

# Commission Briefing Paper 4B-04

## Impacts of Changes in Business Practices and Industrial Locations on Freight Movement, Modal Demand, and Transport Industry Structure

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Date: January 11, 2007

### Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

The object of this paper is to examine how the provision and operation of transportation infrastructure is being affected by a) changes in economic geography, business organization and supply chain systems; and b) related changes in the location, concentration, and performance requirements for freight movement. The implications of these forces for modal demand, and the ways the carrier industry is organizing in response, also are explored.

### Background and Key Findings

- The business enterprise has taken the form of the supply chain, which crucially elevates the significance of freight transportation in commerce and the economy.
- The same forces that transformed business are supplanting manufacturing with wholesale distribution, which is steadily becoming the prime driver of freight demand. Traffic concentrations are shifting toward port centers and distribution hubs on the coasts and at key inland points.
- Logistics requirements favor much more trucking and strong growth in intermodal rail. A core network of intercity, urban, and transfer infrastructure is needed to maintain freight performance and safeguard the nation's competitiveness.
- The carrier industry is adjusting by forming its own networks, primarily to add flexibility and fulfill its integrative role in supply chains.

### Staff Comments

Commission briefing papers 04 and 05 discuss changing logistical practices of American businesses and consequences for the transportation system. Paper 04 emphasizes consequences for freight carriers, and paper 05 emphasizes consequences for transportation infrastructure.

### Business Organization & Freight Performance Requirements

The business enterprise in today's world takes the form of a supply chain. Tightly controlled or loosely affiliated, supply chains embody and influence an entwined set of commercial and technological trends:

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- Globalization, by which business units dispersed over continents can specialize according to comparative advantage, and can access partners and customers almost everywhere;
- Reliance on the enabling technologies of information and transportation, by which these scattered units are drawn together into a coherent enterprise that competes as a chain;
- The drive for responsiveness to markets, by which businesses attempt to make and sell exactly what local buyers want, right when they want it, and nothing else;
- The drive for responsiveness to customers, by which businesses attempt to formulate products as packages of goods and services, using services first as a way to heighten the utility of goods by enlarging them into applications or solutions or experiences, and second as a way to create competitive differentiation.

Historically, one company would perform many functions in the provision of goods; today, they may be handled by multiple companies in a unified system with a dominant partner. These functions are spread across regions and countries, and their range includes design, marketing, procurement, fabrication, assembly, customization, merchandising, and intermediate or final delivery. Businesses haven't so much outsourced as reorganized on a distributed model, with the services portion of the process retained in the U.S. and the production portion relocated. What makes this organizational model work are the connections established by information and transportation, which increasingly are two facets of one system of control. Simultaneously, industries of almost every type have been migrating to low inventory, high speed logistics plans, and this makes them especially sensitive to the performance of the transportation system. However, the more profound development is that the structure of the enterprise itself has come to rely on transportation:

- Business processes depend on transport because they are conducted between distant locations, and are based on the ability to perceive changes in many markets and respond rapidly throughout the chain. The purpose of maintaining low inventories goes beyond cost control to the precise satisfaction of demand.
- Business products depend on transport because they incorporate service in their market package, and this commonly includes a component of logistics. For example, the commercial objective of a leading beverage maker is to ubiquitously remind consumers of the qualities of the beverage and its fit into their lifestyle, and then to place the beverage within ten minutes reach. The whole package – qualities, lifestyle, and accessibility – forms the product, and accessibility derives from merchandising and logistics.

The ramifications of these developments for freight transportation are many, but there are three particularly to highlight:

- *Economic geography is changing.* Fabrication in manufacturing is moving outside the country, and U.S. production is moving up-market toward higher value goods with greater knowledge and lower labor content. Factories are giving way to wholesale houses, distribution centers, and other facilities designed for the staging of goods through an

international supply chain and located accordingly. The dominant firms in many supply chains are becoming retailers, who are stipulating the goods for manufacture based on point-of-sale information, and are coordinating with their vendors on design. The Wal-Mart headquarters town of Bentonville, AR today has been completely transformed by the large offices of vendors whose staff the retail giant wants on hand.

