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The Development of Short Sea Shipping in the United States: A Dynamic Alternative

By

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in Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

Current projections show that U.S. international trade is expected to reach nearly two billion tons by 2020, approximately double today's level. With such a large forecasted growth in trade coming through the United States and growing problems associated with highway congestion, air pollution, and national security, building short sea shipping networks will be difficult, but possible, and potentially of great benefit to the nation. By bringing together shipping providers, customers, and with support from the federal government, short sea shipping can become a reality.

This paper outlines the need for a change in our maritime transportation system. It takes a look at the current uses of short sea shipping in the United States as well as the system used in Europe. The technology associated with this concept is described and high-speed vessel design is investigated. Issues relating to the integration of short sea shipping are brought to light, including customer requirements, capital financing, and government policy. A computer-based simulation model calculates a total cost analysis for two modes of transporting goods, trucking and short sea shipping. The model is applied to a group of products of different size, weight, and value. The quantitative results of the model show that in most cases, for lower value products, the savings in transportation costs from short sea shipping offset the increase in inventory costs. These results are then used to look at other commodities listed on the 2002 commodity flow survey to show the potential for short sea shipping use.

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NOMENCLATURE AND ACRONYMS

AADT – Average Annual Daily Traffic

CCF – Capitol Construction Fund

CMAQ – Congestion Mitigation and Air Quality

CO – Carbon Monoxide

CO_2 – Carbon Dioxide

DOD – Department of Defense

EC – European Community

EEC – European Economic Community

EOQ – Economic Order Quantity

EPA – Environmental Protection Agency

EU – European Union

FEU – Forty-foot Equivalent Unit

FHWA – Federal Highway Administration

GAO – General Accounting Office

GDP – Gross Domestic Product

HC – Hydrocarbon

ILWU – International Longshore and Warehouse Union

JIT – Just In Time Logistics

LO-LO – Load-on/Load-off

LTL – Less than Truckload

MIT – Massachusetts Institute of Technology

MMP – Master, Mates, and Pilots

MSP – Maritime Security Program

MTS – Maritime Transportation System

NAFTA – North American Free Trade Agreement

NO_x – Nitrogen Oxide

PACT – Pilot Action for Combined Transport

PIDN – Port Inland Distribution Network

PM – Particulate Matter

PMA – Pacific Maritime Association

RO-RO – Roll-on/Roll-off

SCTG – Standard Classification of Transported Goods

SIU – Sailors International Union

SO_x – Sulfur Oxide

SSS – Short Sea Shipping

SUP – Sailors Union of the Pacific

TEU – Twenty-foot Equivalent Unit

TL - Truckload

VMT – Vehicle Miles of Travel

VOC – Volatile Organic Compound

WEFA - Wharton Econometric Forecasting Associates

WPT – Wave Piercing Technology

CHAPTER 1: INTRODUCTION

PURPOSE

Current projections show that international trade is expected to reach two billion tons per year by 2020, which is approximately double today's level. This growing trade demand will mean greater use of our landside transportation systems, such as interstate highways and railway systems, which are already stressed. Truck use along main corridors is of the greatest concern. Infrastructure improvements will not be able to meet the growing demand because they are considered, by experts, to be economically and, in some cases, physically impossible. Increases in congestion also come with increases in air pollution and accidents. The Federal Highway Administration (FHWA) expects that there will be a "capacity crunch" within the next decade (MARAD, 2003).

Though the increase in trade for our country is economically good, there are relative social and economic costs to it. Increasing costs to our economy include lost productivity due to growing congestion of our surface transportation. Ask anyone where they see the most traffic congestion and, for the most part, their answer will be somewhere around a major seaport or along coastal transportation corridors. It is important for us to address this issue. Increasing the efficiency of freight transportation will reduce the cost of doing business, which in the end will improve our standard of living.

The proposed answer to this growing problem is short sea shipping (SSS). Currently, the U.S. Maritime Administration (MARAD) has started an initiative, which examines "ways to encourage cargo movements by water whenever possible. It will look at how barge and fast vessel technology can bring new capacity to our intermodal transportation system, and how these advances can mitigate air quality issues and spur economic growth (MARAD, 2003)."

Therefore, this research has five primary goals:

1. To provide a current look at trade trends and the challenges associated with them.
2. To examine a sample of existing, proposed, and past short sea shipping uses in the United States, as well as review Europe's use of short sea shipping.
3. To introduce the technology of short sea shipping and some advances within the maritime shipbuilding industry.
4. To take a look at the issues involved with the integration of this form of maritime transportation system.
5. To provide a simulation cost model and perform a total cost analysis of the trucking and short sea shipping modes of transportation.
6. To help foster discussion on this issue and to promote this form of waterborne transportation.

BACKGROUND

For the most part, large international ships bring cargo into U.S. ports. That cargo is then transported by truck to its final destinations. In some cases, these ships move cargo between US ports, but are limited by their speed, time in port, and the number of ports along the coast they enter. The theory behind short sea shipping is that there will be a network of smaller, high-speed ships that provide regular service between more ports. This allows cargo that would usually be transported by truck to be delivered by ship. Trucks would be used to transport the goods to the final destination in the proximity of the port. These regular, high-speed services would also reduce the number of ports large deep-sea ships have to call on, enhancing their efficiency. Part of this initiative seeks to develop cooperative agreements with European and Western Hemispheric trading partners to foster information sharing, mostly on the topics of start-up programs and technologies. These agreements benefit every country involved since this problem is a global one.

There are a few small, isolated examples of short sea shipping in use today and a larger project in New York, called the Port Inland Distribution Network, being developed, but a true "waterborne transportation system" does not exist. Short sea shipping is considered a true waterborne transportation system because it is a waterborne version of the intermodal rail system. Like rail, it would allow truck trailers, ocean containers, and domestic intermodal containers to be taken off the road for the long haul portion of their transport.

There is no doubt that international trade will increase and the U.S. intermodal transportation system will be stressed to the max. There is no doubt that there will be a need for innovations like short sea shipping to handle the surge in freight. There is doubt on whether a short sea shipping system can be built. There are many obstacles including domestic shipping policy, high longshore labor cost, and the high cost of U.S. built ships. Those obstacles are mainly only associated with cost. There are also issues with slow transit time, turnaround time, and hold-ups in processing cargo in port. Lastly, unlike the road, rail, and air modes, whose policy comes strictly under the Department of Transportation (DOT), maritime transportation comes under the Department of Transportation, Department of Homeland Security (DHS), the U.S. Coast Guard (USCG), the U.S. Customs Service and Border Protection (USCBP), and the Department of Defense (DOD).

Bottlenecks will continue to worsen as time goes by and trade grows. The demand is there for the development of a short sea shipping system. Infrastructure for this system lacks in policy and functionality. Ports today are built around large deep-sea international vessels and less around strictly domestic cargo. Short sea shipping will require new vessel technology and redesign of port layout to meet the needs of the vessels. This is a relatively high cost for a system that is fairly inexperienced. Investors and industry need the guidance of the government to facilitate discussion, subsidy programs, and policy framework. This paper seeks a framework of understanding. It will discuss the issues associated with short sea shipping so there is a better understanding of what it is, why there is a need for it, what needs to be done to implement it, and where the cost savings are in its use. Currently, this concept is so new that there are not many sources or publications on the topic, which also demands research in this area of maritime shipping.

OUTLINE

This discussion will begin with a look at the trend of growing trade and how it will affect the United States transportation system. Looking at issues such as growing gridlock, air quality and emissions, and national security, the attractiveness of short sea shipping will become apparent.

Chapter three will turn in the direction of current uses in the Unites States. It will detail a concept under development, a smaller operation in use, and one system that did not fully mature and was abandoned. These start-ups are important to study because they are the earliest experience of short sea shipping in the U.S.

Chapter four will present what is taking place in Europe as pertains to SSS. Europe has slightly more experience with the concept. They have built their system and it has become a success. Therefore, it is an excellent example to look at.

The technology of short sea shipping will be introduced in chapter five. From the simplest of vessels to the newest high-speed catamarans, this chapter will examine the differences between the choices. It will also go more in depth into high-speed vessel design, a vessel type that is growing in popularity. Port and terminal logistics and layouts will be mentioned, as they are crucial to the success of short sea shipping.

In chapter six, the integration of SSS into the transportation system will be looked at to show the complexity of putting a concept like this into place. It is important for this to be discussed in order for progress to be made in the development of short sea shipping. It will not just happen on its own.

Lastly, in chapter seven, a simulation model will be produced provide a total cost analysis between shipping goods via truckload and short sea shipping. This creates a tool to see where the cost generators are in each mode. A variety of products are examined to see the effects of change in product value.

Chapter 2: Challenges And Opportunities

The United States is currently facing a number of challenges related to the maritime transportation system (MTS). As previously stated, waterborne international trade, which greatly impacts the public, is conservatively estimated to grow at an annual compounded rate of 3.3% (WEFA, 2001). This rate of growth in trade will nearly double, possibly triple, the throughput that the MTS will be expected to handle by 2020. The increase in movement of trade, cargo, and passengers is a significant demand that our current MTS infrastructure is not prepared for. As time passes, this country will be faced with larger and larger problems associated with widespread congestion along the main traffic corridors and increased air pollution. America's economy, national security, environment, and quality of life are all dependant on a healthy marine transportation system. As the world's largest economy continues to grow, the U.S. marine system must adapt to the changes. Short sea shipping is an opportunity, a viable alternative to trucking that will help to reduce congestion, increase air quality, and provide additional security.

Fighting Gridlock

Much of the increase in trade is expected to be in the form of containerized traffic from Europe. Trends continue to show this growth and it is not slowing. The Bureau of Transportation Statistics has recorded the growth of freight activity in the United States. There was a 14.5 percent increase in the tonnage of freight between the years of 1993 and 1997, from 9,688.5 million tons to 11,089.7 million tons. The Gross Domestic Product

(GDP) almost doubled between 1990 and 2001. The I-95 corridor, alone, on the east coast saw an overwhelming 47 percent increase in the number of twenty equivalent units (TEUs) from 1991 to 1999, from 2.7 million to 4 million. A large portion of this rise is do to increased traffic from Europe as well as containers shipped from the Far East and then railed to eastern ports for distribution. Below is a table of the top 10 container ports in the U.S., which shows the amount of container traffic in thousands of TEUs that went through that port. It is very intimidating to see such a large growth in such a short period of time. The total percentage of the nations cargo moving through these ports combined is also increasing meaning these ports are being utilized much more.

Port	1992	1993	1994	1995	1996	1997	1998	1999	2000
Los Angeles	1,639	1,627	1,786	1,849	1,873	2,085	2,293	2,552	3,228
Long Beach	1,356	1,543	1,939	2,137	2,357	2,673	2,852	3,048	3,204
New York	1,294	1,306	1,404	1,537	1,533	1,738	1,884	2,027	2,200
Charleston	564	579	655	758	801	855	1,035	1,170	1,246
Oakland	746	772	879	919	803	843	902	915	989
Seattle	743	781	967	993	939	953	976	962	960
Norfolk	519	519	570	647	681	770	793	829	850
Houston	368	392	419	489	538	609	657	714	733
Savannah	387	406	418	445	456	529	558	624	720
Miami	418	469	497	497	505	624	602	618	684
Total, top 10 ports	**8,035**	**8,394**	**9,534**	**10,271**	**10,486**	**11,779**	**12,552**	**13,458**	**14,814**
Top 10, % of total	**76%**	**69%**	**72%**	**77%**	**71%**	**76%**	**81%**	**81%**	**83%**
Total, all U.S. ports	**10,583**	**12,238**	**13,173**	**13,328**	**14,794**	**15,556**	**15,556**	**16,564**	**17,938**

Table 2.01 – Top Ten U.S. Container Ports: Traffic (thousands of TEUs) (Journal of Commerce, 2001)

Figure 2.01 shows the increase in cargo traffic within the top ten ports graphically.

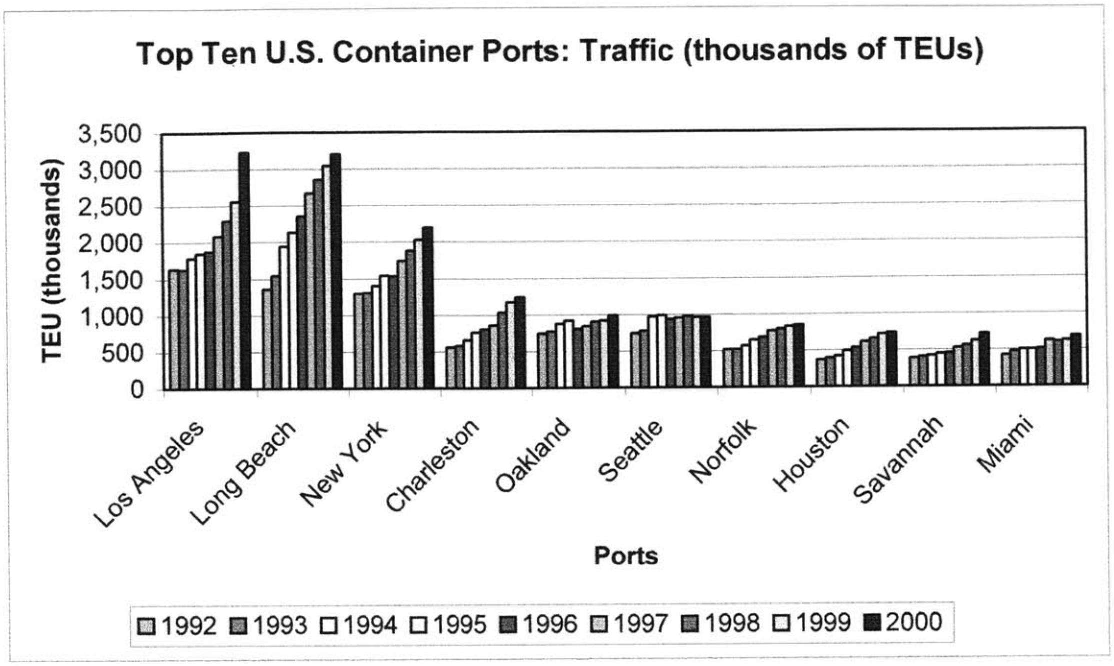

Figure 2.01 – Top Ten U.S. Container Ports: Traffic (thousands of TEUs)

The I-95 Corridor Coalition has reported that "most of the increase occurred at the port of New York/New Jersey, which handled over three million TEUs in 2000, over one million more than just nine years earlier. The Port of Philadelphia grew the fastest in percentage terms, more than doubling the number of containers it handled (Water, 1998)."

The demand for highway travel continues to grow as the population and trade increases, particularly in metropolitan areas. Construction of new highway capacity to accommodate this growth in travel has not kept pace. Between 1980 and 1999, route miles of highways increased 1.5 percent while vehicle miles of travel increased 76 percent. The Texas Transportation Institute estimated that, in 2000, the seventy-five largest metropolitan areas experienced 3.6 billion vehicle-hours of delay, resulting in 21.6 billion liters (5.7 billion gallons) in wasted fuel and $67.5 billion in lost productivity. Traffic volumes are projected to continue to grow. Congestion is largely thought of as a big city problem, but delays are becoming increasingly common in small cities and some rural areas as well (FHWA, 2002). Congestion can have a negative impact on many things. It can hinder efficient movement of freight through the region by both local and long distance carriers, increase costs to both shippers and carriers, raise fuel costs, have negative environmental impacts, and increase traffic accidents. It can also inhibit access to jobs, recreation sites, and attractions for residents and tourists.

Simply put, highway congestion results when traffic demand approaches or exceeds the available capacity of the highway. These traffic demands can vary significantly depending on the season of year, the day of the week, and even the time of day. The overall capacity can also change due to weather, work zones, traffic accidents, or other non-reoccurring events.

The Federal Highway Administration has reported that recent studies and analytical work shows that roughly half of the congestion experienced by Americans is what is known as recurring congestion, caused by recurring demands that exist virtually everyday, where road use exceeds existing capacity (FHWA, 2002). Travelers and shippers are especially sensitive to the unanticipated disruptions to tightly scheduled personal activities and manufacturing distribution procedures. Figure 2.02 shows current domestic truck freight flows for all commodities.

