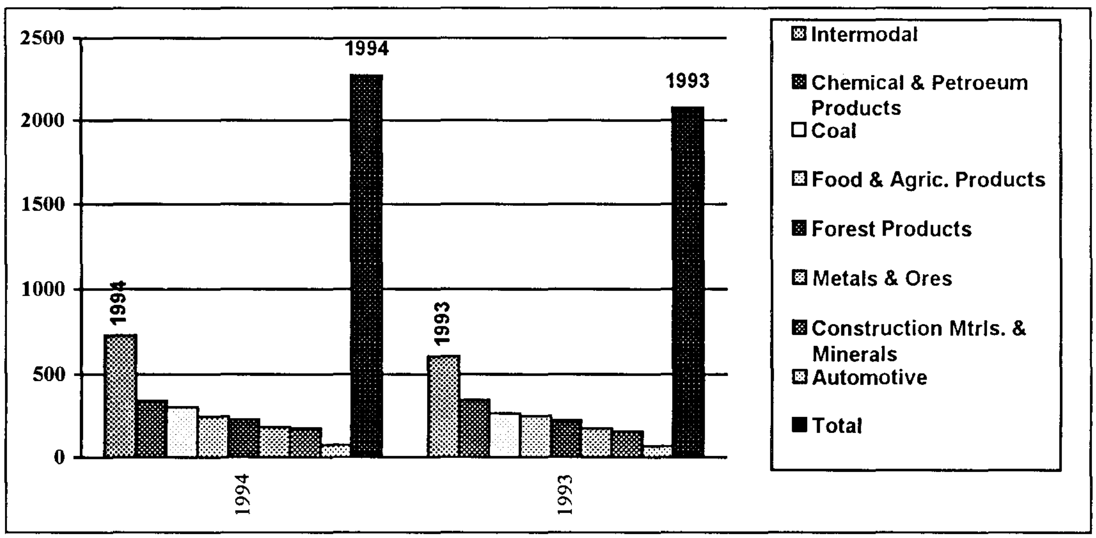


Figure 4.1
SP's Percent Increases in Gross Freight Revenues by Commodity Group, 1994



Source: Southern Pacific Rail Corporation, *1994 Annual Report* (San Francisco, CA, March, 1995), p. 9.

Figure 4.2
Carload Comparisons by Commodity for SP, 1993 and 1994



Source: Southern Pacific Rail Corporation, *1994 Annual Report* (San Francisco, CA, March, 1995), p. 16.

In the first five months of 1995, SP's Mexico operations generated over US$92 million in revenue. Because of the peso devaluation in December 1994, and the resultant decline in Mexican purchasing power, revenues for many commodities were below normal, as they were for other carriers. As could be expected, consumer-oriented shipments were hit hardest, such as automotive, forest products, and food/consumer products. Other commodities, such as grains, fell off slightly because many Mexican firms have been attempting to purchase grains and grain products domestically, or delay new purchases of imported grains. Metals, construction materials, and chemicals showed revenue increases for SP northbound shipments.

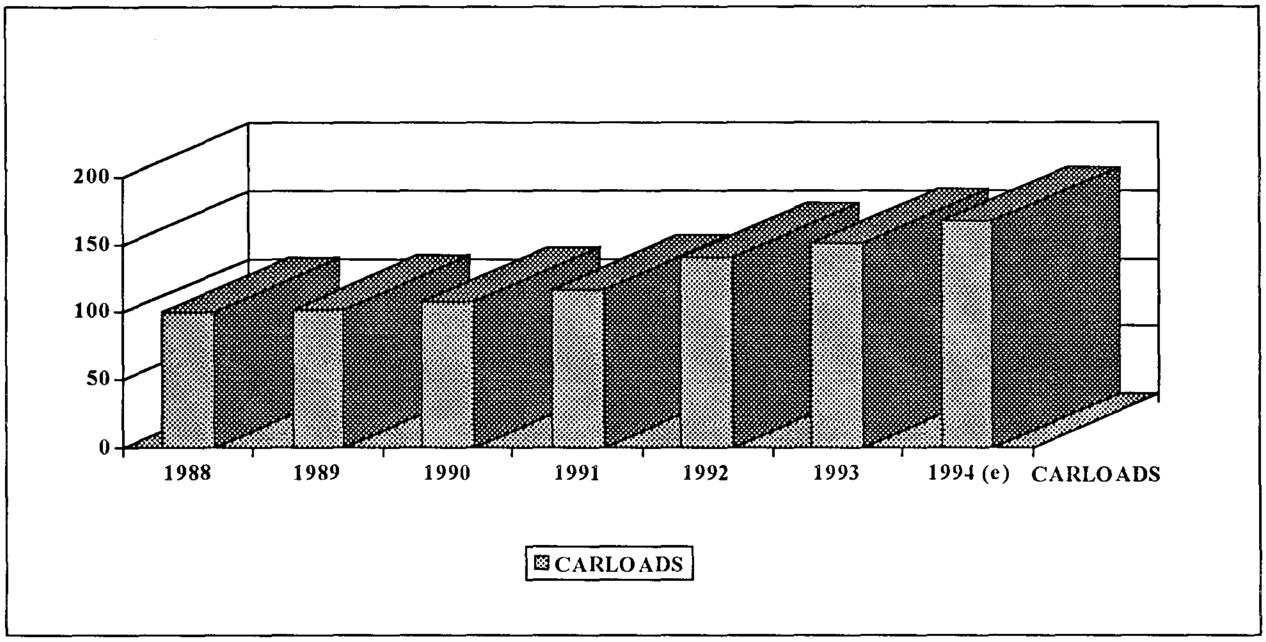
Intermodal shipments, one of the fastest growing segments of SP's Mexico operations, experienced continued negative effects from the devaluation, but still represented the largest percentage of overall carload volume for SP's Mexico operations for the first five months of 1995 -- followed by automotive, forest products, and grains. Intermodal revenues also represented the largest overall percentage of revenues for SP's Mexico operations for the first five months of 1995, followed by automotive, forest products and chemicals. SP's busiest port of entry for the first five months of 1995 by carload volume for freight traffic moving into and out of Mexico was Eagle Pass, followed by El Paso and Nogales.[36]

SP managed to use its geographically advantageous route locations and extensive market access to engage in important domestic and international strategic planning activities over the past few years. In great part, its concentration on intermodal partnerships and technologies encouraged it to use the advanced logistics techniques discussed in Chapter 3 and develop a variety of partnerships and strategic alliances to serve its various markets, particularly in Mexico.

SP in Mexico

SP has a long history of involvement in the movement of commodities to and from Mexico. As discussed previously, this railroad serves more major Mexican border crossings than any other railroad (Brownsville, Laredo, Eagle Pass, El Paso, Nogales, and Calexico). This fact, combined with the effects of the opening of the Mexican economy, the passage of NAFTA, and the decrease in carload rates on the FNM, has placed SP in an excellent position to take advantage of increased north-south trade flows. Not surprisingly, its carload volume, both northbound and southbound, has increased steadily since 1988 (shown in Figure 4.3 below). In 1993, Mexico trade generated in excess of US$210 million for SP, representing nearly 10 percent of the rail carriers total business, and an increase of 10 percent over its 1992 Mexico traffic volumes.[37]

Figure 4.3
Total SP Mexico Traffic, North and Southbound
1988 - 1994 (in thousands)



Source: Adapted from Southern Pacific Lines' SP Mexico Group, *Mexico Overview*, 1994, p. 3.

As a consequence of the peso devaluation, northbound and southbound trade levels have changed, much as they have for the trucking industry. However, most shippers using rail transport options tend to be shipping raw materials, such as coal, minerals, and lumber, rather than the retail and consumer goods that travel more often by truck. The rail industry, therefore, has been affected differently by the devaluation than the trucking industry by the loss of retail trade; this will be explored later in this chapter.

SP's Mexico Operations

As mentioned previously, SP serves its Mexican markets through six overland ports of entry. Shippers from Canada and the United States can reach the interior of Mexico via SP-FNM interchanges in California (Calexico), Arizona (Nogales), and Texas (El Paso, Eagle Pass, Laredo, and Brownsville). The SP, however, must rely on the Texas-Mexican Railway Company (Tex-Mex) tracks to reach Laredo, Texas. Additionally, SP has developed a Mexico Group to facilitate business development in Mexico and conduct strategic planning and analysis of its operations there.[38]

The professional staff of the rail carrier's Mexico Group - which is based in Houston and has offices in El Paso, Mexico City, Monterrey, and Guadalajara - designs service products, performs customer service and sales functions, and manages railroad operations and equipment for the Mexican market. In addition, through the efforts of the Mexico Group on both sides of the border, procedures and systems have been put into place to facilitate the cooperation of SP, the U.S. and Mexican Customs Services, and border customs brokers, in order to expedite documentation and car handling across the U.S.-Mexico border. These include *despacho previo*, or customs pre-clearance (*despacho previo* does not exempt containers from inspection), and *transito interno*, in which containers are shipped in-bond from the border to a "treasury precinct" in the Mexican interior, where they are then inspected and cleared.[39]

The Mexico Group is organized into five sub-groups: strategic initiatives, strategic analysis, border relations, sales, and traffic services. The sales group of SP has the largest Mexico sales force of any U.S. railroad. Its staff is entirely bilingual and fully trained with respect to SP's products and services on both sides of the border. The border relations group designs and implements various processes to smooth cross-border trade movements, improve cross-border asset management, and act as liaison between the rail carrier and the customs agencies and customs brokers of both countries. The sales group's goal is to develop relationships with Mexican shippers and customers to enable SP to negotiate with FNM for competitive rate structures and maximum discount levels. The strategic initiatives group develops products and services to improve SP's strategic position, provide SP and its clients in Mexico with a competitive advantage, and increase levels of responsiveness to the needs of its geographic market.[40]

In addition, SP operates two customer service centers to serve both its domestic market and its Mexican market. The Mexico Group has its own dedicated customer service center, while all domestic traffic is handled through SP's Denver Customer Service center, which is open 24 hours a day. This allows customers to communicate directly with SP regarding billing, tracking and/or custom-tailored activity reports for movement of goods in the United States and in Mexico.[41] SP's corporate Distribution Services Department, which includes marketing, sales, fleet management and intermodal divisions, coordinates efforts between all of the groups involved in developing a market strategy for the rail carrier's clients on both sides of the border. Eight commodity groups within the marketing department work closely with U.S. and Mexican clients, as well as with the Mexico sales, border relations, and the strategic initiatives groups, to develop transportation strategies for specific commodities moving to, from, and within Mexico. These commodity groups include the following:

- Intermodal
- Chemical and Petroleum
- Food and Agriculture
- Coal
- Forest Products
- Metals and Ores
- Construction Materials
- Automotive

The goal of the Mexico Group is to help SP increase business with Mexico. In both the short- and long-term, it will work to bolster SP's competitive position regarding the privatization of FNM, further develop SP's subsidiary in Mexico, SP Mexico, S.A. de C.V., and improve SP's access at the Laredo border crossing. To accomplish these goals, SP has made a commitment to the development and use of logistics management techniques to facilitate cross-border trade flows and seamless transportation networks.

Strategic Initiatives and Logistics Management at SP

Increasing levels of trade between the United States and Mexico, as well as increased levels of economic integration, have had profound effects on the pattern and process of distribution and transportation across the border. An increasing percentage of trade is going into and coming out of the interior of Mexico, resulting in trade patterns that favor longer lengths of haul. For long hauls, particularly of bulk commodities, rail is the favored mode of transportation, linked intermodally with truck. In response to these developments, shippers are demanding seamless transportation and logistics services, in which rail linkages play a large part on both sides of the border. This has placed great pressure on railroads such as SP and FNM to provide these logistics services to their clients. For FNM, this will prove to be more difficult, but via partnerships and cooperative arrangements with railroads like UP and SP, FNM may indeed grow to be a competitive partner in transport services that include warehousing, drayage, customs brokering, tracking, invoicing and customer service.[42]

SP and FNM Privatization Initiatives

FNM is in the process of undergoing privatization; this may well result in a fragmentation of the entire Mexican rail system. In its plan, FNM plans to divide up its rail lines into sections and then offer concessions to private-sector firms, including up to a 49 percent interest in these sections to foreign companies. FNM will offer initial 50-year concessions with the option to repurchase these concessions for another 50 years. FNM also plans to offer a concession for its most profitable section, the line which runs from Nuevo Laredo to Mexico City, which represents almost one-third of total FNM system-wide revenues.[43] However, FNM will not be selling its right-of-way. The goal of this privatization effort is to modernize Mexico's rail network and provide competitive, efficient rail service throughout the country.

The Mexican government has decided to divide the FNM into three major regional sections and various short lines, with a terminal railway designated for Mexico City. The regional sections are the Northeast Railroad, with headquarters in Monterrey; the Northwestern Railroad, with headquarters in Guadalajara; the Southeast Railroad, with headquarters in Veracruz; the terminal railroad for the Metropolitan Zone of Mexico City, owned by an independent company (which can, in turn, be owned jointly by the three major concessionaires or exist as a separate concession) which would provide switching, classification, reception, and delivery of cars for this area.[44]

The short lines are intended to be operated and administered either by the regional concessionaires or by separate companies. In addition, the Mexican government is studying the feasibility of granting access rights on parts of the network and haulage rights within the title of concessions, principally between the Mexico City - Nuevo Laredo line, and separately from what is negotiated between the concessionaires. The FNM plans to eliminate its passenger service except where socially or geographically required, and will allow a governmental agency or private company to provide this service. FNM has also provided for its own downsizing and restructuring, and plans to form a separate corporation to assume responsibility for financial activities, union relations, human resources and asset maintenance. SP expects the formal list of privatization rules to be published in the fall of 1995, with requests for proposals to be submitted beginning in spring 1996.[45] For a more broad description of FNM's privatization and modernization plans, refer back to Chapters 2 and 3 of this report, and to the two previous reports of this three-report series, *Texas-Mexico Multimodal Transportation*, and *Logistics Management and U.S.-Mexico Transportation Systems: A Preliminary Investigation*.

It is obvious that FNM has begun to demonstrate a long-term commitment to partnership arrangements designed to enable it to provide better levels of service and remain competitive. FNM and U.S. railroads are partnering not only to provide traditional rail service, but also to provide more complete logistics services to their customers. The opportunities for SP's involvement in this process are many and varied, and will greatly enhance the competitive and strategic position in Mexico for both SP and FNM.

SP and other U.S. railroads are currently in the process of evaluating the FNM privatization plans in order to assess which segment they are willing to tender a bid for. As U.S. railroads begin to compete with one another during this process of evaluation and bidding, the issue of "trackage rights" will become exceedingly important, and is shaping up to be a political battle, particularly within Mexico. Trackage rights are the rights granted by the railroad that owns a particular length of track to other railroads to move over that track. Without trackage rights, one railroad can freeze other railroads out of an area, in effect creating the potential for a private monopoly in place of FNM's public monopoly. Many U.S. rail companies, as well as many in the Mexican government, including the Secretariat of Communications and Transportation (SCT), are concerned that this kind of monopoly not be created; they believe that the whole point of privatizing the railroads would be defeated by exchanging one kind of monopoly for another and pushing out the factor of competition. However, the Secretariat of Finance and Public Credit is against the granting of trackage rights, indicating that rail lines have greater value if they have exclusive transfer privileges rather than trackage rights.[46] As the time to tender offers comes closer, these differences of opinion will greatly affect the outcome of the privatization.

Improved Access to Laredo -- SP Logistics

As mentioned in previous chapters, Laredo is the most heavily used gateway for both truck and rail traffic into Mexico. SP does not have direct rail access at the bridge in Laredo - the rail lines there are owned and operated the Tex-Mex Railway - and SP competes with UP over access. SP and Tex-Mex are attempting to develop options designed to facilitate SP traffic over the bridge at Laredo so that SP will be able to provide its clients with this option in a cost-effective and efficient fashion in competition with UP. In the meantime, however, SP has formed a dedicated logistics unit located in Laredo, SP Logistics, to help customers who wish to forward freight through Laredo on one bill. SP

Logistics is jointly owned by a subsidiary of SP and Abl-Trans, an SP trucking subsidiary, and in this sense operates as a quasi-separate business unit.

Under the supervision and direction of SP Logistics, SP directs Mexican-bound rail freight destined for Laredo to San Antonio. The trailers are then trucked to SP's Laredo intermodal terminal, drayed across the border and then trucked into the Mexican interior. SP Logistics contracts with a private trucking firm, WW Roland, to move cargo between San Antonio and Laredo. After the cargo is drayed across the U.S.-Mexico border, it is brought to one of the approximately ten Mexican trucking firms which have active interchange agreements with SP for shipment into the interior of Mexico. Via a customized logistics package, SP Logistics in Laredo tracks all the movements of this cargo from origin to destination in Mexico. SP Logistics has been quite successful at making the truck movements from the United States into Mexico efficient, trackable and reliable, and has recently opened up a similar operation in Chicago to track domestic cargo movements.[47]

SP Mexico, S.A. de C.V.

In January 1994, SP incorporated a Mexican subsidiary, SP Mexico, S.A. de C.V. Through SP Mexico, SP is attempting to further develop its multimodal, seamless transportation capabilities. Originally established, among other things, to assist Ford Motor Company in its high-volume rail shipments into Mexico, SP Mexico now works closely with the Mexico Group and a wide variety of clients to bring together all the necessary actors within the transborder logistics supply chain. Often, these individuals and firms step in where SP or the shipper/client has neither the experience nor the resources available to provide the full range of services that are demanded.[48]

SP Mexico performs sales functions in Mexico to encourage northbound shipments, and works on the receiver side to attempt to negotiate better rates from FNM. Because FNM is on a distance-based rate system, and because Eagle Pass, SP's major gateway into Mexico, is further from Mexico City, than Laredo, SP Mexico might try to negotiate rates on the Mexican client's behalf, or attempt to influence the client's gateway choice if this is not possible. Very often, the congestion and delays at Laredo combined with SP's lower rates for moving many commodities through Eagle Pass will influence the client's choice.[49]

Seamless Transportation Initiatives

Seamless transportation initiatives involve the use of partnerships and strategic alliances to facilitate logistics management and intermodalism. As discussed in Chapter 3, these strategic alliances are not only joint ventures between two transportation providers, but are also partnerships with third-party logistics providers. Strategic alliances of this nature allow customers to take advantage of integrated logistics and transportation services, which include single-line freight billing, real-time shipment tracking, the arrangement and payment of customs fees, drayage, warehousing, and multimodal transport services. Customers can have opportunities to custom-design logistics and distribution plans to fit their needs.[50] Partnership logistics and strategic alliances are particularly necessary at the U.S.-Mexico border and for those firms wishing to send freight into the interior of Mexico.

SP, along with other U.S. Class 1 rail carriers, must be concerned over issues of infrastructure development and maintenance, not only at the border but also in the Mexican interior. The fragmentation of activities involving the movement of freight at the border is quite problematic from a logistical standpoint, as is the condition of track in the interior. Many solutions have been proposed to address these problems, which run from interagency and binational problem-solving teams, to harmonization of documentation and trade regulations, to the implementation of a variety of new electronic data interchange (EDI) and tracking technologies. But, in the meantime, railroads like SP turn to contract logistics providers to decrease the problems arising from the fragmentary nature of cross-border trade. These kinds of relationships will allow SP to be competitive in the transportation industry by responding to customer demands, while at the same time remaining sensitive to internal constraints regarding resources and infrastructure.[51] In addition, SP has turned to partnerships and contracts with other transportation firms. SP is considering joint ventures with Mexican transportation firms to reach a larger segment of the Mexican intermodal market, particularly container traffic.

Logistics Management and Strategic Planning in Mexico

The development by SP of market strategies appropriate for Mexico is generally client-driven insofar as the marketing/shipping strategy is based on client needs and feedback. This is not surprising, because transportation is a service that is provided for the client based on its needs. Like most carriers, SP relies upon a system of general operating guidelines while remaining flexible so as to allow for individualized distribution and transportation arrangements.

SP relies on questionnaires and interviews by its sales personnel to design a distribution plan appropriate for the client's needs and budget. These questions are typical of those that any transportation provider would ask a new client, and are commodity-oriented. They include the following:

- What raw products and/or commodities are produced or processed, present and planned?
- What is the product weight, typical dimensions, and typical packaging?
- Where is the desired origin and destination?
- What mode of transport is currently being used? Describe volumes, frequency of shipment, and current costs.
- What is the typical transit time for your commodity? Describe additional costs which impact transit time.
- Are you planning to expand your markets;if so, how?
- Rank the following in order of importance to your firm: transit time, equipment availability, frequency of schedule, rates, special handling, etc.
- What percentage of your commodity is consumed in Mexico? What proportion of total transportation costs do Mexican transportation costs represent?

Taking into account the information gleaned from these interviews and questionnaires, as well as from a detailed knowledge of individual commodity markets, the strategic initiative group provides econometric and macro-level trade forecasting data to one or more of the commodity groups to assist them in setting up a strategy to serve the new client and its market. Sales and marketing personnel coordinate efforts between the commodity group, the strategic initiative group, and the client. Each group acts independently; but when establishing an overall strategy for the client and its market, they attempt to follow an individualized decisionmaking process that revolves around future-oriented market planning strategies. This process is useful as a springboard to customizing transportation and distribution packages for the client.

Strategy Factors and Constraints

Because the movement of freight across the border is a complicated and often frustrating activity, SP personnel must have a detailed understanding of this process and be able to impart this information to the client. Not only are customs and entry procedures different on both sides of the U.S.-Mexican border, but customs procedures at different points of entry also differ from one another. In addition, unanticipated multiple inspections at different sites, combined with the potential for EDI transfer difficulties and concerns over drug trafficking at certain points, makes clearing the border a very imprecise art. This is why logistics management is so necessary to both the client and to SP in designing a strategic plan for transporting any commodity.

