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ABSTRACT

This article describes the development and growth of various modes of transportation in the United States and recent trends in the length, size and value of domestic shipments. Changes in the transportation of goods in the United States are being driven largely by four factors—the shift toward a digital economy, the growth of third-party logistics providers, globalism, and the application of new technologies. Finally, this paper looks at emerging forms of supply chain integration and operation.

INTRODUCTION

Many factors affect the performance of the transportation system: accessibility, safety, environmental restraints, input costs, energy efficiency, capacity-to-demand ratios, reliability, travel time and delay, goods damage, and a host of other variables. The choice of mode used in transporting goods is largely based on desired trade-off between speed and cost. Discernable shifts in modal choices have been occurring. For some time, domestic truck transportation has been the dominant mode in value of shipments and tons shipped. Recently, motor carriage has eclipsed rail as the leader in the category of ton-miles shipped.

Goods and raw materials shipped to factories and wholesale and retail outlets throughout the nation generated almost 2.7 trillion ton-miles in 1997 compared with 2.4 trillion ton-miles in 1993 (USDOC 1999). Most modes showed an increase in ton-miles. Shipments by air (including those involving truck and air) grew the most in ton-miles (55.5 percent), followed by parcel, postal, or courier services (36.8 percent), and truck (17.7 percent). Ton-miles by rail (including truck and rail) increased by 8.5 percent and ton-miles by water decreased by 3.8 percent.

BRIEF HISTORY OF MODAL DEVELOPMENT

To better appreciate the roles currently played by the various modes of domestic transportation, it would be helpful to briefly review their origins and growth patterns.

Development of Waterways

Before the American Revolution, much of the trade and commerce of the thirteen colonies was carried on small ships that sailed up and down the Atlantic Coast. Early in the nineteenth century, improvements were made along some of the rivers leading to the Atlantic so that they could carry waterborne commerce. By the 1850s, much of the United States east of the Mississippi

River was served by an elaborate network of barge canals. Many were constructed before the railroads. Others were built later to compete directly with the railroads. Many of the railroads' business practices were aimed directly at driving the competing waterway carriers out of business. By the end of the nineteenth century, domestic water transportation had virtually disappeared, except on the Great Lakes.

Starting in the 1930s, massive federal improvements to the Tennessee and Mississippi Rivers, which included dams for flood control and power generation as well as locks for passage of barges, combined with enforcement of laws aimed at railroad predatory pricing practices, inland waterway transportation began to revive. Established in 1925 by Congress, the Army Corp of Engineers continues to be the agency that provides most of the federal expenditures for river and harbor improvements. In 1997, 563 million tons of cargo was moved by water (USDOC Census FTD 1997). In 1997, 57 percent of domestic tons moved on the inland waterways, 24 percent moved coastwise, and 11 percent moved on lakes (the rest was local and intraterritorial traffic). Lake and inland waterway movement increased by 13 percent and 7 percent, respectively, over this period, while coastwise movement declined by 19 percent (USACE 1998).

Port performance is typically measured by annual cargo throughput. In 1997, 150 ports handled more than 1 million tons of cargo, and 31 ports handled over 10 million tons. While waterborne trade accounted for more than three-quarters of the tonnage of U.S. international trade in 1997, its share of the value of U.S. trade declined from 62 percent in 1980 to 40 percent in 1997 (USDOC Census 1994, Table 1062; USDOC Census FTD 1997). Among the factors that explain this decline are greater land trade with Canada and Mexico and the demand for faster delivery of high-value commodities, which has increased air trade. In 1997, maritime ports on the west coast of the United States accounted for 42 percent of the value of U.S. waterborne trade with other countries compared with only 24 percent in 1980. East coast ports' share by value, however, declined from 41 percent to 38 percent over this period (remaining relatively stable in the last 5 years), and the share of value for Gulf ports also dropped from 33 percent to 18 percent (USDOC Census 1997, Table 1069; USDOT MARAD 1998).

Increased trade with Asian Pacific countries between 1980 and 1997 helps explain this east to west coast shift. The financial crisis impacting several Asian economies, beginning in the second half of 1997, caused a slight decrease in overall merchandise trade by west coast ports. Between 1996 and 1997, the value of total international trade by west coast ports decreased 1.5 percent compared with a 0.4 percent decrease for east coast ports. Because of the appreciation of the U.S. dollar in relation to several Asian currencies, imports through west coast ports increased 3 percent between 1996 and 1997, while exports declined 12 percent.