- *The purpose of facilities is changing.* To improve responsiveness to markets, import centers are transloading containers and adjusting the destinations of goods. Manufactured components are made for modular assembly, so that assembly and distribution can be combined and product features adjusted on the fly. Consumer goods are blended, packaged, and otherwise customized for local markets at distribution points, in a kind of final stage manufacturing. In the electronic marketplace, warehouses replace storefronts – or alternately, the market reach of storefronts is altered, and they become minor distribution centers. Most of these alterations support fast reaction to markets as well as the retention of consolidation economies. Supply chains also recognize that gains in market share translate into gains in freight operating density, which can bring a competitive edge in logistics efficiency.
- *Performance expectations for freight transportation are changing.* At the same time that the capacity of the nation's multimodal infrastructure is demonstrably challenged and congestion is spilling from urban centers into intercity lanes, the need for precise and reliable carriage continues to rise. A core network connecting the nation's global gateways to its population centers and distribution hubs clearly needs to be offering consistent intercity performance at high levels, and counterpart networks in the nation's urban areas should be doing the same for intracity pickup, delivery, and transfer.

In sum, the modern business enterprise is dispersed across regions and nations, and despite its expanse it is founded on responsiveness. The entire chain is expected to react to local fluctuations in markets, with the combined system of information and transportation making this reaction possible. Business function depends on transportation function, but it does not observe jurisdictional boundaries, and the staging points of the supply chain constitute vital process components of more than local significance. For the U.S., this means that freight transportation is essential to how our economy competes. In the U.S., it means that wholesale distribution is replacing manufacturing, infrastructure demand is mirroring this, and high performance carrier networks are attempting to unite modes, geography, and business processes into integrated systems. The consequence is that wholesale distribution in the U.S. can be expected to grow faster than manufacturing, and high value products should grow faster than the rest of the manufacturing sector. Distribution hubs and international gateway centers should be leading recipients of freight traffic expansion. The high service and international modes of transport – truck, air, and rail intermodal – should benefit most from expansion and place the greatest demands on infrastructure. The rest of this paper will review how these expectations play out in demographic and freight traffic forecasts, and in the evolving structure of the transport industry.

## **Business Demographic Projections**

Shifts in the industrial composition and location of business change the demand for freight transportation. This section examines five industrial sectors of the U.S. economy over nine

regions of the nation. It begins with a summary analysis, demonstrating the significance of these sectors for transportation production, and then presents projections of demographic shift over a thirty year period.

Two assumptions were employed in the summary analysis. First, among the many sectors of the US economy, only commodity and goods producing sectors were examined with respect to the transportation industry. These five “deriving sectors” of the transportation industry consist of agriculture, mining, manufacturing, wholesale trade, and retail trade. Second, the value of production by sector was selected as the most appropriate indicator of activity as it best measures the linkage between the transportation industry and the deriving sectors. Other indicators, such as employment, were prone to produce distorted results due to the impact of varying productivity changes on different industries.

Conducting analysis using correlation techniques, the relationship between the values of production by census region for the individual and aggregate deriving sectors and the transportation industry proves to be quite strong. Although the correlation was insignificant for some individual sectors, it was always strong for the aggregate sectors at both the US and census levels. The table below presents the summary of the correlation results, where "i" denotes insignificant:

**Correlation Coefficients – Transportation Industry  
(Value of Production)**

Region	Wholesale Trade	Retail Trade	Manufac.	Mining	Agriculture	All Deriving
<b>New Engl.</b>	0.99	0.99	0.99	0.94		0.98
<b>Mid At.</b>	0.99	0.99	0.85			0.97
<b>EN Central</b>	0.99	0.99	0.99			0.99
<b>WN Central</b>	0.99	0.99	0.99		0.99	0.99
<b>South At.</b>	0.99	0.99	0.99			0.99
<b>ES Central</b>	0.98	0.98	0.95			0.98
<b>WS Central</b>	0.99	0.99	0.87	0.97		0.98
<b>Mountain</b>	0.99	0.99	0.99	0.90		0.99
<b>Pacific</b>	0.99	0.99	0.97			0.98
<b>US</b>	0.99	0.99	0.98	0.90	0.59	0.98

Thirty year projections of change in the nation's business demography are exhibited in the next two charts. The first shows the percentage contribution of each of the five industrial sectors to the total value of production from the sum of these sectors. Comparisons are presented between 2005 and 2035, and the change in their relative contributions – the "shift in mix" – shown alongside. Finally, the compound annual growth rate (CAGR) over the thirty year period appears for each industry group, again calculated on the value of production.