Equipment Availability

Numerous factors come into play when designing a market strategy for a consumer who wishes to do business in Mexico. The most important factor is the availability of equipment, particularly within Mexico. Scheduling equipment for use is often a difficult process because SP's Mexico operations do not maintain their own fleet of equipment. Compounding this problem is the shortage of equipment in general as a consequence of the devaluation. Although SP's Mexico operations constitute 7 to 8 percent of SP's total operating revenues, this percentage is small when compared to the U.S. market.[52] Therefore, scheduling equipment can be a difficult task for Mexico market strategists: they must compete for the best equipment while at the same time face the reality that their operation is only a small part of a larger whole. This is made more difficult by their being able to use only SP, and not FNM, cars.

FNM

Railroad operations in Mexico are far different from operations in the United States. U.S. rail companies tend to set their rates on a client-specific basis through a process of negotiation in which the type of commodity being shipped is only one of the many aspects that is taken into consideration. FNM continues to set its rates using the old fixed-rate system. Under this fixed rate system, prices are set according to a distance-based tariff. FNM gives each commodity a class number. Prices are then determined by cross-referencing the class number with the distance to be traveled. The distance factor is set independent of any other variables such as geography and accessibility.

To complicate matters for SP customers, 80 percent of all shipments sent into Mexico by rail arrive at public rail yards.[53] Only 20 percent of customers in Mexico have private rail yards. Because such a small percentage of businesses are "rail served," in that they do not have rail lines at the warehouse they use, most commodities go to public loading and unloading facilities. Although this is cheaper for the recipient of the commodity, it is an inconvenience for the rail company and complicates the process of getting the commodity to its destination. SP strategists must also take into account that a large percentage of the rail cars that go into Mexico come back empty (although this has been changing recently as a consequence of the devaluation), in addition to the general scarcity of rail equipment in Mexico. The economics of equipment use, or "yield management," also encourages SP to keep its most technologically advanced and specialized equipment in the United States rather than down in Mexico because it generates more revenue in the United States.[54] SP logistics managers and sales strategists, then, are faced with a variety of problems when attempting to develop a transportation and distribution plan for a client based on efficiency and cost effectiveness.

Devaluation of the Peso

The devaluation of the Mexican peso has had a dramatic effect on the logistics management processes and market development strategies of SP. For example, FNM has increased its distance rates by over 17 percent this year as compared to last year's rates: a 7 percent rate increase was initiated on February 6, 1995, and on April 10, 1995, the Mexican government tacked on another across-the-board rate increase of approximately 10 percent. The Mexican government is also no longer offering the 5 percent discount rate that they were offering at the end of last year.[55]

The devaluation of the peso has also had an impact on bridge crossing charges.[56] The following table shows the increases that have taken place since the devaluation of the peso. In Brownsville, the US$25 bridge crossing charge is paid to SP, which forwards payment to the B&M Bridge Company.

Table 4.3
Southbound Bridge/Border Crossing Charge
(in pesos)

	Before Devaluation[57]	After Devaluation[58]
Laredo	1.45 per metric ton	1.6 per metric ton
Eagle Pass	1.45 per metric ton	1.6 per metric ton
El Paso	1.45 per metric ton	1.6 per metric ton
Nogales	146.9 per car	161.6 per car
Mexicali-Calexico	293.8 per car	323.2 per car

Source: Telephone interview by Clint Small with Al Altuna, Director-International Rates and Price Negotiations, Southern Pacific Lines' Mexico Group, Houston, Texas, April 6, 1995.

As one would expect, these changes in rates and fees have had an effect on southbound traffic into Mexico. SP freight volumes have shown signs of decreasing, but SP has not experienced as large a downturn as many other transportation firms (particularly in the trucking industry), presumably because rail transports a different commodity mix.[59] Rail does not carry as much retail and consumer merchandise as trucks do, and carries more of the raw materials and bulk items necessary for production and manufacturing. This has the effect of partially insuring the rail lines against extreme fluctuations in cargo volumes.

U.S. Customs: Carrier Initiative Agreement

In June 1995, the U.S. Customs Service announced that it is planning to initiate a program for drug interdiction aimed at all U.S. carriers which conduct business at any U.S.-Mexico land border crossing. This program, called the "Southern Land Border Carrier Initiative," was intended by the United States Customs Service to consist of an agreement, or contract, between it and a carrier to deter the illegal importation of drugs into the United States on or within the carrier's conveyances, associated equipment, or lading. It requires the carrier to institute measures, programs, and procedures to conform to what the U.S. Customs Service defines as "the highest degree of care and diligence" against unauthorized use of the carrier's conveyances for the importation of illegal drugs (as required by the Anti-Drug Abuse Act of 1986).

According to a memorandum dated May 5, 1995, from the Department of the Treasury, U.S. Customs Service, to its Regional Commissioners, District Directors, Port Directors, and Directors of Cargo Processing, the purpose of the Carrier Initiative, "is to prevent narcotics from getting on board conveyances and mixing with legitimate cargo at foreign locations" by having land and rail carriers sign initiatives with Customs to enhance facility security and "cooperate closely with U.S. Customs in identifying and reporting suspected smuggling attempts." The memorandum goes on to say that, in return, Customs agrees to train carriers' employees in the areas of cargo security, cargo profiling, personnel security, and conveyance search. According to the memorandum, some of the Carrier responsibilities include:

- Installation of security systems for foreign and domestic cargo storage/handling facilities, container yards, and conveyances to prevent the "improper manipulation,"transportation, or handling of cargo or containers; security procedures to restrict access to conveyances and prevent the lading/landing of drugs while en route from facilities in foreign locations; the safeguarding of the use of seals; and maintenance of a log of seal numbers used.

- Conducting complete employment and security checks, plus institution of photo ID systems.

- Ensuring that all cargo markings, numbers, weights, and quantities agree with the bill of lading or manifest.

- Notification of first-time shippers and cargo documentation anomalies (which can include unusual cargo value-to-shipment charge ratios, unusually routed cargo, and unusual requests made by shippers).[60]

Should illegal drugs be found aboard a conveyance belonging to a carrier that signed an agreement, "the degree of compliance with the terms of the agreement will be considered as an additional positive mitigating factor in any seizure or penalty mitigation or recommendation. Special administrative provisions pertaining to penalty amounts and expedited processing of penalties will be available to agreement signatories."[61] The Customs Service indicates that this "partnership...could save carriers millions of dollars in potential fines...and thousands of man-hours in penalty litigation processes," that a signatory carrier's conveyances "may be searched less frequently than non-signatories because of their strict security practices," and that the carrier "could cite their involvement in the program as a marketing tool."[62]

It is obvious that this agreement has major implications for all carriers, including SP. Implied in the Initiative's requirements is, first, the threat of the assessment of substantial monetary penalties against U.S. carriers if illegal drugs are found on or in any conveyance while entering into, being held in, or departing from any of the carrier's border yard facilities regardless of the documentation status of the goods within the conveyance. Second, there is the implied position of the Customs Service that if a carrier does not agree with all the terms and requirements of the Initiative and does not become a signatory to the agreement, that carrier will be subject to significantly higher fines and stronger penalties. Third, the agreement also provides for the possible seizure and forfeiture of conveyances which have "transported" illegal drugs, regardless of ownership. This is an interesting provision, because many carriers would seriously consider not allowing equipment to enter into Mexico rather than risk its loss upon re-entry. Rail lines like SP are concerned because they do not necessarily operate exclusively with their own equipment, do not necessarily control their foreign shipping contracts, and are not necessarily responsible for loading and transportation from the point of the foreign origin, like a steamship line or an airline operating in a foreign port.[63]

SP's Future in Mexico

SP has used its market power and experience in the industry to insert itself effectively into the Mexican rail market. First, SP has allowed its route structure to generate market potential and wisely realized the potential for growth through the pursuit of intermodalism. Through its Mexican subsidiary and its Mexico Group, SP provides its clients significant strategic planning expertise on both sides of the border, enabling its clients to do businesses efficiently, and as close to seamlessly as possible. The privatization of FNM opens up a whole new area for SP, especially if SP's bids for concessions are successful.

Case Study 3: Transportación Marítima Mexicana, S.A. de C.V.

Transportación Marítima Mexicana, S.A. de C.V. (TMM), together with its subsidiaries, is the largest maritime shipping company in Mexico and the leader among the world's carriers in serving Mexican ports.[64] In 1993, TMM generated over US$150 million in annual revenues.[65] TMM is a full-service shipping company whose services encompass virtually all aspects of maritime dry-cargo shipping. Its liner service accounted for 73 percent of 1992 revenues from freight and services. It provides regularly scheduled calls to 30 ports in 16 countries, transporting containerized, project, and general cargo.[66]

In addition to its liner service, TMM engages in other types of maritime shipping services which accounted for 18 percent of 1992 revenues from freight and services, and consisted primarily of the transportation of automobiles and dry-bulk cargo. TMM also has a long-term contract for the transportation of refined petroleum products.[67] In 1992, TMM transported approximately 234,788 TEUs of containerized cargo and 36,689 tons of noncontainerized cargo, 78,316 automobiles, and 3.13 tons of dry-bulk cargo.[68]

TMM's fleet presently consists of 21 vessels, that include five multi-purpose carriers, five container/bulk carriers, one bulk carrier, one product tanker, and four supply ships. Sixteen of the vessels are owned by TMM, and five vessels are under long-term charters with purchase options. As of March 15, 1993, TMM was also time-chartering nine additional vessels to supplement its fleet for periods ranging from one voyage to one year.[69]

Liner Service

The liner service, which accounts for approximately 80 percent of shipping revenues in 1992, is TMM's principal maritime shipping service.[70] The liner service operates in the general-cargo market. General cargo vessels predominantly carry semi-manufactured and manufactured goods, ranging from timber to electronic components. The following table includes some of the more significant imports and exports that are characteristic of goods transported by TMM.

Table 4.4
Significant Imports and Exports of TMM

IMPORTS	EXPORTS
Auto Assembly Materials	Manufactured Goods
Auto Parts	Automobiles
Electrical Equipment	Chemicals
Machinery	Petrochemicals
Heavy Equipment	Minerals
Rolled Steel	Coffee
Electronics	Textiles
Grains	Fruit and Vegetables
Minerals	Chicken and Fish

Source: TMM, *Prospectus*, Bear, Sterns & Co. and Goldman, Sachs & Co., Mexico, D.F., 1993, p. 29.

In addition, the liner service transports highly specialized noncontainerized cargo which is referred to as project cargo. For example, TMM has carried, from the point of manufacture to the site of installation, entire auto manufacturing plants, steel plants, and electric power plants. TMM claims to be the major carrier of project cargos in Mexico. Three principal projects which have had a positive impact on TMM's revenues in the area of project-cargo transport are Nissan's investment in a new production facility in Mexico and two power-generation projects undertaken by Comisión Federal de Electricidad, the Mexican state-owned electrical power monopoly.[71] A summary of the recent operating performance of the liner service is presented below.

Table 4.5
TMM Liner Service - Summary Operating Information
(millions of $US)

	1992	1991	1990
Revenue	$339.9	$293.6	$280.1
Gross Profit	$55.5	$33.5	$33.2
Volume:			
TEU's	234,788	201,151	197,042
Tons (000's)	2,516	2,340	2,218

Source: TMM, *Prospectus*, Bear, Sterns & Co. and Goldman, Sachs & Co., Mexico, D.F., 1993, p. 29.

Other Maritime Shipping Operations

In addition to its liner service, TMM engages in other types of maritime shipping operations such as car carrier and dry-bulk operations. For example, in 1992, TMM opened the first car shipping terminal in Latin America. This 267,000-square-foot terminal, which is located in the Port of Veracruz, has the capacity to handle 2,200 cars destined for export markets.[72] TMM currently owns a fleet of five car carrier vessels with a combined capacity of 18,380 cars. A total of 65,000 units were transported in 1993, generating revenues of US$32 million, 26 percent less than that recorded in 1992.[73]

A decline in operating results of the car carrier division in 1993 may be attributed to three factors: the contraction in sales of Japanese cars in the United States; the decline in Mexico's unit exports of automobiles to the countries TMM serves; and greater competition in automobile transport traffic.[74] TMM has reduced its activity in this sector, but has managed to compensate by increasing activities related to PEMEX with additional tankers and supply ships.[75]

The dry-bulk cargo market is driven by three major commodities: coal, iron ore, and grain. Globally, these commodities account for approximately 75 percent of the tonnage demand for dry-bulk shipping. The remaining 25 percent of demand consists of minor bulks, including alumina, bauxite, and sugar. TMM estimates Mexican trade for all dry-bulk cargoes to be in the range of 18 million tons per year.[76] Due to poor port conditions and inland transportation limitations, Mexican seaborne trade in these products occurs largely on "handy" size vessels, which generally carry 25,000 to 40,000 tons, and in some cases, 8,000 to 12,000 tons. TMM's dry-bulk carrier has a capacity of 39,100 tons and is equipped for Mexican port conditions.[77]

In 1992, TMM took advantage of its opportunity to obtain, for the first time in history, a long-term contract with PEMEX for the transportation of refined petroleum products, such as gasoline, diesel oil, and jet fuel, from the terminals located in the ports of Parjaritos, Veracruz, Ciudad Madero, and Tamaulipas. For this purpose, TMM purchased a double-bottom tanker built in 1991, which meets all of the international standards for safety and environmental protection. To supplement this tanker, three supply ships are providing support services to the oil-drilling platforms of PEMEX in the Gulf of Mexico.[78] TMM also has three medium-term contracts for smaller supply ships and may seek additional long-term petroleum contracts in the future.[79]

Nonshipping Operations

TMM operates various nonshipping businesses which support its core shipping operations. These businesses include storage for bulk liquids, trucking services, port and terminal operations, shipping agents, cargo handling, and Texas-Mexican Railway. Nonshipping businesses experienced growth of 31.4 percent from US$32.2 million in 1991 to US$42.3 million in 1992.[80] In 1993, nonshipping revenues were US$52 million, representing a 23.3 percent increase over 1992.[81]

In 1990, TMM established a subsidiary to provide better overall door-to-door container service within Mexico. The trucking industry in Mexico is highly fragmented and the road network is poor, making timely overland transportation difficult to arrange. The subsidiary, Transportación Terrestre TMM, S.A. de C.V., was established to help maintain a competitive advantage in this area for TMM's Liner Service. As of March 31, 1993, the subsidiary operated a fleet of 49 trucks with trailers and chassis, allowing for the shipment of one 20-foot and one 40-foot container simultaneously. The truck fleet is used primarily for time-sensitive cargo.[82]

The most significant increase in nonshipping revenue was attributable to a subsidiary designed to provide stevedoring services in the Port of Veracruz. In August 1991, TMM, along with two competitors, was granted a permit by the Mexican government to provide stevedoring services (which include the loading and unloading of cargo to and from vessels) to the Port of Veracruz. In 1993, TMM serviced 341 vessels giving it a 35 percent market share for stevedoring services in the Port of Veracruz.[83] TMM rents all the major equipment used to load and unload vessels from the Port Authority of Mexico.[84]

TMM has an extensive network of shipping agents in Mexico that provide these services to more than 1,570 commercial vessels and cruise ships annually at Mexico's 14 main ports. The main function of these agents is to support TMM's core shipping business in the areas of marketing, financing, bulk cargo transport, port services (refueling, crews, etc.), and overland transportation. Approximately 50 percent of the services performed by these shipping agents is provided to third parties.[85]

The Texas-Mexican Railway Company was formed in 1875 and was acquired by TMM in 1982. This railway covers a 160-mile stretch between the city of Laredo, Texas and the port city of Corpus Christi, Texas. One-half of overland bilateral trade between Mexico and the United States passes through Laredo, making this an important point of rail access for TMM.[86]

Strategic Positioning

While conditions in the global shipping market will be a major determinant of TMM's financial performance, management believes that the following factors provide the company with a competitive advantage in the Mexican liner market: geographic location, configuration of vessels, and door-to-door service. The geographic location of the Mexican market presently makes it costly for many potential competitors to divert their ships from their principal route (i.e., the United States) to service Mexican trade. Mexican port conditions generally require the use of shallow-draft, self-loading/unloading liner vessels such as those used by TMM. In order to achieve economies of scale, large international carriers have gradually changed the configuration of their fleets to favor larger, deeper-draft vessels which do not require unloading equipment. Due to the present state of Mexico's port infrastructure, these carriers are currently ill-suited to service Mexican trade.

Door-to-door service forms an important component of the containerized cargo business. Overland transportation in Mexico is more difficult to arrange and control than it is in other major shipping markets because of the highly fragmented trucking industry in Mexico and the poor road network. By combining the largest network of offices in Mexico with its trucking subsidiary and forming a joint-venture with J.B. Hunt Transport, Inc., TMM has a competitive advantage over non-Mexican shipping companies in providing overland service within Mexico.

TMM calls on more Mexican ports and provides greater frequency of service to these ports than any other carrier. Two significant port agencies operate in Mexico as part of the TMM group. In the Gulf of Mexico, there is Agencia Marítima Mexicana, S.A. de C.V., and in the Pacific Ocean, there is Linea Mexicana del Pacifico, S.A. de C.V. Both agencies have their own office network and more than 300 personnel. They provide services for container carriers, bulk carriers, tankers, car carriers, and general cargo. This generally allows TMM's customers to move goods to a port closer to their final destination in Mexico and with earlier deliveries than could be obtained from competing lines.[87]

Strategic Alliances

Many of TMM's nonshipping businesses operate as joint venture agreements. This reflects a commitment by TMM to implement the most cost-efficient means available in order to offer shippers door-to-door service throughout Mexico. TMM selected firms based in the United States which have proven expertise in offering quality services. This was the case, in mid-1992, when TMM formed a joint venture with J.B. Hunt Transport, Inc., to create TMM/Hunt de Mexico, a corporation which provides commercial road freight transportation services throughout the United States.[88]

The purpose of this joint venture, which is in the form of a corporation owned 51 percent by TMM and 49 percent by J.B. Hunt, is to market TMM's overland transportation services in Mexico and to aid in the development of road freight transportation services between Mexico and the United States. TMM commenced operation of this service in June 1992, using a fleet of trucks leased to TMM by the joint venture. As of March 31, 1993, the joint venture had approximately 50 trucks, and TMM had contributed US$1.5 million to the joint venture.[89]

In October 1994, TMM and J.B. Hunt entered into a five-year contract with Grupo Cifra, Mexico's largest retailer, which owns Aurrera department store chain and is a partner in the Mexican operations of Wal-Mart. Under the agreement, TMM's land transport division will be responsible for providing dedicated service in transporting goods bound for Cifra stores within Mexico, while J.B. Hunt will handle the conglomerate's U.S.-Mexico traffic.[90]

TMM effectively controls 51 percent of Global Reefer Corporation, a bulk refrigerated cargo carrier started as a joint venture with Del Monte Fresh Produce Company. Global Reefer concentrates on carrying food from Central America to Europe, the United States and Asia. Its operations, covered by long-term contracts, have contributed US$120 million in revenue to TMM.[91]

In 1974, TMM entered into a joint venture to provide storage services for chemical products and liquids in bulk form at the Mexican ports of Veracruz and Coatzacoalcos. This joint venture is controlled 51 percent by TMM and 49 percent by Van Ommeren, a Dutch shipping and oil storage company. In 1974, there were no facilities in Mexican ports for storage of liquid products. As of December 31,1992, the joint venture's facilities had a total capacity at each port of 63,200 cubic meters which represents 80 percent of the commercial tank capacity in the ports.[92]

Negotiating an Alliance: Conflict of Visions

TMM/Hunt de Mexico is the fastest growing sector of TMM. However, the success of this joint venture has not been without conflict. Initial negotiations of this joint venture were conducted by only two officials, Terry Matthews, Vice President of the International Division of J.B. Hunt Transport Services, Inc. and Pedro Carranza, Director of Maritime Customer Service of TMM in Mexico City.

Under Carranza's guidance, TMM conducted an analysis of the of the 25 largest trucking companies in the United States. This research resulted in the selection of J. B. Hunt as the best candidate for a partnership agreement. According to Carranza, the single most important factor in this decision was the growth that J.B. Hunt had experienced over the previous decade due to its aggressive efforts to develop its market position in the United States. According to Carranza: "We were impressed with J.B. Hunt's innovative leadership in intermodalism and in technology."[93]

Concerns over cargo theft on Mexican highways still remain an issue for U.S. shippers. J.B. Hunt sought to address this issue through the use of satellite tracking technology developed for use in the United States. According to Carranza, however, this measure would be unnecessary because there would be only three or four major cities between which cargo would move and only one route between each of these cities. Mr. Carranza maintained that they did not need expensive satellite tracking systems to track cargo shipments, and that they would consider them in the future only if domestic trade dramatically increased and road systems proliferated to make these systems necessary.[94] Carranza also found J.B. Hunt's serious consideration of this investment in high technology to be contradictory to their other plans, such as the decision to transport containers via train and then transfer freight at intermodal terminals. Since this activitiy would have resulted in shorter truck trips, Carranza maintained that expensive satellite tracking systems would not have been justified.[95]

Not surprisingly, language was also cited as one of the main barriers to conducting negotiations related to this new alliance. Because all meetings were conducted in English, Carranza admitted that he often felt at a disadvantage. "Many times, my English speaking skills did not enable me to express my exact intentions. Unfortunately, this eventually led to misunderstandings and conflict between management officials of the two countries," he said.[96]

Another point of conflict between the partners concerned the issue of whether to implement use of a training manual for Mexican truckers since truckers employed by J.B. Hunt in the United States follow specific rules and regulations that are outlined in a training manual. According to Carranza, Mr. Matthews wanted to use this type of manual for truckers working for the joint venture. Carranza was not willing to introduce the manual. "Because I was not sure that I, myself, could be held accountable for procedures in a manual, I refused to implement it. I did not want to make a mockery of a training manual," he explained. His refusal to follow Matthew's advise proved to be a divisive factor in their professional relationship.[97]

Trucking in Mexico is fundamentally different from the United States. The difference is characterized as cultural by Carranza. Trucking has been a family profession for generations; it is a career that is respected and well-paid.[98] In the United States, trucking is a job that people train for in a classroom; truckers do not have the same power and position in society. Carranza explained that this cultural difference caused joint-venture managers from the United States to mishandle employee relations. "In Mexico, you cannot easily fire people and replace them, that is just what Hunt de Mexico managers did," he explained. This resulted in approximately 20 lawsuits over the course of the first two to three months of operations. Not only was this costly in financial terms, but also costly in terms of professional working relationships.[99]

Decision Factors in a Maritime Alliance

One of TMM's primary competitors for Far East Service is American President Lines, Ltd. (APL), a significantly larger company. APL is a wholly-owned subsidiary of American President Companies, Ltd. (APC).[100] In Mexico, the company operates through a wholly-owned subsidiary, APC de Mexico, based in Mexico City, with offices in Guadalajara and Monterrey. APL helped pioneer double-stack intermodal service between the United States and Mexico and introduced the first single-contact container service linking the United States, Mexico, and Canada. APL also offers intermodal marketing services in Mexico and both full- and less-than-containerload transportation services between Mexico and key markets throughout Asia.