The majority of west coast waterborne trade transits the ports of Long Beach and Los Angeles. Long Beach is also the leading U.S. port both by value and for containerized trade, as measured by the number of 20-foot equivalent units (TEUs) handled. In 1997, $85 billion worth of international trade passed through the port of Long Beach, and the port handled 2.7 million TEUs (USDOC Census FTD 1997). Other west coast ports such as Los Angeles, Seattle, and Tacoma are also important gateways for U.S. trade with Asia. The port of New York/New Jersey is the east coast leader in both the value of trade ($68 billion) and in the number of containers (1.7 million TEUs) handled in 1997. Charleston and Norfolk are also major east coast container ports. The importance of Gulf ports (e.g., Houston and South Louisiana) in the trade of bulk commodities and crude petroleum can be seen from their listing as the top two U.S. ports by tonnage.

Development of Railroads

The first railroad in the United States was the Baltimore and Ohio (B&O), incorporated in 1827. The next year construction was started, using the standard English track gauge—which is still used today—of 56.5 inches between rails. In 1830, the first steam engine operated over a thirteen-mile stretch of B&O track.

The strength, speed, durability, and year-round availability of the railroad (waterways often freeze during winter) made it the dominant form of transportation. Its growth was spectacular. From 40 miles of track in 1840, railroads expanded over 31,000 miles by the start of the Civil War (Kirkland 1951). Trackage peaked a hundred years later at 152,000 miles, dropping to about 115,000 by 1990. Improved technologies, such as automatic couplers, air brakes, and diesel-powered locomotives facilitated the growth of railroads. In the decade between 1862 and 1872, Congress enacted several land-grant programs, giving railroads free land, usually alternating sections, each section a square mile or 640 acres, in a checkerboard pattern for six miles on each side of the track (Wood and Johnson 1996). Land was granted to accelerate westward development of railroads. However, the railroads accepting the grants had to agree to charge lower rates to the federal government for carrying freight and passengers—military traffic and personnel.

With the advent of the Interstate Highway System in the 1950s, truckers gained a distinct cost advantage over railroads, under the existing system of regulated rates, on hauls up to 500-600 miles in length. However, we have seen a resurgence of railroads since deregulation in 1980. Revenue ton-miles reached 1,349 billion in 1997, an increase of 47 percent since 1980, although revenue-ton miles increased only 16 percent in the eastern United States, but climbed to 68 percent in the western United States (AAR 1998, p. 61).

Intermodal (trailer or container on flatcar) and coal are the largest categories of rail traffic, each accounting for approximately one-quarter of the carloadings of the railroad industry. Intermodal traffic increased from 3.1 million loadings in 1980 to 8.7 million in 1997 (AAR 1998). The introduction of double stack container trains in the early 1980s played a major role in this growth. Since the late 1970s, when the Powder River Basin opened in Wyoming, coal shipments grew from 4.4 million carloads in 1978 to 6.7 million carloads in 1997, reflecting the increased demand for low sulfur western coal by electric utilities to comply with clean air standards (AAR 1998). A combination of chemicals, motor vehicles and equipment, and farm products account for roughly 20 percent of rail traffic.

Development of Pipelines

In August 1859, close to Oil Creek, near Titusville, Pennsylvania, Colonel Edwin Drake drilled the first commercially successful oil well. Both waterway and wagon transportation of oil had limitations overcome by a dedicated pipeline. Samuel Van Syckel built the first successful pipeline in 1865 (Johnson 1956). It reached five miles from Oil Creek to the Oil Creek Railroad. The pipe came in 15-foot sections that had to be screwed together. It was laid on the ground, although in some areas it was buried below the level reached by plowing. With three steam-powered pumps, it was able to transport 80 barrels, or 3,360 gallons, per hour. It could move as much as 300 teamsters could transport in a day.

At first, railroads did not object to pipelines, because they were relatively short—less than ten miles—and were primarily used to bring oil to the railroad collection points. The first trunk line, from Bear Creek, Pennsylvania to Pittsburgh was six inches in diameter and transported 10,000 barrels per day over its 108-mile length (Johnson 1956).

The emergence of John D. Rockefeller's Standard Oil Company in the 1870s triggered a war for control of both oil and natural gas pipelines. By 1890, Standard had a virtual monopoly on pipeline transportation. Today there are over

half-a-million miles of pipeline in the United States, working with minimum labor and risk 24 hours a day, seven days a week, transporting crude and refined oil, natural gas, slurry, and other commodities. The Trans-Alaska Pipeline is the largest diameter pipeline in the United States at 48 inches.