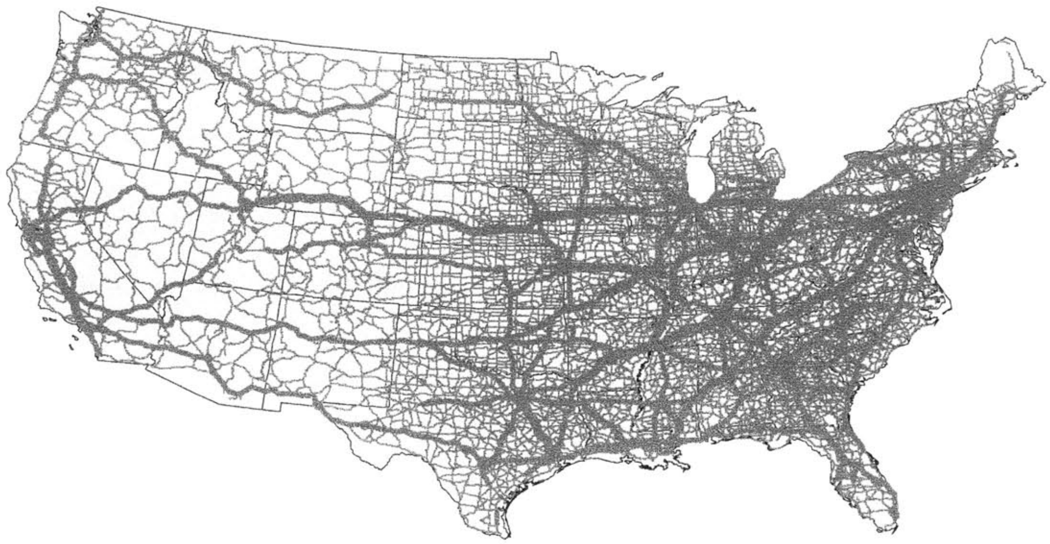

Figure 2.02 – Highway Freight Flow Density (Marshall, 2002)

The I-95 corridor on the east coast is an excellent example. From the 80s to the 90s, over 20 percent of the U.S. population lived and traveled daily in only 6.2 percent of the U.S. landmass that stretches from Virginia to Maine. Over 38,000 trucks daily carried nearly two-thirds of all North American trucking tonnage through the New York-Northern New Jersey region, trips that were vital to the economy of the burgeoning corridor and to the nation (Baniak, 2003). This region had a GDP of $3.6 trillion and carried 5.3 billion freight tons. This growing high volume of traffic results in frequent and increasing gridlock. In the year 2010, it is expected there will be 10,000 more trucks per day on Interstate 95.

Reoccurring congestion is proven costly. The I-95 Corridor Coalition estimates the cost of congestion in their region is over $20 billion per year. The cost of congestion in the New York/Northeastern New Jersey region alone is over $7 billion per year, ranked 2nd nationally behind only Los Angeles. The Washington, DC region ranks 6th nationally at a cost of over $2 billion annually, and the Boston, MA region ranks 10th at an annual cost of over $1.5 billion. These economic costs accrue not only to local residents, but also to long distance travelers, and to those moving freight through the region (I-95, 2003).

Not only will the amount of trade flowing through coastal ports in this region continue to grow, but also the U.S. Census Bureau reports the population in this region is expected to grow nearly three million by the year 2025. The current population is taking more frequent and longer trips, most of which occur on the nation's highways. Vehicle miles of travel (VMT) within the region have been increasing rapidly and currently exceed 550 billion, which is a 140 percent increase since 1970. Trucking statistics are of concern showing that over 195 billion ton-miles of this region's freight moved by truck in 1997. Figure 2.03 shows the degree to which increases in delay within the region's metropolitan areas has outpaced demand, as measured in VMT; capacity increases, as measured by highway mileage; and even population. This representation is not very encouraging knowing that delays in the freight world means lost productivity and lost money.

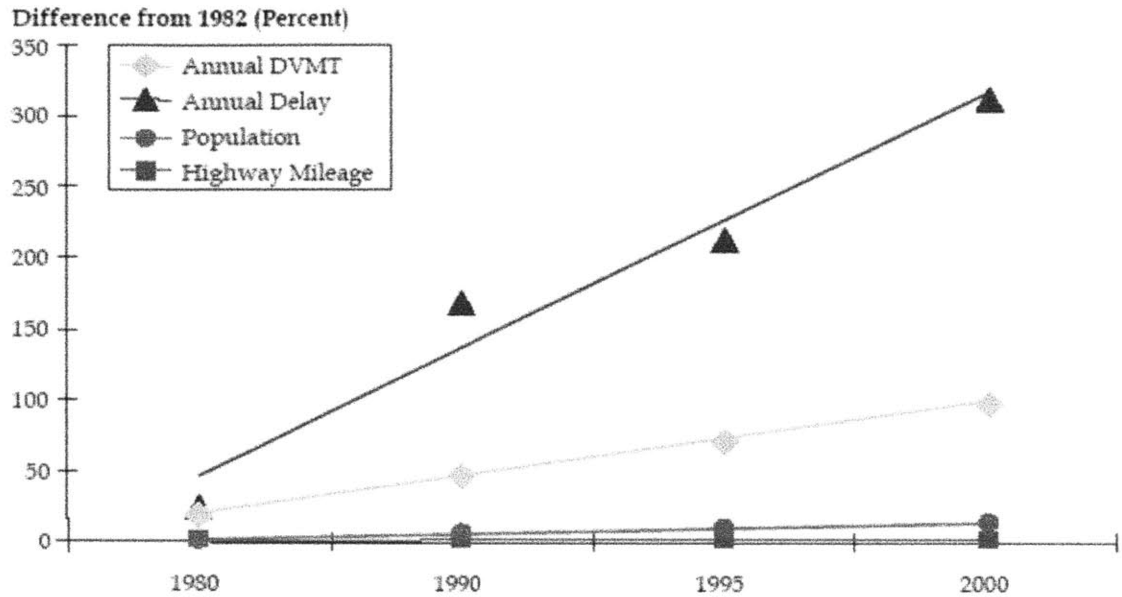

Figure 2.03 – Increases in Population, VMT, Highway Mileage, and Delay in the I-95 Corridor Region, 1985-2000 (TTI, 2002)

Figure 2.04 shows the anticipated growth in traffic volumes that are expected to occur from 1998 to 2020 in measurement of average annual daily traffic. Most of the growth will occur between major urban areas. This is the future as international trade and population increase.

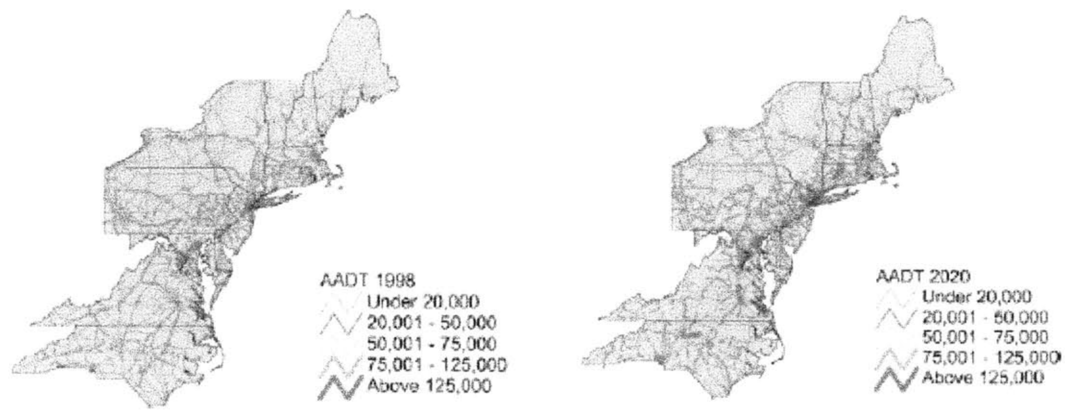

Figure 2.04 – AADT in the I-95 Corridor Region, 1998 and 2020 (Highway, 1998)

PUBLIC SAFETY

As trade begins to increase, so too will the number of large trucks on this nation's highways. Together with the fact that the population will certainly rise, means there will be an increase in the number of traffic accidents involving heavy commercial trucks. Shipping has continued to have a better safety record with less accidents and fatalities. The National Traffic Safety Administration cited that in 2000, 5,282 fatalities occurred in crashed involving large trucks, trucks with a gross vehicle weight greater then 10,000 pounds. Annually, the number of such fatalities varies, from a low of 4,462 in 1992 to a high of 6,702 in 1979 (Figure 2.05). The overwhelming majority of people killed in large truck collisions, 78 percent in 2000, were occupants of other vehicles or nonmotorists (Safety Admin, 2001).

In two-vehicle crashes involving a large truck and a passenger vehicle, driver related crash factors were cited by police officers at the scene for 25 percent of the truck drivers involved and for 82 percent of the passenger vehicle drivers.

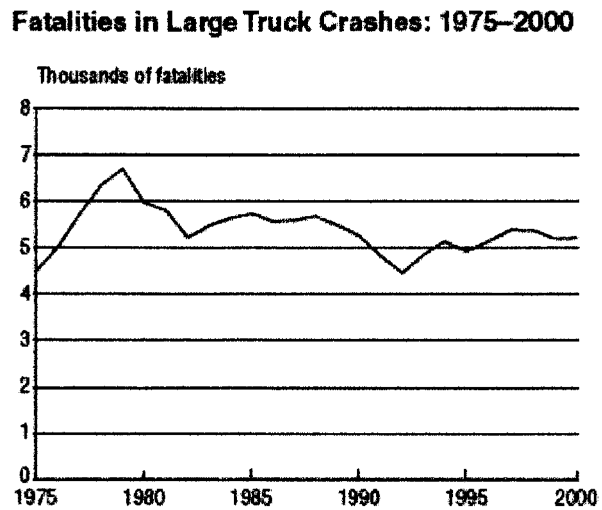

Figure 2.05 – Large Truck Related Fatalities (Safety Admin, 2001)

Truck drivers are not only the ones at fault. The vehicles they operate many times are not up to inspection standards. In order to enforce safe trucking, the government has mandated increased roadside inspections. Approximately 24 percent of the over 2.4 million motor carrier vehicles inspected in 2000 were taken out of service (Figure 2.06).

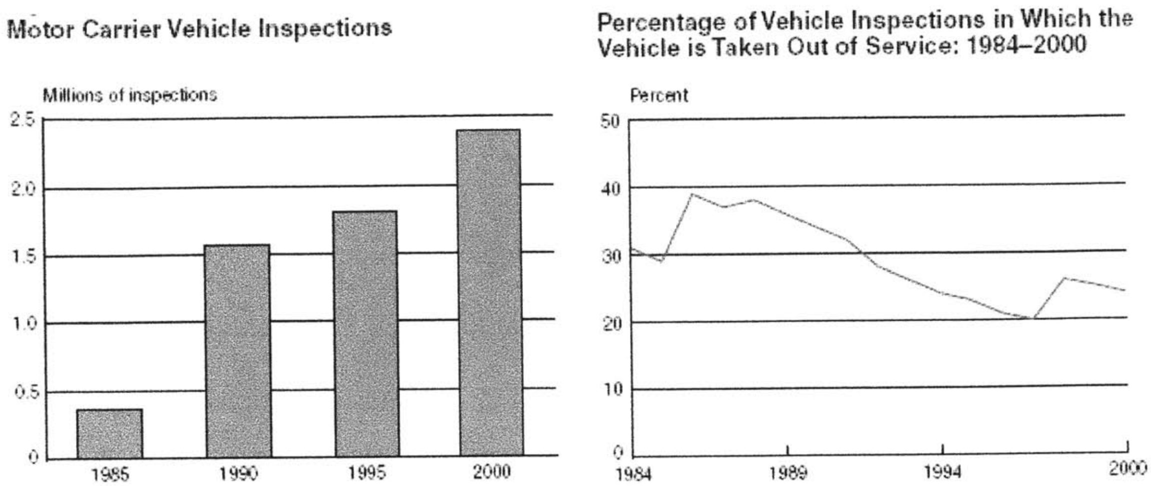

Figure 2.06 – Motor Carrier Vehicle Inspection Statistics (FMCSA, 2001)

ROADWORK

The rise in traffic and large heavy trucks on this nation's highways will also mean that freeways will need to be expanded and roadwork maintenance will need to be accomplished more frequently. The Transportation Statistics Annual Report for 2001 cited real concern for major collectors in rural areas, roads known to carry approximately 8 percent of all VMT in 2000. This concern was generated because the proportion of miles on these roads in poor or mediocre condition increased between 19 and 22 percent between 1992 and 2000. Urban areas have concerns as well. Major and minor arteries carried about 15 and 12 percent respectively of the total VMT in 2000. The proportion of miles in poor or mediocre condition of major and minor arteries increased as well, from 23 percent to 30 percent for major arteries and 22 percent to 26 percent for minor arteries (Transportation, 2001). It is interesting that the decrease in road conditions took place between the same years that container traffic and international trade as a whole had increased significantly. The costs to repair these roads are significantly expensive and in the future these costs will only increase with the additional trucking that will take place on them.

With more trucks on the roads and greater congestion there may be a need to expand highways and make them larger. In some locations it is technically difficult to increase the size of the highways, especially through downtown portions of some cities. The costs of new highways are also high. It has been estimated that a new highway in the U.S. costs around 32 million dollars per lane mile and a new highway interchange costs around 100 million dollars. By 2020, trucks will increase pavement costs by 8.3 percent on rural interstate, 2.5 percent on urban interstate, and 4.3 percent overall (Marshall, 2002).

Short sea shipping is an excellent alternative for trucking. It has the possibility of taking a large number of trucks off the roads, which will in effect reduce a portion of the highway congestion. It certainly will reduce the influx of trucks on the highways that will be required to handle the increase in trade that is forecasted. SSS could save lives. The number of fatalities related to large truck accidents may also decline. This alone is a significant reason to take heavy trucks off the roads.

This concept alone could save this country billions of dollars in road maintenance and expansions. The roadways of SSS, the waterways, are already built and are an under-utilized resource. This underutilization can easily be seen on the east coast, 6 percent of the tons carried move by water, 16 percent by rail, and 78 percent by truck. Value wise, the same trend can be seen, 1 percent by water, 6 percent by rail, 5 percent by air, and 88 percent by truck. The waterways could easily carry more domestic freight and passengers than they do now. With short sea shipping, some ports may need improvements in order to facilitate the increase in traffic and for faster movement and handling of cargo. Currently, the U.S. has 25,000 miles of Inland and Coastal Waterways, which connect to 152,000 miles of rail, 460,000 miles of pipelines, and 45,000 miles of interstate highways. This country also has over 3,700 waterfront passenger and cargo terminals as well as extensive regional and local passenger ferry systems (Marshall, 2002).

AIR QUALITY AND EMISSIONS

Short sea shipping is an environmentally friendly alternative to trucking goods via the highways. It is well known that waterborne transport is more fuel efficient and cheaper when compared to other modes of transportation such as air, trucking, and rail. This is certainly even more true for heavier or more dense bulk freight. The cost savings from this efficiency can then be moved on to the shippers and it will be seen that shipping is the shipper's choice because of the low cost. Air pollutants from exhaust emissions are also considerably less for waterborne transportation. The coastal and inland waterways and the Great Lakes offer this country viable decongesting alternatives for cargo transportation with the added benefit of a reduction of per ton-mile fuel consumption (Advisory Council, 2001).

The U.S. Maritime Administration has come up with some figures that show the relative energy efficiencies of the various transportation modes. By looking over the figures, it is clearly seen that water transport is fuel-efficient. Based on the number of miles one ton of freight can be carried per gallon of fuel, trucking was the worst at 50 miles. This was followed by rail with 202 miles and inland barge with 514 miles. The ratio of fuel use between trucking and shipping is 10 to 1. Cost savings have been found to be along the lines of 5 to 1, with shipping costs for trucking around \$5.35 / ton-mile, rail around \$2.53 / ton-mile, and \$0.97 ton/mile (Vokac, 2003).

Economies of scale play an important role into the trend presented above. Waterborne transportation is able to handle greater cargo capacity. Barges or ships can carry a larger amount of goods then a single truck. What is most interesting is just how much a barge or ship can carry compared to that of a truck. One 1500-ton barge can carry the equivalent load of 58 trucks each with a capacity of 26 tons. When barges are towed together, a 15-barge tow is equivalent to 870 truckloads. The overall length of the two modes of transportation is also fascinating. A 15-barge tow has a length of one-quarter mile. Assuming 150 feet between trucks, trucks lined end-to-end would have an equivalent length of 34.5 miles (Marshall, 2002).

Maritime transport is much cleaner and provides the lowest amount of air pollutants. Overall, since 1980, transportation air emissions have decreased despite large increases in the U.S. population, GDP, and VMT. Exhaust emissions are of concern because of their effects on the environment and their negative impact on human health. They include Nitrogen Oxides (NO_x), Carbon Dioxide (CO_2) (greenhouse gas), Carbon Monoxide (CO), Hydrocarbons (HC), Sulfur Oxides (SO_x), and Particulate Matter (PM).

Nitrogen Oxides is a generic term for a group of highly reactive gases. Many of these are colorless and odorless. The common pollutant, nitrogen dioxide (NO_2), along with particles in the air can be seen as a reddish-brown layer over many urban areas. The chief causes for concern as cited by the U.S. Environmental Protection Agency for this pollutant are:

- Is one of the main ingredients involved in the formation of ground-level ozone, which can trigger serious respiratory problems.
- Reacts to form nitrate particles, acid aerosols, which also cause respiratory problems.
- Contributes to formation of acid rain.
- Contributes to nutrient overload that deteriorates water quality.
- Contributes to atmospheric particles, which cause visibility impairment.
- Reacts to form toxic chemicals.
- Contributes to global warming.

Carbon Dioxide is a greenhouse gas caused by the complete combustion of fossil fuels. There is a natural seasonal cycle in carbon dioxide levels in the atmosphere. CO_2 decreases in summertime when plant productivity consumes it.

Carbon Monoxide is a colorless, odorless gas, which is formed when fuel is not completely burned and contributes to smog. Vehicle emissions account for about 56 percent of all CO emissions nationwide. Other non-road vehicles and engines account for about 22 percent. Higher levels are found in areas of high congestion. In cities, 85 to 95 percent of all CO emissions come from motor vehicle exhaust. The EPA claims that carbon monoxide is poisonous even to healthy people at high levels in the air. It can affect people with heart disease and can affect the central nervous system. Heart disease patients, even when exposed to low levels, can experience chest pain and reduce the person's ability to exercise. Healthy people who are exposed to high levels can develop these effects:

- Visual problems.
- Reduced ability to work or learn.
- Reduced manual dexterity.
- Death.