TMM had consistently held that, because APL's focus is the United States rather than Mexico, it posed to real threat to capturing the Mexican market. TMM based these claims on the fact that its competitor had not allocated significant capacity to the Mexican market. However, in a vessel-sharing arrangement between TMM and APL late in 1994, TMM demonstrated an interest in sharing in APL's extensive research and development in intermodal operations. TMM perceived this agreement as an opportunity to reduce costs and diversify services to other ports, thereby achieving a competitive cargo traffic position.[101]

Under this slot charter agreement, TMM and APL will offer a weekly, fixed-day, all-water container service between Asia and ports on the Pacific Coast of Mexico. It is the first of its kind linking the two markets. While APL offers an intermodal option that combines trans-Pacific ocean carriage to the U.S. West Coast with rail or truck connections into Mexico, the direct service will eliminate the need for time-consuming double customs entries.[102]

Each party is committed to purchase a minimum amount of vessel space at contract rates and may buy available extra space as needed. APL's minimum space purchase commitment exceeds that of TMM by approximately US$5.3 million per year.[103] Both carriers market their services separately and coordinate their own customer's moves.[104]

According to Luis Goya, Executive Director of TMM Liner Services in Mexico City, this agreement offers expanded port coverage and enhanced transit times. TMM will use APL's efficient ocean terminal at San Pedro (Los Angeles) and is negotiating with APL's affiliated business unit, APL Stacktrain Services, to expand TMM's intermodal capabilities in the United States. Goya explained that transit times will also be decreased: "the Hong Kong to Southern California voyage will be reduced by six days to 13 days, and from Los Angeles to Yokohama, two days will be cut from TMM's previous 13 day transit."[105]

With this agreement, APL registered a vote of confidence in the decentralization and privatization of Mexican ports. Ironically, APL had spent the past few years marketing its intermodal operations as an alternative to the inefficient and historically corrupt port system. Its decision to move freight away from the land border and through

Mexican ports such as Manzanillo and Lazaro Cárdenas demonstrated a change in trend. By awarding 120 private terminal concessions over the past two years, the Mexican government has helped to overcome the stranglehold of unions whose rules often stalled cargo movements through those ports.[106] For example, before privatization, five unions controlled stevedoring in Veracruz and they were discharging only eight to 10 containers per hour. Now only three unions remain and they are unloading about 40 containers per hour.[107] Also, APL pursued all-water service as a way to allow trans-Pacific cargos to avoid the delays that sometimes result from customs inspections of Mexico-bound shipments at Los Angeles, and also to avoid possible border congestion at El Paso or Laredo.[108]

Prior to the agreement, TMM operated six vessels which every eight days linked ports in Mexico with California to the Far East. With the commencement of joint service, TMM added a seventh vessel to this service. APL currently moves about 200 40-foot cargo containers into Mexico weekly, including about half by land.[109] In January 1995, APL announced the start-up of an intermodal rail service to shuttle containerized cargo between the Mexican container port of Manzanillo and consumer centers in Mexico City and Guadalajara.

Decisionmaking within strategic alliances, initially formed to capitalize on opportunities afforded by Mexican port privatization and NAFTA, is currently influenced by the difficult times resulting from the economic crisis in Mexico. According to Joaquin Montalvan , Director General of APL de Mexico, "The currency crisis in Mexico has put a halt to APL's plans to develop doublestack service at Manzanillo. APL will probably continue to rely on weekly, fixed-day single stack service from Manzanillo to Mexico City and Guadalajara. Delays in plans are due solely to the devaluation, not to problems in terms of cargo handling, brokers, trucking or rail at Manzillo."[110]

Improving Distribution Systems

In October 1994, TMM and J.B. Hunt entered into a five-year contract with Grupo Cifra, Mexico's largest retailer, as described previously. Under the agreement, TMM's land transport division will be responsible for providing dedicated service in transporting goods bound for Cifra stores within Mexico, while J.B. Hunt will handle the conglomerate's U.S.-Mexican traffic. The decision to have TMM handle Cifra's transportation and distribution is due in part to an emerging trend in Mexico. While TMM is not concentrating heavily on the retail sector, it is taking advantage of the decision by retailers to concentrate on marketing and outsource other services.[111]

In this case the economy is to blame for a stall in plans for Cifra; this is unfortunate for TMM. Lic. Jose Antonio Tellez, newly appointed Director of Logistics for Aurrera, explained that Cifra's relationship with TMM developed as a result of their distribution joint venture with Wal-mart. Initially, Cifra and Wal-mart had planned to manage several distribution centers throughout Mexico and manage 90 percent of merchandise through these centers, but due to problems with peso, these expansion efforts were temporarily suspended. According to Tellez, "we need to develop sufficient volume to justify a total integration of advanced logistics management systems. We know we are going to get there sooner or later, but it won't be this year as planned".

Furthermore, top-level management resists the implementation of technologically advanced logistics management systems at Aurerra. Although Aurerra hired Tellez in an effort to implement procedures used by their U.S. partners Wal-Mart and Sam's Club, their level of commitment to this plan remains uncertain. For example, recent suggestions for inventory control procedures have not yet been taken seriously. Clearly, there still exists an attitude that what has worked in the past is sufficient to address future demand. According to Tellez, "this token interest in improving distribution systems is due to the lack of competitive forces in transport systems in Mexico. The pervasive lack of understanding within Mexico stems from the inability to see logistics beyond merely a means of transportation or distribution and in terms of cost advantage and improved customer service."[112]

Emphasis on the Future: Options for Land

Many of the current plans for TMM's future in Mexico are dramatically different from those of the past. The liberalization of the economy and a greater presence of foreign competitors has caused TMM to take customer demands more seriously. In order to serve these demands, TMM plans an aggressive intermodal campaign and modernization of existing facilities. These plans coincide with the privatization of FNM. TMM wants to position itself to be a full contender in the negotiations for FNM concesions. According to Leopoldo Gomez Gonzalez, TMM's Executive Director of Operations, "we want to give better transportation service on a door-to-door basis. We feel that is where we can be most competitive."[113]

TMM recently hired Brad Skinner, a veteran of Southern Pacific Lines, American President Lines, and Schneider National, to serve as Chief Operating Officer of Intermodal and Land Operations. Furthermore, TMM will form an intermodal company this year. It has not been determined whether the intermodal company will be a subsidiary of TMM or a separate company owned by Grupo Servia, TMM's holding company. Instead of selling each leg of its transportation services separately, it will combine its marketing departments to offer total packages.

To make the intermodal company feasible, TMM is investing in expanding and upgrading Tex-Mex railway facilities in Laredo, Texas, to create a consolidation facility for intermodal use and use as a car-load terminal. Tex-Mex's operating costs have been cut due to a 40 percent reduction in staffing levels. "We are confident that the Tex-Mex can operate as a very efficient, low-cost Class 3 railroad," claimed Mr. Skinner.[114] TMM is also seeking to manage a second ramp at the busy Pantaco railyard in Mexico, and is negotiating with Mexican transport officials for through service into Mexico that does not involve FNM locomotives.

An idea which has continued to resurface in Mexico since the 1840s is that of a rail landbridge across the Isthmus of Tehuantepec. Thus far, there have been sufficient alternatives to this landbridge. But, the upcoming concessions which will be made available by the privatization of FNM have renewed interest in the idea. TMM is currently performing a cost-benefit analysis to determine the potential of a rail landbridge between the Pacific Port of Salina Cruz and the Gulf of Mexico Port of Coatzacoalcos is economically feasible.[115]

The landbridge would be an alternative to a U.S. landbridge or to the Panama Canal. Because the canal is becoming increasingly crowded and expensive, TMM feels that a new landbridge is worth consideration. "Obviously, it is the numbers that will determine if it makes sense to pursue the concept," said Skinner. With the deregulation of rail in the 1980s and the introduction of intermodalism, transport has become inexpensive. "We are well aware that it will be hard to compete with doublestack service by companies such as UP and APL on routes between the Far East and Europe or the U.S.," he added.[116]

TMM's Future

Corporate decisionmaking has begun to transform as a result of the liberalization of the Mexican economy. TMM clearly recognizes the need to expand and diversify their holdings in order to compete in the global economy. Their efforts to improve their position in this arena has been in response to customer demand and joint-venture agreements.

TMM plans to position itself strategically in order to secure private concessions. Strategic alliances, improved efficiency in existing operations, and concentration on a variety of intermodal options all play important roles in TMM's plans. Officials at TMM are clearly aware that all of these options require innovative approaches to decisionmaking within the corporate structure.

Unfortunately, aggressive efforts to move ahead to restructure the transportation system have been halted in response to a sharp devaluation of the peso. Mexican entrepreneurs remain committed to competing in a more open economy, but are hesitant to make significant investments. This guarded optimism in the light of current economic situation signals the atmosphere in which future strategic planning will proceed.

Case Study 4: Almacenes Nacionales de Depósito, S.A. de C.V.

Up to this point, we have examined transportation providers and how they are responding to changes in the market for transportation services. But what about the distribution side of the logistics equation? In this case study, we will explore how Mexico's leading public warehousing concern, Almacenes Nacionales de Depósito, S.A. de C.V. (ANDSA), is responding to new information technology requirements and industry standards. How does ANDSA plan to develop certain geographical or commodity markets? How does it conduct its strategic planning? What function does logistics management play in its future?

Warehousing has become an increasingly important link in the logistics chain. The warehouse has evolved into a major intermodal center for distribution of all kinds of goods, placing new demands and emphasis on the efficiency and level of technological advancement of warehouses. A warehouse must now employ a wide variety of automated technologies, including automated inventory management systems, locator systems, EDI, bar coding, and tracking systems to satisfy client needs. These forms of technology closely link together the client, the warehouse, and the transportation company. The closer relationship between these actors requires the warehousing firm to be acutely aware of customer requirements, particularly with regard the handling of certain commodities and/or the special needs of different geographical markets.

The complex technical systems now being used in most warehouses lend themselves to economies of scale. There has been, in the past few years, a definite increase in the size of warehouses (in square footage), and also an increase in the scope of value added services offered to customers. As warehouses become larger, they develop into networks to facilitate service, like the hub-and-spoke systems mentioned in Chapter 3. Warehouse networks are able to offer clients additional services, such as transportation and other kinds of logistics services beyond intermodal transportation links.

Warehousing in Mexico, An Overview

General deposit warehouses support trade and efficient distribution of resources by providing storage space and financing. Despite the advantages of shared warehousing from both a logistical and economic standpoint, many Mexican companies still insist on maintaining their own facilities for storage. As a result of this low level of demand for warehousing space, and also as a result of the lack of capital in general, public warehouse space in Mexico is limited. As indicated in Chapter 3, Mexico has only about 2 million square meters of storage capacity compared to an estimated 500 million square feet in the United States. Moreover, warehousing space often costs up to 50 percent less in the United States than it does in Mexico.[117] In addition, the Mexican warehousing industry is extremely concentrated: there are only 33 warehousing companies in the entire country, with the 10 largest of those companies making up 90 percent of the entire industry.[118]

The majority of Mexican warehouse operations have traditionally been subsidiaries of Mexican banks wherein the bulk of activity usually involved borrowing money against a company's inventory in the warehouse. In fact, turnover was so slow that most of the warehouses served as storage houses not distribution centers. This led to observations by many that Mexican warehouses during the 1980's functioned as large-scale pawn shops.[119] This storehouse mentality has resulted in poor warehouse design and limited equipment investment. Dim lighting, a scarcity of receiving and shipping docks, and scant material handling areas severely limited inventory turnover. Manual labor predominated over fork lifts and racking systems and even aisle and row layouts were viewed as a luxury. Given these factors, inventory control systems and high-performance warehouse econometrics were scarcely employed and most transactions, including inventory management, were recorded by hand.[120]

Changes in regulations as a consequence of NAFTA will affect many trade practices and customs procedures. This has required the Mexican government to reassess the role of warehousing in the economics of trade, and the importance of technology, logistics management, and strategic planning to the warehousing industry. In its reassessment, the Mexican government decided to work toward the privatization of its state-run warehouse network managed by ANDSA. ANDSA currently has 170 warehouses, representing an estimated 60-70 percent of the entire warehousing market in Mexico.[121]

History of ANDSA

During World War II, the United States sent most of its agricultural food surplus to its troops overseas. Mexico was effectively cut off from this food supply because there was virtually no surplus. In an effort to prevent shortages of food and other agricultural products, the Mexican government created a national network of warehouses to store Mexico's agricultural reserves. ANDSA began, therefore, as a network of state-run storage facilities for agricultural commodities. This grains program run by the government allowed ANDSA to store 70 percent of Mexico's basic grains and foods for future distribution to the population. As a consequence, ANDSA has grown into an industry with a custom-built infrastructure and almost 4 million metric tons of storage space.[122]

The Mexican government's grains storage program continued into the 1980s, when the government opened up the market for the storage and distribution of some agricultural commodities to private industry. The government allowed the warehousing and distribution of seeds and oils to be contracted out to private warehousing firms in 1984, and, in 1987, allowed wheat to be stored and distributed by private warehouses. But because ANDSA owns and operates most of the warehousing infrastructure and storage space in Mexico, as well as the largest facilities at most intermodal centers, it continues to dominate the warehousing industry. Now that ANDSA is on the road to privatization, it is handling more materials for private industry, many of which are not agriculturally-related; the private sector now handles most of the nation's agricultural commodities. In a strange turn of events, these private warehouse operators are turning to ANDSA to help in the temporary storage and distribution of these agricultural goods because ANDSA owns most of the grain storage infrastructure at Mexico's largest intermodal hubs.[123]

Firm Location

Like many warehouses in the United States, ANDSA locates its warehouses at rail depots, truck depots, seaports, border crossings, intermodal hubs and other areas from where it would be convenient to distribute or move goods, particularly agricultural goods. In addition, more than 20 percent of its warehouses are located in Mexico City. Of its 170 warehouses, most are concentrated in the main cities and agricultural areas of Mexico, particularly in the northwest and northeast. Although ANDSA owns a variety of warehouse facilities, most of them are specialized to store and distribute various kinds of agricultural commodities, and serve the special requirements of different kinds of perishable and/or semiperishable commodities, both solid and liquid (such as grains and the oils that are pressed from those grains, like corn oil or cottonseed oil). Much of ANDSA's warehousing space consists of outside lots or buildings with dirt floors used to store agricultural products such as beans and grains. However, in contrast, ANDSA is the only warehouse company in Mexico with modern grain elevators and storage facilities in the four major Mexican seaports of Veracruz, Guaymas, Lazaro Cárdenas, and San Carlos.[124]

Recently, ANDSA has become more involved with the warehousing of goods for the private sector, and it has realized the importance of being located close to transportation links. ANDSA now owns and operates Mexico's largest intermodal facility, Pantaco, in Mexico City,[125] which is conveniently located adjacent to the FNM railyards.[126]

Firm Size

The average number of employees within public warehousing firms in the United States is 64. This number is deceptive because of the variety of warehousing firms, including large public warehouses, that can employ up to 1,500 people.[127] Surprisingly, ANDSA does not at this point have an exact count of the number of individuals employed in its 170 warehouses and other operations. It is in the process of completing a study about its operations which will hopefully provide an estimate of this figure.[128]

In the United States, the past few years have seen changes in the total space allocated to warehousing, both public and contract. The amount of square footage used for public warehousing in the United States has declined by 38.3 percent in the past five years. However, the amount of space allocated for contract warehousing has increased by almost 360 percent over the same period. Most of this change is attributable to the fact that a great deal of public warehousing space has been shifted to contract use, and that square footage is becoming less and less important as a measure of the volume of warehousing business in general. Many U.S. warehouse operators indicate that they are pursuing growth through the addition of value-added services, rather than through physical expansion.[129]

ANDSA controls approximately 4 million metric tons of storage space throughout Mexico with most of its warehouse space located in Mexico's major ports and larger cities. It has been experiencing intense competition from smaller contract warehouse operators whose square footage has increased as a consequence of the increasing privatization of the warehousing market. However, ANDSA has made a big push to expand into the United States. ANDSA has reopened its marketing office in Houston, Texas, and the company's representative there, Mr. Jorge Canavati, has noted that ANDSA is looking at Houston and Laredo as potential sites for future warehousing operations. According to Mike Andrews, president and chief executive of the American Warehouse Association in Chicago, "ANDSA coming to the U.S. is a natural extension of the North American Free Trade Agreement just as many U.S. companies have opened warehouses in Mexico City, Monterrey, and Guadalajara."[130]

Because there is such a wide gap between the smallest and largest warehousing firms in the United States, revenues and profit levels also cover a broad range. Small firms may only have annual revenues averaging US$5,000, whereas the median annual revenues for U.S. public warehousing firms are about US$2 million, and the most common level of revenue is approximately US$1 million.[131] Materials indicate that ANDSA grossed approximately US$230 million in 1993.[132]

Industry Groups

The most common commodity handled by U.S. warehousing firms (both public and contract) is paper products (approximately 65 percent of warehousing firms handle this commodity). An estimated 63 percent of U.S. warehousing firms handle general merchandise, with almost 57 percent handling food-related items. Other common commodities handled by U.S. warehouses include: chemicals (45.9%); building materials (36%); appliances (31.5%); electronics (28.4%); hazardous materials (24.7%); and automotive parts (22.3%).[133]

ANDSA handles mostly agricultural commodities, as its facilities were designed and located to serve this market. However, now that ANDSA is beginning to handle a wider variety of commodities, it has realized that its infrastructure will need to be modified and its locations expanded to serve these markets. At the moment, ANDSA does not have information on all the types of commodities they handle, mostly because until recently, they only handled one kind of commodity - agricultural goods. But in the study it is conducting, ANDSA will provide a complete accounting of the types of commodities each of its warehouses handles, and the percentage of its activities and space that is devoted to each type.[134]

Business Types

Not surprisingly, most warehousing firms in the United States, both public and contract, have warehousing operations as their primary business. Secondary businesses also include transportation, contract warehousing, leasing, and other services. These other services include the following:

1. contract packaging;
2. development and construction of built-to-suit distribution centers;
3. distribution services, such as trucking, promotional packaging, product manipulation, and end-aisle displays;
4. foreign trade zone operations;
5. truck and trailer leasing;
6. pressure sensitive labeling and bar coding;
7. light assembly;
8. handling returned goods;
9. in-state transportation; and
10. rail equipment servicing.[135]

Sometimes, these kinds of added services will become a separate business for the firm. Well-executed and profitable services, when treated as a separate business unit, are assured continued profitability. In addition, customers are more likely to understand that they will be charged for an added service if it is offered by a separate business unit, as opposed to being charged for a service they believe should be included warehousing operations as an additional and uncompensated service.[136]

ANDSA does not currently offer many of these kinds of separate business services, but it expects to offer them in the near future. First, in Mexico, warehouses function as credit providers and are classified under Mexican law as credit organizations. Two of the most common forms of financing ANDSA provides are security bonds and deposit certificates. ANDSA is therefore considering, pending the results of its study, branching out into the financing industry in Mexico.[137] Second, and more importantly, pending the results if its study, ANDSA intends to act as a logistics platform and provider. ANDSA believes it can place itself in the position where it will be able to market and sell its logistics management services. Although most of its warehouses are technologically primitive by American standards, some are mechanized and most do provide extensive inventory control and security for the stored commodities and goods. ANDSA would like to develop its technological level, and then work with brokers and other individuals to provide the logistics management services required to move a commodity from origin to destination.[138]

In addition to typical warehousing services, a warehousing firm usually offers certain services, such as materials handling (order processing) or shrink wrapping, that it does not intend to develop into a separate business. These services are defined as value-added services. If warehousing firms can perform these services better and more cheaply than the customer can on its own, the value-added services can become an important competitive weapon. These added services provide several important functions for both the warehousing firm and for the customer. They can help the firm to diversify and can enhance the firm's ability to explore potentially profitable niches. They may also improve the warehousing firm's ability to attract and retain new customers, and simultaneously increase switching costs[139] for customers who have become reliant on the value-added service(s). Many warehousing firms believe that these increased switching costs are critical in the retention of their client base, the success of strategic alliances, and the ability to plan strategically for the long term.[140]

ANDSA offers a variety of additional and important, but very basic, services to its clients; these services vary depending on the warehouse, its client base, and the market served. For example, it provides for the complete mechanized movement and storage of grains at its facilities at the port of Guayamas. ANDSA is also an experienced provider of financing, refrigerated storage facilities, customs brokerage, and computerized inventory tracking and assessment. However, unlike many U.S. warehousing firms, ANDSA does not provide trucking, rail, or any other transportation services, except sometimes between its warehouses. Because all of its facilities are located either directly on or extremely close to FNM rail lines and intermodal yards, the effects of ANDSA's inability to provide transportation for its clients are mitigated to some extent. But as a matter of course, it contracts out all transportation functions, and all inventory security and tracking stops at is door.[141] ANDSA, at the moment, only provides storage and other services related to storage.