**Demographic Shift by Industry**

Sector	Percent of US 5-Sector Value		Mix Shift	Value CAGR
	2005	2035		
Agriculture	2%	1%	-1%	1.1%
Mining & Extraction	2%	1%	-1%	1.9%
Wholesale Distribution	29%	41%	12%	5.2%
Retail Trade	29%	25%	-4%	3.4%
Manufacturing	38%	32%	-6%	3.4%
All US				3.9%

The chart indicates two primary things: first, all industry groups are growing, including the manufacturing sector that those of the authors and do not S. Department of Transportation. 4

historically was the prime driver of freight demand. Second, wholesale distribution is outstripping all other sectors and is causing a 12-point movement in mix. Wholesale trade is the industrial group most heavily influenced by imported goods, and indeed it is able to outgrow other sectors *because* of its import component. By 2035, wholesale distribution replaces manufacturing as the largest contributor in the five industries affecting freight transportation.

The next chart reports demographic change by region caused by growth of the five sectors relative to geography. The format is the same as the previous chart, this time utilizing the total value of production in each region to calculate expansion and changes to mix. Again all regions are growing – almost every one over 3 percent annually – implying a steady accumulation of

Region	Percent of US 5-Sector Value		Mix Shift	Value CAGR
	2005	2035		
New England	5%	4%	-1%	3.2%
Middle Atlantic	13%	10%	-3%	2.9%
South Atlantic	17%	19%	2%	4.3%
East North Central	17%	16%	-1%	3.7%
East South Central	6%	6%	0%	4.0%
West North Central	7%	7%	0%	3.7%
West South Central	13%	10%	-2%	3.2%
Mountain	6%	7%	1%	4.5%
Pacific	16%	22%	5%	4.9%

freight demand. Fast expansion in the Mountain states is driven by wholesale and retail trade; while lagging growth in the Middle Atlantic is buoyed by a wholesale sector that offsets stagnant manufacturing and losses in agriculture and extraction. The biggest shifts in the national industrial mix favor the South Atlantic and Pacific regions. The South Atlantic emerges as the country's leading

center for the wholesale trade, with its multiple container ports from Virginia to Florida and distribution hubs at Atlanta and elsewhere. The story in the Pacific states is manufacturing, as this region surpasses the still-strong East North Central (Great Lakes) district as top producer in the United States, measured by the value of output.