Hydrocarbons, HC, are compounds that contain hydrogen and carbon. Hydrocarbons are produced when unburned or partially burned fuel is emitted from engine exhaust and when fuel evaporates directly into the atmosphere. These include many compounds that cause cancer and other adverse health effects. With nitrogen oxides, they form ozone (O_3).

Sulfur oxides dissolve easily in water. Sulfur dioxide (SO_2), when dissolved in water produces acid. It also interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and the environment. High levels of SO_2 can be particularly problematic for people with asthma. Sulfur dioxide's other causes of concern include:

- Contributes to respiratory illness, particularly in children and elderly and aggravates existing heart and lung diseases.
- Contributes to the formation of acid rain, which damages trees, crops, buildings, and monuments.
- Makes soils, lakes, and streams acidic.
- Contributes to atmospheric particles that cause visibility impairment.

Particulate matter (PM), refers to particles found in the air, such as dirt, dust, smoke, soot, and liquid droplets. These particles can remain in the air for long periods of time. These are usually seen as soot or smoke in the air. Some can only be seen by microscope. Particulate matter:

- Is associated with serious health effects.
- Is associated with increased hospital admissions and emergency room visits for people with heart and lung disease.
- Is associated with work and school absences.
- Is the major source of haze that reduces visibility.
- Settles on soil and water and harms the environment by changing the nutrient and chemical balance.
- Causes erosion and staining of structures.

Since 1970, most all air emission pollutants have decrease significantly, except NO_x, which has increased approximately 10 percent (EPA, 2003). Transportation statistics show a breakdown of nitrogen oxide and other pollutants by modal share. Figure 2.07 is a representation of this.

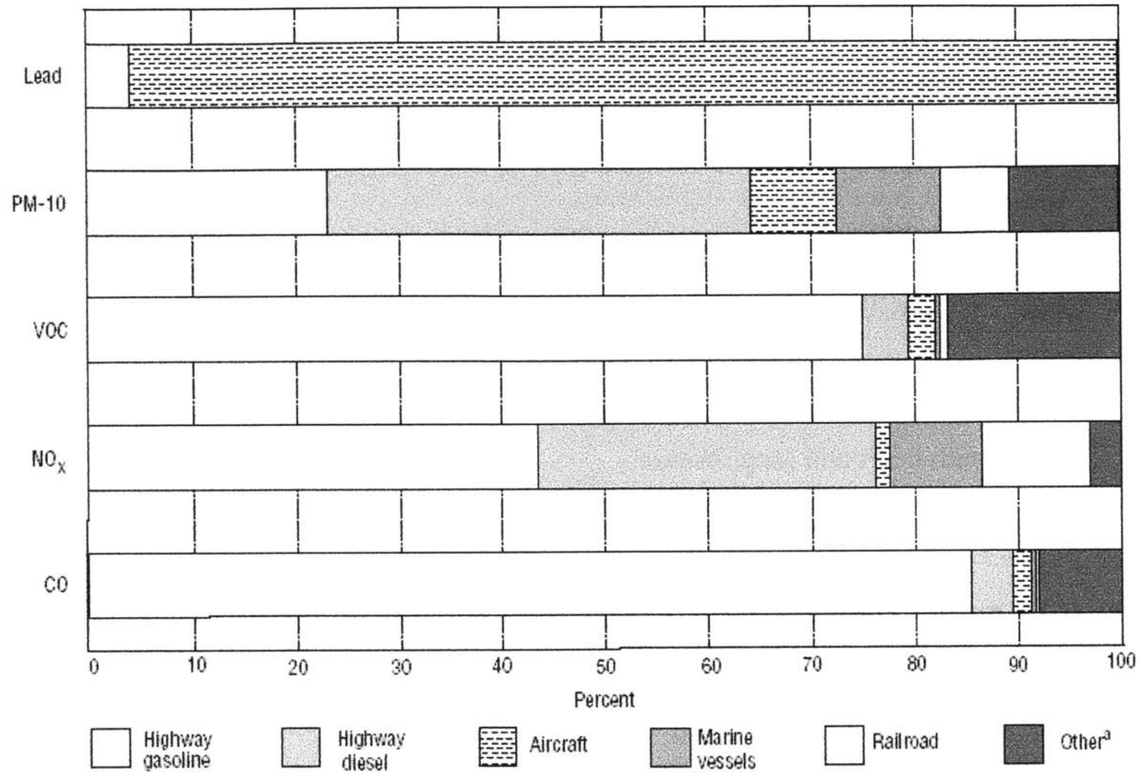

Figure 2.07 – Modal Share of Key Transportation Air Pollutants: 1999 (Transportation, 2001)

This figure shows the large portion of air pollutants that come from road transportation as compared to marine vessels, specifically for particulate matter and nitrogen oxides. Shipping produces less CO_2 than other modes of transport per tonnage carried. A ton of cargo carried one mile by shipping, affects the environment less than that carried by trucking or rail. Another study performed by the EPA shows similar results. Table 2.02 shows the emissions produced in pounds for moving one ton of cargo 1,000 miles.

MODE	Hydrocarbon	Carbon Monoxide	Nitrous Oxide
Tow Boat	0.09	0.2	0.53
Train	0.46	0.64	1.83
Truck	0.63	1.9	10.17

Table 2.02 – Emissions Produced (in pounds moving one ton of cargo 1,000 miles) (Emissions, 2004)

Not only does shipping consume less energy per ton-mile of freight carried by truck, it is clear it pollutes a lot less as well. Furthermore, ships often operate offshore removing their emissions from population centers, which helps to reduce the after effects of the pollutants.

Another interesting study was completed by the Department of Transportation. They studied the effects that a shift or movement of freight from vessels to trucks would cause. Their results were as follows (Emissions, 2004):

- A 826% increase in fuel use annually
- A 709% increase in exhaust emissions annually
- A 5,967% increase in truck related accidents each year
- The need to annually dispose of 2,746 used truck tires
- An additional traffic load of 1,333 heavy vehicles each day in the study corridors.

Although the study corridors were not specifically mentioned in this research, the point is abundantly clear from the results that the use of land transportation can be very damaging to the environment, especially if it replaces the use of waterborne transportation. Short sea shipping can be a helpful method of reducing some of the future emission pollutants by removing a large number of heavy commercial diesel trucks from the roads and highways. Maritime transport has a much higher energy-efficiency than other modes of transport. The economies of scale for shipping allow it to be a great cost savings alternative for shippers, especially when shipping large or heavy quantities.

NATIONAL SECURITY

One of the greatest challenges this country currently faces is that of national security. Since the events of September 11, 2001, there has been heightened interest at the local, statewide, and national levels in improving the security of the nation's freight shipments, especially by strengthening security at coastal freight facilities and ports. Increased security is also being implemented by educating freight transportation workers and tightening personal screening, by enhancing shipper, broker, and carrier control over their shipments, and by increasing the frequency and intensity of intermodal container and truck-trailer inspections.

U.S. Representative William Delahunt, democrat from Massachusetts, has said,

> "that greater reliance on short sea shipping would boost national security by expanding the supply of civilian maritime forces. It will mean more shipbuilding, more mariners, more longshoremen (Seafarers, 2003)."

This increase in jobs will be spread out over the nation's waterfront and ports. This means more people and more eyes are able to keep a vigilant watch at our borders and ports. Civilian maritime forces are hard American workers who are very patriotic and believe in defending this country's interests. Increasing the number of ships and watchful eyes on the waterways will promote increased security.

Short sea shipping would also help to build a strong U.S. Merchant Marine. The war in Iraq has underscored this need. At the AFL-CIO Maritime Trades Department executive board meetings last year, Charles Raymond, Horizon Lines President, said,

> "We continue to resurrect a merchant fleet and call up workers to operate our aging ships in times of international conflict. This need is basic and of no different cause than ever before in our history. Specific surface and technical needs are the only things that have changed. We need better logistics overall, but the core need for people and for assets has not changed."

This statement could probably not be more true. The merchant marine provides large-scale mobility for personnel and material in times of war or national emergency. It has always provided a significant portion of this capability in the U.S. Currently, many of the ships involved in the merchant marine are reaching their lifetime expectancy and are slowly being retired. The growth in these U.S.-flag vessels will help to support national security requirements, and maintain a competitive U.S.-flag presence in international commerce. Since 1996, only 18 modern commercial liner vessels, with an average age of less than nine years, have been reflagged to the U.S. registry for participation in maritime security. Short sea shipping will be an opportunity to build up this fleet of ships up. These new ships will be more modern, efficient, and effectively serve a military role more.

As well as being used for the civilian merchant marine fleet, short sea shipping provides a transportation infrastructure that provides strategic mobility for equipment, fuel, supplies, ammunition, and forces in times of national security. The U.S. military has taken steps in the years since the end of the Cold War to be more prepared for rapid deployment in a domestic or international crisis while at the same time decreasing the number of troops stationed in foreign countries. This results in the greater need for higher speed vessels that serve an advanced waterborne transportation system, such as the ships built and used for SSS. The Maritime Security Program (MSP), enacted by the Maritime Administration, ensures the existence of modern and commercial vessels, as well as U.S. crews for use by the Department of Defense (DOD) when needed (Transportation, 2001).

Additionally, short sea shipping provides extra security in many of this country's cities by moving more hazardous materials via water. Congestion may spike an increase in the number of traffic accidents, including those involving hazardous material cargo, which results in increased injuries, death, and environmental impacts. The Bureau of Transportation Statistics reported that approximately 800,000 domestic hazardous material shipments are made each day using all the modes of transportation, about 90 percent transported by highways. These shipments are essential to industrial production and the economy so we cannot decrease these numbers all together. Better risk management, safety, and security measures are the answer to reduce accidents and terrorist use of these materials. The types of materials that are considered hazardous include petroleum products, flammable gases, poisons, corrosives, infectious substances, and radioactive materials. By providing an alternate water transportation source with frequent service such as short sea shipping, it may be possible to route some of these materials away from large congested populated cities, national monuments, large athletic events, or government sites and buildings.

CHAPTER 3: CURRENT USES IN THE UNITED STATES

OVERVIEW

Looking into the future, there is concern that this country's maritime transportation system will not be able to handle the growth in international trade. Captain William G. Schubert, the Maritime Administrator, has said,

> "International trade is projected to reach two billion tons within the next twenty years – twice today's level. This increase will place significant stress on an already overloaded landside transportation system and nowhere is this stress more evident than at our major port gateways and coastal transportation corridors (Schubert, 2002)."

The Maritime Administrator's remarks can be considered as a conservative projection. There are some projections that container trade at the coastal borders could nearly triple (O'Neill, 2003). Many driving forces will propel this trend. Trade with China, the Far East, and Europe is expected to increase, especially with China's accession to the World Trade Organization. Free trade agreements with Latin America, Mexico, and Canada will also promote greater trade within North and Central America. Figure 3.01 represents this forecasted growth. The take away from these graphs is that U.S. trade with the world should double by 2020 and that U.S. trade with Latin America should nearly triple.

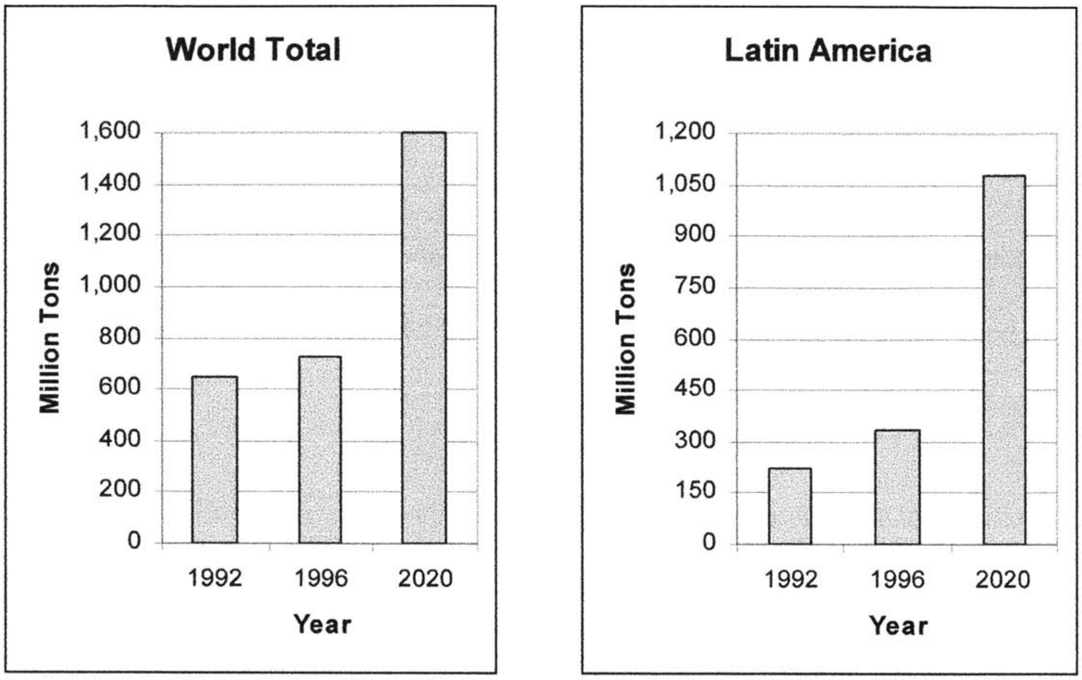

Figure 3.01 – Trade Growth Trends: Forecasts (Wilbur, 2002)

These future trends mean that the Department of Transportation and Maritime Administration will be looking for ways to accommodate the demand. Short sea shipping is one method that will modify our existing maritime transportation system by effectively managing this freight growth and providing an effective alternative to the already congested landside transportation system. Some short sea networks have been started and abandoned, as well as ones that are in planning. The following gives a description of a few.

PORT INLAND DISTRIBUTION NETWORK

The Port Authority of New York and New Jersey has developed and is implementing plans to transship cargo to smaller regional centers around the rim of a circular zone known as the Port Inland Distribution Network. This new system distributes containers through the Port of New York and New Jersey by barge and rail, in addition to trucks. A "hub and spoke" system will use barges to move containers to and from water accessible points. Albany, New York will be the first port to utilize this service and will be used as a testing ground. South Jersey, Bridgeport or New Haven (CT), Dansville (RI), and Wilmington (DE) are the next ports on the list to be added to the network. The rail portion of this network will maintain routes to western Pennsylvania (Pittsburg, PA) and New York (Buffalo, NY). Figure 3.02 shows the network that is planned.

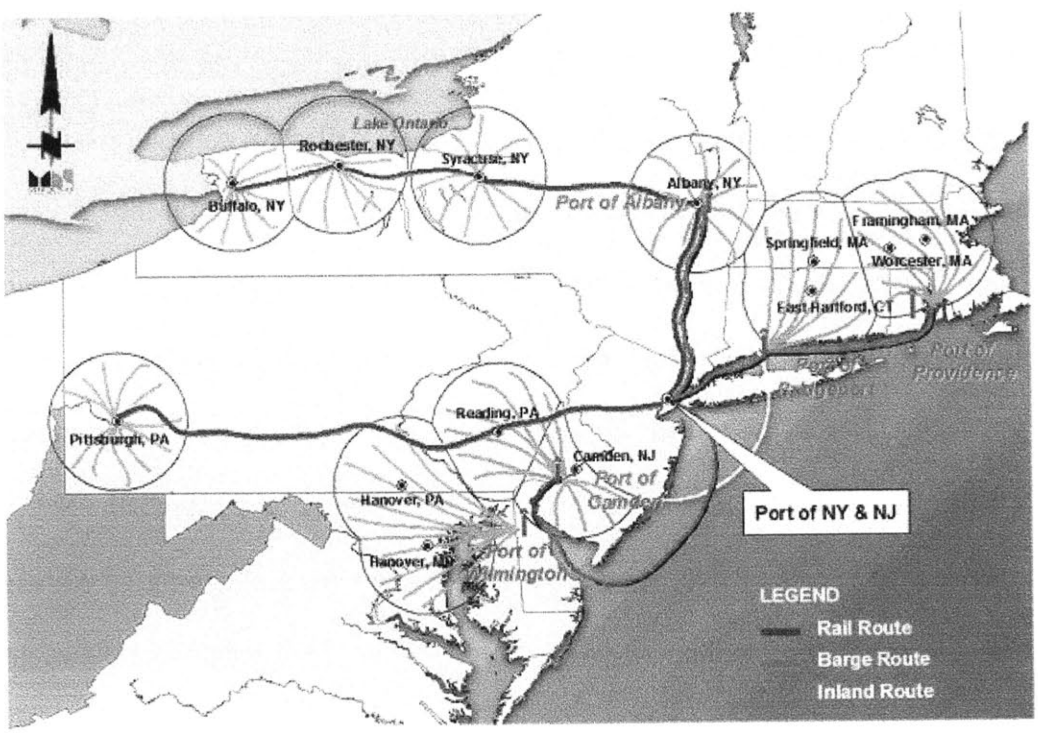

Figure 3.02 – Port Inland Distribution Network (Port NY&NJ, 2003)

Columbia Coastal, under contract, operates barges that run up and down the Hudson River twice a week. Columbia Costal is a New Jersey – based company that runs 13 sea-going barges up and down the east coast of the United States. They expect there will be enough movement north to make a profit. If containers start moving south empty, they have said they will reposition the empties (Columbia Coastal, 2004).