Development of Trucking

In 1896 the first self-propelled trucks began appearing in the United States. By 1898 a limited amount of competition was present among the several manufacturers of "motor delivery wagons." By 1902 the horse versus truck controversy was in full bloom.

General Motors Truck Company advertised, "During the next three months it will be no unusual sight to see horses dropping dead on the streets, having succumbed to the heat... The beauty of the motor truck is that it is not affected by the heat" (Karolevitz 1966). G.M.C. issued full-page advertisements to illustrate this point, showing ten different pictures of horses dying in the streets, attended by their anguished owners. A later advertisement for trucks stressed their economy over "Old Dobbin." The lead sentence read, "1 GMC, 1 Driver, Displaces 16 Horses, 4 Drivers, 4 Wagons" (Karolevitz 1966). By 1911 there were about 25,000 trucks in operation.

Both the pursuit of Pancho Villa into Mexico in 1916 and World War I provided great stimuli to the motor truck industry. As an indication of the general acceptance of trucks after World War I, 335,000 trucks were produced in 1920. The replacement of the wooden wheels and solid rubber tires with steel wheels and pneumatic tires enormously increased truck carrying capacity, speed and smoothness of ride. In the 1920s trucks performed mainly drayage operations to and from railroads. By 1925 about 2.5 million trucks were in operation. In the 1930s the industry developed intercity markets and began to compete with the railroads.

Trucking (for-hire and private) moves more of the nation's freight, whether measured by value, tons, and ton-miles, than any other mode (USDOC Census 1999). In 1997, trucks transported $5.0 trillion of freight, a 13 percent increase over 1993 (in constant 1997 dollars). Truck shipments accounted for 72 percent of the total value of shipments in 1997. Measured by value of shipment, trucking was followed by parcel, postal, and courier services; rail; pipeline, if crude oil is included; air; and water in 1997.

While the shipment value per ton increased overall between 1993 and 1997, it decreased for trucking from $755 to $690 per ton (in constant 1997 dollars). The average reflects the wide range of commodities moved by truck—from sand and gravel, coal, and grain to electronic equipment and pharmaceuticals. Interestingly, the average value per ton of rail shipments (as a single mode) increased from $175 in 1993 to $210 in 1997 (USDOC Census 1997).

Development of Aviation

There was great interest in the development of powered aircraft at the beginning of the twentieth century. The first successful flight was in late 1903 at Kitty Hawk, North Carolina. Wilbur and Orville Wright, two brothers who had a bicycle business in Dayton, Ohio, accomplished this feat. Their first flight lasted only a minute, but by 1905 the Wright brothers were making flights lasting as long as thirty minutes. In the early days of World War I, aircraft were used primarily for observation. Before the end of the war, aircraft were being used as fighters and bombers. With government subsidies to carry the mail, the domestic airline industry began in the mid-1920s. The first U.S. aircraft designed primarily to carry passengers was the Ford Trimotor, introduced in 1926 (Woods and Johnson 1996). Because of the high cost of air transportation, the airlines have not been a major factor in commercial cargo transport, except for selective high value, perishable, or extremely time sensitive

TABLE 1
VALUE OF SHIPMENTS

Domestic and Export-Bound Freight Shipments Within the U.S.

	1997 Value	1997 % of Total Value	1997 vs. 1993 Growth in Value (%)
Truck	4,982	71.7	13.1
PPC	856	12.3	51.9
Other/Unk	368	5.3	7.9
Rail	320	4.6	29.2
Air	229	3.3	64.7
Pipeline	113	1.6	26.3
Water	76	1.1	23.1
Total	6,944	100.0	18.8

Value of Shipments in $Billions, inflation-adjusted
PPC = Parcel, postal, and courier
Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *1997 Commodity Flow Survey*: United States, EC97TCF-US (Washington DC: 1999)

TABLE 2
TONS SHIPPED

Domestic and Export-Bound Freight Shipments Within the U.S.

	1997 Tons	1997 % of Total Tons	1997 vs. 1993 Growth in Tons (%)
Truck	7,700	69.4	20.6
Rail	1,550	14.0	0.4
Other/Unk	630	5.7	-15.7
Pipeline	618	5.6	27.8
Water	563	5.1	11.5
PPC	24	0.2	25.4
Air	4	0.0	42.6
Total	11,089	69.4	14.5

Tons of Shipments in Millions
PPC = Parcel, postal, and courier
Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *1997 Commodity Flow Survey*: United States, EC97TCF-US (Washington DC: 1999)

TABLE 3
TON-MILES SHIPPED

Domestic and Export-Bound Freight Shipments Within the U.S.