Obviously, revenue and profitability of value-added services (offered by both U.S. and Mexican warehousing operators) vary across firms. In most cases, value-added services are more profitable in both the long and short term than typical storage services; in fact, many U.S. warehousing firms report that the majority of their revenues are derived from value-added services. ANDSA, to this date, is uncertain about what the value or cost of its added services are, and even which additional services it offers. However, ANDSA anticipates, through its study, to identify the value-added services it provides to its clients, and assess their cost and value.[142]

Customers of U.S. warehouses indicate that most warehousing firms do not communicate well with their clients about what value-added services they can or would provide. In turn, customers tend to forget about these added services and assume they are part of normal service levels. When asked to describe the value-added services that their warehouse operator is currently providing, many customers are unable to do so.[143] This also happens with ANDSA's operation, but in a slightly different fashion, as will be discussed below. However, it is widely acknowledged that communication may be improved by increasing the levels of formalization found in warehouse operations.

Customer Selection Factors

When selecting a warehousing firm, U.S. customers consider a wide variety of variables. In the United States the most important criteria are price and level/quality of service. It is clear that the pricing of warehousing services is critical for the American customer, but it is also clear that price is not as important as service quality, reliability, performance, and client communication and support. In fact, many warehousing firms cite that 1) many of their customers leave because of price only to return because of service considerations; and 2) many customers often do not leave on the basis of price alone if the warehouse is performing competently, but will always make price a crucial part of the negotiation. Many warehouse operators in the United States also believe that price becomes less and less of an issue once a client has been working with the firm over time. However, most warehouses find that an inability to compete on price is a definite liability when it comes to attracting new business.[144]

Location is also an important factor in customer selection decisions. Customers often select distribution points based on market accessibility. Traditionally, though, these decisions revolved around where there were available warehouses. Now, many contract warehouse firms with multi-city operations are willing to move a contract space into a location based on a large customer's requirements. They can then use this new base of operations to develop business opportunities in the new location.[145]

Another critical decision factor for a potential customer is systems development, use, and capabilities. Some customers that want to inventory certain types of commodities are more interested in the availability of information and data about the location and condition of inventory than they are in the inventory itself. Also, customers often look for systems compatibility with their own to facilitate EDI technologies. Apparently, warehouse operators who can link up directly with clients have a distinct competitive advantage.[146]

Lastly, other criteria in a client's decision to choose one warehouse operator over another are flexibility and innovation. Clients have come to expect that their warehouse service providers can and will do more than just hold inventory or move it. Customers are refocusing on their own businesses, and reengineering or outsourcing activities that may fall outside their core competencies. This may mean that the warehouse operator will frequently be asked to develop and provide diverse services, that are specialized or unique to an individual client. Many warehousing firms are also increasingly willing to custom-tailor service packages to solve customer problems and meet customer needs. The downside to this is that due to their increased flexibility, warehouse firms are finding it more difficult to manage their operations and engage in long term and/or strategic planning.[147]

ANDSA operates differently. At the moment, its business is completely client-driven. For example, a client will approach an ANDSA representative with its requirements for storage, movement, distribution, etc., and ANDSA will comply with the request. It offers no service packages in the formal sense; it determines the prices for its services on an individual, not commodity-oriented, basis. ANDSA will negotiate its prices with each client, and make price decisions based on the size of the order, the amount of goods, the number of facilities used, the type of facilities used (mechanized or nonmechanized), the cost of the contracts with other firms, such as ship, rail, and/or truck transport firms, and its relationship with the client.[148]

Formalization

Because warehouses are more willing to provide customers with specialized packages of services, the ability to create internal rules and procedures is important. Many U.S. warehousing firms do not have formal programs in place that solicit customer feedback and facilitate customer contact. The major reason for this is presumed to be the more informal nature of marketing in the warehouse industry which allows for more sporadic client contact.[149] This pattern is changing, however. Firms which have recently adopted formalized programs to support and encourage customer communication and feedback have indicated that these programs were critical to the maintenance of the bottom line because both small and large problems can be handled more quickly and effectively, and because client needs, especially with regard to the creation of special custom-tailored packages of value-added services, can be met.[150]

It is commonly understood that firms which understand their mission and actively pursue planning for both the short and long term will be better able to compete. Because of the nature of the warehousing industry, however, warehouse operators must be more flexible and reactive. This limits their ability to plan strategically. As a service supplier, the warehousing firm cannot always plan in detail many critical business variables, such as space of customer service requirements. However, those warehousing firms which have managed to develop formalized, but flexible, plans believe that they have increased the success of their business in the long run.[151]

ANDSA does not conduct any formalized internal planning or long/short term strategic planning. In fact, the Logistics Division at ANDSA was only created in

February, 1995[152] and is still in the process of completing its internal study which intends to provide a description of its business focus and a reevaluation of its mission and long term goals, as well as the means to achieve those goals. Presumably, the study will also include a detailed accounting of the current state of business.

ANDSA, through its study, clearly intends to bring itself up to date with industry trends and achieve an edge over its competition. It would like to achieve this goal by concentrating on the provision of logistics services to its clients and attracting new clients by offering them the kinds of services few, if any, Mexican warehouse operators provide (mostly because most Mexican warehousing firms simply do not have the infrastructure in place, or the locational advantages, or even the sheer square footage of storage space that would enable them to compete with ANDSA). ANDSA knows it can sell logistics services competitively, but it also realizes that it cannot do so unless and until it is able to assess what markets it serves, what services it provides, what infrastructure it has, and what infrastructure/technology it needs. ANDSA also knows that it must begin to market itself as a intermodal organizer and base of exchange for a variety of products, and not simply a storer of goods.[153]

At present, for example, if a Mexican firm (or even another warehouse) needs to export 300,000 tons of wheat to Asia, the Mexican firm would be able to contract with ANDSA only for storage of the wheat. All transportation required to move the goods over land and by sea is the responsibility of the Mexican firm. By next year, ANDSA would like to be able to organize all this for the client (although not perform the actual trucking or shipping itself).[154]

ANDSA would also like to be able to serve entire commodity markets. For example, ANDSA plans to work jointly with FNM to provide warehouse storage and secure transportation for the entire automotive industry. This would include storage of auto parts, collecting of autos in yards prior to shipment in FNM rail cars, and the transport of automobiles over FNM rail lines; ANDSA, with the help of FNM, would like to be able to coordinate the movements and track the items from origin to destination. Additionally, ANDSA is one of the leaders in Mexico for refrigerated warehouse technology; it would like to better integrate this aspect of its business into its service package for clients, and market this service to the burgeoning agricultural industry.

The Future

ANDSA is making a serious effort to bring itself into the age of logistics management and more advanced technology/business practices. However, it is being hampered in its recent efforts. The devaluation of the peso has hit the warehousing industry in Mexico hard, particularly because the industry is so heavily involved in financing and credit. Many Mexican firms that store their goods prior to export to the United States are now storing their goods in U.S. warehouses to get a less expensive and more dependable rate of financing.[155] Many Mexican firms have also stopped storing their goods in warehouses and have chosen instead to use their own storage space. At a time when ANDSA is planning to position itself as an industry leader, this downturn in business is particularly ill-timed.

The devaluation, by making Mexican exports so much less expensive, has, on the other hand, boosted northbound traffic levels (by value and tonnage) from Mexico to the United States. Trade statistics provided by Mexico's SCT show that southbound and northbound crossings are beginning to equalize, with northbound crossings having increased almost to the point of being equal with the number of southbound crossings.[156]

This has interesting implications for warehousing services, particularly facilities at the border. With trade on the increase, warehousing space, already scarce in Mexico, will be in demand, as will the logistics management services, techniques, and technologies that are necessary to move increasing quantities of commodities from their origin to their destination. Unfortunately, Mexico's current lack of warehousing space, logistics professionals, poor highways and other forms of transport, and relatively low level of technological awareness will make it difficult for ANDSA to take advantage of this opportunity. This is compounded by the fact that the Mexican government has begun licensing *ferropuerto* facilities to be developed by private enterprise. These enterprises have an exclusive distribution area of 400 kilometers within which the government will not license another *ferropuerto*. The first one to open is in Torreon, Chihuahua. It is a multimodal public warehousing facility set up to provide convenient service for goods and product distribution. There are grain silos, cross docking facilities, warehouses for finished goods, container storage, and efficient access to rail service.

Still, ANDSA's plan to become a logistics provider is an important step toward the development and use of logistics management techniques in Mexico. ANDSA, in making this commitment, will be the industry innovator, placing it in an excellent position for the future.

Notes

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[139] "Switching costs" can be defined as the costs a firm incurrs when it switches service providers. These costs may be explicit, such as costs for attorneys to negotiate a new service contract, or implicit, such as

costs incurred in the time spent leaning how a new company operates, or the time spent teaching a new service provider about your business and your needs.

[140] American Warehouse, *Trends and Practices in the Public/Contract Warehouse Industry*, p. 10.

[141]Interview with Ing. José David Castro, April 3, 1995

[142]Ibid.

[143] American Warehouse Association, *Trends and Practices in the Public/Contract Warehouse Industry*, p. 12.

[144] Ibid., p. 8.

[145] Ibid., p. 9.

[146] Ibid.

[147] Ibid., pp. 8-9.

[148]Interview with Ing. José David Castro, April 3, 1995.

[149] Often, in the warehousing industry, services are not typically marketed or advertised. Warehouse space is often used by clients out of necessity and convenience, rather than because they have been convinced that they need warehousing space, or services. Warehousing firms save on marketing and advertising costs, and instead rely on word of mouth. Or simply wait for clients to show up. This strategy is no longer truly practical with the rise in popularity of contract warehousing services. This had made the industry much more competitive.

[150] American Warehouse Association, *Trends and Practices in the Public/Contract Warehouse Industry*, p. 113.

[151]Ibid., p. 12.

[152]Interview with Ing. José David Castro, April 3, 1995.

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Chapter 5. The Role of Technological Innovation

Introduction

During the past two decades, deregulation and increased global competition have compelled firms in the transportation industry to cut costs and become more responsive to customer demands. From initial production to final sale, businesses are attempting to save money by decreasing inventories, streamlining operations, and moving goods as quickly and efficiently as possible from origin to destination. Given the limitations of existing transportation modes and infrastructure, information becomes the most effective tool for logistics managers to make their organizations more competitive in the short term. Virtually all of the most important technologies to emerge in the transportation industry in recent years have responded to this need for better information and improved customer service. By enhancing communication among firms along the supply chain and permitting accurate tracking of shipments between countries and across modes, new technologies are helping logistics professionals to meet the complex demands of a rapidly changing transportation environment.

Last year's report, *Logistics Management and U.S.-Mexico Transportation Systems: A Preliminary Investigation*, noted the role that deregulation has played in furthering efficient operations in transportation.[1] This diminution of economic regulation has not only resulted in greater competition among modes, but also more cooperative arrangements within and across modes. A competitive market has required that transportation firms be efficient in order to meet user or customer demands. Technology permits greater efficiency and facilitates new arrangements among transportation firms, leading to a tremendous increase in technological applications related to transportation. Deregulation, therefore, has had an indirect effect upon the technological revolution in transportation. The dramatic growth in technological applications has also created uncertainty due to the lack of technological standards across different modes, raising the need for federal standards in technology development.[2]

The purpose of this chapter is to examine various new technologies and their impact on logistics decision-making processes, with a particular emphasis on the effects of technological development on U.S.-Mexico trade. Following this introduction, the second section will examine the status of Intelligent Vehicle Highway Systems (IVHS) and survey a number of tracking technologies that provide shippers and carriers with real-time information about the location of containers and equipment. The third section examines technologies facilitating greater communication and better planning among partners in the logistics chain, such as Electronic Data Interchange (EDI)and logistics software packages. The fourth section will consider technological improvements in the rail and maritime transportation industries which have encouraged the growth of intermodalism. The fifth section examines the relationship between technological development and the emergence of new logistics management practices such as "Just-In-Time" (JIT) inventory and distribution strategies. The sixth section surveys existing and potential transportation applications of artificial intelligence technology. Finally, conclusions will be drawn about the role of technology in the transportation industry during the 1990s and the impact of technological limitations in Mexico on North American trade practices.

Table 5.1 provides a general summary of the technological innovations discussed in this chapter.

Table 5.1
Innovations in Logistics and Transportation Technology

Innovation	Function	Uses
Satellite Tracking	*Provide driver-base communications link*	Real-time shipment tracking over long distances; efficient scheduling
Global Positioning Systems	*Provide accurate air traffic control information*	Aircraft guidance; worldwide location information; automated precision landing
Intelligent Vehicle Highway Systems (IVHS)	*Provide Driver Information* Highway and traffic conditions; location of vehicle, destination; alternate routes; automatic vehicle spacing; accident avoidance	Identify most direct route; transmit vehicle diagnostics; avoid hazardous road conditions; avoid congestion and delay
Automatic Equipment Identification (AEI)	*Transmit vehicle/container information* Identification; contents, size, and weight	Wayside rail tracking; precise railyard/intermodal yard tracking; automatic toll collection; seamless intermodal tracking
Automatic Equipment Monitoring	*Transmit real-time shipment condition information* Temperature; physical damage	Prevent shipment damage, especially frozen goods; record accident information; ensure carrier responsibility
Electronic Data Interchange (EDI)	*Transmit business data between supply chain participants* Purchase order; packing slip; bill of lading; invoice; electronic funds transfer	Efficient, integrated scheduling; verify pick-up and delivery; electronic ordering and billing
Logistics Software	*Provide comprehensive shipment management capability* Carrier selection; materials management; cash flow improvement	Automated load tendering; match best carrier to load; shipment tracking; demand forecasting; automated document auditing

Standardized Modal Software	*Support modal networks* Improved and standardized electronic communication within mode	Standardize freight shipment information; real-time shipment booking and tracking; provide common EDI system
Public On-Line Reservation System	*Provide order placement and shipment tracking capability to customer*	Automated, on-line ordering; real-time shipment tracking
2-D Barcode Technology	*Provide expanded product and packing information* Full bill of lading	Store all EDI information; eliminate paper bills of lading; improve inventory management
Smart Card (Lasercard)	*Accompany shipment and store relevant data* Error detection and correction	Expanded data storage Direct shipment data download
RAIL TECHNOLOGIES		
High horsepower locomotives; alternating current motors; electric braking	*Provide increased propulsion* *Provide improved traction* *Provide safe braking techniques*	More power at lower cost; increased adhesion levels; graduated braking
REFRIGERATION TECHNOLOGIES		
Improved mechanical refrigeration	*Provide narrow-range cooling*	Reduce spoilage or long-distance frozen shipments, especially non-deep freeze vegetables
Power Packs	*Provide multi-container cooling*	Reduce shipment damage; more efficient, regulated cooling
Cryogenic refrigeration	*Provide chemical cooling free of moving parts*	Increased reliability and lower cost in cooling; reduced maintenance
ARTIFICIAL INTELLIGENCE		
Expert systems	*Store logistics knowledge gained by experts over time*	Retention of institutional knowledge; automated processing of qualitative information; scheduling and tracking

Speech recognition systems	*Digitize analog voice signals*	Verbal data input; increased convenience and accuracy in warehousing and inventory management
Intelligent Robotics	*Automated warehousing functions*	"Lights out" warehouses; intelligent order pickers and packers; automated loading and unloading
Neural Networks	*Human thought pattern mimicry*	Recognition of patterns in data; recommendations made based upon subjective information

Tracking Technologies and IVHS

The ability to have constant knowledge of the location of goods and the equipment which transports them is an invaluable resource for both shippers and transportation firms. These technologies also have potential applicability to the general population through facilitation of traffic along America's highways. While a number of these technologies are merely in the development and testing phase, others have been fully implemented in the transportation market.

Satellite Tracking and Mobile Communications

Using satellites to track and communicate with vehicles containing shipments is becoming a common practice among larger transportation carriers. In recent years, several new systems have been introduced which enable truck drivers to communicate with their home bases from any location in the country. Qualcomm, Inc., a San Diego satellite communications manufacturer, has installed its Omnitracs system in over 33,000 vehicles. The system allows drivers to send and receive typewritten messages while on the road. J.B. Hunt Transport, Inc. has begun using a data transmission device created by IBM which is "programmed to hold all the information a driver would need for his route, including the names of the shipper, consignee, location of terminal and billing information. In addition, locations of fuel stops with Hunt accounts and other trip data can be brought up for driver convenience."[3] Such information is loaded into the device either by means of a satellite antenna placed on top of the truck's cab or by a modem hookup with the truck's dispatcher. To develop the devices, J.B. Hunt has teamed up with IBM, Qualcomm, and software designer SAIC, Inc. The units will be capable of using any satellite service company, according to Larry Davenport, J.B. Hunt's senior vice president of information services.[4]

By helping carriers to track and communicate with all of their fleet vehicles, devices like those being used by J.B. Hunt enable firms to develop scheduling programs that efficiently match vehicles, drivers, and customers. Supported by software programs like those discussed below, satellite communications technology enables firms to develop more farsighted and comprehensive logistics strategies.

Global Positioning Systems

In the aviation industry, satellite navigation is quickly on the way to becoming the standard. The 186-member International Civil Aviation Organization (ICAO) "hopes to have a global navigation satellite system operational worldwide by the year 2010." The impact on the air transportation industry, in the form of savings and greater efficiency and safety, will be substantial. ICAO's Secretary General, Phillippe H.P. Rochat, says that satellite navigation could save the civil aviation community about US$5 billion a year. Today's radar systems, many of which cannot reach over oceans, often require pilots to radio their location to air traffic controllers and to use maps and charts to determine their exact location. Using the U.S. government's Global Positioning System (GPS), which has been made available for use by the global aviation community without charge, satellite positioning signals will continually report an aircraft's exact location to air traffic controllers. Recent tests conducted by the Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA) have shown that, by combining GPS satellites with ground-based tracking stations, a technique called triangulation, the system can even guide pilots through a precision landing in low-visibility conditions. United Parcel Service is currently conducting similar air navigation tests with Ohio University at Athens. Satellite navigation is being adopted by all modes of transportation, including rail, truck, air, and maritime, as a safer and more efficient means for decision making and control.[5]

Intelligent Vehicle Highway Systems (IVHS)

Investment in IVHS had seriously declined in the early 1980s due to the reduction in government spending. The budget for fiscal year 1994 comprised $174.5 million for highway and research technology, including $101 million for IVHS or smart highways - a $70 million increase above the 1993 level. IVHS makes use of on-board computers and satellite technology to assist drivers in the selection of travel routes and provide the latest traffic information. In order to gather information on a real-time basis, the system plans to employ roadside detectors, television surveillance, and electronic devices (loops), which are cut into the pavement and measure the number of cars and the time it takes to pass over a given distance.[6] Officials can then collect the information and send safety messages to warn motorists about upcoming traffic concerns such as accidents and road work. The planned outcome is a more efficient movement of traffic and a reduction in infrastructure investment in the long-run.

In addition to these objectives, the system envisions automatic toll collectors which scan electronically tagged windshield decals, and roadway sensors to help keep vehicles in the proper lane.[7] The development of transponders that automatically identify and classify vehicles as they roll through toll station, weigh-in-motion scales, and other roadside checkpoints is discussed below. Smart highway test projects have been employed in a number states including California, Florida, Michigan, New York, and Texas.[8]

The on-board elements of smart vehicles will include information systems and automated vehicle controls. The Freightliner/Heil Advanced Concept Truck (FACT) is an example of these current state-of-the-art technologies. The information system on FACT is Rockwell's Tripmaster on-board recorder and Qualcomm's satellite-based communications and positioning unit. The satellite system provides a terminal or dispatcher with location information and allows communication with the driver through preset messages or keyboards to type text messages. It is also possible to transmit vehicle diagnostic information through the system.[9]

With respect to automated vehicle controls, FACT adds traction control - which uses electronics to govern engine speed and brake applications in order to prevent drive wheels from slipping in low traction conditions - to all its wheels. Another enhancement controls the air suspension on the tandem axle, automatically transferring load to the front driven axle from the nondriven axle when it senses that the drive axle is losing traction.[10] The FACT also has a video rearview "mirror" with a video monitor for the driver and a warning device called Scan which lets a driver know about objects ten feet or less to the truck's right, left, or rear.

The implementation of IVHS technology is tied to affordability. The systems are becoming more sophisticated, and for them to be useful and accurate they will need to be made available to the general population. This translates into massive costs to fully implement the systems across the nation. Additionally, coordination among the private sector and local, state, and federal government officials is necessary in order to develop a coordinated national system with standards.

Automatic Equipment Identification

While satellite tracking technologies provide excellent real-time location information to shippers and carriers, especially those engaged in long-haul trucking, they are not affordable to many small and mid-size transportation firms. A more accessible tracking technology, and one which provides more precise location information in the confines of terminals and intermodal yards, is Automatic Equipment Identification (AEI).

The AEI system identifies containers, trailers, railcars and other equipment using a technology called Radio Frequency Identification (RFID). Readers placed at strategic positions at terminal gates, waysides, and railyards transmit a signal which is returned by a tag attached to each piece of equipment through a technique called modulated backscattering. The tag contains specific information about the container or equipment and its contents. This information is then forwarded in real time to a central database to give logistics managers precise information about the location of a shipment. The AEI system was developed by Amtech Corporation of Dallas, Texas. The system was adopted by the Association of American Railroads (AAR) in 1991 as a mandatory standard for railcars and containers, with full compliance required by the end of 1994.[11] As of January 1, 1995, over 1.2 million freight cars, 22,000 locomotives, and 8,000 electronic braking system monitoring devices were equipped with AEI transponder tags.[12] Because the Amtech AEI system may operate at three distinct frequencies, it meets the standards set forth by the International Standards Organization, the American National Standards Institute, the American Trucking Associations, the International Air Transport Association, and the Union International des Chemins de Fer (European Rail Association). To date, the AAR is the only association to have mandated use of the AEI system, but with the growth of intermodal world trade, the potential benefit of a mandated standard for all modes is clear.