The goal of this project is to try to cut the number of containers being unloaded in New Jersey and shipped by truck by a third. Additional goals are to create jobs and economic activity as well as speed the flow of goods to customer markets in the area and reduce highways traffic. Currently, 84 percent of the containers arriving in New York Harbor are loaded onto trucks. It is hoped this will reduce to about fifty seven percent once all the regional ports are online. The Port Authority wants to divert at least 10,000 containers from New Jersey docks to Albany in the first year, increasing this number to more then 250,000 in the future. Compared to a truck, one barge can carry approximately 300 twenty-foot long containers each trip. Deck barges will serve roll-on/roll off (Ro-Ro) or lift-on/lift-off (Lo-Lo) traffic. Ro/ro barges can handle about 100 TEUs per barge, while lo/lo barges can carry up to 380 TEUs, stacked three or four high. Shipping this cargo up river by barge and rail will reduce air pollution by eliminating large quantities of truck emissions as well as reduce highway congestion in the New York region. This project will also ease pressure on the main docks in Newark and Elizabeth, N.J. These docks, about 2,100 acres in size, are packed to capacity with oceangoing containers most days while the number of containers passing through New York harbor continues growing each year by 4 percent. Once the containers arrive in Albany, the containers will be placed on rail or truck and shipped across the state and the Northeast (McKinley, 2002).

Adding this network to Albany will help to revitalize the port. In the past, the Port of Albany was a bustling port for fruit, cars and durable goods. Over time, the port has changed and now deals mainly in bulk commodities like fuel and salt. Trucking has taken a majority of the old business away. In the future, this port may begin to see more Volkswagens and bananas. In order to help facilitate this, the Port of Albany has installed a new cargo crane and improved rail lines feeding the docks. In addition to greater trade, this port is expected to create more jobs. Governor Pataki has said,

> "All of us together are taking an enormous first step towards economic growth and economic opportunity here in the Capitol Region and across upstate...Having an inland port that's able to handle this containerized freight right here at the Port of Albany is a huge and very important step forward (Durr, 2002)."

Figure 3.03 – Port of Albany, New York (Port NY&NJ, 2003)

An important characteristic behind the development of the PIDN is that of "dwell time". Dwell time is the time interval from when a container comes off a ship until it leaves the gate of the yard. For containers transported by truck, the dwell time is around six to eight days. When moved by rail or barge, this dwell time can be reduced to about two days. This dwell time can increase considerably if containers arrive weeks early and in some cases, the port will charge demurrage fees for this time. The program manager, William Ellis, has stated a basic theme:

> "Maximizing the capacity of existing terminals by reducing dwell time through transshipping containers by barge and rail, thereby taking demand off trucks and getting faster turns in the container yard (Mottley, 2001)."

The PIDN should reduce dwell time by providing routine service between ports. This gets shipments to customers faster and may reduce costs to shippers by reducing the chances of demurrage fees.

The management of this program believes that the outer range of this network, the 200 to 400 mile ring around the Port of New York-New Jersey, offers the most opportunity for barges and rail modes. This is because barges and trains need to travel considerable distance to overcome the economic advantage of trucking (Mottley, 2001). Though this program sounds like it may compete against the trucking industry, it doesn't have to. The use of feeder ports could benefit trucking companies that are hampered by frequent driver shortages and transcontinental competition. This is because PIDN would shift the use of trucks from long-haul single rings to multiple turns in a day.

In order to handle the forecasted growth in container traffic, the Port Authority of New York-New Jersey has said there are some additional needs that will need to be met by 2040:

• Channel Depth	50 feet
• Terminal Productivity	1,500 lifts/acre to 2,500 lifts/acre
• Total Land Required	2,400 acres
• New Land Required	1,120 acres
• Reclaimed Land Required	600 acres
• Terminal Development Cost	$3.4 Billion

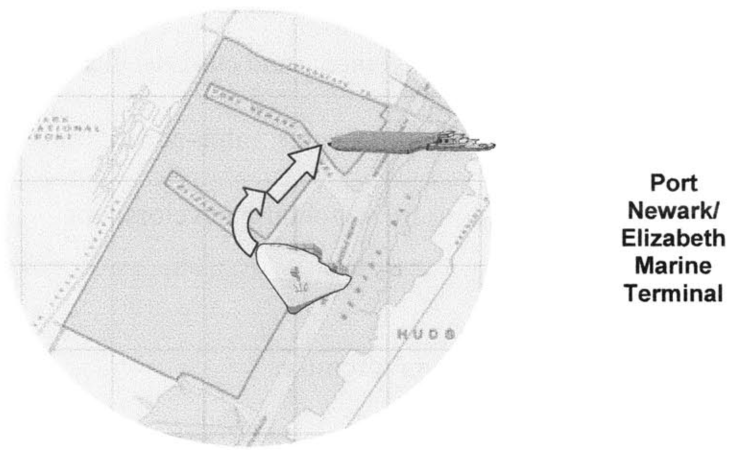

Figure 3.04 – Ship to Barge Flow (Port NY&NJ, 2003)

The PIDN is a form of short sea shipping that will provide many logistics benefits to its users. These benefits include (Port NY&NJ, 2003):

<u>Mainline Ship to Barge or Rail Transshipment within Hub Terminal</u>

- Avoid truck gate delays, congestion and costs

- Reduce assessment and royalty charges
- Accelerated yard turnover/terminal utilization

Regularly Scheduled Delivery to Feeder Terminal

- No chassis required on barge
- No empty return required
- No over-the-road weight restrictions
- Location at the center of market, close to customers

On-Dock Warehousing

- Barge to warehouse delivery inside gate (eliminates local truck dray costs)
- Full service container terminal (empty storage, repositioning management, and local delivery chassis management) and customs clearance available
- Enables growth of distribution center, value-added, trans-loading, Just-in-time (JIT)
- Potential Federal funding for warehouse development

Local Delivery

- Short distance to customers' premises
- Local trucking available

As can be seen, the Port Inland Distribution Network provides an alternative for shipping, while creating many opportunities for all users including the ports, shippers, receivers, truckers, and the public.

DETROIT-WINDSOR TRUCK FERRY

The Detroit-Windsor Truck Ferry is an excellent example of how short sea shipping will help to meet the expected increase in trade, congestion, and national security needs. It is a much smaller operation than the Port Inland Distribution Network, but it serves a similar purpose, to distribute cargo via an alternative route and mode.

The Detroit-Windsor truck ferry is made up of barges and tugs that transit the Detroit River between Detroit, Michigan and Windsor, Ontario. This transit is of particular interest because it crosses an international border. The maps below in Figure 3.05 and 3.06 show the location of Detroit and Windsor.

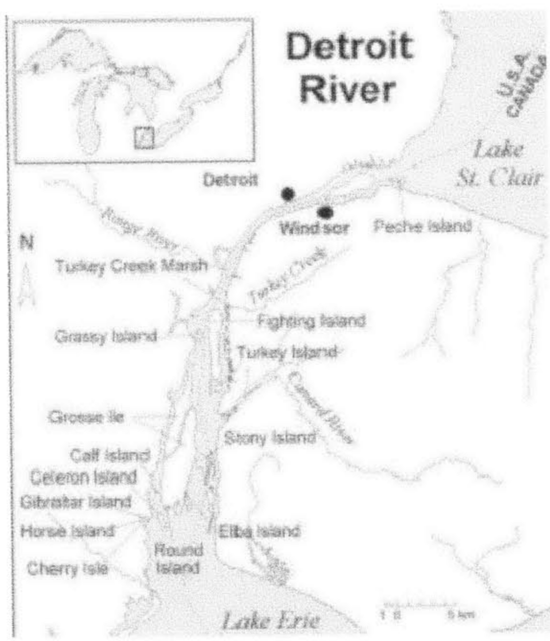

Figure 3.05 – Detroit River (EPA, 1998)

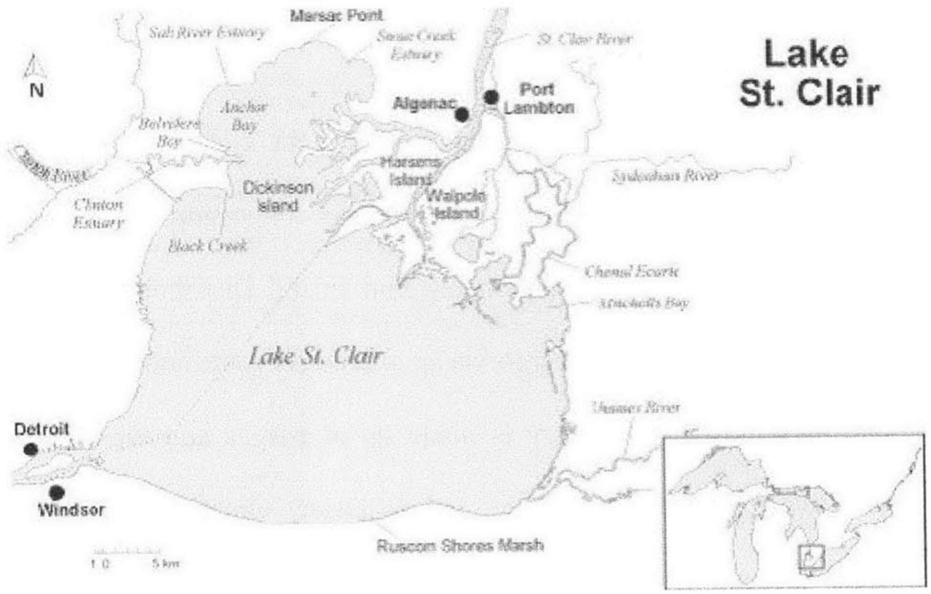

Figure 3.06 – Lake St. Clair (EPA, 1998)

The goal of the Detroit-Windsor Truck Ferry is to provide a service that saves the user time and money. They utilize a "drive-on/drive-off" strategy. Cargo and trucks can be driven directly onto the barge, which makes loading and unloading very efficient. The ferry runs on a regular 20-minute schedule. This can be drastically faster then other route alternatives for truckers, especially trucks carrying dangerous cargos.

Since September 11, 2001, concerns have arisen that trucks transporting hazardous materials could be used as weapons in future terrorist attacks on North America. Both the United States and Canada have been increasingly concerned with this type of cargo for that reason. Therefore, it was made federal law that transportation of materials that are explosive, radioactive, flammable, and corrosive are restricted from using the Windsor and Detroit local bridge and tunnel crossings, more specifically the Ambassador Bridge and

Detroit-Canada Tunnel. The Detroit-Windsor Truck Ferry is the only legal method of transit in this border area (Modern Bulk Transporter, 2003).

With the hazardous material cargo restrictions in place, a trucker in Windsor, Ontario wanting to get to Detroit would have to drive to Chatham, Ontario and then to Sarnia, Ontario to cross the border at the Blue Water Bridge. The total distance for this trip can be seen in Table 3.01. It is easy to see the difference in time and mileage between taking the Ferry and driving around Lake St. Clair and crossing the border at the Blue Water Bridge. Additionally, Figure 3.07 shows the difference in routes as well.

Windsor, ON to Chathem, ON	54 Miles	1 Hour 6 Minutes
Chathem, ON to Sarnia, ON	46 Miles	2 Hour 4 Minutes
Sarnia, ON to Detroit, MI	66 Miles	1 Hour 2 Minutes
TOTAL	**166 Miles**	**4 Hours 12 Minutes**

Table 3.01 – Travel Distance and Time for Blue Water Bridge Route (Mapquest, 2004)

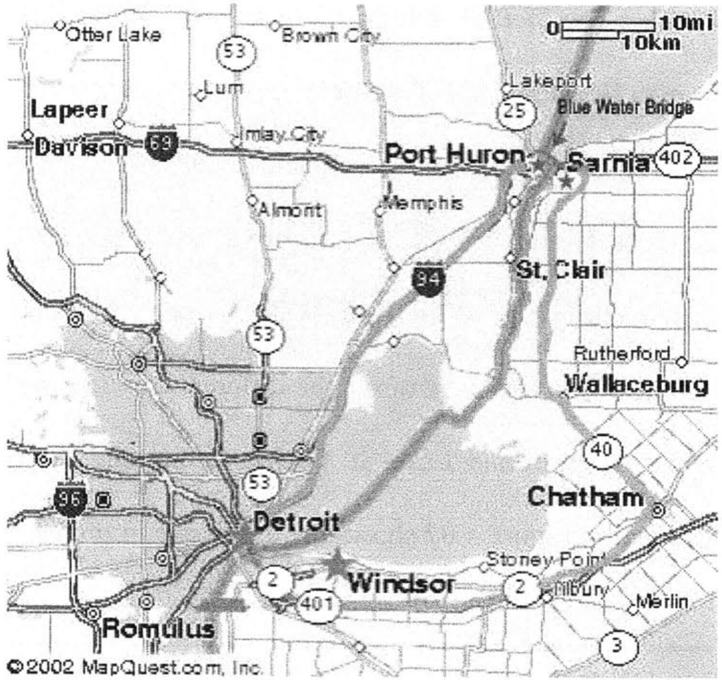

Figure 3.07 – Windsor-Detroit Hazardous Cargo Trucking Route (Truckferry, 2002)

The regular schedule service makes the truck ferry a convenient alternative for regular, non-hazardous trucks as well. It is cost effective and practical for general freight. The ferry is very cost competitive with the costs of gas, mechanical usage of the vehicle, time, and tolls of driving. In terms of congestion on highways and bridges, it is very simple for truckers to catch a ferry. This saves on fuel, maintenance, and drive hours. It also reduces driver fatigue and frustration by giving them much needed rest. Space can be reserved ahead of time for truckers so that they are able to pass at a specific time and avoid delays. The restriction on the type and size cargo is very limited making this service available to just about everyone. Currently, the capacity for weight and height is unlimited, width is 21 feet, and length is 225 feet plus (Truckferry, 2002).

The Detroit-Windsor Truck Ferry incorporates U.S. Customs services into their business. On-site customs facilities for both the United States and Canada are located at each ferry terminal for immediate clearance of goods. Unlike many ferry crossings, the Detroit-Windsor crossing is so short, it is considered an extension to the highway, which means the requirements and procedures for land border crossings apply. Using it saves a lot of time as compared to passing over bridges with the rest of the other car and truck traffic.

Lastly, the truck ferry plays an important role in hazardous material trucking. In 2002, it was awarded a U.S. port security grant to design and implement an advanced notification and tracking system. This bi-national system tracks each shipment and provides accurate and detailed activity reports for each trip. This information includes data on the driver, vehicle, and hazmat profile of the cargo. This system has improved border safety and efficiency of the ferry and helps to expedite the customs process (Modern Bulk Transporter, 2003). Table 3.02 shows the most recent competitive truck ferry fees.

Non-Commercial Vehicles: (including driver and passengers)	Current Rates
Auto: passenger vehicle	$30.00
Trailer towed by passenger vehicle	$60.00
Commercial Vehicles: (including driver and passengers)	
Tractor Only	$30.00
Van or Pick-up	$60.00
Straight Truck	$85.00
Tractor-Trailer - less than 80,000 GVW and less than 80' length	$115.00
Over width only - less than 10' wide and less than 80,000 GVW* and less than 80' length	$115.00
Over width only - between 10'-14' wide and less than 80,000 GVW* and less than 80' length	$200.00
Over width only - between 14' - 16' wide and less than 80,000 GVW* and less than 80' length	$250.00
Over height only- less than 80,000 GVW* and less than 80' length	$250.00
Over height and over width - less than 100,000 GVW* and less than 80' length	$500.00
Heavy lift - greater than 80,000 GVW* and less than 150' length	$1,100.00

Table 3.02 – Detroit-Windsor Truck Ferry Fees (Truckferry, 2002)

Matson Pacific Coast Shuttle

The Matson Navigation Company is one of the largest domestic ocean carriers in the United States. It is most notably known as the leading carrier of containerized freight and automobiles between the U.S. Pacific Coast and Hawaii, Guam, and the mid-Pacific. Matson has a fleet of containerships, barges, and tugs that are equipped to handle virtually any type of cargo for domestic or international service. They own long haul vessels that provide frequent service to allow customers scheduling flexibility, while their fleet of barges is designed to handle a number of shorter distance transits, such as islands and coastal regions. They also have the ability to handle any inland transportation moves needed to deliver freight to west coast port facilities.

Matson has a history of trying to tailor service to the needs of its customers. One instance of this, which was an early form of short sea shipping, was the Matson Pacific Coast Shuttle. Matson launched this service in July of 1994. It provided weekly service between Los Angeles and the Pacific Northwest. Ports included Seattle and Vancouver, B.C. (Matson, 2004). The Pacific Coast Shuttle ran on a fixed day of the week schedule with a combination of dedicated and mixed services between these two regions of the west coast. This means that they would have one ship dedicated to sailing between the port of Los Angeles and the ports of Seattle and Vancouver. They would also have another ship running a mixed route. It would service the previous ports and at times sail to Oakland and Hawaii. The transit from Los Angles to Seattle was 1,144 miles and would take approximately 2.5 days. The transit from Seattle to Oakland was 807 miles and would take approximately 1.7 days (Matson, 2002).