	1997 Tons-Miles	1997 % of Total	1997 vs. 1993 Growth (%)
Truck	1,024	38.5	17.7
Rail	1,022	38.4	8.5
Water	262	9.8	-3.8
Pipeline	(*1)	(*1)	(*1), (*2)
Other/Unk	329	12.4	(*2)
PPC	18	0.7	36.8
Air	6	0.2	55.5
Total	2,661	100.0	9.9

(*1) CFS data restated in December 1999 to exclude crude oil shipments by pipeline
(*2) Category component changed in 1997 survey not comparable to 1993 survey

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *1997 Commodity Flow Survey*: United States, EC97TCF-US (Washington DC: 1999)

commodities. There are a few all-cargo airlines, like FedEx, UPS, and DHL. They principally handle overnight delivery of small packages. Otherwise air cargoes move on scheduled passenger aircraft operated by Northwest, United, Delta, American, and others. Usually shipments need to originate and terminate in trucks, making airlines a speedier alternative to truck transportation only over long distances.

Airfreight moves both by all-cargo carriers and carriers that transport passengers. Between 1980 and 1997, airfreight's share of the value of U.S. international merchandise trade increased from 16 percent to nearly 28 percent (USDOT BTS 1998). Commodities that move by air tend to be high in value—air's share of U.S. trade by weight was less than 1 percent in 1997. Western European and Asian Pacific countries dominate airfreight to and from the United States. The top three countries by value of airfreight with the United States are Japan, the United Kingdom, and Singapore. New York's John F. Kennedy (JFK) International Airport was the leading gateway for shipments into and out of the United States by all modes, accounting for over $89 billion in 1997 (USDOC Census 1997). Following JFK in shipment volume were the airports of Chicago, Los Angeles, and San Francisco.

CHANGING SHIPMENT CATEGORIES

Parcels, Postal and Courier Shipments

Business establishments in the United States shipped much more commercial freight on the nation's transportation system in 1997 than in 1993, the two most recent years for which comprehensive freight data are available (USDOC Census 1997). While parcel, postal and courier shipments comprised a very small amount of the 11 billion tons moved in 1997, only two-tenths of a percent or 24 million tons, these shipments represented over 12% of the nearly $8 trillion in total value of shipments. This equates to $2.4 billion per day in value of shipments in this category. This category of shipment grew

significantly between 1993 and 1997: 52% in value of shipments, 25% in tons, and over 36% in ton-miles (USDOC Census 1997). The phenomenal growth in this category is likely due to Internet-based sales that are delivered by U.S. mail, and companies like Federal Express and UPS.

Multimodal Shipments

Multimodal transportation (shipments reported as moving by more than one mode) increased substantially in value between 1993 and 1997 from $932 billion to $1.2 trillion (in constant 1997 dollars), or 31% (USDOC 1999). Multimodal shipments declined in both tons and ton-miles by 14% and 2%, respectively. These shipments are typically international shipments. Air, land, and water modes are all-important in transporting goods in U.S. international trade. The leading gateway overall in 1997 was JFK International Airport in New York with $89 billion of activity (USDOT BTS 1998). This was followed by the water port of Long Beach, California, which handled $85 billion worth of shipments, and Detroit, Michigan, a land gateway with $83 billion worth of shipments in 1997 (USDOT BTS 1998). Changes in the mix of commodities traded internationally, geographic shifts in centers of production, global trade patterns, and many other factors will continue to affect these gateways as well as the movement of international trade shipments to, from, and within the United States.

Local Versus Long-Haul Freight

Freight shipments can be categorized as local (less than 100 miles), intra-regional (between 100 and 1,000 miles), and interregional (over 1,000 miles). In 1997, local shipments constituted nearly 67 percent of the weight (7.7 billion tons), 40 percent of the value ($3 trillion), but only 9 percent of the ton-miles (254 billion) of all U.S. shipments, about the same proportion of the value, tons, and ton-miles identified in 1993 (USDOT BTS 1998).

Intra-regional shipments in 1997 accounted for 45 percent of the value of goods shipments ($3.4 trillion), 29 percent of the tons (3.3 billion tons), and 62 percent of the ton-miles (1.7 trillion). Interregional shipments accounted for a relatively small proportion of the total tonnage (4.4 percent in 1997), but they have had a large impact on the U.S. transportation system and the tonnage of such shipments has grown rapidly. In 1997, longer haul shipments accounted for 29 percent of the ton-miles, about the same proportion as in 1993. Nevertheless, the tonnage moving such long distances grew about 40 percent, with value increasing nearly 30 percent in real terms (USDOT BTS 1998).