The AEI system has distinct advantages over traditional bar-code identification technologies because of its durability and flexibility. AEI transponder tags can be read at a distance of up to 200 feet and at speeds of up to 180 miles per hour.[13] Unlike optical bar code technologies, accurate reading of AEI transponder tags is not affected by weather conditions or dirt, oil, and other materials associated with harsh transportation environments. Finally, AEI tags come in read-only and read-write format, so that new information can be written onto the tag as it passes a reader at high speed.

Because readers may be placed at designated intervals along rail waysides, for long-haul operations AEI technology offers the most accurate tracking information to the railroad industry. However, AEI's intermodal applications are also providing clear benefits to logistics managers. Matson Navigation has tagged its entire maritime container fleet with Amtech system tags, providing seamless tracking and identification from marine to rail transport.[14] The AEI system is extremely beneficial in keeping track of equipment in busy intermodal yards. Readers are being installed at terminal gates and on cranes and other yard equipment to maintain precise information about the location of containers and equipment on a real-time basis.

AEI technologies are directly impacting the decision-making processes of transportation managers, particularly by making rail more competitive with trucking. In the past, due to the size and complexity of their cargo loads, railroads were not always able to provide individual customers with accurate information on freight location. By providing improved long-haul and railyard tracking information, AEI technology has allowed the rail industry to provide competitive customer service so that it may fully exploit its cost efficiencies in long-haul transport.

But the applications of AEI technology are so widespread that no single industry monopolizes AEI's benefits. For example AEI's electronic toll and traffic management applications are saving time and money for commercial trucking firms. By allowing tagged vehicles to pass through special toll lanes and weigh-in-motion facilities, AEI technology relieves truckers of burdensome delays in transport time. Amtech has installed AEI automatic toll collection facilities for the Dallas North Tollway, the Sam Houston Tollway and Hardy Toll Road in Houston, and at 14 toll roads and 32 toll bridges in Mexico for Caminos y Puentes Federales de Ingresos y Servicios Conexos, the federal toll administration for the Republic of Mexico.

According to Amtech executives, no serious implementation of AEI technology has taken place in Mexico beyond the toll facilities mentioned above. The AAR mandate for tagging all North American rail equipment has lagged behind in Mexico. American President Lines (APL), one of Amtech's largest intermodal customers, has discussed expanding AEI technology to its facilities in Mexico. However, for AEI technology to provide the full benefits of seamless intermodal transportation to and from Mexico, organizations such as the Mexican National Railways (Ferrocarriles Nacionales de México--FNM) and Transportación Marítima Mexicana (TMM) will need to be assertive in incorporating AEI into Mexico's transportation infrastructure. Amtech is currently marketing AEI technologies to these and other organizations in Mexico through a number of distributors.

Logistics Technologies

Much effort has gone into the development of computer networks and software technology to transfer information in order to facilitate a seamless and paperless logistics network. The development of effective systems to accomplish this goal is but one concern of logistics technologies; the other is the proliferation of these logistics technologies to the point that there is no potential for interface amongst the different systems.

Electronic Data Interchange

The rising importance of computer network telecommunications has had a significant impact on the transportation industry. The ability to communicate information rapidly and inexpensively over networks, many of which are linked to the global Internet, has allowed companies at every level of the transportation supply chain to create innovative approaches to logistics management, tracking, and customer service. The transmission of information between organizations is referred to as Electronic Data Interchange (EDI), and it is quickly becoming the standard means of communications in the competitive transportation industry. Chrysler Corporation's logistics productivity specialist, Roger M. Allison, says, "We are getting away from paper. And if you can't do EDI, you can't do business with us."

By establishing a real-time communications link among organizations along the supply chain, EDI creates opportunities for a more comprehensive logistics strategy. Increased global competition and a desire to respond quickly to changing customer demands have led to the emergence of new strategies such as JIT manufacturing, which is discussed below. EDI is essential to the implementation of these and other strategies leading to greater efficiencies in transportation logistics. For example, using EDI, Chrysler has revamped its entire logistics configuration. All of Chrysler's truckload carriers "can stay on top of Chrysler's haulage needs for freight by linking up by phone to an electronic bulletin board system." This has enabled Chrysler to move away from the use of less-than-truckload carriers since it can now carefully consolidate most shipments. These changes represent substantial savings to Chrysler. Since 1984, the company has reduced the number of truckload carriers it uses from about 250 to under 30. In the same time period, it has reduced its use of less-than-truckload carriers from 25 to just one. Chrysler's new Supplier Cost Reduction Effort, or SCORE, asks the automaker's parts suppliers to analyze its supply chain and identify possibilities for improvement. Robert Allison says that "in 1994, SCORE has generated almost $500 million in money saving ideas" and has "taken ten to twelve days out of delivery time over just the last year." None of this would be possible without EDI. According to Allison, Chrysler is "leaning toward getting everybody (in the supply chain) talking to everybody else through their computers."[15]

Logistics Software

The emergence of EDI and global computer networks as the most effective means of communication between players in the transportation supply chain is being supported by a variety of new software technologies. These new software packages are typically part of a larger network or central database offered as a service by logistics companies. For example, Innovative Computing Corporation (ICC), a subsidiary of Westinghouse Electric Corporation, offers comprehensive shipment management software and services to over 600 companies worldwide. Using EDI to eliminate the "telephone tag" problems of traditional communications, ICC's "Sure Shipping" software provides a number of important logistics support services. On-line coordination provides automated load tendering and notifies shippers in real time when a carrier accepts a load. Comprehensive information including rates and carrier performance statistics are provided to shippers on a constant basis. The Sure Shipping software matches the best carrier to each load and passes the recommendation on to the shipper's load planners. It also identifies opportunities to save money by taking advantage of special rates offered by carriers for continuous moves and dedicated fleets. Finally, real-time shipment tracking is provided so that shippers have access to in-route status information and actual arrival and departure times. Like many of the new logistics software programs supporting EDI, Sure Shipping is "available on a service bureau basis, where the software resides on an ICC host computer." The software can also be purchased or leased so that shippers may implement independent logistics management systems. [16]

Another powerful logistics software package, Virtual Logistics, is produced by TADMIS, Inc. of Bohemia, New York. Virtual Logistics uses a modular approach to manage the entire supply chain, seeking to fulfill TADMIS' stated goal of "managing, integrating and controlling the flow of information, material and money."[17] Each of four software modules focuses on a different aspect of the supply chain, sharing a centralized database to guarantee that data are consistent among all applications. A description of each module and its benefits to managers follows.

The FILMS (Forecasting and Integrated Logistics Management System) component of Virtual Logistics, itself a modular system, "coordinates the materials management activities of the supply chain."[18] To meet this goal, the FILMS software assists managers in making accurate projections of product consumption, controls inventories, makes recommendations for producing a master production schedule, sends purchase orders to manufacturers, assists distribution requirements planning by consolidating multiple warehouse information in one location, and assesses the priority of product requirements to tell managers what products need attention immediately without having to review each product individually.[19] The FILMS module allows TADMIS' clients to save money and become more competitive by reducing inventories and automating important parts of the distribution process.

TADMIS' Expert Freight Management and Integrated Transportation/Logistics System (INTRLOG) manages the movement of materials throughout the supply chain. Tapping into stored data on inventory, equipment availability, and customer demand, INTRLOG coordinates tasks such as dispatching and routing, multimodal equipment optimization, and shipment tracing. The decision support capabilities and on-line, real-time tracing features of INTRLOG help logistics managers choose the most cost-effective means of transportation while improving communication between carriers and shippers.[20]

The TIPS (Transportation, Information and Payment System) module of Virtual Logistics reveals hidden transportation costs in logistics. For example, the software examines freight bills for excess charges, including duplicate bills, extension errors, and misapplication of tariffs, which may overlooked by busy transportation staff. The TIPS software also anticipates freight expenses by assigning charges to the bill of lading and other pre-shipment documents, allowing shippers to improve their cash flow by simultaneously invoicing their customers for product and freight charges. Finally, the software audits paper and EDI freight bills on-line, comparing them to preshipment data and conveying appropriate payments and reductions in charges to carriers electronically.[21]

The final module of the Virtual Logistics software package, Routemaster, is an on-line, real-time transportation reservation system. Using EDI, Routemaster links shippers, carriers, and their financial institutions. Carriers post their geographic and unit space availability in real time, allowing shippers to browse a marketplace of many carriers. Finally, the software processes payments to carriers electronically, based on terms already agreed upon by shippers and carriers.

Kenneth Miller, President of TADMIS, Inc., says the proliferation of the personal computer and the growing availability of advanced logistics software packages has dramatically changed the transportation environment. By automating many processes and connecting all partners in the supply chain, logistics software and EDI are "driving out the space between events," permitting transportation firms to cut costs and meet the demands of increased global competitiveness. Moreover, these technological benefits are no longer monopolized by the largest transportation firms. With powerful personal computers (PC s) on practically every desk, comprehensive control over logistics processes is now available to even the smallest companies, allowing them to take advantage of efficiencies that were out of their reach not long ago.[22]

Advanced logistics software is becoming more available in Mexico, due primarily to the growing number of U.S. firms operating in the Mexican market. As mentioned above, however, the lack of implemented tracking technologies such as AEI prevents the growth of accurate real-time tracing capabilities in Mexico, except for those trucking companies that can afford to equip their Mexican partners with satellite tracking technologies such as those described above. Logistics software executives indicate that most logistics hardware and software technologies in Mexico are being installed by U.S. firms. Convincing Mexican transportation firms of the benefits of advanced logistics technology is apparently easier than persuading them to install and use that technology.[23]

Standardized Modal Software

A variety of new softwares have emerged as the transportation industry strives to mandate freight shipment information standards and improve electronic communication. For example, TSI International has developed a new Windows PC software called Ocean

Carriers' Electronic Access Network (OCEAN). The new network software was introduced at the National Industrial Transportation League's 87th annual meeting in San Antonio in November 1994. It will allow shippers to book and track their shipments electronically by connecting to a 24-hour database, regardless of differences in carriers' EDI applications. The OCEAN software was sponsored by the Information System Agreement (ISA), an organization of nine ocean carriers. William Kenwell of ISA says that the software will probably phase out member carriers' own EDI applications because the industry realizes that customers benefit from a common system.

A similar standardized database is being developed by the Association of American Railroads. The Customer Identification File will be compatible with all EDI systems and will be made available to all freight transporters, not just railroads. The new database is "designed to replace the current practice of listing and tracking shipments by the customer's alphabetical name and address with a numerical code. Besides the ID number, the database will contain information about a company's name, physical and mailing addresses and corporate parent." The new software and database is expected to bring the railroad industry $10 million in annual benefits.[24]

Public On-Line Software

New consumer and business-oriented computer networks such as Compuserve, Prodigy, and America On-line are providing opportunities for improved customer service by allowing individual shippers to place orders and track shipments on-line. The nation's top two express mail couriers, United Parcel Service and Federal Express, have recently established agreements with electronic information services which offer customers a direct link to shipment databases. Customers can place shipping orders and identify the location of their shipment at any time by entering the package's tracking number. Mark Dickens, Federal Express' managing director for customer automation programs, says the company plans to do 100 percent of its business on-line by the year 2000. In 1995, Federal Express customers will be able to connect to the company's new "FedEx Ship" software by local or 800 numbers, making on-line ordering and tracking available to customers in rural and urban areas.[25]

Bar code Technology

One of the latest advances in EDI shipment processing is the emergence of two-dimensional (2-D) bar code technology. This new "honeycomb" graphic bar code can hold up to three times as much information as the traditional linear Universal Product Code (UPC) technology and can be read using a special optical scanner. Developed in response to shipper demands for more data on package labels regarding routing and tracking, 2-D's potential for carriers and shippers using EDI is enormous. The 2-D bar code serves as a portable data file containing all relevant EDI information. An entire EDI bill of lading can be carried in one 2-D symbol. In contrast, the traditional UPC bar code contains only a package's purchase order number, which must then be looked up in an EDI database. If the database information is incomplete and a paper bill of lading cannot be filled out, the shipment may be delayed. By eliminating paper bills of lading and attaching important information to the package, 2-D technology has the potential to increase accuracy, improve inventory management, and reduce personnel costs.[26]

Due to a lack of official standards, the 2-D bar code has not yet been widely adopted in the transportation industry. However, a number of companies have begun developing their own 2-D symbology. One example, United Parcel Service's (UPS) new Maxicode, is being considered by the American National Standards Institute as the standard for parcel sorting. Earle Timothy, UPS' Maxicode implementation manager, says that in addition to a consignee's name and address, Maxicode contains information about "package weight, tracking and routing data, service codes and any special handling instructions." UPS is currently testing Maxicode at its Grand Rapids, Michigan hub and plans to implement the 2-D technology at its largest hub in Chicago, which is currently under construction.[27]

Another new piece of technology which will potentially reduce processing time and increase accountability in shipment transportation is the U.S. Defense Logistics Agency's new Lasercard. This "digital, credit-card-sized optical memory card," developed by Information Spectrum, Inc., holds 2.86 megabytes of data and includes error detection and correction. After shipment information is loaded into the card from a PC data file, the card accompanies a shipment to its destination. Once the shipment arrives, information from the Lasercard is compared with that scanned from the shipment containers' bar-codes. A PC software application then reconciles the two records and flags discrepancies. Currently, the Lasercard, also known as the Automated Manifest System, is being used by the Defense Logistics Agency at five of its thirty supply depots. Once similar technologies reach the private-sector market, they hold the potential for substantially reducing processing time and increasing shipment accuracy.[28]

It should be noted that even with all of the advancements in electronic information storage and retrieval, shippers and carriers may still not be able to implement entirely paperless operations. Highway law enforcement officials frequently want to see paper copies of bills of lading when they inspect vehicles on the road. Also, rules of the United States Department of Transportation and other state agencies may require that some hazardous materials information be in paper form for any mode of transportation.[29]

Technologies Supporting Intermodalism

The dramatic growth of container usage in commercial transportation has led to the proliferation of automated intermodal terminals linking maritime, rail, and motor carrier transportation lines. Of particular importance in recent years has been the rise of rail-truck intermodalism as firms search for economies of scale in long-haul operations and attempt to avoid the road congestion and high energy consumption associated with excessive use of trucking.

New Technologies Benefiting Rail

The recent improvement in the overall health of the rail industry has led to a search for greater economies of scale and a push for the development of new technologies.

Several new technologies have appeared which promise to greatly improve performance in the rail industry. These include higher horsepower locomotives, alternating current motors, and electric braking.

In 1993, Morrison Knudsen Corporation announced plans to develop a 5,000-6,000 horsepower locomotive, which is about 1,000 horsepower greater than the normal locomotive in operation today.[30] General Electric and General Motors'(GM) Electro-Motive Division responded with plans for new models which will operate at above 5,000 horsepower. According to Randolph Resor of ZETA-TECH Associates, Inc., "high horsepower in a single unit, with a single prime mover, is a more effective means of assuring more horsepower at lower cost." However, traction often becomes a problem at higher levels of horsepower. For this reason, the industry's attention is focusing on alternating current (AC) motors. Both General Electric and GM's Electro-Motive Division are testing AC motors and finding that rail adhesion rates are better than expected. "We're achieving adhesion levels we thought were impossible two years ago," explained Tom Hovious, manager of new product development at General Electric. Furthermore, concern that high adhesion would cause damage to rails has proved to be unfounded, according to Curt Swenson, chief engineer at GM's Electro-Motive Division. "Everything points in the direction of AC being kinder, not harder, on rails."[31]

Electric braking is another new technology which is changing the rail industry. According to Leonard McLean, chief mechanical officer for CSX, "braking equipment has advanced light years." One of electric braking's outstanding benefits is that it gives locomotives the ability to do graduated braking, which is not possible with traditional air brakes. "The actualization time is instantaneous. It's the speed of light versus the speed of sound," said McLean.[32]

New Refrigeration Techniques

The rail industry lost a large portion of its refrigerated traffic to the trucking industry during the 1980s. Between 1982 and 1992, the size of rail's refrigerated fleet fell by 47 percent. According to the AAR, between 1981 and 1991, shipments of fruits, potatoes, and other produce declined by 35 percent.[33] In response, rail carriers are seeking to improve their refrigerated services in a number of ways, including the refurbishment of existing refrigerated cars, improved monitoring of temperatures throughout a refrigerated shipment's journey, and the implementation of new refrigeration technologies. As international trade in refrigerated cargo continues to grow, oceangoing carriers are also taking advantage of improvements in refrigerated container technologies.

Improvements in traditional mechanically refrigerated container technologies for sea and rail allow temperatures to be held within a narrow range, which is ideal for long-distance transportation of fresh frozen products such as vegetables. Furthermore, atmospheric gases "can be controlled so carbon dioxide levels can be increased and oxygen levels decreased," which reduces spoilage.[34] New, multi-container power packs are being used to cool several refrigerated containers at once. As a result of these improvements, damage to frozen shipments sent by rail and sea has been declining.

Richard Fetzer, traffic manager for Patterson Frozen Foods, said that damage to his company's rail shipments of frozen vegetables has "almost disappeared in recent years."[35]

Accompanying these improvements in rail and oceangoing carriers refrigeration services are significant advances in tracking and monitoring technology for refrigerated equipment. By combining thermocouples placed inside the cold compartment with satellite uplinks, a carrier "can receive a continuous printout of the temperature in the box from a remote location."[36] The RFID counterpart to satellite monitoring is Amtech's Automatic Equipment Monitoring (AEM) technology. Transponder tags equipped with sensors are placed on refrigerated containers and railcars to provide real-time temperature information in addition to the contents and location of equipment. In cases where accidents or power failures cause damage to cargo, Amtech's "Tattletale" AEM technology provides reliable information about the time, location, and extent of damage to shipments. AEM technologies maintain accountability in the transportation industry by accurately identifying the responsible party in situations where a shipment has been handled by multiple carriers. This information is important to shippers and carriers in settling disputes over shipment spoilage or damage.

Cryogenic Refrigeration

In an effort to recapture a portion of the refrigerated business it had lost to trucking, Union Pacific Railroad (UP) recently spent $36 million over four years to refurbish its 3,800-car fleet of mechanically refrigerated boxcars.[37] But due to the emergence of new nonmechanical refrigeration techniques, UP spokesman Mark Davis said that the refurbishing of existing cars is essentially a short-term approach. Over time, rail carriers like UP will probably begin investing in new technologies such as cryogenic refrigeration. Unlike traditional mechanical refrigeration, cryogenic cooling is chemical and uses no moving parts. For this reason, it is more reliable and less expensive than mechanical cooling, making it popular among shippers. Although UP reportedly plans to expand its small fleet of cryogenic railcars, the railroad industry generally has been slow in investing in this new technology. Shippers have responded by purchasing their own cryogenic equipment. Ed Brandt, general manager of transportation operations for J.R. Simplot Company, an Idaho agriculture company, said that his company owns and operates 157 cryogenic units. He explained that the company saves roughly 10 to 30 percent in shipping frozen potatoes by using the cryogenic refrigeration technology.[38] Marvin Weiner, president of Cryo-Trans, Inc., said in early 1993 that his company had leased "all 333 of its cryogenic cars to shippers that primarily move frozen potatoes." He said that the fleet of traditional mechanically refrigerated boxcars was dwindling since no cars had been built since 1972.[39] One disadvantage of cryogenic refrigeration equipment, however, is that it is not yet as effective as traditional coolants in maintaining precisely controlled temperatures. For this reason, it is often used in transporting foods which are deep frozen.

While it has lost a large share of the refrigerated freight business to trucking, the rail industry is "well-positioned for future growth" in this area, according to Dean Wise, vice president for Mercer Management Consulting in Lexington, Massachusetts. Because the food trade requires long-distance and high-volume traffic, both of which are well suited to rail, the railroads should have a larger market share than they currently have. As technological improvements permit them to control costs and monitor equipment and shipments more closely, rail carriers should be able to regain some of their lost shares in the refrigerated goods market.

Management Practices Related to Technological Improvements in Logistics

Peter Drucker, head of the Drucker Management Center at the Claremont Graduate School in Claremont, California, called logistics, "the last great frontier of cost reduction."[40] In the supply chain process it has been said that, "From earth to consumer, there is an average of 39 handlings, most of which add no value to the product."[41] The formation of partnerships in product handling has the potential of cutting inventories by half and eliminating 90 percent of transaction costs.[42] This is the hope of logistics.