The main vessel that Matson used for this route was the S.S. Manulani, a cellular containership. It has a total capacity of 649 forty-foot equivalent units and 260 twenty-foot equivalent units. The annual container carriage was about 30,469 made up of 27,675 full containers and 2,794 empty containers. The Manulani traveled at a speed of 22.5 knots and was manned by twenty-eight personnel. The ship's crew was made up of licensed officers and non-licensed sailors. The licensed officers on this ship were from the two main sailor unions, Master Mates and Pilots (MMP) and Marine Engineers Beneficial Association (MEBA). The unlicensed sailors were from the Sailors Union of the Pacific (SUP) and the Sailors International Union (SIU). Figure 3.08 is a picture of the S.S. Manulani.

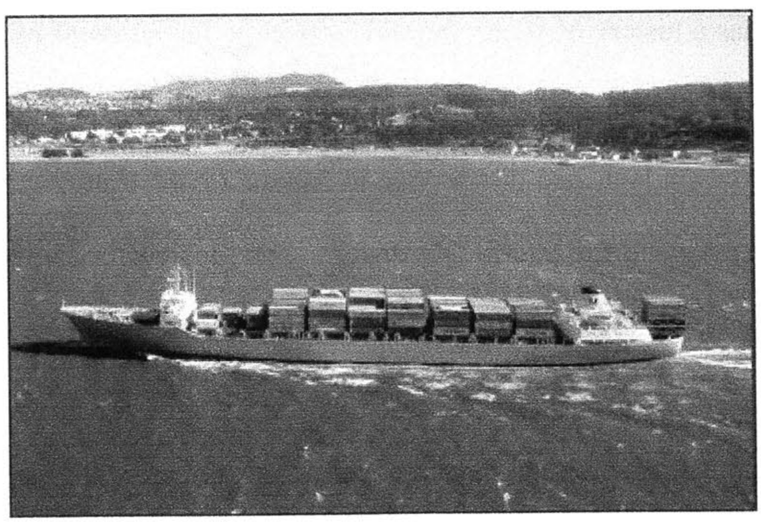

Figure 3.08 – Matson Navigation Company, S.S. Manulani (Matson, 2002)

With the Pacific Coast Shuttle, Matson was trying to target a number of markets. First, it served as a connecting carrier for cargo coming into these ports on various foreign ships. For instance, it might move the cargo, destined for Seattle, off a Japanese ship that unloaded it in L.A. that was headed for Seattle. Second, it took on cargo that would otherwise be shipped through the I-5 corridor via truck or rail. This would help to reduce the frequent congestion and air pollution found between the west coast ports. Besides the main markets above, this service would also try to take on some Canadian shipments that were headed for southern California, dangerous and hazardous cargo, and military cargo. The following pictures in Figure 3.09 show one of the uses of this service, military reposition. Military vehicles and equipment can be loaded onto platforms and then placed aboard the ship. This provides faster transport along the west coast then via highway.

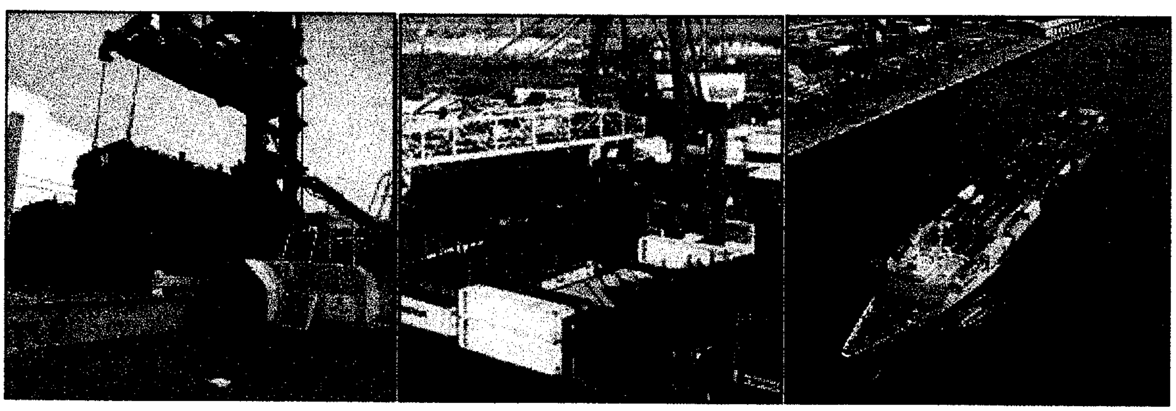

Figure 3.09 – Military Reposition, Loading Skid (Matson, 2002)

In a presentation at the first annual Short Sea Shipping Conference, Matson's CEO at the time, Mr. Brad Mulholland, listed the basic principles and service cost structure behind this service for the two primary markets, connecting carrier and truck-rail (Matson 2002). They were as follows:

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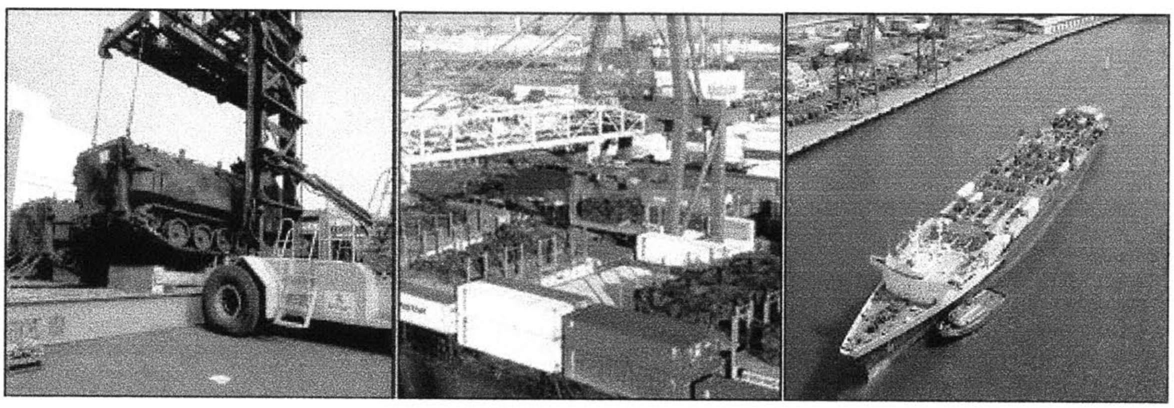

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Service Cost Structure	
Cargo expense and overhead	44%
Vessel operating and overhead (ex dep)	38%
Port expense (tug - dockage, etc.)	6%
Operations overhead and G&A	6%
Depreciation	6%
TOTAL	100%

Table 3.03 – Pacific Coast Shuttle Cost Structure (Matson, 2002)

The pricing criterion for the connecting carrier market segment was based on the size of container used. Container loads utilizing a forty-foot container would be priced between \$575 and \$1,025. Customers shipping in twenty-foot containers would be charged between \$575 and \$900. Empty containers would be repositioned as needed by the company. For the truck-rail market segment, Matson priced their containers based on the trucking market where trucking rates were between \$1.00 and \$1.50 per mile (Matson, 2002). These prices are very competitive with trucking and rail thereby creating a market for this service.

In 2000, Matson discontinued this weekly service and reconstructed it into a twice-weekly container rail service operated by its own intermodal service. This was a result of the company having been forced to remove the vessel from this service to replace a ship being utilized on its west coast to Hawaii service when that ship had to be sent to dry-docking for repairs. It had been planned that the ship would return to the Pacific Coast Shuttle service, but later the company decided against it and increased their weekly rail service to twice weekly (MM&P, 2000).

Though this service provided by Matson came to an end, it is an excellent example of a service short sea shipping can provide. Though financial performance in the end was a problem and justified the decision of not returning the service, there were some lessons learned that might be of use to carriers in the future. This service lasted a little over six years with approximately 52 sailings per year. It had a very high performance rating being on time within one hour 95 percent of the time. The shuttle brought in revenue of about $25 million per year and was marginally cash positive, but it didn't cover the cost of capital (Matson, 2002).

Looking back at the service, there are some factors that could be improved upon in order to make a future shuttle more profitable and user friendly. The shuttle had only one sailing per week. This could be increased to two or three sailings per week. This would create faster service and add more flexibility for the customers whose cargo was more time sensitive. Cheaper drayage costs would reduce the costs of hauling containers to and from the ports. Another challenge was the use of twenty and forty-foot containers when the domestic market favored larger boxes. The capacity of the box could be increased through the use of 45', 48', and 53' X 102' containers, instead of the standard 40 foot, but the type of ship chosen for the service would have to be compatible with these sizes. The service cost structure could be examined and methods of cutting costs researched, like the use of offshore unions, such as the International Longshore and Warehouse Union (ILWU). Wharfage and dockage charges could be less. Access to lower cost capital would also help. Furthermore, tax incentives, government financial assistance, legislation to address

Jones Act loopholes/enforcement, and reduced manning requirements would help to make future services such as the Pacific Coast Shuttle more competitive and financially stronger.

CHAPTER 4: A GAZE ACROSS THE POND

OVERVIEW

Europe has begun to see the effects of increased trade as well and they have already started building their short sea shipping network to handle it. Therefore, it is a good model for the U.S. to watch and learn from. European freight transport, since 1970, has increased more that 70 percent and passenger transport has increased about 110 percent. It is estimated that annual growth in both these sectors will be about 2 percent. In the U.S., domestic freight activity has increased approximately 160 percent between 1970 and 1994. That's an average annual growth rate in domestic freight of 2 percent (BTS, 1997). In 1996 alone, 12 billion tonnes of goods were moved in the European Union (EU). This constituted about 2,600 billion tonne-kilometres. Ninety percent of the tonnes and fifty percent of the tonne-kilometres were transported within one single Member State (European Commission, 1999).

The European Commission has come up with a working definition for short sea shipping in terms of Europe. It reads:

> "Short sea shipping means the movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non-European countries having a coastline on the enclosed seas bordering Europe."

Short sea shipping in Europe includes domestic and international maritime transport, including feeder services, along the coast and to and from the islands, rivers and lakes. Feeder services form a short sea network between ports in order for freight to be consolidated or redistributed to or from a deep-sea service in one of these ports, usually called a "hub-port". The range of their network covers maritime transport between Norway and Iceland and other states on the Baltic Sea, the Black Sea, and the Mediterranean. Sixteen countries within the European Union have committed themselves to the promotion of short sea shipping. They include Portugal, Sweden, Ireland, Netherlands, Finland, Denmark, Belgium, Italy, France, Greece, Spain, Germany, Slovenia, Sweden, United Kingdom, and Norway.

In Europe, short sea shipping is well established but still evolving. Together, these countries have contributed money to both research and subsidy programs to promote this network of shipping.

FRAMEWORK AND PROMOTION

In order to promote the growth of short sea shipping, the European Economic Community (EEC) has provided a regulatory framework. Council Regulation (EEC) 4055/86 allows the freedom to provide international maritime transport services in the Community. Council Regulation (EEC) 3577/92 further established free maritime cabotage, removing legal constraints that have prevented competition for maritime transport services within EEC States.

The customs regime has also been changed. The general rule has been that if goods are moving by sea, they are deemed to be non-Community goods and consequently are subject to customs control. If goods are community goods, proof of this status has to be shown to customs. After this, the goods are able to move freely. Customs can now grant the status of "regular shipping service" to ships that call exclusively at Community ports. With this, goods that are assumed to be Community goods, when unloaded, can move freely as if crossing a Community land border. When goods carried on these vessels are non-Community goods, they are still subject to customs control. This regulatory framework allows for competition, making shipping a more affordable option. It also sets up faster processing of goods within the European Community ports, which will decrease the transit time delta of some cargo between shipping and trucking.

The Pilot Action for Combined Transport (PACT) program was introduced in 1992 and financed 167 projects between 1992 and 2000. It had a total budget of EUR 53m. The PACT had a few successes (European Communities, 2001):

- A new combined rail/sea link between Sweden and Italy, via Germany and Austria, which took some 500,000 tonnes a year off busy highways. This decreased some journey times by approximately 48 hours.
- A daily barge service between Lille and Rotterdam that removed some 50 lorries from a congested highway corridor.
- A rail/sea service between Spain and Germany, which took approximately 6,500 lorry trips per year off congested highways.

The Marco Polo Program superseded the PACT program in 2001. It was created to provide assistance to short sea services. Although critics believe it will not be enough, the four-year budget for this program was in the area of EUR 75million (MariNova, 2003). The first objectives of this program included supporting start up phases of operations that would provide a commercially viable service in the long term and help the shift of cargo from road to the other modes of transport. Second, to improve operation of the entire intermodal chain. Lastly, to foster cooperation and dissemination of information regarding best practices (European Communities, 2001). This program contributed to the success of 57 services. Some include (Europa, 2004):

- Ferry service from Ipswich, U.K. to Ostend, Belgium, 2000.
- Establishment of Baltic Container Lines feeder service from Wallhamm, Sweden to Gydnia, Klaipeda, Bremerhaven and Hamburg, 2000.
- Container ro-ro service by Northern Continental Lines from Moerdijk to Blyth, UK, Riga, Latvia and Ahus, Sweden, 2000.
- Weekly service of Mediterranean Shipping Co (MSC) from Antwerp to St. Petersburg, Helsinki, Rauma, and Gydnia, 2000.
- Weekly container service with two 250 TEO vessels between Spain and eastern Mediterranean, 2000.
- Cargo ferry in Baltic connecting Vyborg, Russia to Kiel, Germany, using 64-trailer capacity ferries, 2000.
- Ro-ro service by Gulf Stream Ireland Co., between France and Ireland, between Brest, France and Rosslare, Ireland, 3times per week, 2000.
- Service by Superfast Ferries connecting Rostock, Germany and Hanko Finland, using 4 ships, 2001.
- Service operating by Bow Marine Oy of Finland, between Bremerhaven, Tallinn, and Helsinki, 2001

- Service connecting Spain, Italy, Greece, Turkey, Israel, and Eygpt by CTE, owned by Naviera del Odeil and Lykes Lines. Three loop feeder service using six 500-1,000 TEU vessels, 2001.

An excerpt from the Atlantic Canada Short Sea Shipping Background Study can be found in the appendix B. It takes a look at many of the European short sea shipping operations and ports.

SHORT SEA SHIPPING GROWTH

Since the EU began to promote short sea shipping more and more in the 1990s, they have recorded data to track trends in the industry. This data allows them to examine comparative trends in short sea shipping and other modes. It shows that short sea shipping has increased considerably from 1990 to 1997, by 17% in tonnes to 757 million tonnes and 23% in tonne-kilometers to 1070 billion tonne-kilometres. Road performance has also seen an increase over time, approximately 26 percent in tonne-kilometers. Inland waterway performance also grew by 10 percent, while railroad use decreased 7 percent [EU Commission, 1998]. Though there is an increase in road performance as well as short sea shipping, this increase is less then it would be if cargo were not diverted to waterborne transportation.

In looking at the total intra-EU transport, short sea shipping and road transport are about equal with about 43 percent and 42 percent respectively. For international intra-EU transport, they become 69 percent and 18 percent respectively (European Commission, 1999).

Statistics also show that there has been considerable growth in the use of containerization. This form of cargo grew by 44 percent in tonnes between 1993 and 1997, which was more than the overall volume growth of short sea shipping. Between 1990 and 1996, short sea container traffic grew by about 70 percent (European Commission, 1999). This is being attributed to the overall growth in deep-sea container traffic and the various sea-to-sea feeders that have been started. With the larger use of these feeders, deep-sea vessels are making fewer port calls.

As cargo is transported throughout the EC, it can be carried via road, inland waterway, rail, or short sea shipping. The average distance a tonne of freight is transported by each of these services has been around 100 kilometers (62.1 miles) for road, 270 kilometers (167.8 miles) for inland waterway, 300 kilometers (186.4 miles) for rail, and 1385 kilometers (860.6 miles) for short sea shipping (European Commission, 1999).

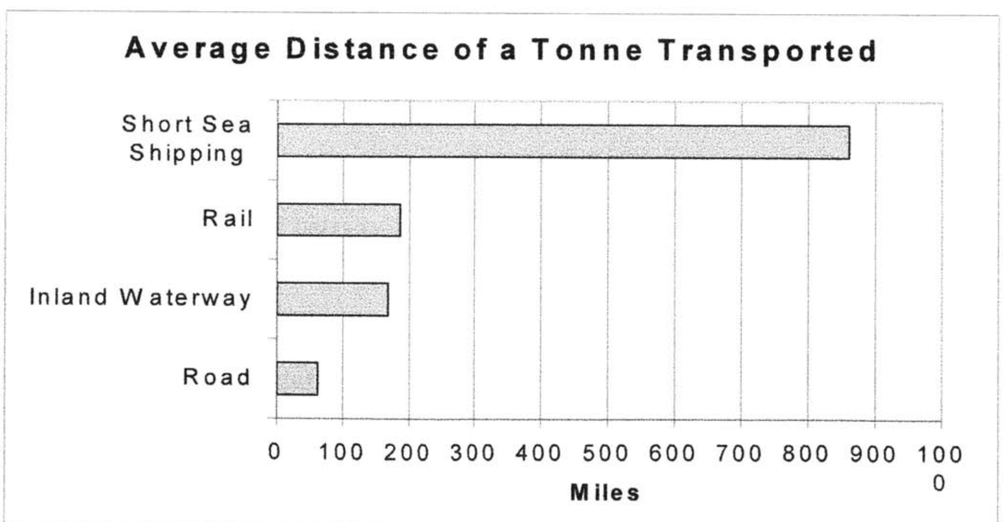


Figure 4.01 – Average Distance of a Tonne Transported by mode in the EU.