Shipments of Major Commodities

Merchandise in the category "electronic, other electrical equipment and components, and office equipment" accounted for the highest dollar value ($925 billion) of U.S. shipments in 1997, followed by motorized and other vehicles (including parts); textiles, leather, and articles of textiles and leather; and miscellaneous manufactured products (USDOT BTS 1998). It should be noted that the Department of Transportation discontinued reporting crude oil shipments and does not include values or volumes of crude oil shipments made by pipeline or water in its reports.

As for total tonnage shipped, the top commodity groups were gravel and crushed stone (1.8 billion tons), coal and coal products, gasoline and aviation fuel, and nonmetallic mineral products. Although gravel and crushed stone accounted for 16 percent of total tons, shipments in this category accounted for less than 1 percent of the value and about 4 percent of the ton-miles of all shipments, impacting mostly local transportation.

The transportation of coal generated the most ton-miles (520 billion), followed by cereal grains, gasoline and aviation fuel, and prepared foodstuffs. Coal produced the most ton-miles

because, unlike gravel and stone, which move mostly in local areas, coal is often shipped long distances. Coal mined in Wyoming and Montana is transported nationwide. In 1997, a ton of coal was shipped 416 miles on average, compared with 55 miles for a ton of gravel and crushed stone (USDOT BTS 1998).

Shipment Size

Freight shipments are divided into several weight categories: less than 100 pounds, 100 to 999 pounds, 1,000 to 49,999 pounds, and over 50,000 pounds. In 1997, the value of U.S. shipments under 100 pounds exceeded $1.1 trillion, 37 percent greater than in 1993 (USDOC Census 1997). Growth in parcel, postal, and courier services and an increase in just-in-time production and distribution systems are partly responsible for this rise in smaller size shipments. Shipments of less than 100 pounds are often high-value, time-sensitive commodities transported by truck and air intermodal combinations, or by truck alone. In 1997, such small-size shipments accounted for 15 percent of the value of shipments, little different from the 13 percent in 1993 (USDOT BTS 1998).

Large-size shipments (over 50,000 pounds) accounted for nearly 66 percent of the ton-miles, 56 percent of tons shipped, but only 12 percent of the value of shipments in 1997. The relative share of large-size shipments fell slightly between 1993 and 1997 in value, tons, and ton-miles (USDOC Census 1997).

MAJOR INFLUENCING FACTORS

The Role of the Digital Economy

The real purpose of a supply chain is not to help companies get rid of products in their inventories but to help customers find and acquire them efficiently. Electronic commerce (e-commerce) has significantly changed the way companies "go to market." The Internet provides an opportunity for supply chains to work 24 hours a day, seven days a week, in all countries using the language of the customer to effect an exchange of values. The power of the Internet lies in its capability to connect companies, their trading partners and consumers easily, quickly and inexpensively. The impact of the Internet on the supply chain is nothing less than profound in its contribution to improved planning, improved asset management, shorter cycle times, tailored product positioning, and customer service. Adoption of the new technologies that enable this capability has been at a remarkably fast rate.

The concepts of aggregation of purchases, inventories, orders and shipments and slower cycle times to achieve logistics economies are being challenged by the e-commerce enabled supply chain concepts of make-to-customized order, transact in units of one or a few, and complete the fulfillment within hours, not weeks. This results in customer expectations of "overnight deliveries," and will shift truckload to less-than-truckload deliveries and dramatically increase the freight moved by parcel delivery companies.