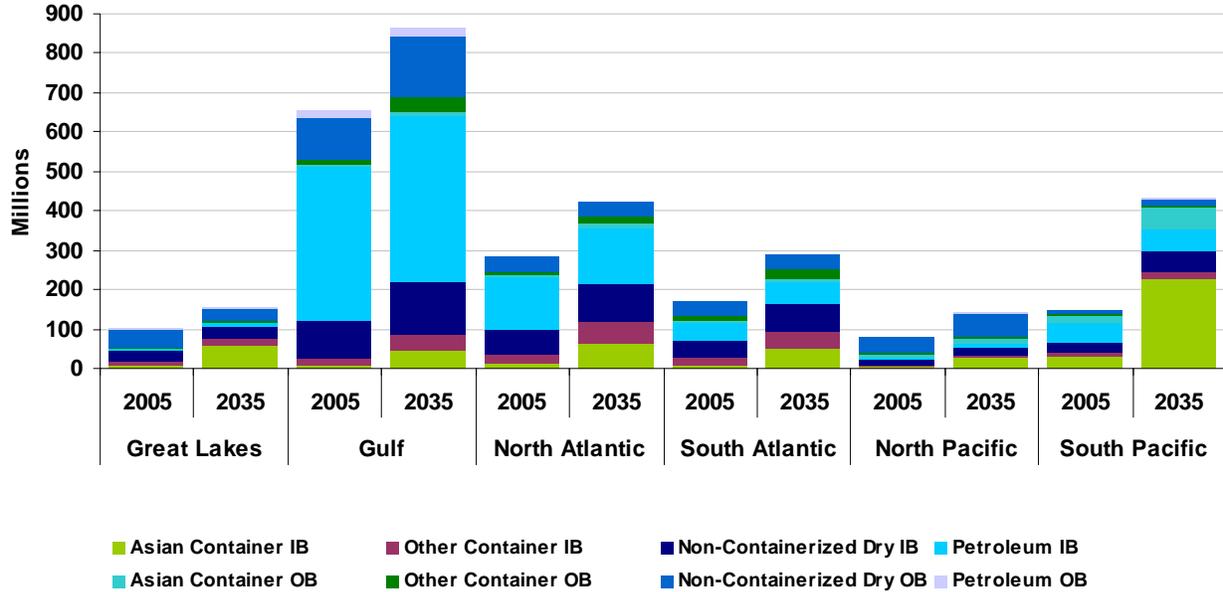
### **Freight Traffic Projections**

The consequences of demographic change for transportation demand are explored in this section. It employs thirty year traffic forecasts in physical volume terms – tonnage, instead of value – because it is a better indicator of the requirement for provision and management of infrastructure. Traffic expansion is gauged in two ways: share of growth, which means the contribution to incremental tonnage attributable to a given element, and the rate of growth, compounded annually. The analysis begins at the coasts with foreign trade, and then reviews industrial groups, regions, and freight modes.

The profile of growth in U.S. marine trade appears in the following chart. It is depicted in tonnage by coastal customs district, and then distinguishes Import (IB for Inbound) from Export (OB for Outbound) traffic in four components: containers in the Asian trade, containers in other trades, non-containerized dry goods, and petroleum. The single largest driver of growth is Asian import containers, which account for 46% of new tonnage over three decades and grow around 6% annually on every coast. The largest focus of Asian expansion is the South Pacific coast, whose overall growth will represent one-third of the nation's total, and where the Los Angeles and Long Beach ports have been absorbing the Asian import trend for years. The Atlantic ports account for another 30% of growth primarily because of the container trade, with imports the

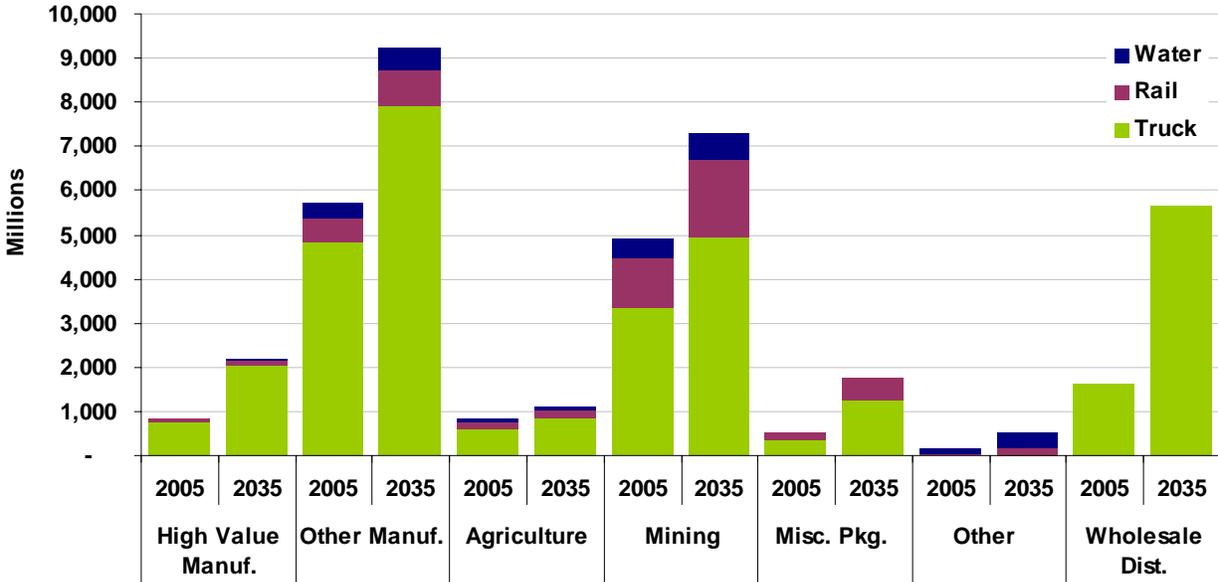
greater component. The Gulf produces 24% of new volume; its traditional heavy tonnage in petroleum and bulks persists through future years, although here, too, containers are climbing.