These numbers show that road transport is very competitive over short distances, while short sea shipping is preferred over longer distances. Over 80 percent of total tonnes, mostly domestic, transported in the EU are carried by road over short distances. Short sea shipping only carries a small percentage in this grouping, only about 6 percent. Short sea shipping takes on a larger share of international transport, about 40 percent. Road transport takes on about 30 percent of this (European Commission, 1999).

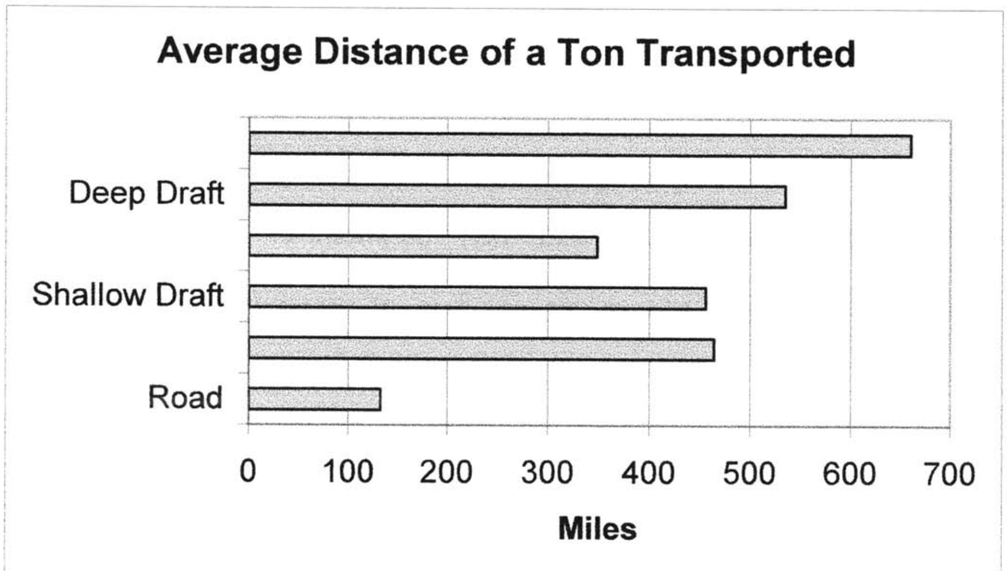


Figure 4.02 – Average Distance of a Ton Transported by mode in the US.

A similar study of U.S. intermodal transportation statistics by mode of transportation shows the average distance a ton of cargo is transported. The results include 132.9 miles for road (truck), 659.8 miles for rail, 464.5 miles for water (combination of all water transport), 456.4 miles for shallow draft, 349.0 miles for lakes, and 535.4 miles for deep draft. Of the total tons transported in the U.S., approximately 70% is transported by road and about 5% is transported by water (BTS, 2003). These numbers are hard to compare against Europe's because of the geographic differences. European countries are smaller thus trucking distances are shorter. Many of the countries have access to water therefore more cargo can move by water more easily. These numbers are also calculated using short tons. One significant difference is that, in the U.S., road miles are more then double that of average road miles in Europe. The second significant difference is in the average distance traveled by water. The average distance of a tonne of goods that travels by water in Europe is almost double that of the U.S. These numbers suggest that there may be under utilization of U.S. waterways.

Europe also sees the environmental impact of short sea shipping. Modern marine engines produce less CO_2 then the other forms of cargo transport, such as trucking, per tonne of cargo. Shipping is much more energy efficient as mentioned in Chapter 2. Europe sees the use of maritime transport as a method of reducing emissions and reaching their environmental goals set fourth by their Kyoto obligations.

Since Europe started promoting short sea shipping, it has grown and there is still room for it to take on a larger part of the road transport market. The use of feeder services or regular short shipping services, outside of barges, has been seen as unprofitable in the United States, and many have not wanted to invest in the idea. What we learn from Europe is that it is possible and it is a viable option for our problem of growing highway congestion.

CHAPTER 5: SHORT SEA SHIPPING TECHNOLOGY

OVERVIEW

While short sea shipping here in the United States is in it's beginning stages, for the last decade, Europe has been building their short sea networks and infrastructure. As the U.S. follows in the footsteps of Europe, there will be some similarities and differences based on the geographies of the regions, the needs of the regions, and the maritime policies of the different regions. There is at least one facet that both Europe and now the United States have in common, the need for new technology.

The process of revitalizing the efficient use of the waterways has demanded research in technology related to the maritime industry. It is believed that significant technological advances could take place with the type of ship, which may be employed in a coastwise service. As the short sea industry begins to take off, routes most likely will utilize barges and smaller container vessels. Barges offer a "low barrier to entry" but are restricted by service capabilities, namely speed. Smaller container vessels that travel up to 15 knots most likely would be a better fit for this type of service. They are economical, service capable, and relatively a "low barrier to entry".

The technology of short sea shipping includes the size and type of vessels, new high-speed vessel design, and port and terminal reorganization.

Types of Vessels

Pull Deck Barge

Pull deck barges are flat level tug propelled platforms that are used exclusively for feeder operations and for repositioning of containers. The cargo stowage on one of these barges is quite simple. Containers sit on the flat deck of the barge without any support structure. The containers are usually placed immediately adjacent to one another with no separation across the entire deck. Stacking of the containers is usually around three of four rows high, with some larger barges stacking containers six rows high. A typical deck barge has a carrying capacity of around 690 TEUs and dimensions of 343 feet long, 86 feet athwartship, and 24 feet high. Some barges can be large enough to carry about 900 TEUs or small enough to carry around 200 TEUs. Deck stowage makes barges fairly simple to use because there are no hatches to access or hatch covers to remove as would be on the conventional container ship. Containers are secured for transport by lashing, which requires time and manpower, and adds to operating cost and port time. On some barges, this cost is reduced by the installation of a cellular structure to hold the containers, but this adds weight to the barge and could slow handling. Like container vessels, there is a need for gantry cranes to load and unload the containers.

Barges are not very efficient in the water. Because they are fairly rectangular, they have a large frictional area preventing the efficient flow of water around the hull. Because of the poor hydrodynamics of the typical barge hull shapes, they are more sensitive to weather as compared to self-propelled vessels. This is a service and reliability concern. Barges also tend to be very slow. The tugboats pull the barges only at about 10 knots.

Container Feeder Ships

Container feeder vessels are ships that operate in support of the mainline vessels, which are the much bigger ships that bring a very large number of containers or cargo to a port. Feeder ships are usually smaller in size and cargo capacity. This allows it to be able to have a faster turn around time in port and allows it to be more versatile in port, helping to save time. With the development of short sea shipping, the design of these vessels has changed somewhat. In order to be able to keep up with the demand, which is speed and time, these vessels can now cruise at about 15 to 17 knots, slightly faster from the older versions of 12 to 14 knots. Though some of these ships can carry a load of nearly 2,000 TEUs, some can carry as little as 250 TEUs.

Roll-on/Roll-off (Ro-Ro)

These vessels are unique in that are intended to carry wheeled cargo on trucks, such as containers on chassis and regular commercial trucks. Fitted with ramps that unfold and reach shore, the vessel allows trucks to be driven on and off, making cargo loading and unloading very efficient and easy. Some new features of these ships include double level ramps and straight driving lanes that make the roll-on/roll-off even more efficient. Use of Ro-Ro vessels has declined on most longer routes, they are not competitive with regular lift-on/lift-off container ships due to of the large amount of wasted space taken up by the wheels and chassis of the trailers. Ro-Ro ships do have one advantage; they are extremely efficient in cargo-handling operations, which makes them perfect for short sea shipping. The faster cargo handling capabilities allows for faster turn around times (shorter port time). Some current Ro-Ro ships bring cargo on and off with wheeled dollies in order to reduce wasted space while keeping the ease of loading/unloading. Though these vessels can be very large and carry as much as 16,000 deadweight tonnes, vessels more appropriate for short sea shipping would be around 12,300 dwt. A vessel of this size would have a capacity of approximately 3,000 to 4,000 linear meters of cargo on trucks, or approximately 858 TEUs. Vessels this size have an operating speed of about 22.5 knots (Zubaly, 1996).

Ro-Pax

This is a concept that carries a mixture of trailers, trucks, car, and passengers. Ro-Pax vessels usually have a capacity of 5,000 to 10,000 dwt and operate at speeds of 22 to 28 knots. There are different versions of this type of ship that have different cargo capacity mix. One ship might carry 400 passengers and 170 trailers, while another may carry 1,000 passengers and 200 trailers and a third may carry 2,000 passengers and 270 trailers. These types of cargo ships are a newer generation from the older, more luxurious vessels, which carried up to 3,000 passengers and 450 autos. A small portion of these passengers is made up of truck drivers and the rest are normal ferry passengers. This type of vessel could help alleviate future congestion by taking not only cargo off the roadways, but some cars as well (MariNova, 2003). Figure 5.01 is an example of this type of vessel.

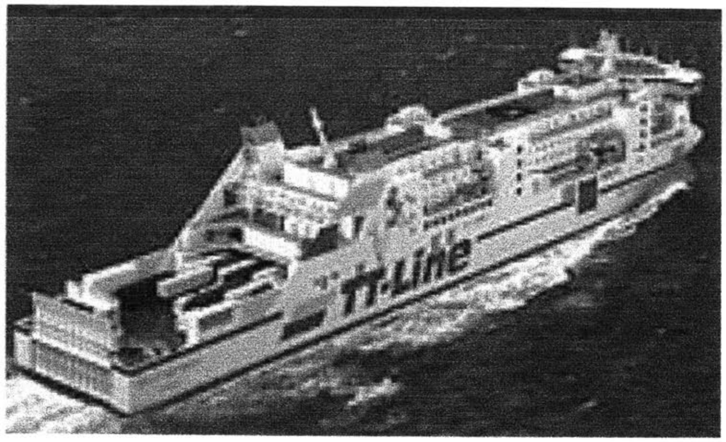


Figure 5.01 – T-T Line Ro-Pax Vessel (T-T Line, 2002)

Con-Ro-Pax

This newer concept adds to Ro-Pax the capacity to carry containers. The addition of containers increases the overall carrying capacity of the ro-ro vessel and allows the ship to carry intermodal cargo. A vessel of this type would carry approximately 400 TEU and 700 trailers and operate at a speed of about 22 knots. A disadvantage of this type of ship is the slower turn around time due to the use of lift-on/lift-on containers. This type of vessel is most suitable for routes of 8 hours or more duration (Brogren, 2002). Figure 5.02 is a picture of a typical Con-Ro-Pax.

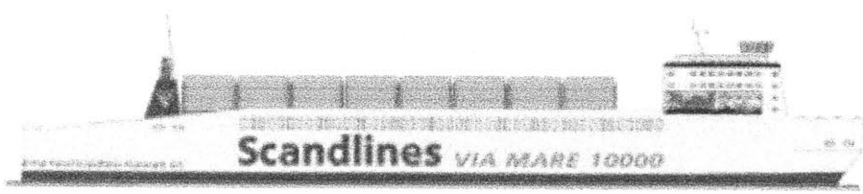


Figure 5.02 – Scandlines Con-Ro-Pax Vessel (Scandlines, 2004)

Train Ferries

These vessels carry whole rail cars loaded with cargo. Like Ro-Ros, this type of vessel radically declined with the introduction of containerization. This type of ship has complicated on-loading and off-loading operations. For one, the port has to have rail capabilities up to the ship. Operations are very time consuming and they require more lane meter capacity then ro-ro. Though the number of these types of vessels has dramatically declined in the last few decades, there has been some speculation that they may come back due to the changes in intermodalism. New train ferries have begun operations in both Europe and China. China's train ferry has a carrying capacity of 4,200 tons. Its main deck alone can carry 19 passenger empty carriages or 18 passenger carriages with 1,360 passengers onboard. It is 165 meters long and about 23 meters wide with a cruising speed of 8.8 knots (Xinhua, 2002).

High Speed (Fast Ferries)

This is a technology that has been around and has been gaining more and more popularity lately. It has been used more in situations carrying passengers and cars and has gained acceptance because of its high speed, short trip time, and fast turn around time. For example, Incat produced an Incat 98, which only carried passengers and autos. With current trends in intermodalism, Incat has come up with a newer version, the Evolution 112. This vessel had an increase in capacity of 25 percent. This vessel can carry 1,500 tons of cargo or 1,000 passengers. There is one issue with this type of vessel. When the ship is full to capacity with cargo, it must sail at lower speeds. At top speed, this vessel can travel at about 45 knots. Fully loaded, it must travel at 23 knots, still much faster then normal vessels. Capacity wise, it has 589 truck lane meters plus room for 50 cars. In full tourist mode using mezzanine decks, it can handle approximately 312 cars (Incat, 2004). Below is a picture of this vessel. This vessel goes for approximately $45 million in cargo mode.

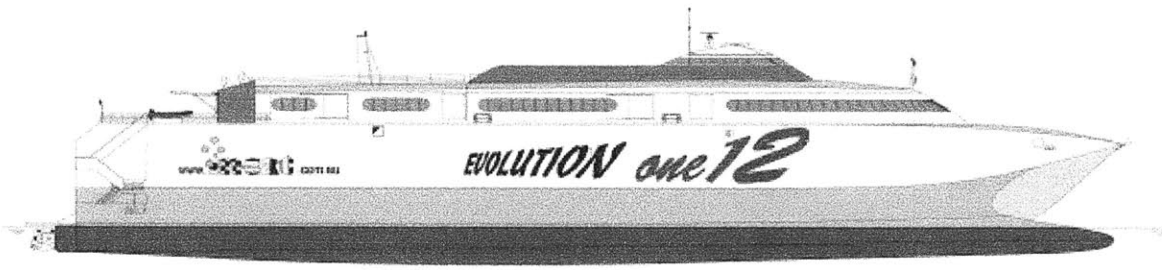


Figure 5.03 – Incat Evolution One 12 (Incat, 2004)

With the transportation freight market seeking greater efficiencies and shorter delivery times, there are many shipbuilders involved in building high-speed ships, such as Austal Ships. This is an Australian shipbuilder and competitor with Incat. Austal Ships carries a wide range of these types of vessels and had broken them down into six categories including: vehicle/passenger ferries, passenger ferries, cruise yachts, military, offshore support, and fast freight. Depending on the version, these vessels can carry trucks, trailers, pallets, as well as refrigerated cargo. Versions include the Ro-Con Express, the Ro-Ro Express, the Ro-Pax Express, the Reefer Pallet Express, and the Austal Air Hub feeder. Austal claims the Ro-Ro version would best suit the needs of short sea shipping, reducing the at-sea trip time by 50 percent and offer increase service frequency. These ships also provide shallow draft and high maneuverability, which means little or no need for major port developments. The Austal Ro-Con Express is powered by gas turbines. Containers are loaded by roll-on bogeys. The ship is approximately 312 to 380 feet long. It has a carry capacity of 80 to 140 TEUs, which can all be reefers if needed. The Ro-Con Express travels at 30 to 45 knots and is best suited for a transit distance of 300 to 800 nautical miles (Austal, 2004). Below is a representation of this type of vessel.

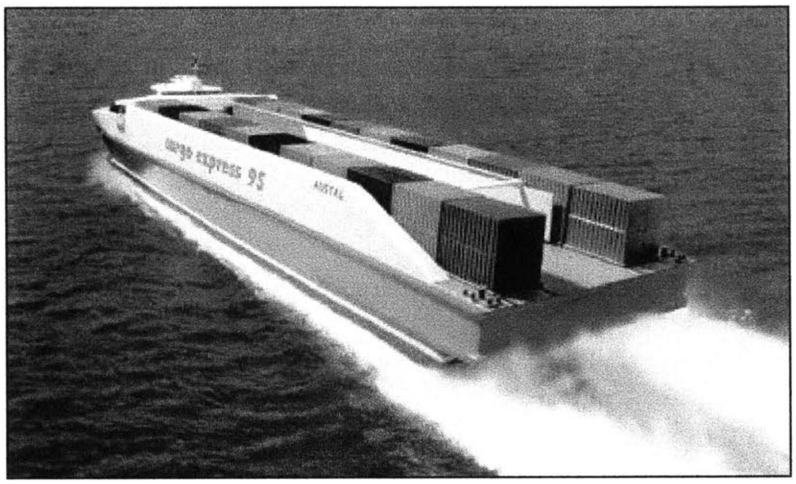


Figure 5.04 – Austal Ro-Con Express (Austal Ships, 2003)

StoraEnso Boxes

StoraEnso boxes are a new type of cargo handling equipment used by very few, but are important to look at because they serve a short sea purpose. They are cargo units that have dimensions of 13.8m X 3.6m X 4.8m and have a gross weight of 90 tonnes, which is approximately three times the weight of a typical marine container. These boxes were designed and built by the StoraEnso paper company in Sweden and Finland. The company has built three vessels to carry these boxes, each able to carry a capacity of about 1,000 boxes. The ships use a double deck, full width linkspan, to load/unload and the boxes are compatible with the Swedish railway system (MariNova, 2003).