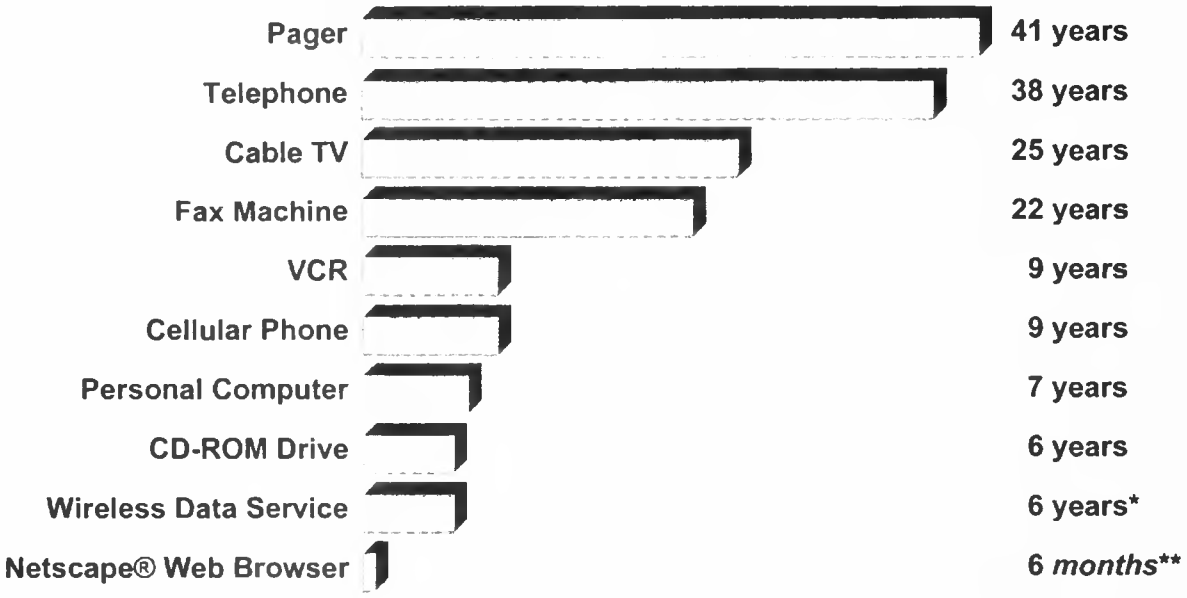
Shifts in the U.S. economy toward more services and high-value, low-weight products are influencing the mix of commodities, even as overall shipments increase. Such shifts affect the average value by unit of weight of commodities shipped (e.g., personal computers have a much higher value per ton than lumber). On average, a ton of goods shipped in 1997 was valued at $580, a slight increase from $563 in 1993 (both in constant 1997 dollars) (USDOT BTS 1998).

The Role of Third Party Logistics Providers

Companies have long recognized that it is to their advantage to outsource functions and activities that do not matter much from a business perspective, such as the operation of the company cafeteria and provision of janitorial services. Companies have expanded this thinking to include logistics functions, believing it is appropriate to outsource activities that some other firm can do better than they can. The providers of services for transportation

FIGURE 1
ABSORPTION RATES OF NEW
INFORMATION TECHNOLOGIES ARE ACCELERATING

The following is the time it took (or is taking) for these technologies to reach the 10 million customer mark after being introduced to the mass market.



*Based on a forecast through 1999
**38 million in 18 months

Sources: *USA Today*, Info Tech, Pac Tel Cellular and Netscape Communications (Keebler et al., 1999)

management, warehousing, order handling and other logistics activities are called third-party logistics providers, or 3PL's.

Third-party logistics providers enable firms to achieve reduced operating costs and increased revenues in new and existing markets (Keebler and Durtsche 2001). 3PL's provide firms an opportunity to enhance their market value by reducing a company's ownership of assets, which translates to a higher return on remaining assets and greater return on stockholder investment. 3PL's also bring to the relationship their specialized expertise in managing logistics with contemporary technology and systems. The COO's decision to outsource company logistics operations to the 3PL is often justified solely on the favorable difference between the more efficient 3PL's price for the services and the firm's higher costs of existing operations. The chief marketing officer views the enhanced services and distribution reach of 3PL's in existing and new markets as translating into increased sales and better long-term relationships with customers. CFO's are delighted to see assets—property, plant, equipment, and even inventory—disappear from the firm's balance sheet, freeing up cash for more

productive uses, instantaneously and "permanently" improving the company's returns on assets. CIO's are often very pleased to have access to the 3PL's systems and technology resources, avoiding the cost and trauma of upgrading their own. Reliance on the 3PL alliance frees up company employees to focus on their core competencies, doing more of what they are good at and less of what can be done better by the 3PL. Chief logistics officers begin to realize that ownership of resources is not necessary to achieve control over the results.

Third-party logistics providers with sophisticated data base management systems and competency in activity-based costing can secure long-term alliances with their customers and their trading partners. Firms value timely, accurate, comprehensive, and actionable data about the activities that constitute their sourcing and fulfillment processes, whether it is used for planning, scheduling, measurement, costing, or pricing purposes. Successful third-party providers supply this knowledge. Under gain sharing arrangements, the firm and its 3PL partner can implement improvements that result in lower costs and share the benefits on an equitable basis. There remains a great opportunity for this alliance to involve the firm's trading partners in the gain sharing program. Changes by suppliers and customers in how and where the work gets done can produce additional logistics savings that can be shared by all. Third-party logistics providers are seen as key facilitators of supply chain management.