### Growth in U.S. International Marine Trade (Tons of 2,000 Lbs)



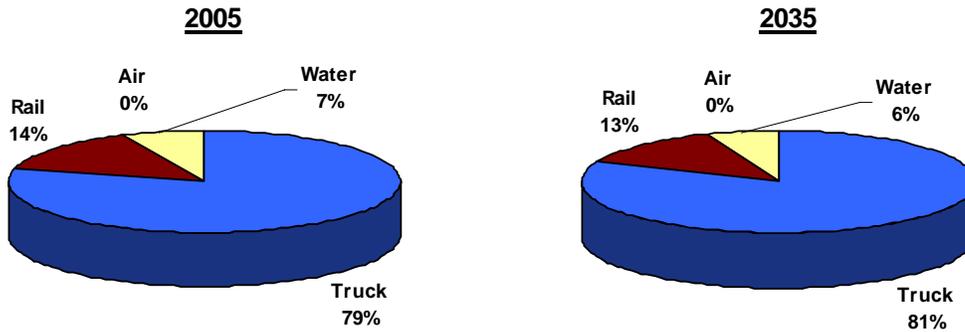
The trade profile follows the pattern described previously in this paper: the distributed enterprise brings goods from around the world into the wholesale channel, concentrating demand on the transfer points and the inland network. More features of this pattern appear in the industrial profile of domestic tonnage (which includes the inland flow of trade goods). As depicted in the accompanying chart, wholesale distribution leads all other sectors in tonnage growth, expanding the fastest at 4.2% annually, more than tripling in size and generating nearly a third of the incremental volume over the next thirty years. The catch-all category of miscellaneous packaged goods largely belongs with the wholesale and retail trade as well. Its biggest components are containerized goods in intermodal transport – many of them imports – and it grows at a similar rate to wholesale goods, contributing 10% of incremental tonnage. Measured in tons, manufactured goods are still the top freight generator in 2035 at just over 40% of volume; however, the high value group is growing twice as fast as other products (3.2% compounded annually versus 1.6%). Mining remains important because of coal and construction aggregates and represents a quarter of the tonnage thirty years out, yet its growth isn't much above 1% per year. The summary picture is this: wholesale trade, the related packaged goods, and high value manufactured products together generate half of the new freight traffic over the next three decades. Other manufactured goods account for a quarter and mining a fifth; while they still are the largest elements of tonnage, they are giving way to new forms of industry.

### Freight Growth by Industrial Sector & Mode Domestic Tonnage & Inland Portion of International Tonnage



The change in industrial mix especially favors trucking, and it takes the lion's share of growth. Capturing 84% of the new tonnage through 2035, trucking is strong in every sector and squarely meets the demanding performance requirements of contemporary supply chains. The expansion in trucking comes 39% from manufactured products and 44% from wholesale distribution and packaged goods; imports are a component of both, but play a larger role in the latter. Wholesale distribution growth also benefits rail; the railroad portion appears under miscellaneous packaged goods in the chart above, and comprises much of the intermodal business. With its trainloads of import containers and its competitive service, rail intermodal actually grows faster than any other mode over the next thirty years, expanding at 3.8% annually compared to trucking at 2.3% and air freight at 2.8%. (Note that air freight is invisible on charts because it is relatively small in volume terms, yet it carries the most time-sensitive and highest value goods.) Nevertheless, most rail tonnage like most waterway tonnage is in low growth sectors, and as the pie graphs below indicate, highway freight continues to gain share. The result is that truck volumes double by 2035, presenting serious challenges for a road network that is already strained, for business enterprises that are founded on responsive transportation, and for the competitiveness of the national economy. The rail system certainly can handle more volume, especially with its higher performing intermodal service and provided that substantial investments are made in new capacity; new waterborne services also can help in some lanes. Even so, the inescapable fact is that a robust economy will require a core network for highway freight that can operate at supply chain standards.

**Shift in Modal Shares**  
**Percent of Tonnage (Domestic & Inland Portion of International)**



The projected shifts in location that the national network must serve are summarized by region in the following chart. The net changes in freight demand reveal some realignment away from the central districts and toward the Pacific and South Atlantic coasts, although the overall effect at the regional level is not very pronounced. While all areas are forecasted to grow, imports and

Region	Percent of US Tons		Tons Growth	Share of Growth	Tons CAGR
	2005	2035			
New England	2%	2%	99%	2%	2.3%
Mid Atlantic	11%	12%	96%	12%	2.3%
South Atlantic	17%	18%	101%	19%	2.4%
East North Central	16%	15%	71%	13%	1.8%
East South Central	8%	7%	87%	7%	2.1%
West North Central	11%	10%	80%	9%	2.0%
West South Central	15%	14%	86%	14%	2.1%
Mountain	7%	7%	89%	7%	2.1%
Pacific	14%	15%	104%	16%	2.4%

new manufacturing will create much faster expansion in the west than in the traditional North Central factory region. The South Atlantic is expected to generate the greatest proportion of new tonnage, at about one-fifth of the U.S. total, due to its multiple ports and vigorous development of wholesale distribution.