HIGH-SPEED VESSEL DESIGN

Lightweight and powerful are the two key design characteristics behind the high-speed vessel technology. In order to provide a light ship, the entire hull structure of these ships are built completely of fabricated aluminum, welded and glued together. Unlike most ships that ride up and over waves, these vessels are built with a twin-hulled catamaran configuration that is designed to pierce waves. This is sometimes referred to as wave piercing technology (WPT). This design includes a large center region or bridging section in the hull that stops the nose of the ship from diving into heavy seas. This ship remains light even when fully loaded due to the aluminum hull. This combined with the fact that the catamaran sections stay long and slender when submerged reduces drag and increases speed and efficiency.

The structure of these vessels is made from high-strength marine grade aluminum alloy. This material is attractive in design of these ships because of its high strength to weight ratio. Figure 5.05 shows the displacement breakdown on various Incat wave piercing catamarans. It shows the displacement in tonnes broken down between structure, machinery, outfit, and deadweight. It is interesting to note that in some cases, these ships are able to carry an amount of deadweight almost equal to the weight of the ship.

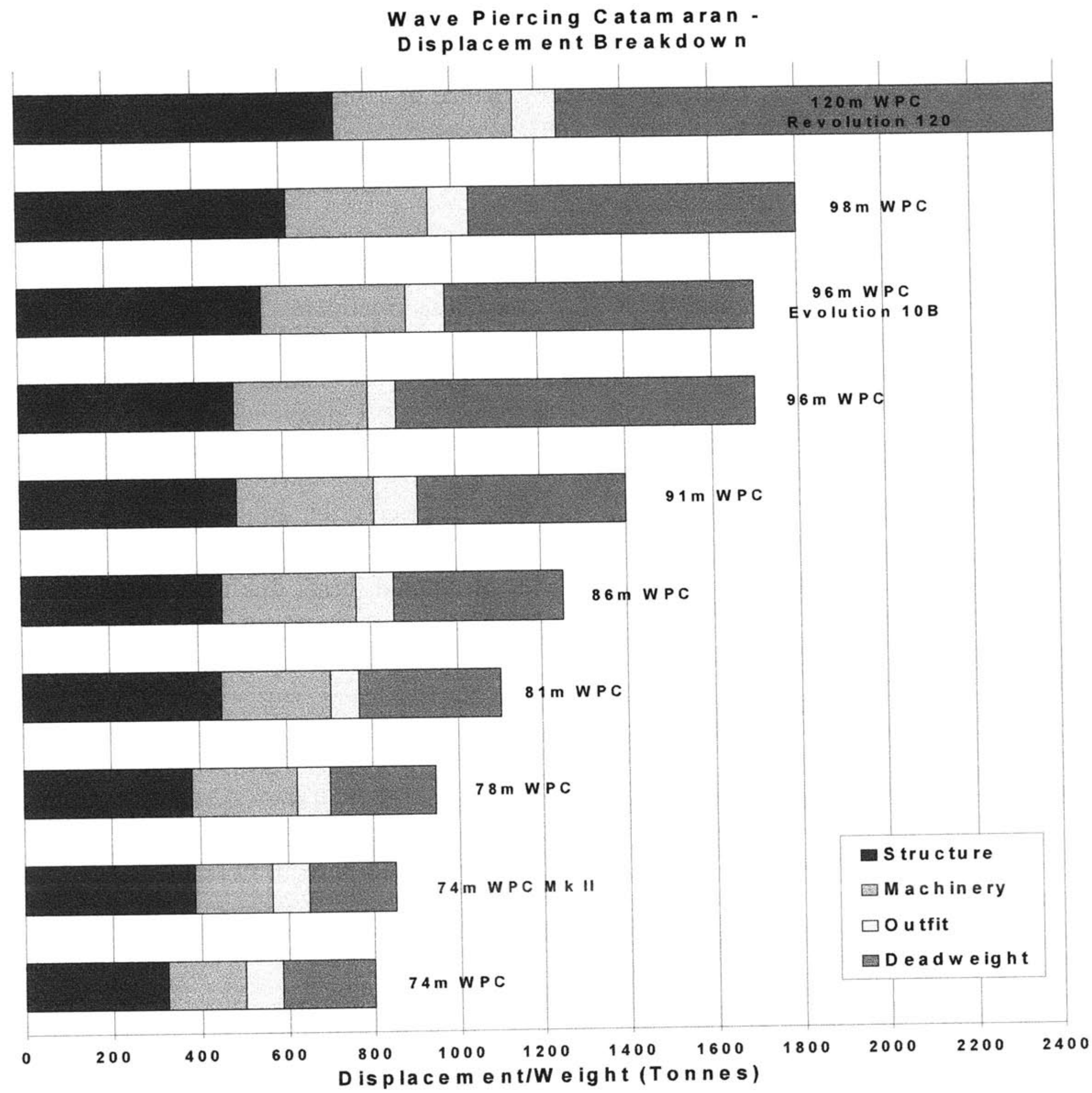


Figure 5.05 – Incat Vessel Displacement Breakdown (Bollinger/Incat, 2003)

The aluminum alloy design also allows the structure to be very corrosive resistant, but care must be taken in the fabrication process to prevent them from being in contact with dissimilar metals. This problem can be contained by the use of gaskets or special coatings. Use of aluminum in ship structures, until these types of vessels had been designed, was primarily used in small vessels or ship superstructure, where the weight reduction resulted in improved stability. An important characteristic of the use of aluminum construction is reduction in maintenance and prolonged structure life. When pricing out these types of high-speed and technological vessels it is important to keep in mind the reduction of lifetime operating costs such as reduced manning.

The use of aluminum in these ships means shipbuilders also have to take on and learn new welding and cutting technologies. Aluminum fabrication requires highly skilled workers because it is notoriously difficult to work with. They need to be able to keep up with improved welding technologies to improve weld strength and fatigue lift. Figure 5.06 shows the trend in mechanical properties of welded joints due to improved welding technology.

Research and design in wave piercing catamarans continues. A study between two types of catamarans showed that increasing hull separation by 4 meters reduces transverse accelerations by 25 percent and vertical accelerations by 15 percent in beam sea or long waves. Raising the tunnel height by 1 meter reduced acceleration loads by 8 percent and SAG moment by 20 percent. Additionally, increasing the bow clearance and improving the bow flare angle resulted in a 24 percent reduction in bow impact loads and a 21 percent reduction in fore body side impact loads respectively. These modifications reduce fore body and bow impacts by 45 percent. This shows the importance of research in shipping technology.

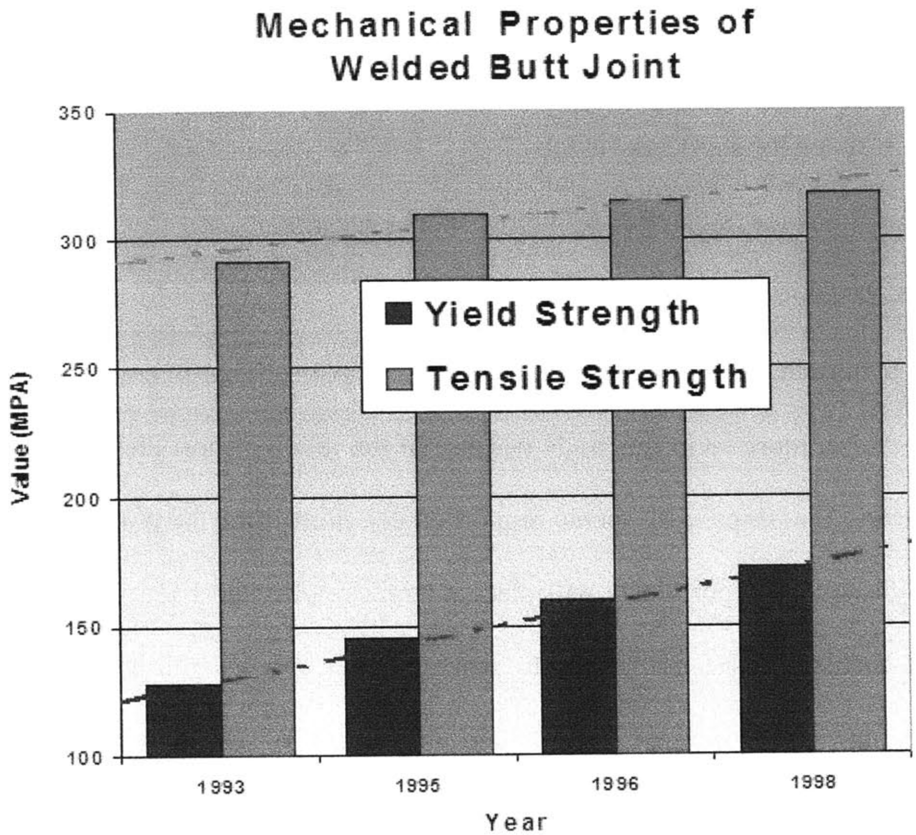


Figure 5.06 – Aluminum Welding Strength Trend (Bollinger/Incat, 2003)

PORTS AND TERMINALS

In talking about short sea shipping, types of ships, routes, and policy are usually the first topics to come to mind, but there is a component that is very critical to the existence and success of short sea shipping, ports and terminals. Ports are a main barrier to get around in the implementation of this new system. This is because most ports centralize around deep-sea trade and cannot provide short sea services in an efficient manner. There are high port costs from cargo handling and they can be operationally inflexible. These characteristics create:

- Long port times for short sea vessels.
- Long port times for trucks/rail delivering short sea cargo.
- Long dwell times for short sea cargo.

Short sea shipping requires efficient and low cost ports. That is key to almost any shipping network, but more so in this trade because of the relative short distances between ports. This means the ships will spend proportionally more time in port compared to transit time. Subsequently, port costs will place a larger role in short sea vessel shipping costs. Beyond terminal costs, ports need to provide better cargo handling processes for short sea shipping. The increase in efficient movement of cargo will prevent the lengthening of the overall transit or trip time making this service more competitive with trucking services. The longer a vessel sits at the pier, the higher the operating costs will be. Ships do not make money waiting around. Furthermore, it does not make sense to use a high-speed vessel that can make a trip in two days, if it will be sitting around for a day. Currently, the majority of feeder barges and vessels move in and out of deep-sea terminals to provide feeder repositioning services. There is no alternative to deep-sea terminals in the U.S. for short sea vessels strictly shipping on domestic coastal routes. Deep-sea terminals do not accommodate short sea vessels well because they are designed around very large trans-ocean vessels, large transfers of cargo, and U.S. Customs regulations.

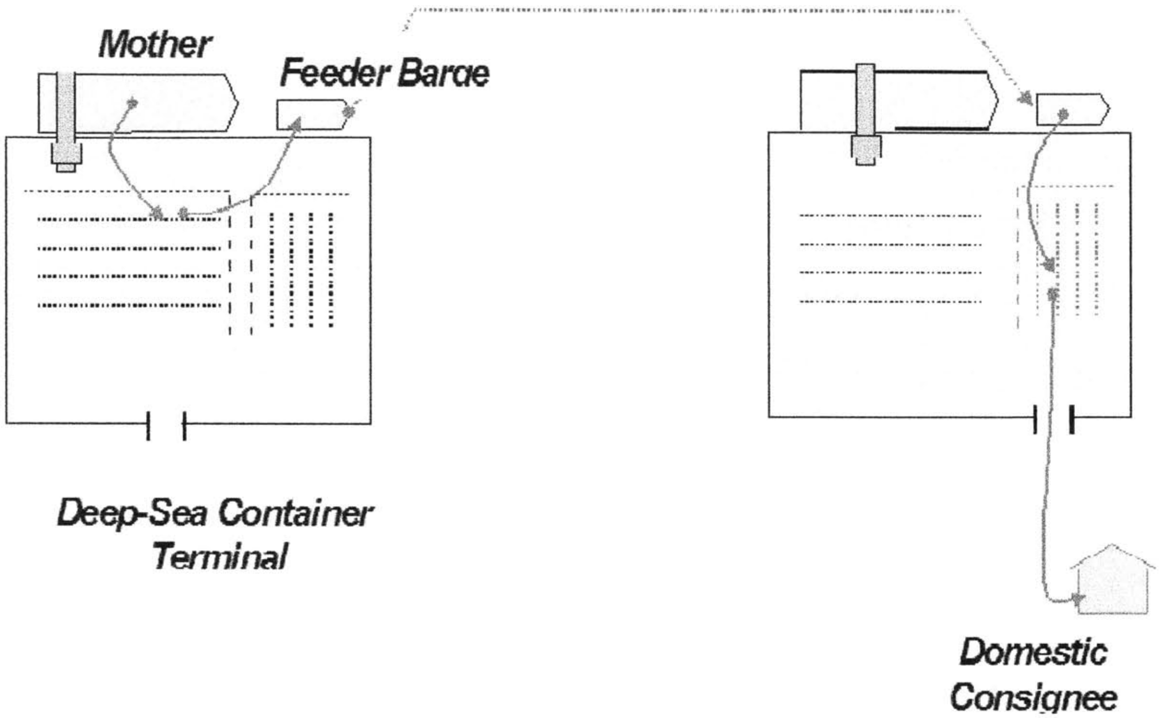


Figure 5.07 – Current Shipping System (LSU, 1999)

Deep-sea terminals become much more expensive to use because of the services offered. Additionally, short sea vessels will not be given preference due to their smaller size, lower operating cost, and less generated revenue for the port. This could result in an additional 24 hours of waiting time, a very negative situation in the purpose and operation of a short sea network. This current system also does not work in the sense of a domestic cargo truck entering the port for delivery to a short sea vessel and having to go through the same gates as a truck carrying an international container. This could result in the domestic container waiting for the gates to open or having to sit in unnecessary truck lines.

Essentially, short sea shipping must have terminals mainly based around domestic short sea cargo.

The perfect terminal for short sea shipping would be one in which the vessel would enter the berth at any time of day or night. Work on unloading and loading of cargo would begin immediately as the ship was secured to the pier. The transfer of cargo was efficient and the vessel sails immediately after completion of handling operations.

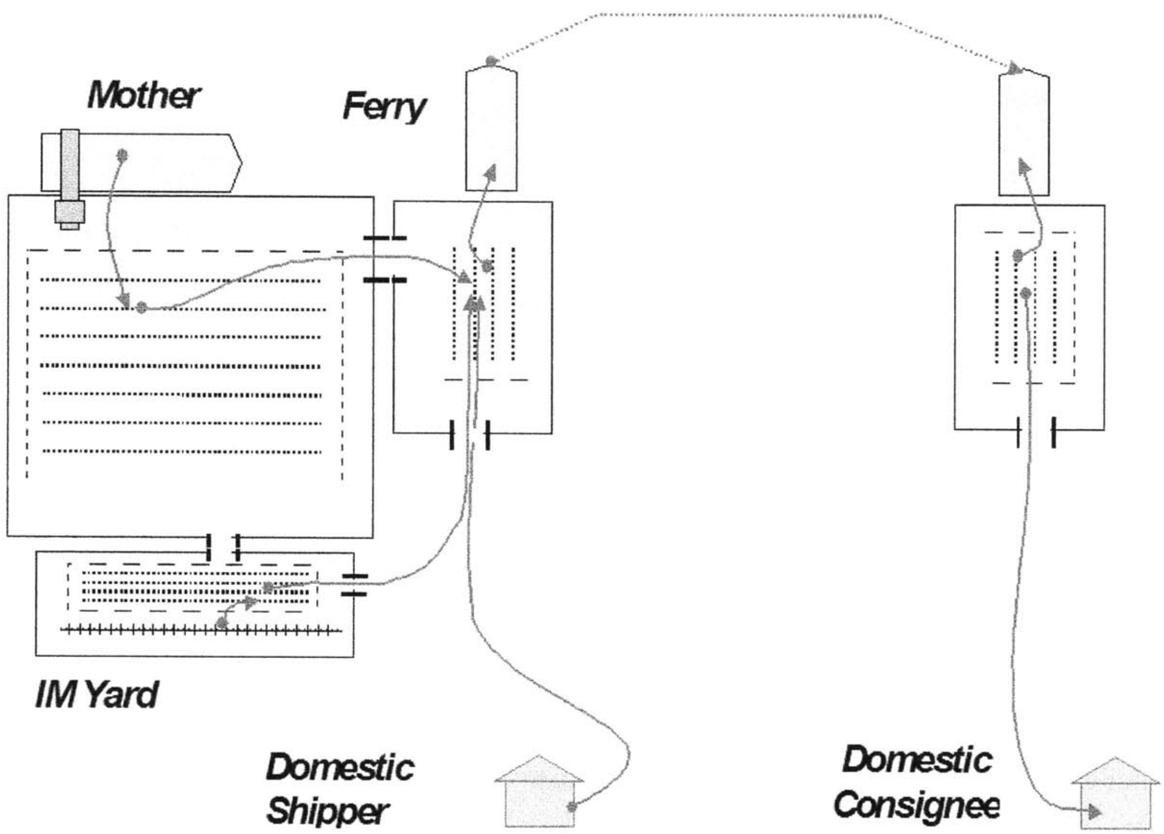


Figure 5.08 – Domestic Terminal Theory (LSU, 1999)

Avoidance of any delay would be key. This is very similar to trucking terminals, which makes sense because trucking could be considered one of short sea shipping's competitors, though trucking should not be seen as a competitor but as a partner in all reality. There is less labor required in these terminals because there is less cargo to be moved. With the increase in the number of roll-on/roll off ships, less labor may be needed, as the drivers of the trucks will be able to drive off the vessels themselves. All of these factors would help reduce the overall cost of short sea shipping and make it more competitive.