The selection and integration of a capable 3PL requires managerial skill in establishing and maintaining trusting, long-term relationships. It also requires a continued investment in the success of each party, based on a strategic and systemic perspective of the interdependencies and potential of the alliance.

In today's competitive market place what distinguishes winners from losers is the ability to differentiate themselves through their service and product offerings. For many firms, the service differentiation is accomplished by how well the logistics process is managed. To achieve excellence in logistics, successful firms ensure that the key logistics processes are aligned with the firm's business strategy and measured against predetermined performance objectives. Additionally, the top firms are jointly defining the specifics of each measure with their trading partners (customers / suppliers / 3PL's) to create a common understating of expectations. While some firms are developing their measurement capability internally, a number are turning to 3PL's to support their needs. As focused service providers, 3PL's are ideally positioned to bring the systems, process design, and managerial expertise to aid in establishing and implementing a comprehensive logistics management effort. The 3PL is also often in the position to act as a catalyst for meaningful dialog between trading partners to establish a level of service performance that truly adds value.

The Role of Global Supply Chains

Changes in how and where goods are produced, and increase in international trade, have contributed to the rise in freight tonnage and ton-miles over the past few years. For example, the manufacture, assembly, and sale of a single product may involve several different facilities located hundreds or even thousands of miles apart.

The importance of international trade to the U.S. economy can be seen in the increased value of U.S. merchandise trade in recent decades. Between 1980 and 1997, the real-dollar value of U.S. merchandise trade more than tripled, from $496 billion to $1.7 trillion (in 1997 dollars). In addition, the ratio of the value of U.S. merchandise trade relative to U.S. GDP doubled from about 11 percent in 1980 to 23 percent in 1997 (USDOC ITA 1999).

During the past two decades, changes can be seen in the geography of trade. Trade with Asian Pacific countries grew greatly. In 1997, five Asian countries were among the top-10 U.S. trading partners, despite a slight downturn in trade in the second half of 1997 related to

economic problems in the region. These five countries accounted for 26 percent of overall U.S. trade in 1997, up from 17 percent in 1980 (USDOC Census FTD 1997). Canada and Mexico were the first and third largest U.S. trading partners in 1980 and in 1997. While the rankings remained the same, the U.S. trade relationship with these two countries deepened. In 1980, Canada and Mexico together accounted for 22 percent of all U.S. trade by value. By 1997, this had increased to over 30 percent (USDOC Census FTD 1997). Canada accounts for approximately 20 percent and Mexico 10 percent of U.S. merchandise trade. U.S. trade with Mexico has grown more quickly than with Canada, and in 1997 Mexico surpassed Japan as the second largest market for U.S. merchandise exports (although Mexico remained the third largest trading partner overall). Between 1993 and 1997, trade with North American Free Trade Agreement (NAFTA) partners increased 62 percent in current dollars, from $293 billion to $475 billion. During this same period, U.S. trade with Mexico grew most rapidly, almost doubling from $81 billion in 1993 to $157 billion in 1997 (USDOC 1998, table 1323; USDOC Census FTD 1997).

Changes over the past two decades also occurred in the commodities traded. Higher value manufactured goods now dominate U.S. trade, accounting for $1.3 trillion or 85 percent of the value of all merchandise trade in 1997 (USDOC ITA 1999). Of these goods, motor vehicles, computers, telecommunications equipment, and aircraft are among the top U.S. import and export commodities by value. While the value of manufactured goods increased as a share of U.S. trade, the share of agricultural commodities declined from 13 percent in 1980 to 6 percent in 1997. Mineral fuels accounted for approximately 6 percent of the value of U.S. trade in 1997, primarily imports of crude petroleum and petroleum products (USDOC ITA 1999).

In terms of commodities, motor vehicles and motor vehicle parts and accessories dominate trade between all of the North American countries. Other leading North American trade commodities include consumer electronics, telecommunications equipment, and aircraft equipment and parts. In addition, crude petroleum, natural gas, and petroleum products are important U.S. imports from both Canada and Mexico. Mexico is also a chief source of U.S. imports of clothing and textiles, while paper products, furniture, and wood products are among leading U.S. imports from Canada.

In their search for new markets and customers as well as more favorable sources of supply and production sites, U.S. companies have been pursuing globalization strategies as a means of insuring access to resources and growth in revenues. Joint ventures and strategic alliances with trading partners around the world are characteristic today of major American companies. Elimination of country tariffs and quotas and simplification of trade documentation have been pursued by the U.S. government and trade organizations. Market defensive strategies are being replaced by market prospecting strategies where the goal is to establish supportive, interdependent business relationships and influence emerging industries, technologies and supply chains.