The linking of logistics with marketing has required that logistics be integrated into the manufacturing process at the design stage of new products. The internationalization of the production process and sales requires consideration of issues such as sturdiness and packaging in this initial stage. This innovation, involving logistics planning from the proposal to installation, has led to the development of logistics guides by AT&T Network Systems.[43] The country logistics guides provided to the marketing staff determine what they can promise to the customer; this is a vast improvement over traditional processes in which sales people made a promise to the customer and then logistics staff were brought in to figure out how to fulfill the promise. Before any sales are committed, a menu of delivery options is developed which includes variables such as cost, speed, extra security, and any others dependent upon the particular customer's needs.[44] The measure now for logistics performance is how effectively the logistics system coordinates with the marketing strategy rather than simply the efficiency measures of logistics activities.[45]

The implementation of cross-functionality - coordinating the activities of various internal functions within the company - increases the potential for logistics in attaining customer satisfaction. In addition to the development of a number of options which provide flexibility in servicing the customer, there is a real increase in the efficiency of performance. For instance, AT&T's recent installation of wireless infrastructure for most of Argentina would have taken two years to complete under the old management system rather than the six months it took under the new logistics strategy.[46]

Third-Party Logistics

It is estimated that just 37 percent of U.S. companies outsource their transportation. This percentage shrinks to ten percent when one considers actual volume. The approximate dollar value of contract logistics is $9 billion; its long-term potential is estimated to be $365 billion.[47] Third-party logistics firms offer services such as dedicated contract carriage, contract warehousing, advanced management information systems (MIS), accountability, and consultation: all aimed at reducing the costs to shippers. Affecting this potential, however, is the concern of a number of shippers with the loss of management control over customer service with outsourcing. Ironically, some of the most successful vendors today are spin-offs from the traffic departments of major shippers. The loss of control of the customer service base or system that they have developed is a major concern for shippers when they consider outsourcing.[48] The three determining factors for the successful third-party logistics firms are (1) a strong balance sheet; (2) a wide array of transportation services covering multiple modes; and (3) a willingness to tailor programs to the specific needs of customers.[49]

While the vision of many of these firms and the shippers are of full-service providers, the key to the successful providers is specialization.[50] The firms carve a niche in a particular transportation service and subcontract with other parties to provide a complete package of services. Innovations in services is a method of developing a niche. Choice Courier Systems, a New York-based logistics firm, is developing a service called "Twilight Express" which includes installation of the equipment along with delivery.[51] The expectations for this service, referred to as "third-party technical support," are high.

Third-party logistics firms are essentially management-based firms whose only capital assets are computers and office furniture. One example of firms of this type is Innovative Logistics whose biggest asset is the personal computer.[52] Its capital investments in technology are modest compared to investments in transportation capital. Also, its areas of expertise in rail intermodal and computer technology are a function of that extant in the company.[53] The transportation needs of these firms are obtained from independent vendors.

The companies that have come and gone are those whose capital assets are heavily invested in transportation services.[54] The failure of the latter is tied to the lack of flexibility they can offer customers because their transportation services are predetermined by their capital investments. One firm with a capital-intensive operation is GATX Logistics Inc. Its initial start was in warehousing, but along the way it has acquired a trucking fleet consisting of 190 tractors and 360 trailers, in addition to packaging and information services. The key to GATX's success, however, has been specialization. Additionally, its growth has been tied to actual demand via growth in market share rather than new acquisitions or speculative investment.[55] Other firms in this category, such as Hub Group Logistics, insist that they "don't force assets, but we do give our clients greater assurance of equipment availability."[56] The firm assures that it is always able to offer multiple alternatives to avoid the perception a conflict of interest in service provision.

Spin-off logistics firms are, by design, completely independent of their parent companies. Again, the intent is to convey to the customer that the firm is carrier neutral.[57] However, these spin-off firms have not moved too far from the parent company. For example, about 95 percent of Sears, Roebuck & Co. business is handled by Sears Logistics Services. This arrangement, however, can be contrasted with Caterpillar Logistics Services, which does not handle transportation for Caterpillar Inc., the manufacturer of tractors and other earth-moving equipment.[58] The challenge for these and other third-party logistics firms in fulfilling the potential for their market will be to convince shippers to give up direct control of transportation. Even those companies that do outsource are retaining some control over in-house logistics to hedge their bets. One method for attaining more of this market share is for third-party logistic firms to aim their marketing at the chief financial officer and the chief executive officer rather than the traffic manager. The potential growth of these firms is aided by the trend in the companies and corporations to downsize and focus on the core of their respective businesses--manufacturing, retailing, wholesaling, etc.[59]

Just-In-Time (JIT)

To facilitate this complex network of transportation and other services and attain efficiency, logistics firms and managers continue to seek advantages through technological innovations. JIT in assembly lines has revolutionized the manufacturing process around the world. JIT requires the adoption of flexible production schedules. Companies employing JIT reduce the time from the concept and design of the product to its placement on the store shelf by employing computer modules. In 1990, 18 percent of all U.S. products were shipped JIT; in 1992, this grew to 23 percent of all U.S. products. It is expected that by the year 2000, 39 percent of U.S. products will be shipped JIT.[60] The outcomes of JIT are streamlined work practices and increased ability to anticipate problems before they occur.[61]

The global application of JIT has been labeled "virtual logistics."[62] This process allows multinational corporations to produce at the lowest cost anywhere in the world and still be competitive in getting its goods to market. Robbins Company, a tunnel-boring-machine maker based in Kent, Washington, has boosted on-time delivery to Europe by 92 percent through forward planning and coordination.[63] The key to the success of virtual logistics is getting modern communications and transportation to work as a team.

In addition to JIT, the driving force behind logistics is EDI. Logistics, in fact, has been referred to as the progeny of JIT and EDI.[64] The capabilities of a logistics system with EDI is exemplified by the statement of Thomas Hardin, president of the Hub Group, with respect to their client Sears Logistics: "What makes it work is a customized, paperless system. When a Sears store sells a hammer, a transaction-driven order process begins that reaches all the way back to Sears Logistics and Hub. Orders flow electronically to Hub for trailers or containers at the same time goods are ordered from suppliers."[65]

Wal-Mart is currently attempting to take its point-of-sale information system which is used to monitor sales and replenish goods one step further. The new system it would hold payment of the supplier until the product is sold to the final consumer. In essence, the funds would flow to each partner in the supply chain through electronic funds transfer.[66]

Other developments include a company called Air Products and Chemicals, Inc., which is attempting to expand its EDI capabilities to include a pilot program for truck bills of lading and is making plans to install a new client server computer network.[67] Knighted Computer Systems of Glenham, New York has developed a fully integrated software system to handle warehousing and distribution operations. The "Warehouse Management System uses bar coding, laser scanning, RF terminals and printers, badge security and UPC coding. Their are nine modules which include receiving and storage, order processing, warehouse control, automatic restocking, management reporting, labor analysis, cycle counting, physical inventory and time and attendance.[68] Another company, Teledyne Brown Engineering's Transportation Information Exchange Network (TIE-Net) has three computer interface options -- host-to-host, LAN-to-host, and PC-to-host.[69]

As with any innovations, there are failures. One such system called "Axiom," developed by Roadway Logistics Systems (ROLS), was a computer program developed "to book, track and provide decision-making support for shippers."[70] The project has been downgraded to internal use only, with no commercial applicability. One method of monitoring logistics productivity, especially amidst a wave of software development, is through benchmarking. Benchmarking is simply comparing one system to another in order to locate and implement the best practices.[71] Edward Frazelle, director of the Logistics Institute at the Georgia Institute of Technology, concluded that effective benchmarking "starts with selecting the right format and focusing more on incremental improvements instead of sweeping solutions."[72] Robert M. Allison, logistics productivity specialist for Chrysler Corporation, summed up the role of benchmarking in the high-technology arena of logistics: "I believe we are on the cutting edge of technology. Change is a constant. If something flops and doesn't work, we change it. We are benchmarking every day. If we find something better, we change it."[73]

Both EDI and JIT are certain to play an important role in the future of logistics. Clients are demanding EDI to accompany their JIT processes. The issues of affordability and standardization are important concerns, but they are unlikely to be a permanent hindrance to the availability of technology. It is clear that current and future participants in the logistics market must be technology-minded.

Artificial Intelligence

One area of technological development which is just beginning to have an impact on logistics decisionmaking is artificial intelligence (AI). AI is defined as software that emulates human reasoning. While many AI technologies are only in the experimental phase, others are being implemented today; the potential of AI applications to revolutionize transportation management is widely recognized. Tom Peters, co-author of *In Search of Excellence*, wrote, "I conclude that any senior manager in any business of almost any size who isn't at least learning about AI, and sticking a tentative toe or two into AI's waters, is simply out of step, dangerously so."[74] Researchers for the Council of Logistics Management studying AI's current and potential impacts have divided this innovative technology into six areas: expert systems, natural language, speech recognition, 3-D vision, intelligent robotics, and neural networks. Of these, expert systems is the area where extensive implementation has already taken place, while the other areas are just beginning to see extensive use.

Expert systems software captures and stores logistics knowledge gained by experts over time "in much the same way a conventional computer program stores numeric information in a database." This offers tremendous advantages to companies by allowing them to save institutional knowledge; a company can retain expert knowledge, for example, even when an experienced logistics manager leaves the firm. Logistics expert systems offer the ability to process qualitative, incomplete, or uncertain information and they provide permanent and reproducible knowledge.[75] These systems are often components of larger logistics software packages such as those described earlier. Sea-Land Service, Inc. uses an expert system to ensure proper scheduling and routing of marine vessels "by providing consistent decisions by customer service representatives." The system also offers automated tracking of shipments.[76]

Speech recognition systems allow direct verbal communication with computers by accepting analog voice signals, digitizing them, and comparing them to stored patterns in order to recognize the meaning of spoken information. The Air Force Logistics Command has installed speech recognition systems in its depot warehouses which allow warehouse personnel to communicate directly with the warehouse automated storage module. Warehouse personnel, wearing wireless microphones and headsets, read the stock number of incoming items into the system, which updates the inventory and tells the staff member exactly where to place the item. The speech recognition system has eliminated the need to manually type in new product data to the automated storage module, providing more accurate inventory records and removing the problem of typographical errors.[77]

Other AI technologies with potential transportation applications are being investigated by academic and business research groups throughout the world. Intelligent robotics may someday provide "'lights out' warehouses with intelligent order pickers and packers and intelligent robotics systems capable of loading and unloading transport vehicles and containers."[78] Neural networks are being used to help computers mimic the human brain's capability to recognize patterns and make recommendations based on subjective information. The U.S. Air Force's experimental Comprehensive Engine Management System uses cameras attached to neural networks "to examine parts more accurately and consistently to check for stress" and possible structural failure.[79]

Researchers are just beginning to discover the potential benefits of AI technologies in the transportation industry. In the future, hybrid systems, combining AI technologies with EDI and various tracking systems, are likely to make firms more competitive by permitting them to retain expert knowledge, streamline operations, and cut costs in the process.[80]

Conclusion

The role of technology in generating efficiencies in transportation is unquestionable. This role is evident by observing recent technological developments as well as ongoing research efforts to stretch the bounds of technology in search of an automated society. As firms seek new ways to cut costs and become more competitive, the growing demand for precise information among transportation managers and their customers will continue to drive technological innovation.

The search for improved information and streamlined operations is a natural outgrowth of the increasingly global nature of trade and logistics planning. Pondering the future of logistics management, transportation managers everywhere envision an international business environment that enables them to accurately control the flow of materials and information around the world. To bring this vision to reality, one technological firm explained its planning process for marketing its product to potential customers. It formulates an intimate profile of the company which includes (1) its business processes; (2) function; (3) internal (intra-enterprise) exchange of information; (4) external (inter-enterprise) exchange of information; and (5) its role in the global market.[81] This effort toward global efficiency in trade, however, is hampered by the lack of cooperation and mandated standards in the development of transportation technologies. Intermodal and international inconsistencies in technological development hinder the seamless and paperless system envisioned by firms in the transportation industry.

With the passage of NAFTA, increased trade between the United States, Mexico, and Canada continues to grow, even in the face of Mexico's current economic difficulties. Significant increases in traffic promise to place increased demands on existing infrastructure. Technology and intermodalism can play a significant role in alleviating this demand. Mexico will be required to make huge infrastructure investments in its telecommunications and power networks if the seamless shipping envisioned by North American logistics professionals is to become a reality. Today, for instance, the only EDI networks in Mexico are the internal networks of private companies.[82] In order to realize the efficiencies of EDI technology, it will be necessary for Mexico, in conjunction with private firms, to develop an adequate and accessible telecommunications infrastructure which can support this endeavor. Expanded implementation of equipment tracking and monitoring technologies like AEI will also be necessary to provide reliable logistics information to support Mexico's expanded EDI capabilities.

As technology proliferates, transportation firms continue to become more competitive, offering faster and more reliable service to their customers. Greater global competition, in turn, drives the development of new transportation technologies as firms seek ways to further streamline their operations. The continual process of technological development and increased competition is likely to accelerate in years to come, as powerful logistics technology becomes more available to small firms in the developing world. Given the probability of ever-increasing competition, it is in the interests of U.S. and Mexican businesses to push aggressively for the implementation of improved transportation technologies throughout North America.

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Chapter 6. Forecasting Freight Demand and Modal Choice Models

Introduction

This chapter examines the traditional methods of forecasting freight demand and modelling modal choice so that the diversion of traffic among modes may be determined for planning purposes. With the ratification of the North American Free Trade Agreement (NAFTA), the volume of traffic entering the United States from Mexico through the border states will increase dramatically, causing a strain on the transportation network and facilities. Thus, predicting how traffic will be distributed among the modes is necessary for maintaining transportation infrastructure and system wide performance so that goods may continue to be delivered efficiently.

In addition to the provisions of NAFTA, freight transportation is undergoing other changes. For example, logistics practices have evolved with the desire to cut costs through more efficient production and distribution of goods to customers. New technologies and services offered, as well as a move towards intermodalism, have allowed shippers to streamline their logistics processes, thus reducing costs to the consumer. The introduction of these factors is affecting the way in which decisionmakers select modes. Not only is modal choice determined by a variety of decisionmakers, but also the decisions are based on numerous criteria including reliability, commodity type, transit time, and rates charged. The decisionmakers range from shippers to inventory managers.[1] These issues explain the less extensive research performed in the area of forecasting freight modal choice as compared to urban transportation. The development of these models has been significantly limited due to lack of data as well as the complexity of freight transportation.

Traditional freight forecasting models have been developed with the need for better planning techniques and also to be able to determine the implications that policies and system changes have on freight demand and modal choice. The different types of models are a result of various needs for the models. Early research concentrated primarily on determining which factors influenced modal decisions. These attributes may be categorized into four groups: commodity attributes (type, value, weight, shipment size, annual tonnage), transport system attributes (distance, transit time), shipper attributes (reliability, transport cost, frequency of service), and market attributes (origin and destination locations, production and consumption volumes).[2]

As a result of the research conducted during the mid-1960s and early 1970s, certain factors were acknowledged to have an effect on the accuracy of freight demand models, in particular the level of aggregation. In addition, the lack of available disaggregate data, specifically traffic flow data, which reflect modal and commodity attributes, also hindered the application and development of these models. The greatest data needs have been identified as "commodity flow and traffic flow data, routing data, rates/tariffs data, transport level-of-service, and unit cost data (capital and operating)."[3]

Other issues which have impeded research in this area include difficulty of aggregating commodities into homogeneous groups and difficulty in incorporating all attributes affecting the modal decision.[4]

As research has progressed in the area of freight demand forecasting, some researchers have attempted to incorporate the total cost of a good, from production to distribution, because total cost is believed to affect logistics decisions including modal choice. Nash and Whiteing (1987) stated that modal choice is an "investment decision." This total distribution cost approach attempts to optimize the entire logistics process by minimizing the total cost of the system. Thus, the mode with the lowest cost is not always selected since the cheapest mode may contribute to higher costs in other areas of the distribution system. For example, depending on the commodity, modal choice may be determined along with other logistics decisions. The decision may be affected by the location of warehouses and the availability of storage space.[5]

This chapter introduces the traditional methods of forecasting modal choice and specifies the data requirements for the various models. For each type of model, a general form is presented. An attempt will be made to assess the applicability of these models, which may have only previously been tested on a statewide or regional level, in a binational context. The type of model chosen depends on the level of analysis whether it be on a regional level, where more aggregate results are desired, or on a micro-level, where link flows by mode (i.e., more detail and less aggregation) are desired. In addition, recommendations will also be made regarding further research and data needs.

Methods of Forecasting Freight Modal Split

This section summarizes different approaches to determining freight modal choice, including a few packages which have been used to forecast freight demand. The models may be categorized as econometric or network-based models. Econometric models are models which describe the relationship between modal choice and the factors influencing that decision such as level of service of the mode, transit cost, and transit time. Network-based models are those which describe and simulate the transportation system.

The econometric models, which use cross-sectional and/or time-series data, do not require a detailed synthesis of the transportation system network in order to model behavior. They may be further broken down into supply-side, demand-side, and integrated models. Supply-side models deal with the cost of transportation services and were not intended to be used as predictors. On the other hand, the demand-side models, which were developed for predictive purposes, depict the characteristics of the freight transportation services. The demand for the particular mode is dependent on its cost as well as the level of service it provides. These demand models may be further classified as aggregate, network-level analysis, or disaggregate analysis which is based on the individual decisionmaker's behavior. The integrated models combine the supply and demand approaches and attempt to achieve an equilibrium. However, Friedlaender and Spady (1981) indicate that an equilibrium in the integrated models may not be attained.[6]

Because the policy analysis desired in this project requires predictive models, supply-side models may not be applicable. These methods attempt to determine economies of density and scale for various transportation industries. They were inconclusive in finding the latter. Furthermore, the integrated models, which have been used to analyze the effects of deregulation, are not applicable to the analysis desired in is study. Thus, the following review of existing modal choice models will fall under the category of freight demand models.[7]

Network-based models, as stated earlier, describe the transportation system. From the volume of goods generated in a region, the flows of these goods may be distributed by mode throughout the network depending on the demand for the good in another region. These models, which include the spatial price equilibrium and freight network equilibrium models, require that the transportation system network be described in detail. Thus, the system is represented by nodes for facilities, trans-shipment nodes (which do not produce or consume the commodity), and arcs (as the infrastructure linking the nodes). Regions are then joined by a series of these links. Associated with nodes and arcs are their levels of service which may be defined as being dependent on flows.[8]

The spatial price equilibrium models are applied at the tactical (short-term) level since the investment in the system is constant. Computation of an altered network is involved so the models have not been used for predictive purposes in the context of industry changes. The spatial price equilibrium model illustrates the role of transportation firms as cost functions that do not account for the decisions made by carriers.[9]

This type of model determines network flows based on the equilibration between consuming and producing regions. The flows will be assigned between regions depending on the cost of the commodity and the transport cost. The lower-cost route will be assigned the commodity flow. Thus, transportation demands are derived from the region's demand for the commodity.[10]

Freight network equilibrium models describe the transportation system network and the relationships among shippers, carriers, and potential carriers. Some of the models developed have been based on Wardrop's first and second principles: user equilibrium and social equilibrium. User equilibrium is defined as the condition in which all routes with traffic flow between an origin and destination have equal costs, and those that do not have higher costs. Social or system equilibrium may be defined as the condition in which the total cost on the network is minimized.[11] These models, however, do not take into consideration that commodity demand may derive transportation demand.[12]

Network equilibrium models assign flows to a network, allowing for multimodal transport of various commodities. In some previous applications, modal choice and transportation demand have been assumed to be exogenous (i.e., independent variables). However, in our attempt to predict modal split, they may be endogenous, with the inclusion of econometric models.[13]

Econometric models: Aggregate

Regression (Linear Probability) Models

Regression models attempt to establish a relationship between independent variables and the dependent variable. It most often uses cross-sectional data (data for variables collected at one point in time), which implies that shippers will behave the same across time. This type of analysis is based on mathematics and relates independent variables with a dependent variable, in this case, modal shares. Advantages to this model include the ability to assess the power of independent variables in explaining the dependent variable (i.e., the probability of choosing a mode). The probability of an event occurring ranges from zero percent to 100 percent. Although these models are applicable to statewide planning, the inherent statistical problem of the probability possibly being outside the acceptable range of 0 - 1 exists. Thus, the logit or probit models, which do not have this problem, are sometimes preferred. The general form of a regression model is the following:

$$\mathbf{P_k(X_{ij}) = b_0 + b_1X_1 + b_2X_2 + ... + b_nX_n + u_i} \quad \text{where}$$

$\mathbf{P_k(X_{ij})}$: estimate of the dependent variable which is the probability of selecting mode *k* for the shipment between origin *i* and destination *j*

$\mathbf{X_1 ... X_n}$: independent variables such as transit rate or shipment size

$\mathbf{b_0 .. b_n}$: parameters (i.e., coefficients)

$\mathbf{u_i}$: error term.[14]

Perle (1964)

Perle developed a regression equation to model mode split as a function of rates. He combined the data into five commodity groups and determined the volume of freight carried by truck and rail from time-series data. The independent variables included average rail and truck rates and the dummy variables: type of commodity, year, and region. Dummy variables are variables for which no data exist and are given a value of 0 or 1 in the model to represent whether or not the independent variable has an effect on the dependent variable. Furthermore, the levels of service offered by each mode were not well represented. The results of his models were poor because the estimated coefficients had incorrect signs so the model did not fit the data well. These results indicated that disaggregate data and commodity attributes in addition to price are needed. Also, as a result of the correlation of commodity dummy variables with commodity and level of service characteristics, the coefficients did not accurately reflect the relationship of the explanatory variables and the mode split. Furthermore, the price elasticities were affected by the aggregation level.[15] Price elasticities measure the percent change in quantity demand due to a one percent change in price.

Perle also tested a joint, aggregate demand model based on the same data. A joint model incorporates the interaction between several choices in one equation since some decisions are made jointly. It yielded results with lower R^2 and *t*-statistics than the previous model because this model does not account for the dependence of transportation demand on commodity demand.[16] R^2 is a statistical value between 0 and 1 that represents how well the dependent variable is explained by the model. The closer the R^2 value is to 1, the better the model represents the data, thus implying that the model can better predict the dependent variable. A *t*-statistic is a statistical value that shows the significance of a coefficient of an independent variable in the model.