The pattern by metro market is somewhat sharper, both as a reflection of the industrial trends this paper has been observing, and for what it suggests about the objectives for a core network of freight. The top ten U.S. metropolitan markets, measured by new freight volume over the next thirty years, are all either coastal cities at or near a major seaport, or they are one of the three principal hubs of the inland distribution system. Taken together, the ten account for one-third of the nation's incremental tonnage, with foreign and wholesale trades figuring prominently in each. Supporting them for supply chain functions will require reliable intercity service, and efficient cross-town service within markets for the transfer and distribution of goods. Three kinds of interlocking infrastructure are needed to accomplish this: an intercity linehaul network, which connects to intracity stem route networks, which in turn serve port, other modal, and industrial park distribution facilities.

<u>Coastal Markets</u>	<u>Inland Hubs</u>
Los Angeles	Chicago
New York	Dallas
San Francisco	Atlanta
Houston	
Washington	
Philadelphia	
Seattle	

## Carrier Organization in Response to Markets

For freight carriers serving today's distributed enterprise, integration is the key. This briefing has recounted how contemporary business models are constructed around the integration of significant processes into the complete supply chain. These supply chains incorporate a wide variety of business functions, cross international borders, and include a number of different economies. In order to be effective, transportation providers must operate as an embedded unit within the business model rather than the external element they may have been in the past. This creates a requirement for a sophisticated partner possessed with the ability to be actively involved in both tactical and strategic decisions related to all aspects of the product life cycle. In recent publications and discussion forums regarding the search for transportation partners, collaboration and flexibility emerge as key words. The ability of a company to operate in a collaborative environment can be the central element to success, at times more important than the specific service capabilities they might offer.

The type and number of companies involved in a particular supply chain varies with the scale of the enterprise and the requirement for rapid change. Partners in the process must fill a variety of roles. In some organizations the needs can be met by one large supplier. For others a connected network of different organizations may be more effective. While the supply chain of an individual company is unique, most will include some or all of the functions listed below:

<ul style="list-style-type: none"><li>▪ Ability to coordinate product movement from vendor to port in foreign countries</li><li>▪ Information systems to monitor purchase orders and filled orders in process</li><li>▪ Ability to manage ocean contracts</li><li>▪ Ability to create and monitor export and import paperwork</li><li>▪ Arrival planning and schedule management</li><li>▪ Transloading from international containers</li></ul>	<ul style="list-style-type: none"><li>▪ Shipment to manufacturing facilities or to distribution points</li><li>▪ Warehousing of goods and work in process</li><li>▪ Delivery to end customer</li><li>▪ Cargo security</li><li>▪ Reverse logistics for return goods management</li><li>▪ Data flow for tracking, managing goods in transit, and for processing bills</li></ul>
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In addition to providing such varied functionality, the service providers in the supply chain must be flexible and able to meet changing demand. This requires access to partnerships that will fill gaps in a carrier's product offering, and the ability to access and manage multiple modes of transportation. The integration of business processes requires a support team with a strong interest and understanding of the customer and the ability to respond with service to exacting requirements - and in fact, the level of service is often the primary way for a company to differentiate itself from its competitors. Finally, the entire structure must be connected with technology that will meet the information requirements of the individual parties that form the chain. In current business practice it is important to be able to track products at their very lowest level of identification, the stock-keeping unit (SKU), and make decisions to move product from one market to another, often times while the product is still in transit. As the structure of the market shifts more and more to the import/distribution hub model described above this need for flexibility increases, as does the need for information. Partnerships are built around companies who are able to respond with information that is quick, accurate, and easy to access.