Application of Technologies

Technologies exist today that can be used to create more effective and efficient supply chains. Examples include bar coding, scanning, data warehousing and data mining architectures and software systems, and use of the Internet to connect trading partners and customers. Applications of radio frequency and computer directed storage and handling systems, of satellite supported ground positioning systems (GPS) for tracking and expediting shipments, and of point of sale and point of use capture of demand data are examples of 'new' technologies being used. Progress toward improved supply chain management does not appear to be limited or propelled by available technology as much as the capability and desire of management to establish strategic, and mutually beneficial multi-firm relationships.

CONCLUSION

As the U. S. economy continues to grow, so does the demand for transportation services. Truck transportation is the dominant mode, accounting for 69% of 1997 tonnage. The nearly 15% increase in domestics tons shipped between 1993 and 1997 can be attributed to trucking, which grew by 20% over the same period.

The way companies go to market, increasingly moving smaller shipments faster to meet shorter fulfillment cycle times, is having a visible impact on the domestic transportation trends. Today, Internet based catalogues offer everything from consumer electronics, luxury goods, sporting gear, freshly produced foods, prescription medicines, and replacement parts. Demanding customers are expecting overnight delivery of this Internet based e-commerce. This can occur out of a network of market-based distribution centers filled with inventory, or more cheaply out of fewer fulfillment hubs, requiring much less inventory, where overnight delivery is still possible. Parcel express companies, like Federal Express and UPS are developing sophisticated new software for customer order fulfillment and electronic warehousing at strategic "pick and pack" hubs. Orders placed today over the Internet can be delivered anywhere in the US from locations in Seattle, Memphis or Lexington. International shipments can be cleared by customs electronically before they land, overnight or the next day, in the destination country. Pick up and delivery carriers can be coordinated electronically on both ends to schedule the quickest and least expensive movements.

The supply chains of tomorrow will be supported by virtual logistics networks where manufacturers and their suppliers and customers, repair vendors, delivery companies, and logistics service providers will be connected electronically via virtual data centers and web interfaces on the Internet. Internet based collaborative relationships will provide enterprise-wide and supply chain visibility for improved planning and execution.

As we head into this new millennium, the movement toward globalization, with emerging markets, cheaper supply sources, and new trading partners, is compelling enterprises of all sizes to build alliances and on-line commerce systems that efficiently deliver products to customers while providing a worldwide view of operations. Virtual along with traditional organizations are developing new strategies to track orders and react to changes in real time in handling and transporting materials as they move across the supply chain from originating suppliers to end customers.

The goal is to electronically link the entire forecasting, planning, sales, procurement, production, delivery, freight payment and revenue collection processes into one seamless flow of information across national borders, time zones, and differing languages, creating a global view of the supply chain flows. Transportation and fulfillment providers, including Federal Express, UPS, Sea Land, DHL and SkyWay, are opening up their systems allowing e-commerce vendors to access, track, and communicate logistics information in a variety of innovative ways. Web casting and publish/subscribe techniques allow all interested parties to be alerted to situations requiring their attention. This includes changes in customer demand, order revisions and cancellations, adjustments in quantity and/or locations for deliveries in progress, customs clearance problems, and on-time delivery or installation issues. An integrated, virtual solution can diagnose when a critical piece of equipment is about to fail, can tell when a hub is short of replacement or repair parts, and also can locate the source of the problem, whether it is due to an enroute delivery, warehouse situation, or change in the scope of an order.

These new Internet-based solutions have the potential to all but eliminate the strategic role of distribution centers for replacement parts, putting the emphasis on moving information, not parts. This new capability provides for dynamic decision opportunities, or fixing problems before they arise.

Automated online personalities that emulate human customer service representatives will become widespread in the Internet at a much lower cost than traditional support functions. These web-

based "virtual reps" will be able to react to customer inquiries and handle frequently asked questions twenty-four hours a day, seven days a week, in any language.

Internet-based, extra enterprise-wide e-commerce applications are part of a fundamental shift in how computing is being applied to the business of managing logistics across the trading landscape. New strategies and software to support those strategies are being developed, tested and implemented in order to help companies find the best balance between demand opportunities and supply constraints while enabling effective, controlled logistics execution. As trading partners work together to improve the overall performance of their supply chain, they are beginning to discover the solution might just be a virtual reality.

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