Mathematica (1969)

This technique is an aggregate conceptual (i.e., unspecified) model system comprised of four phases which yields the modal split of interregional commodity flows. It attempts to incorporate all decisions regarding shipment through a sequential approach. Regression analysis is applied to each of 16 defined commodity groups. Then, the volumes produced and received in each region and the interregional volumes of commodities are predicted. Finally, from the estimates of the interregional flows, modal shares are determined. The independent variables needed in this four step procedure are time, Gross National Product (GNP) projections, population, retail sales, per capita income, production at origin, consumption at destination, distance, commodity value, and average gross revenue per ton.[17]

Surti and Ebrahimi (1972)

Surti and Ebrahimi developed two curvilinear regression models and a linear regression model to predict modal shares on truck and rail using data obtained from 24 shipper groups. This data were collected from the 1963 *Census of Transportation*. One of the curvilinear regression models was tested with distance and shipper groups as independent variables, whereas the other was evaluated with shipment size and shipper group. The linear regression model with shipment size, distance, and shipper groups resulted in higher R^2 values than the others, implying that these variables explain the dependent variable, truck-rail traffic distribution. In addition to distance and shipment size, type of commodity, plant size, geographical area of the origins and destinations were also used as independent variables. However, the latter two were not very significant. Also, individual models must be calibrated for each commodity type.[18] From their study, Surti and Ebrahimi concluded that the linear regression model can be used to predict modal shares for carriers, help firms determine plant locations, and forecast freight traffic.[19]

A. D. Little (1974)

This method predicts the proportion of freight traffic that will be assumed by barges. It incorporates both tactical and strategic variables; in other words, it considers long-term factors in predicting modal choice. The independent variables used in this formulation are distance, circuity (water distance/rail distance), shipment size, commodity value, location of production and consumption facilities, and whether or not the commodities are bulk goods. Circuity and distance were included as proxy variables for the level of service of barges compared to truck and rail.[20]

The results of this model showed that a strong relationship exists between waterborne freight movement and strategic variables, thus indicating that strategic variables such as plant location influenced decisions to ship by water carriers more than tactical factors such as transit time. Distance was the most important factor influencing decisionmaking.[21]

Aggregate Logit Model

Kullman (1973)

Kullman tested a binary choice logit model which would predict the modal split between truck and rail with aggregate data. The logit model is considered a disaggregate, behavioral model and is explained in further detail later in the chapter. However, Kullman applied the logit model on a aggregate level. Several different combinations of variables and levels of geographic and commodity aggregations were tested. The results indicate that a commodity's value and market characteristics are important to analyzing modal choice on an aggregate level. Modal choice was determined as a function of the modal and commodity attributes. Specifically, the independent variables included highway distance, annual tonnage, commodity value, transport rates, and mean travel time. However, the model did not account for fixed costs or the level of service of the mode.[22] Thus, even the best model (in terms of R^2 value and t-statistics), using value, tonnage, and distance as explanatory variables, had a low R^2 although all coefficients were significant at the 95 percent level.[23]

Murthy and Ashtakala (1987)

Murthy and Ashtakala analyzed modal choice using the logit model. This analysis was conducted on a regional level, and the data combined shipper and receiver survey responses. They organized the frequencies of data into multi-dimensional contingency tables of explanatory variables such as average shipment size, loads, control, hire, and type of commodity versus modes. A log-linear model was used to determine whether an association between the explanatory variables and the dependent variable existed. The logit model then allowed the analyst to assess the combined influence of the independent variables over the dependent variable and determine the preference for each mode, and thus modal share.[24]

Econometric models: Disaggregate

Abstract Mode Models

This approach represents the mode of transport abstractly, as a vector of values associated with the mode's attributes. By estimating shippers' demands for attributes rather than the actual modes themselves, it is possible to infer what would happen if the value of the attribute were changed. Furthermore, data may be used to test the model's performance. The model can also be applied to forecasting the demands for commodities with few data by defining the commodities with values representing their characteristics. An advantage of this method is its capability of estimating demands for modes which may or may not currently exist. Consequently, historical experience is not needed.[25]

Although this approach was first investigated by Mathematica, Herendeen also developed an abstract mode model which was used in the U.S. Department of Transportation and National Standards of Institutes and Technology multimodal network model. His formulation is as follows:

$$\mathbf{P_k(X_{ij}) = \beta_0 R_k^{\beta 1} C_k^{\beta 2} T_k^{\beta 3} F_k^{\beta 4}} \text{ with the constraint that } \mathbf{\Sigma P_k(X_{ij}) = 100}$$

where

$\mathbf{P_k(X_{ij})}$: percentage of X_{ijk} shipped by mode k

$\mathbf{R_k}$: reliability of mode k;

$\mathbf{C_k}$: relative cost by mode k;

$\mathbf{T_k}$: relative transit time by mode k

$\mathbf{F_k}$: relative frequency of service

$\mathbf{\beta_0, \beta_1, \beta_2, \beta_3, \beta_4}$: parameters determined by regression analysis.[26]

Mathematica (1967)

This method estimates freight demand for each mode along each link in the transportation network. Unlike Herendeen's model which only estimates modal choice, this one performs freight generation, freight distribution, and modal split in one step and yields the volume of flow between two locations by a particular mode.[27] Because of the data requirements and the need to calibrate a model for each commodity, this approach was never tested. The explanatory variables included in the model are the following: population of the origin and destination, gross regional product of the origin and destination, industrial characteristic indices, the cost of each mode, transit time, and number of modes. In order to apply the model, the data must be disaggregated by mode. However, given the availability of the data, the model can predict the effect of the new mode. A new mode may be modeled by specifying its cost, shipping time, and other major characteristics.[28]

This type of model formulation allows for evaluating policy impacts such as changes in transport cost or rate. However, a disadvantage of abstract mode models is that the mode which is determined to be the best will always assume the same proportion of freight unless its own attributes change regardless of any improvements among the other modes. Also, since it defines the modes abstractly based on attributes, a mode may be better than another under certain circumstances but not others. For instance, for large shipments, rail may be less expensive than truck which may not be the case for small shipments. The same may be true for the length of haul.[29] Furthermore, a demand model for each commodity must be determined because the model does not incorporate commodity attributes.[30]

Linear Programming

Linear programming is a mathematical tool that consists of optimizing (either maximizing or minimizing) an objective function subject to a series of constraints. This procedure may be applied by a firm to select the lowest costing mode within defined constraints. However, because no commodity attributes may be included in the formulation and the difficulty of including reliability, the constraints of the model may not be accurately described. Nevertheless, a major advantage to linear programming is its capability to be implemented on a personal computer. Also, the programmer is able to limit modal choices and depict any captivity associated with a consignment using the linear program.[31] An example of the objective function *Z* for a linear program is the following formulation by Tripp:

$$\text{Min } Z = \Sigma_i \Sigma_j \, [\, r_{1ij}T_{1ij} + r_{2ij}T_{2ij} + r_{3ij}T_{3ij} + r_{4ij} + T_{4ij} \,]$$ subject to a series of demand, capacity, and logistics system constraints;

where

T_{ijk}: amount of freight moved from origin *i* to destination *j* by mode *k* (thus, four modes are specified in the above formulation)

r_{ijk}: tariff charged by carrier to move good from *i* to *j* by mode *k*

Tripp (1972)

Tripp used the linear program above to determine the volume of one type of commodity by a particular mode. The modes he included were rail, truck, and piggyback. Thus, intermodal shipments were possible. His formulation was based on the minimization of total shipping cost between two locations provided that the mode was within the constraints of the logistics system. He did not test this model with actual data; also, the formulation lacks commodity and level-of-service attributes. Moreover, the logistics system constraints may not have been specified correctly.[32]

Microeconomics and Inventory Theory

Mathematica (1967)

This micro-economic and inventory theory approach determines modal choice by using shippers' indifference curves which illustrate the trade-offs between two or more variables. In their formulation, the modes are each represented by speed and economy, which are the inverses of transit time and freight rate, respectively.[33] The explanatory variables used in the formulation are shipping costs, waiting time between shipments, transit time, and commodity type. The formulation is specified as follows but was never tested:

$$C_{ijk} = r_k X_{ij} + ut_k X_{ij} + a/S + WSX_{ij}/2 + h\tilde{A}(S+t_k)X_{ij}$$ where:

C_{ijk}: expected total annual cost of handling shipment from origin *i* to destination *j* by mode *k;*

$r_k X_{ij}$: direct shipping cost;

$ut_k X_{ij}$: total in-transit carrying cost;

a: cost of ordering and processing per shipment;

S: interval between shipments;

$WSX_{ij}/2$: recipients' inventory carrying cost;

$h\tilde{A}(S+t_k)X_{ij}$: safety stock cost.[34]

From the above equation, an indifference curve for a shipper may determined. The selected mode will be one which will minimize the shipper's total annual cost of handling and will perform the best in terms of the attributes of speed and economy.[35] According to Paul O. Roberts, this model is effective for evaluating a firm's operating policy or different location possibilities.[36] Limitations to this approach include the large amount of data required to apply the model. Also, the model may not be transferable between shippers with similar characteristics. That is, the behavior of one shipper may not explain the behavior of another similar shipper. Consequently, it could not be applied to regional level planning.[37]

Discrete Choice Models

The logit model is a statistical technique that calculates the probability that a mode will be chosen based on all of the modes available to the decisionmaker. The probability, therefore, must be between 0 and 1 and the sum of the probabilities for selecting each mode must be 1. Consequently, the nature of the logit model ensures that the problem of unbounded probability encountered with regression models is avoided. The multinomial logit formulation is as follows:

$$P_k(X) = e^{U(X)}/(1+e^{U(X)})$$ where:

$P_k(X)$: probability of a shipper choosing mode *k* out of all the mode alternatives available

$U(X) = x_0 + x_1 X_1 + \ldots + x_n X_n$ where $X_1 \ldots X_n$: independent variables expressed as differences, and

x_n: coefficients of X_n.[38]

The probit model is also a disaggregate, behavioral binary choice model for analyzing freight modal split. Whereas the logit model represents the probability function as a logistic growth curve, the probit model is represented by a sigmoidal response curve or cumulative frequency curve. A shipper's threshold level is assessed which represents the cutoff of choosing one mode over another. Three shortcomings of the technique are that probit analysis does not incorporate commodity type, model calibration is taxing, and it only applies to deciding between two modes.[39]

Discriminant analysis is a behavioral, statistical technique which may be applied to determining modal choice. Two assumptions regarding the variables are that their distributions are multi-variant normal and their variance-covariance matrices are identical.[40] If a shipper's frequency distribution for a commodity is known, then the value discriminant function, comprised of the linear combination of explanatory variables, is calculated to determine the modal choice. Although this type of model may be applied to more than two modes, it is ideal for analyzing two modes.[41]

Hartwig and Linton (1974)

Hartwig and Linton tested whether the logit, probit, or discriminant model could be used to model binary freight modal choice at the disaggregate level. They assumed that the objective of the shipper is to maximize profit over all the operations of the firm. The models determine the probability of choosing the rail and truck modes as a function of commodity and modal attributes. Shipper data were obtained from waybills for rail car and truck trailers from one firm for one commodity.[42] The independent variables of transit time, freight cost, reliability, and commodity value were used in the model.[43] For both the logit and probit models, the parameters were calculated using maximum likelihood estimates.[44]

The analysis showed that all three models had statistically significant results indicating that they are applicable to modelling individually-based freight modal choice. The variables which had a significant effect on the decision were relative cost, reliability, and commodity value. Relative transit time would have been more significant if not for the data available. The logit model performed best in terms of accurately predicting the shipper's modal choice. Also, elasticities and marginal rate of substitution were determined. The probit model predicted the correct mode 90 percent of the time with 0.5 value on S-curve. In addition to the independent variables listed above, shipper and commodity attributes should also be incorporated into the probit model so that the model may be applied on a wider scale. Their model of individual shipper's modal choice using discriminant analysis showed that cost and commodity value were significant in the decision. Nevertheless, this method was sensitive to data changes. Their study also indicates that the inclusion of independent variables in the model specification depends heavily on data availability.[45]

Miklius (1969)

Miklius used discriminant analysis in estimating freight modal split between rail and truck. The explanatory variables included in his model to determine the likelihood of a shipper choosing a particular mode were average shipment weight, distance, and plant employment. Only one commodity was analyzed, so transferability to other commodities may not be valid. Moreover, the model was calibrated with aggregated data from the 1963 *Census of Transportation*. This early research showed applicability of discriminant analysis to predicting modal choice and that the accuracy of the model's results are dependent on data availability.[46]

Beuthe (1970)

Beuthe developed a binary choice model that predicted the mode split between a very expensive and fast mode and very inexpensive and slow mode. He based his discriminant model on several assumptions including the following: one homogeneous commodity, the commodities are consumed by only one market, and all inputs to manufacturing are purchased locally. The volume of the commodity shipped by a particular mode was said to be a function of travel time, transport rate, shipment weight, and market price.[47]

Antle and Haynes (1971)

Antle and Haynes applied discriminant analysis to estimating freight demand for barge and rail modes. The model was tested on a small data set for three types of commodities obtained through shipper surveys. The data required for the model include annual tonnage between an origin and destination, distance, average travel time, shipment size, rate, alternative mode rate, and handling cost. The value obtained from the function was then used to determine whether the initially chosen mode or alternative mode will be used by the shipper. They also showed the greater accuracy of disaggregate models over aggregate ones. The results were not as good when the model was reapplied with data aggregated over the commodities.[48] Furthermore, the model did not incorporate any commodity attributes which means that a different model must be calibrated for each commodity type.[49]

Joint Choice Model

Chiang (1979)

This disaggregate freight demand model considers logistics decisions made by a firm which impact modal choice, shipment size, and origin. Chiang developed a short-run model which is based on minimizing logistics costs for a fixed demand of production inputs. This model incorporates the interrelationship of the above variables into a joint choice model which enables the shipper to respond to policy changes by making transportation related decisions with consideration of logistics costs.[50]

Intermodal Competition Model and Cross Elasticity Model

The diversion model developed for use by the American Association of Railroads (AAR) consists of the Intermodal Competition Model (ICM) and the Cross Elasticity Model (CEM). The ICM assumes that shipping decisions are based on total logistics costs. It is a discrete choice model which calculated the rail to truck diversion using probabilities that each mode is chosen given a specified scenario. For the most part, it is used to assess the impact of truck size and weight changes on rail. The data used by the model are obtained from the Interstate Commerce Commission (ICC) Carload Waybill Sample which provides information on a number of rail shipments between origins and destinations. The model also requires commodity information which may be obtained from the Commodity Attribute File. This file gives commodity characteristics such as its shelf life, value, density, and special handling requirements. The specific information from the waybill record utilized by ICM includes commodity type, origin, destination, routing, distance, equipment, railroad, and revenue.[51]

The CEM, on the other hand, is a model which measures the diversion from trucks to railroads. It was used by the Intermodal Policy Division (IPD) to determine the impact of a ten percent reduction in railroad operating expenses on modal share. No truck traffic data similar to the ICC Carload Waybill Sample is available; thus, the CEM "constructs a truck analog from the National Motor Transport Data Base (NMTDB), ICM, and the size and constituents of the trucking industry." These sources provide information regarding the annual mileage for all classes of trucks, truck passing counts, commodity, average rail revenue, market share, shipment size, total logistics costs, and length of haul. The methodology of the CEM is analogous to the ICM. That is, the total logistics costs for each mode are calculated first. This procedure is accomplished with information on market share, distance and consignment size of current truck traffic and potential rail traffic. It then applies the logit equation to calculate modal share.[52]

Truck-Rail, Rail-Truck (T/RR/T) Diversion Model

The Truck-Rail, Rail-Truck Diversion Model (T/RR/T) was developed by Transmode Consultants, Inc. The model uses files available on CD-ROM and requires Microsoft EXCEL 5.0 and ACCESS 1.1 set up under Windows to be executed.[53] It is comprised of several models: mode-choice, shipment size diversion model, and level of service models. The shipper logistics cost model, developed by researchers at the Center for Transportation Studies at MIT, is the basis for the ICM model mentioned earlier in the chapter. It is a discrete choice model used with disaggregate freight movement databases. Two versions have been formulated: one is deterministic (i.e., one mode is chosen), and the other is stochastic, giving the probability of selecting a particular mode.[54]

The various factors affecting transportation demand can be better represented by a disaggregate modelling approach. At the disaggregate level, the decisionmaker's (usually the shipper's) behavior is the basis for the model, and by calibrating the model with a disaggregate sample, the variation of the decisionmaking group is retained. With each level of aggregation, a bit of variation among the individual behavior is lost.[55]

The basis for the diversion model is that the decisionmaker attempts to minimize total logistics costs. The shippers logistics cost module is based on past research involving the rationale behind the behavior of the decisionmaker. From previous studies conducted at MIT, modal decisions have been determined to affect the receiver of the commodities. Because the shipper acts on behalf of the receiver, a single decisionmaker may be assumed to be the shipper/receiver. This decisionmaker chooses not only the mode of transport but also consignment size. The researchers also point out that shipper behavior depends on annual use of commodity. For instance, annual use creates a trade-off between shipping a large quantity of the good at a lower price versus having an excess of a good and having to store it or only ordering a small shipment which costs more to transport.[56]

The T/RR/T model utilizes three disaggregate databases in spreadsheet form which are accessible through a database manager: ICC Carload Waybill Sample, Rail Intermodal Sample, and Truckload Movement Sample. The model predicts modal share of rail carloads, rail intermodal trailers, rail intermodal containers, roadrailers, truckloads, longer combination vehicles, less-than-truckload (LTL) trucks, wholesalers, and private trucks. It also can perform policy impact analysis if the policy changes can be expressed in level of service and data changes.[57]

For each modal alternative, the total delivered cost per unit for the mode, which is comprised of total transport cost and total logistics cost, is calculated. Next, the "competitive margin" between rail and truck is assessed by comparing total delivered costs for all modes. The competitive margin establishes competition between rail and truck because rail rates may be adjusted. Finally, the total delivered cost per unit is recalculated to determine best mode.[58]

Network-based Models

Four-Step Process for Freight (1983)

This approach is analogous to the four-step process used in urban transportation planning. It consists of four phases: freight generation, distribution, mode division, and traffic assignment. The procedure provides different subtechniques based on the user's problem definition. Data availability may also factor into which subtechiques are chosen. The required data cover base and forecast-year vehicle or commodity flows and present and future service, cost, and rate characteristics for each mode. This procedure has been defined for rail, truck, and inland waterway transportation. Depending on the problem definition, all steps and inputs may not be required.[59]

For the modal split step, three subtechniques have been developed. A model may be specified based on cost comparisons of marginal unit costs, rates, or physical distribution costs. In addition, the process is flexible enough to allow other mathematical techniques to be implemented. However, since not all transportation personnel will be familiar with these other methods, they were not included as subtechniques. In each of the above subtechniques, commodity or vehicle flow data are a necessary input. A limitation to the mode split step of this four-step methodolgy arises because it is based on economics or logistics and does not adequately consider the service attributes of each mode.[60]

Kresge and Roberts (1971)

Kresge and Roberts developed a technique to describe a multimodal transportation network. Roberts' transport model estimates interregional commodity flows using a gravity model and linear program. It consists of eight steps: commodity disaggregation, network definition, modal choice and routing, commodity distribution, commodity assignment, modal cost-performance calculation, transport price determination, and a summary of system performance measures.[61] Commodity flows from Kresge's macroeconomic model serve as inputs into the transport model. The network consists of links representing the mode that join supply and demand points. It allows for transfers from one mode to another. The modal choice and routing step is based on sequential decisions by shippers to minimize costs such as waiting time and travel time to transport a commodity.[62]

The gravity model ensures that all the demands are satisfied by producers and that there are no excess products being supplied. It provides good results for forecasting highly aggregated flows of heterogeneous commodities. The objective of the linear program is to minimize overall cost of transporting a commodity from production points to consumption points subject to fulfilling demands. The linear program provides good results for estimating flows of homogeneous commodities such as coal and rice. After applying the linear program, the flows can be converted from value per year to tonnage. They can then be assigned to the network by minimum paths (lowest cost) and also converted into number of vehicles.[63]

Guélat, Florian, Crainic (1990)

This model, which predicts commodity flows on a multimodal network, is useful for strategic planning. It has been implemented in an interactive-graphic system called STAN, Strategic Planning of Freight Transportation. The network consists of links defined by the origin, destination, and mode. Changes from one mode to another are modeled with cost functions. The approach assumes that the commodities are shipped at a minimum total generalized cost.[64] The behavior of shippers and carriers is also assumed to be implicit in the origin-destination matrices and modal decisions. This information, if available, may be incorporated into the matrix.[65] Although the application of STAN has been used to simulate freight flows by mode with modal choice being an independent variable, it may be possible for modal choice to be exogenous. The decision may be determined from econometric models such as the ones described earlier. If modal choice may be determined simultaneously as other decisions, the distribution of flows will have to be determined through an iterative process.

Harker (1985)

Harker developed a generalized spatial price equilibrium model (GSPEM) which simultaneously determines generation, distribution, modal split, and assignment by shippers and carriers. The necessary inputs are commodity demand and price, inventory, transport costs, productivity, and carriers and their networks.[66] The model reaches equilibrium with buying and selling of goods in producing and consuming regions by shippers. It attempts to show the behavior of producers, consumers, shippers, and carriers.[67] For example, carriers are assumed to be profit-maximizers, whereas shippers determine routes based on their desire to minimize transport costs which results in spatial price equilibrium.[68]

Currently Available Data

Because these models would be used under a binational situation, it is necessary to assess the availability of data for both the United States and Mexico. This section comments on data available from the following sources:

- U.S. Customs;
- U.S. Department of Transportation's Bureau of Transportation Statistics (BTS);
- ICC Carload Waybill Sample;
- NCHRP Report #178;
- Current Lyndon B. Johnson (LBJ) School of Public Affairs Policy Research Projects;
- Texas Department of Transportation's (TxDOT) Technology Transfer Program with Mexico; and
- NCHRP Project 8-30 Interim Report Draft.

At the end of this section are three tables which summarize the variables in the econometric and network-based models and the sources for data for each of these types of models.