Successful players in the supply chain fit a specific profile. Some are third party firms, selected by companies to manage their services and integrate among the relationships in the supply chain. This includes access to technology to connect the pieces of information provided by the various

vendors. Sometimes this technology and information piece is the only role the third party will provide. In other cases they provide multiple functions from procurement assistance through carrier selection and warehouse management. Among carriers, size certainly matters in the ability of the organization to provide variety in function and to flex capacity to meet customer needs. In general, larger carriers and service providers have access to more sophisticated methodologies, to better technology solutions, and sophisticated personnel as well as more outside relationships to supplement their service offerings. Smaller carriers can fill specific niches with customized service but most operate with more limited variety and scope, and often must be integrated within other relationships.

The consequence is that freight carriers are consolidating, diversifying, and growing larger. Ship lines and railways clearly have gone this way, and truck lines increasingly have followed suit. The U.S. motor carrier industry has revenue of about \$620 billion, with \$345 billion in the for-hire sector. The top 100 for-hire carriers listed by the American Trucking Association in 2005 had combined revenues of \$176 billion, or about half the total, and the smallest was a \$200 million firm. Even allowing for the fact that this list includes companies with interests outside of pure trucking, it is clear that concentration is building in motor carriage because of advantages to scale. U.S. truck lines have begun to purchase intermodal trains from railroads because they can command the volume to fill them, and have begun investing in trucking firms in Asia so they provide service at both ends of the supply chain. Like their supply chain clients, carriers may not construct an end-to-end conglomerate; instead, they may design an integrated network with strategic points of control, like relationship management and operations volume.

Collaboration among divergent entities requires tight connectivity, and some links are missing:

- *Technology* - The major supply chain service providers have large sums of money invested in their individual technologies. Smaller companies often lack this, and the third party fills some of this gap currently. In the future there is a role for additional expertise with software and technology that allows these various companies to link their information systems in a seamless and simple process that will meet the end client needs.
- *People* - All of this advanced process planning and control, for integrated services, and collaborative relationships calls for a sophisticated work force. This work force must include technically skilled individuals that also have well rounded experience and the ability to communicate effectively and work in teams. This work force is developing and evolving as the supply chain experience continues but is and will continue to be in short supply.

The market requires companies who can flex their capabilities and meet a variety of functional needs related to the movement of product. The future of freight transportation may not lie with mega providers offering one stop shopping, but with networks of companies offering their individual expertise and the collaborative spirit to integrate their services with others and with the business model of their end customer. This network approach requires not only the basic supply chain services but also that the development of the infrastructure, the technology, and the workforce converge. This successful convergence is the organizational challenge for the future.

## **CONSOLIDATED COMMENTS FROM MEMBERS OF THE BLUE RIBBON PANEL OF TRANSPORTATION EXPERTS - PAPER 4B-04**

One reviewer commented as follows:

On page 3, the statement, “U.S. production is moving up-market toward higher value goods with greater knowledge and lower labor content,” is not well supported. Yes, much U.S. manufacturing is moving to higher end goods with greater knowledge content, but how could manufacturing of such goods require less labor content? In truth there is a bifurcated market for manufacturing in the U.S. One requiring high knowledge and high labor content, but an equally large market for lower value commodity goods – chemicals, metals, paper, ceramic, where labor content and cheap transportation are crucial for success (see graph p. 7).

On page 3, in the discussion on, “How our economy competes,” there is no mention of the export market, although the graph on page 6 apparently indicates this could be substantial.

On page 3, distribution and trans-load centers are often located in congested urban area – see table on page 8 “Top 10 growth markets”. These are the places where highway expansion is the most difficult and costly.

On page 5, how much can whole distribution expand in the next 30 years if both retailing and manufacturing continue to shrink? Distribution is not needed for exports.

On pages 3-5, it would be appropriate to discuss the transportation needs of the service economy.

On page 5, even with the decline in manufacturing, given the strong wholesale, retail and service industries within its borders, this reviewer finds it difficult to understand that the Middle Atlantic States would suffer the greatest decline (-3%) of any of the geographic areas as shown in the table, “Demographic Shift by Region” on page 5.

On page 7, which discusses the graph on page 8 – It would be appropriate to give a more detailed discussion on how high-value manufacturing is more dependent on air cargo movement, and that in the future due to lower costs brought about by larger, more efficient planes will be air cargo will play a larger part in the transportation mix. Overall, and particularly on page 8, there is no discussion of the impact of higher energy prices or other driver shortages.