The data available from U.S. Customs for the United States-Mexico Border include the following:

- mode of transport (no information regarding carrier or transfers to or from other modes);
- city of origin of shipment (no destination information);
- port of entry;
- ten-digit harmonized tariff code;
- value of shipment; and
- weight of gross shipment

Additional data are also collected for water and air cargo shipments. Destination information is catalogued by a consignee number and manufacturer identification number; however, this information can only be obtained with the permission of the Internal Revenue Service (IRS). The Customs data are transmitted to the United States Bureau of the Census for processing.

BTS has several products available that would fulfill some of the data requirements for estimating modal split with the models. The *National Transportation Atlas CD-ROM* is comprised of infrastructure and network data bases for each state and for the entire country. Although the network specifications currently include terminals, they do not show the connections between modes and terminals. The *Rail Waybill Data: 1988-1992 CD-ROM* consists of aggregate data for shipments by rail. This source provides information on origin and destination, commodity type, tonnage, revenue, length of haul, number of cars, participating railroads, and intermodal facilities. *Waterways CD-ROM* provides the waterways network and trade data for navigable waters. It gives 1993 domestic and foreign tonnage for major ports as well as information on physical facilities and dredging contracts. Another source which will be available in the future is the *Commodity Flow Survey* which gives information regarding commodity flow by mode (i.e., truck, rail, water, and air). Origin and destination, 5-digit Standard Transportation Commodity Classification (STCC) code, weight, value, and modes of transport are given for each of the shipments sampled.[69]

Beginning in April 1994, another set of data that provides information on freight flow of U.S. imports and exports with Canada and Mexico is the *Surface Transborder Commodity Data*. The data were gathered by U.S. Customs and provided to the Bureau of Census for processing and are then disseminated to the public by BTS. The flows are categorized by commodity and transport mode (i.e., mail, rail, truck, or pipeline). The data have been sorted by both state of origin and exporter; however, caution must be exercised when using this information since the state of origin may actually be a consolidation point for a particular commodity. Also, the exporter may not be the producer of the commodity. The files applicable to U.S.-Mexico situation contain origin and destination, commodity value, port of import or export, containerization, Harmonized Tariff Schedule/Schedule B code, and freight charges to the U.S. border for imports. Note that origins and destinations have been defined according to the 89 National Transportation Analysis Regions (NTARS) which are a consolidation of the 183 Bureau of Economic Analysis Areas (BEAs).[70]

Each year, ICC conducts a survey for AAR of rail shipments for all railroad classes called the ICC Carload Waybill Sample. The database contains commodity type by STCC code, shipment weight and number of transport units (carload, trailers, containers), origin and destination in terms of BEAs, routing (states where interchanges occur and number of interchanges), distance, equipment, railroad, and revenue. Although it is not available to the public, AAR does produce an annual Public Use Tape.[71]

In addition to the data sources listed above, NCHRP Report #178: *Freight Data Requirements for Statewide Transportation Systems Planning* provides a detailed description of various secondary sources including their costs. This report cites sources which may be applicable to all states and contains regularly collected or recent data (at that time, 1977). Unfortunately, an impedance to gathering data is that some carriers do not want to share data. The NCHRP report categorizes data into five groups: traffic flow (must be collected directly, usually through shipper surveys), shipper/consignee attributes, direct/indirect impacts, carrier, and physical/operating statistics. The latter two may be obtained from secondary records, whereas information on the first two can be collected through shipper surveys.[72]

The policy research projects conducted by the LBJ School of Public Affairs may also serve as an initial inventory of information available for modelling modal choice. For instance, information exists on tonnage passing through Texas ports which may be further disaggregated into imports, exports and domestic goods in short tons. Also, information such as number of warehouses and access channel dimensions, as well as the number of operating vessels and highway and railroad distances to cities, is available for Mexican ports.[73] Rail service at Texas ports and railroad intermodal facilities in Texas may also be obtained. Finally, highways linking major cities, gateways, railroad, and ports is also available for Mexico and Texas. From this information, a network could be roughly depicted. However, in order to apply the network-based models described earlier, information regarding production and consumption volumes as well as a more detailed carrier network would be needed.[74]

Another source of information is the Mexico's transportation department, the Secretariat of Communications and Transportation (SCT). The Technology Transfer Program with Mexico has been established to facilitate the information exchange necessary in providing an efficient system of transporting goods internationally. The Texas Department of Transportation (TxDOT) has recently received diskettes from SCT which have been used in transportation planning in Mexico. SCT has implemented a geographic information system (GIS) of highways, roads, rail lines, and ports to aid in freight planning at both the national and municipal levels. The GIS databases also contain socioeconomic information on both the municipal and state levels.[75]

Recently, Cambridge Systematics, Inc., produced an interim report of NCHRP Project 8-30 titled, *Characteristics and Changes in Freight Transportation Demand*. The report documents the first phase of the project which consists of survey results of various public and private groups regarding freight demand issues and ways of addressing them as well as data sources currently used in freight forecasts. It also identifies the key characteristics and measures of freight demand and the scope of freight databases. The following is a brief description of freight databases cited in the report which could provide the data needed for modelling:

1. **TRANSEARCH**

   TRANSEARCH is a database developed by Reebie Associates (Greenwich, CT) that integrates truck, rail, air, and waterborne traffic from various sources. Origin and destination information is available in terms of the 183 BEAs and some Canadian provinces. Truck mode is divided into private, for-hire, and LTL. Distinctions are also made between rail, carload and intermodal. Commodity type by four-digit STCC code, shipment weight, and the number of modal units are also included.

2. **U.S. Imports/Exports of Merchandise on CD-ROM**

This database of foreign trade is maintained by the U.S. Bureau of Census and available on CD-ROM monthly. It provides commodity type in various forms including ten-digit Harmonized Code, SITC, or Standard Industrial Classification (SIC). Origin and destination information is limited to the country shipped to/from and the domestic district of entry or exit. Consignment value and quantity for all modes combined and value and weight for both water and air modes is given. Imports by water and air modes also have freight charges documented.

3. **U.S. Exports of Domestic and Foreign Merchandise by State/Region/Port (State of Export Tapes)**

These magnetic tapes from the Census Bureau contain information from Shipper's Export Declaration and U.S. Customs Entry Summary and are available every four months. They provide commodity type (two-digit SIC and four-digit SITC), state/region of origin, foreign country of destination, port and district of export, total value of shipment for all modes combined, and total value and weight for water and air.

4. **U.S. Exports by State of Origin of Movement (MISER State of Export)**

Massachusetts Institute for Social and Economic Research (MISER) developed this data file from the Census Bureau's EQ912 and EA917 tapes which denote commodity by two-digit SIC code. The data provided by these files, which may be obtained through the U.S. Department of Commerce, includes state of origin and foreign country of destination, total value of shipment for all modes combined, and total weight and weight for water and air.

5. **U.S. Air Freight Origin Traffic Statistics**

The Colography Group (Marietta, GA) developed this data set of annual air cargo shipments (domestic and export) from surveys and trade information of the industries producing over 90 percent of the total air cargo shipments. Origin information in the form of state, county, and Colography's designations of "market areas" which are aggregates of counties and destination information of domestic or foreign are provided. Also available are commodity type classified by four-digit SIC, shipment size (express or heavy freight), annual shipment weight and value, employment, and number of plants for each market area.

6. **Freight Commodity Statistics**

AAR publishes these rail commodity statistics for all U.S. Class 1 railroads which are required to file a report with the ICC. The data is aggregated according to Eastern and Western Districts by headquarter location and commodity type which is classified by two- to five-digit STCC. Total shipment weight, freight revenue and carloads by commodity is also available.

7. **North American Trucking Survey (NATS)**

This database replaces the National Motor Transportation Database. AAR contracts Arthur D. Little, Inc. to survey drivers at various truck stops regarding the current and previous shipment. The data include commodity type (three-digit STCC), origin and destination (city, state), shipment weight, trailer type, annual vehicle-miles traveled by driver, and carrier attributes (private, for-hire). Although this source is proprietary, it may be possible for federal and state agencies to obtain the data from AAR.

8. **LTL Commodity and Market Flow Database**

The American Trucking Association (ATA) contracts Martin Labbe Associates to collect data from member carriers who then are able to use the database. The data for LTL shipments include commodity type by service (e.g., special handling requirements), origin and destination (domestic zip codes or foreign region), distance, shipment weight, number of shipments and shipment units, and revenue.

9. **Port Import/Export Reporting Service (PIERS)**

The Journal of Commerce maintains this database of international shipments by water from hard copy manifest reports and Customs Automated Manifest System. The data available are commodity type (six-digit Harmonized code, seven-digit PIERS code, and hard copy description), origin and destination (shipper, city, country), U.S. and foreign port of entry or exit, shipment weight, volume and value, and carrier and vessel names.

10. **U.S. Waterborne General Imports/Exports and Inbound/Outbound Intransit Shipments**

Records of waterborne shipments are available on tapes through the U.S. Bureau of the Census. Shipments are aggregated based on commodity, ports, vessel type, and foreign country. The data are comprised of commodity type (SITC and six-digit Harmonized Code), foreign country of origin and destination, domestic and foreign ports of entry and exit, shipment weight and value, and import freight charges.

11. **Waterborne Commerce and Vessel Statistics**

This database, produced by the U.S. Army Corps of Engineers, relates to domestic and foreign waterborne shipments. It consists of commodity type, port tonnage summaries, domestic state of origin and destination, shipment weight, and number of vessels.

12. **World Sea Trade Service**

World Sea Trade Service, developed by DRI/McGraw-Hill (Lexington, MA), is comprised of both past and projected waterborne traffic for over 700 international trade routes. It identifies the commodity type by 20 SITC-based categories, origin and destination by foreign country, trade route, total shipment weight and containerloads, and number of containers.

Other freight databases are industry or commodity specific and provide information regarding origin and destination (production and consumption points or foreign country of import and export) and shipment value, volume, and weight. Some do not distinguish between modes while modes provided by other databases are constrained by the commodity type. A list of these type of databases follows:

- Exports from Manufacturing Establishments;
- Fresh Fruit and Vegetable Shipments;
- Quarterly Coal Report;
- Natural Gas Monthly;
- Natural Gas Annual;
- Petroleum Supply Monthly; and
- Grain Transportation Report.[76]

Table 6.1.
Data Requirements for Econometric Models

	DATA NEEDS											
	Commodity					Transport System		Shipper			Market	
	Type	Value	Weight	Shipment Size	Annual Tonnage	Distance	Transit Time	Cost/ Rates	Reliability	Frequency of Service	O-D (P/C)* Volumes	O-D (P/C)* locations
AGGREGATE MODELS												
Regression												
Perle (1964)	X							X				
Mathematica (1969)	X	X				X					X	
Surti and Ebrahimi (1972)[a]	X			X		X						X
A. D. Little (1974)[b]		X		X		X						X
Aggregate Logit												
Kullman (1973)		X			X	X	X	X[c]	X			
Murthy and Ashtakala (1987)	X			X								

Notes:

* O-D: origin and destination; P/C: production and consumption

a. Model also requires plant size.

b. Model also requires circuity, bulk commodity, and seasonality.

c. These variables are represented relative to competing mode.

	DATA NEEDS											
	Commodity					Transport System		Shipper			Market	
	Type	Value	Weight	Shipment Size	Annual Tonnage	Distance	Transit Time	Cost/ Rates	Reliability	Frequency of Service	O-D (P/C) Volumes	O-D (P/C) locations
DISAGGREGATE MODELS												
<u>Abstract Mode</u>												
Herendeen (1969)							X[c]	X[c]	X	X[c]		
Mathematica (1967)[d]							X	X				
<u>Linear Programming</u>												
Tripp (1972)[e]						X						
<u>Microeconomics and Inventory Theory</u>												
Mathematica (1967)[f]	X						X	X				

d. Model also requires number modes and industrial character index.

e. Model also requires commmodity attributes (loading characteristics, susceptibility to loss/damage, traffic volume and regularity, equipment required, route characteristics), weather, and traffic density. Constraints: demand satisfaciton, capacity, logistic system.

f. Model also requires inventory costs and value of time.

	DATA NEEDS											
	Commodity					Transport System		Shipper			Market	
	Type	Value	Weight	Shipment Size	Annual Tonnage	Distance	Transit Time	Cost/ Rates	Reliability	Frequency of Service	O-D (P/C) Volumes	O-D (P/C) locations
<u>Discrete Choice</u>												
Hartwig and Linton (1974)		X					X	X	X			
Miklius (1969)[g]			X			X						
Beuthe (1970)[h]			X				X	X				
Antle and Haynes (1971)[i]				X	X	X	X	X				

g. Model also requires plant employment.

h. Model also requires market price.

i. Model also requires handling cost.

Table 6.2.
Econometric Models: Data Sources for Frequently Used Variables

Data Need	U.S. Sources*				Mexican Sources*[77]			
	Truck	Rail	Water	Air	Truck	Rail	Water	Air
Commodity								
• Type	1, 3, 5, 6, 13, 14	1, 2, 3, 5, 6, 11, 12	1, 4, 5-9, 15-18	5-10	1, 4	1, 2	1, 6	1
• Value	1, 3, 5,	1, 2, 3, 5,	1, 5, 7, 8, 9, 15, 16	5, 7, 8, 9, 10	1	1	1	1
• Weight	1, 5, 6, 13, 14	1, 2, 5, 6, 11, 12	1, 5, 6, 7, 8, 9, 15, 16, 17	5, 6, 7, 8, 9, 10	1, 4	1, 2	1, 6	1
• Shipment Size	6	6, 12	6, 15, 18	6, 10				
• Annual Tonnage		2		10	1	1, 2	1, 6	1
Transport System								
• Distance	14	2, 11				2		
• Transit Time								
Shipper*								
• Cost/Rate								
• Reliability								
• Frequency of Service								
Market								
• Origin-Destination Volumes								
• Origin-Destination Locations*	1 (origin only), 3, 5, 13, 14	1 (origin only), 2, 3, 5	1 (origin only), 4, 5, 8, 9, 15, 16, 17, 18	5, 8, 9, 10	1, 4	1, 2	1, 6	1

* See notes on next page.

Notes:
The numbers on the previous page designate the following sources from which the data may be obtained.

U.S. Sources
1. U.S. Customs
2. Rail Waybill Data: 1988-1992 CD-ROM
3. Surface Transborder Commodity Data Diskettes
4. Waterways CD-ROM
5. Commodity Flow Survey
6. TRANSEARCH
7. U.S. Imports/Exports of Merchandise
8. U.S. Exports of Domestic and Foreign Merchandise (State of Export Tapes)
9. U.S. Exports by State of Origin of Movement (MISER)
10. U.S. Air Freight Origin Traffic Statistics
11. ICC Carload Waybill Sample
12. Freight Commodity Statistics
13. North American Trucking Survey
14. LTL Commodity and Market Flow Database
15. Port Import/Export Reporting Service
16. U.S. Waterborne General and Intransit Service
17. Waterborne Commerce and Vessel Statistics
18. World Sea Trade Service

Mexican Sources
1. Secretaría de Comercio y Fomento Industrial (SECOFI)
2. Ferrocarriles Nacionales de México (FNM)
3. Instituto Nacional de Estadística, Geografía e Informática (INEGI)
4. SCT- Direcci6n General de Servicios Técnicos y Concesiones
5. Caminos y Puentes Federales de Ingresos y Servicios Conexos (CAPUFE)
6. SCT- Direcci6n General de Puertos y Marina Mercante
7. Aeropuertos y Servicios Auxiliares (ASA)

Note that the Mexican sources listed above are organizations which maintain the data rather than the name of the database as with the U.S. sources. At the time of this report, no description of the specific databases had been obtained.

Shipper information is difficult to obtain for each shipment because they do not want their identity revealed. Public use tapes have been modified so that any means of identifying the shipper are removed.

Origin and destination locations are documented differently by each source. For instance, the Surface Transborder Commodity Data has origin and destination as exporter location which may not be the same location as the producer of the good. Also, the locations could be transfer or storage points for a type of commodity and not the original production point. Also, for U.S. exports, the ultimate Mexican state of destination is provided; however, for U.S. imports, only the country of origin is listed.

Table 6.3.
Network-Based Models: Required Inputs and Data Sources

Model	Inputs	U.S. Sources	Mexican Sources
Four Step Process For Freight (1983)	Base and forecast year vehicle or commodity flows	Commodity Flow Survey	
	Present and future mode service	N/A	
	Rate characteristics for each mode	N/A	
Kresge and Roberts (1971)	Commodity Flows	From Macroeconomic Model (Kresge)	
	Network Representation by origin, destination, and mode	National Transportation Atlas CD-ROM	SCT diskettes (Technology Transfer Program)
	Costs such as waiting time, transit time, direct shipping cost	N/A	
Guélat, Florian, Crainic (1990)	Network Representation by origin, destination, and mode	National Transportation Atlas CD-ROM	SCT diskettes (Technology Transfer Program)
	Origin-Destination Matrices	Commodity Flow Survey	

Conclusions and Recommendations for Further Research

This chapter provides an overview of existing forecasting methods for modal split. Some of these methods are used to forecast intercity freight flows by a particular mode; however, selection of a mode may be a decision within the methodology. The methods are applicable to a range of situations which depends on the type of analysis desired.

An aggregate approach is used for system-level analysis. Firms with similar characteristics are thought to behave in a similar manner; thus, they are aggregated into a group within their region. However, the homogeneity of a group is difficult to achieve for numerous reasons including the alliances that firms establish with specific carriers. Another reason grouping shippers together is difficult is that their behavior is influenced by ownership of equipment and facilities and the commodity they are distributing. Also, differences among shipper behavior is averaged out when aggregation is performed. Furthermore, competition among modes is not as finely depicted as on a disaggregate level. The unit of analysis in this case may be in production terms, i.e., modal share by commodity by region.[78]

A disaggregate approach, on the other hand, better represents the behavior of the decisionmaker. According to Winston, this analysis level is more applicable toward the optimization of logistics processes and also reflects competition among the various modes. Disaggregate analysis is generally based on behavior or inventory theory. The models based on behavior theory do not consider annual production or seasonality of the good. They also do not consider other logistics decisions such as shipment size and frequency of shipments, although the inventory theory does. These decisions are based on inventory at production and consumption points. The optimization of modal choice, shipment size, and frequency of shipments allows for the firm to maximize its profit.[79]

Although disaggregate analysis better represents the individual decisionmaker, limitations to this approach also exist. For example, data requirements for estimating a model are great. Also, since the firm is the decisionmaker, the modes available to the firm for shipping, along with modal characteristics, need to be determined. Estimation may be difficult if the number of modes available to the shipper is high or if many factors are considered endogenous in the model specification. Thus, this type of analysis may not be practical for studying behavior at the regional level.[80]

Provided the data may be obtained from databases or manipulation of available data, the existing models may be used to predict demand and modal choice between Mexico and the United States. However, they may not adequately represent the current situation between the two countries for several reasons. The situation is continuously changing so that long-term analyses will not hold. In addition, many models use historical data to predict demand and modal choice. However, the facilitation of trade between the United States and Mexico and the coordination of the two countries in doing so is an entirely new situation. Past modelling efforts have not had to consider some of the changes in freight demand that are occurring. Thus, any future predictions based on what has occurred in the past will not accurately reflect the current state of freight transportation between the U.S. and Mexico. Other issues which make modelling modal choice difficult include mergers among carriers, shipper alliances, changes in logistics practices, and the economic instability of Mexico. Changes must be adequately represented by the network if a network-based model is to be tested. Also, data must be gathered on short, regular intervals so that the models may reflect the condition between Mexico and the United States as accurately as possible. This type of data acquisition may be extremely expensive due to the state of existing data sources.

In terms of the applicability of econometric models, surveys probably should be performed to assess whether new variables have entered into the decisionmaking of the firms. The move toward a multimodal transportation network suggests that shippers may use various modes to ensure that the commodities are transported in a cost-effective and efficient manner. Containerization is facilitating the use of different modes. Thus, shippers may be more likely to use a combination of modes to minimize their overall logistics costs.

Another issue is the implementation of policies such as the allowance of Mexican trucks to travel within U.S. border states in December 1995 and the lack of conformity between U.S. and Mexican laws regarding truck weights. With laws that are uniform across the two nations, predicting modal share will be facilitated. Less guesswork will be involved in assessing the knowledge of decisionmakers in Mexico of relevant attributes of the United States (e.g., infrastructure and transport costs) and vice versa.

The predictive power of modal choice and demand models to a large extent depends on the quality of data available and the accurate representation of attributes influencing modal selection. Various suggestions for improving the predictability of modal choice models and demand models can be found in literature. For instance, Winston recommends that joint choice model of variables such as modal choice, shipment size, and frequency of shipments be developed as they should better reflect a firm's decisions.[81] He also states that modal choice is related to the location of the firm and the market area which should be represented in the models. Harker believes that models may be improved with the integration of econometric and network-based models.[82]

These are cursory comments regarding the accuracy of the predictive models and characteristics of freight transportation between the United States and Mexico. Therefore, the usefulness of these models greatly depends on not only the quality of data but also the factors influencing freight demand. A methodological approach is useful in evaluating the models in terms of their applicability to forecasting modal split of international freight traffic between Mexico and the United States. Some of the features that an appropriate model should possess, include, but are not limited to, the following:

- timeliness of information;
- data availability;
- multimodal consideration;

- past modelling results (theoretical basis); and
- ease of application.

The next step is to assess how well each of the models is able to capture these characteristics of U.S.-Mexico freight traffic. As a greater understanding of the influences in freight demand is achieved, the ability of these models in forecasting and improving their performance may be assessed in more detail. However, regardless of a model's theoretical predictive ability, its actual ability depends on the accuracy of data. Thus, upon evaluation of these models according to the features listed above, testing them with available data may be another step in identifying the predictive power of the models and the degree of the models' weaknesses in forecasting demand and modal choice on a binational scale.

Notes

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