This concept is an ideal situation, but is not possible in today's deep-sea terminals. Therefore, it can be used as a model to work towards. Alternative systems need to be researched and developed in each individual port because different ports have different constraints such as land space. Creation of domestic terminals would help separate cargo that is international bound and cargo that is domestic bound. Situated adjacent to deep-sea terminals is the best place for domestic cargo because the domestic cargo coming off inbound deep-sea vessels can be easily brought to the domestic terminal. This idea does not require domestic cargo on trucks to have to go through the custom requirements and processes involved with the deep-sea terminals. The idea of building new terminals sounds expensive, therefore, it usually does not go very far. However, by placing SSS terminals next to the deep-sea yard, allows both terminals to share land and waterfront. Deep-sea terminals can be reorganized to provide more efficient land-space management. This would reduce the cost of having to build an entirely new terminal.

CHAPTER 6: INTEGRATION OF SHORT SEA SHIPPING INTO THE TRANSPORTATION SYSTEM

MEETING CUSTOMER REQUIREMENTS

When planning out and designing the changes in the maritime industry, as it pertains to the integration of short sea shipping, it is imperative to keep in mind the needs of the customer, or shipper. Customers operate in a global market place. They are involved in many forms of business from manufacturing and resource extraction to distribution and retail. Shippers are subject to constant pressure from competitors to market a better, cheaper, and more convenient product. Therefore, when they need the use of transportation services, their decisions are based primarily on price and service characteristics. Service characteristics are different between the various carriers and are broken down into five key factors: transit time, on-time performance, protection of the commodity, reliability, and flexibility.

A concept in today's world is changing the way businesses set up and utilize their supply chain. "Just in time" logistics management, or what is referred to within industry as "JIT", has become a major practice around the world. The basic foundation of this concept it to minimize inventory levels at each step in the supply chain. Consequently, the freight transportation industry has changed greatly in terms of the types of services that shippers are requiring. Before the dawn of JIT, shippers had inventory stock. There wasn't great demand for fast service and the goods just had to get to the warehouse. They looked for larger, less frequent shipments because the economies of scale diminished transportation rates as shipment size increased. With the advent of "just in time" logistics, there is greater need for more frequent, smaller shipments that are time sensitive. The reduction in costs associated with inventory and warehousing justified the increase in transportation costs. Not every business supports the idea of JIT because it may not be the right method of supply chain management for them. The point is that there are many tradeoffs between the different customers based on their individual logistics strategies. It may not be the cheapest transportation alternative, but shippers choose the mode that best supports their overall business strategy.

Another change within the transportation service industry over the last decade has been the emergence and fast growth of third party logistics providers. Freight forwarders, or intermediaries, have always been around. The older versions of these transportation providers specialized in shipping or rail inter-modal services. The newer generation of these types of carriers have been renamed and called third party logistics providers. With kicking the idea of keeping large inventories out the door, goods producing industries are outsourcing peripheral functions and logistics more and more, while putting more focus on their core competencies and business. The third parties contract to provide all the logistics management and decision making for these companies.

"Just in time" logistics and the use of third party management have changed the way shippers are doing business. Their needs of price and service quality have changed as well. Short sea shipping should be cultivated around the needs of the customer to become more successful. Many times, it seems that ideas are founded around the idea of "build it and they will come". Often in reality, this is unlikely to be a recipe for success. It is important that the new maritime initiative to build short sea shipping up into an integral part of the maritime transportation system be done carefully to be assured it is structured towards the needs of the potential client base.

Changing Maritime Culture

With the increase in demand for 'just in time" logistics, the challenge for the maritime industry to provide better service has increased as well. This is made difficult when transit times are longer and integration with other modes of transportation is insufficient. Another drawback to short sea shipping is the lack of transparency in port charges. Carriers usually must pay the harbor maintenance tax each time they enter a port. Longshore labor rates that apply to international cargo are probably too high for domestic cargo. These costs increase the overall transit cost for the shipper and they need to be addressed. At the same time that the maritime industry lowers its rates, the railroads and trucking companies could respond to the potential loss of intermodal cargo by dropping rates as well. This downward spiral would have negative affects for all modes. The culture of the maritime industry will have to be revised in order for short sea shipping to take place effectively and efficiently. The Maritime Administration has set up industry wide conferences to try to open up a forum for all sectors to voice their opinions and to work together to make short sea shipping successful for all.

At the first Short Sea Shipping Conference organized by the Maritime Administration in November 2002, there was discussion based on two important questions:

What do shippers need?

How can coastal shipping services fill the bill?

In order to find out how short sea shipping can become competitive against the other modes, the questions were posed to the industry. In response to the first question of what shippers need, they responded with:

- Competitive rates
- Reliable service
- Competitive service

Each of these needs were broken down into actions that need to take place in order for them to become possible, the group assigned to the action, and the term for when it should be accomplished. The following is a table of the actions required for competitive rates.

ACTION STEP	WHO	WHEN
Reduce Costs: Vessel Capitol Sea Labor Terminal Costs Harbor Maintenance	Fed and private Fed State and port Fed	Med-term Med-term Med-term Short-term
Reduce terminal time	Port and Industry	Med-term
Relocate terminals to lower cost real estate and closer to interstate to minimize truck delays	Fed/State and Private Industry	Med to Long-term
Tax Incentives: Reduce/eliminate state taxes or Marine Fuel waived	State and Fed	Med to Long-term
Government cargo commitments to set a pattern	Fed	Med-term

Table 6.01 – Competitive Rate Action Items (Berkowitz, 2002)

Table 6.02 lists the action steps towards reliable service. Unlike the competitive rate action items that were assigned mainly to the federal government, state governments and ports, the actions for reliability fall strictly with the private industry and carriers.

ACTION STEP	WHO	WHEN
Assumed schedule of Marine Transportation frequency	Private Industry (vessel owner)	Short-term
Assurance of freight integrity	Port and Industry	Short-term
Cargo data disposition communications	Private Industry	Med -term
Continuity of service (Marine Transportation)	Private Industry (vessel owner)	Long-term
Portal to Portal service responsibility (door to door)	Private Industry (vessel owner)	Short-term

Table 6.02 – Reliable Service Action Items (Berkowitz, 2002)

The competitive service action items below in table 6.03 have been given to specific federal government agencies and are all to take place in the mid-term.

ACTION STEP	WHO	WHEN
Department of Transportation should produce detailed information on origins and destinations of pure domestic cargo in the 48 states	DOT	Med-term
Government research of higher speed vessels for commercial services	MARAD and DOD	Med-term
Vessel designs to lower stevedoring and terminal costs and to provide for smaller crews	MARAD, Classification Societies, and Coast Guard	Med -term

Table 6.03 – Competitive Service Action Items (Berkowitz, 2002)

Likewise, when the industry was asked at the short sea shipping conference how short sea shipping could fill these needs of the shippers, three general concepts where given:

- Reduction of Intermodal Costs – Landside
- Volume commitment at Stable Prices
- Address Capital Costs/Lower US Vessel Costs

These topics where broken down as before into the group responsible for implementing the action and the timeframe for it to be investigated. Table 6.04 lists the action items concerned with the reduction in intermodal costs.

ACTION STEP	WHO	WHEN
Labor- require labor rules similar to other transportation labor unions	Industry	Short-term
Separate domestic/international terminals	Regional	Short-term
Automated gate and terminal yard- implement advanced technology	Private firm and Industry	Short -term
Standardize industry data and service: ANSI or ISO	Industry	Med-term
Reduce land costs (TEU/acre)(Incentives)	Regional	Med-term
Good access to roads	Regional	Med-term

Table 6.04 – Reduction of Intermodal Costs Action Items (Berkowitz, 2002)

Volume commitment at stable prices action items are found below in table 6.05.

ACTION STEP	WHO	WHEN
Determine shipper requirements in order to commit volume and price	Shippers	Short-term
Develop strategy to provide reliable service and pricing stability	Fed, Regional agencies, and Ports	Med-term
Demonstrate planned capabilities to shippers	Shippers	Med -term

Table 6.05 – Volume Commitment at Stable Prices Action Items (Berkowitz, 2002)

Lastly, the final concept towards filling the needs of the shippers, addressing capitol costs/lowering U.S. vessel costs. See table 6.06 below.

ACTION STEP	WHO	WHEN
Implement lean manufacturing techniques to reduce initial shipbuilding costs	Private Firm	Short-term
Standardize designs for mass production	Industry Group	Med-term
Reduce manning and operation costs for service life of vessel	Coast Guard	Short -term

Table 6.06 – Address Capital Cost/Lower US Vessel Cost Action Items (Berkowitz, 2002)

These action items are the first of their kind on the topic of short sea shipping. They represent the initial framework to what needs to be accomplished in order to make this initiative a success. If anything, they start a discussion in many different areas within this industry that is greatly needed.

U.S. DOMESTIC AND INTERNATIONAL SHIPPING POLICY

Chapter 24 and 27 of the U.S. Merchant Marine Act of 1920, also known as the "Jones Act" after Senator Wesley Jones, states that cargo may not be transported between two United States ports unless it is transported by vessels built in the United States and owned by citizens of the United States (46 U.S.C. app. 883). The Act covers a variety of maritime issues, including harbor dredging, compensation to seamen, and government loan guarantees to shipbuilders. Efforts within the U.S. have been made to amend this Act, but the efforts have generally failed.

This act comes under fire many times because it means that carriers wanting to deliver cargo between consecutive U.S. ports must have purchased the vessel from a U.S. shipyard and must employ U.S. citizens. The operator of such a vessel must be of U.S. origin itself. Some complaints are that crewing requirements and high salaries are burdensome and the price of U.S. built vessels is extremely high compared to vessels built in other parts of the world. Some go as far as to say that the Jones Act creates such high prices that hurt the U.S. economy and cost the American households thousands of dollars a year. The Honorable Gene Ward (R-Hawaii) has stated,

> "Independent consultants in Hawaii estimate that Hawaii residents pay an additional $1 billion per year in higher prices because of the Jones Act. This amounts to approximately $3,000 for every household in Hawaii (Ward, 1997)."

Rick Couch, president of Osprey lines in Houston, is interested in a waiver of the Jones Act requirement that ships in domestic trades be built in the U.S. because he could buy three ships in Europe for the price of one in the United States (Edmonson, 2003).

President Bill Clinton defended the Jones Act back in 1997:

> "My administration also continues to support the Jones Act as essential to the maintenance of our nation's commercial and defense maritime interests.... Thanks to the Jones Act, the United States has a robust domestic shipping industry that directly supports 80,000 jobs and generates about 44,000 jobs in related industries. In addition to its economic contributions, the domestic shipping fleet supports our nation's defense. Segments of this fleet — including the tugs and barges serving

the inland waterways and the ships serving Great Lakes ports — have also helped staff reserve ships during international emergencies."

In the beginning stages of the development of short sea shipping here in the U.S., the Maritime Administration has signed a "Memorandum of Cooperation" agreement with Mexico and Canada to:

- Share information and knowledge about short sea shipping technology where appropriate.
- Exchange information in support of mutual research efforts.
- Keep each other informed of policy decisions and directives.
- Aid the other's efforts to promote short sea shipping.

The memorandum of cooperation should assist all three countries in individually developing an enhanced coastwise shipping fleet and supporting infrastructure.

It is essential that the development of this initiative with trading partners such as Mexico and Canada be monitored carefully to ensure that short sea shipping does not become an avenue for weakening or eliminating the Jones Act. The Jones Act is not just a set of U.S. cabotage laws that govern domestic point to point shipping, it protects the U.S. maritime industry, including shipping lines, jobs in shipbuilding, longshoremen and seagoing jobs. With the Jones Act in place, short sea shipping is a potential boom for the U.S. shipping and shipbuilding industries as new cargo ships to service U.S. coastwise point to point trades would have to be built in the U.S., crewed by U.S. citizens, and owned and operated by U.S. companies.

Former Chairman of the Joint Chiefs of Staff, General John M. Shalikashvili said,

> "After two centuries, our Merchant Marine is every bit as important, and every bit as vital, to the commerce and to the defense of our nation as it has ever been... We simply cannot overstate the vital contributions of our U.S. Merchant Marine. Our national security depends on its vitality..."

The Jones Act not only is important in the way of keeping American shipping and shipbuilding jobs, it is vital to this nation's commerce and national defense. It secures a fleet of ships that can be used in time of war and also maintains a shipbuilding base by requiring those ships to be built in the U.S.

Opponents of the Jones Act claim that shipyards have declined with the Act in place and for the most part rely on naval contracts outside of commercial contracts, therefore there is no need for it. As mentioned, they also claim the Act hurts the U.S. economy with high shipping rates. Many economical studies that have been done, but each is politicized. The General Accounting Office (GAO) performed a report on the economic impact of the Jones Act. Their findings were basically that it does cost the economy money, but how much could not be measured until more foreign ships are allowed into U.S. domestic shipping and the country is able to see the types of shipping rates that would be charged (GAO, 1998).

Proponents claim the repeal of the Jones Act would diminish what little shipping fleet we have and it would be replaced with foreign shipping. This would literally dissolve our shipbuilding base, though some would maintain only naval contracts. As a result, the United States would have to rely solely on foreign shipping and shipbuilding companies. Not only could foreign shipping rates increase in the future and begin to cost the American people more, but in times of international crisis or war, the U.S. would not have the merchant marine fleet it has today to deploy the equipment and cargo it needs to maintain a war effort while at the same time continuing international commerce. With a short sea shipping fleet eventually utilizing more roll-on/roll-off vessels, it would be helpful in maintaining commerce while supporting roles during conflict.

Canada has already suggested undermining the Jones Act by broadening it to include other nations (AMO, 2002). Their attempts to encourage liberalization of the U.S. domestic shipping policy go back to both the Canada U.S. Trade Agreement and the North American Free Trade Agreement (NAFTA). In both cases, Canada placed this issue on the agenda for discussion, but they were not able to alter the U.S. position on the issue.

Currently, the issue of short sea shipping seems to be mostly looked at on the domestic front. With the addition of Mexico and Canada as possible partners it may become an international coastwise shipping system. What both Canada and Mexico would like to see is a U.S. and Canada Jones Act, which would be an extensive cabotage waiver system. Once established, it would allow Canadian and Mexican vessels to operate freely in the U.S. domestic coastwise trades. Whether the Jones Act should be repealed is a research topic in itself. What is important is that before it is repealed, there must be a very careful study to determine all the after affects of doing so.

GOVERNMENT SUPPORT

As the population continues to grow, consumption of goods will follow and the amount of cargo transported will escalate. Increased international trade in the future will breed more highway congestion and air pollution as previously mentioned. Such nuisances impose social costs that at first seem to be borne by the transport provider, but are really paid for by the consumer and taxpayer. The United States has seen similar trends to Europe in road congestion and pollution. Pressure has been increasing to provide support to mitigate these social costs. This can be done by providing support to move cargo from road transport to more fuel-efficient modes of transportation such as marine.

Europe has tried applying carbon taxes and enforcing stricter measures to improve vehicle emission standards, but these routes have not seemed to alter the choice of cargo transport by the buyers of the services. They have introduced many ideas to foster this change and to try to increase the competitiveness of marine transportation, but some changes have created strong opposition from trucking companies. Usually, they become scaled back due to the negative response.

Short sea shipping is continually being dismissed due to the time factor. Opponents claim it is not compatible with "just in time" delivery systems. The flip side of this argument is that fast ferries can be used to mitigate the slow response, but they are seen as being more costly than than other options. This is one area in which the government could help fund innovation. After a solution to this situation is achieved, the problem moves on to the port cargo handling capacity. Therefore, short sea shipping vessels may have increased in speed, but the bottlenecks created at the ports may detract from any gains in speed. Because the total transit time does not alter significantly, modal switch by the users may not take place. Innovation within the ports must take place as well to improve vessel turnaround time. A "hub and spoke" method would be a good choice.

Until volume grows to support investment, the government will need to provide support by financing this concept.

The government should take the role of supporting research in this field, investigate the business case of short sea shipping, and encourage collaboration within the industry, such as having future short sea operators start partnerships with trucking firms.

The U.S. should provide subsidy programs to promote short sea shipping. Europe's example of this is their Marco Polo Program. This program encourages the removal of trucking from roadways by providing start up funding to new companies that want to provide this type of service. The U.S. through its Maritime Administration has begun to promote short sea shipping. It has hosted two annual short sea shipping conferences to begin industry wide discussion. The initial aim was at shipping between the U.S. mainland and offshore territories, but within the last year, MARAD has tried to integrate discussion with Canada and Mexico. Though some companies claim to have some short sea services in place, the Port Inland Distribution Network (PIDN) being built out of New York is aimed at providing short sea shipping between the Port of New York/New Jersey and Albany and will be one of the first SSS networks since the conferences have been held.

One approach to encouraging development of a short sea shipping network with a Jones Act qualified fleet would be to modify the Capitol Construction Fund (CCF) so that it includes ships operating in domestic contiguous trade. This program allows owners of U.S.-flagged ships operating in international trades to deposit funds in tax-deferred accounts for use in building new ships in U.S. shipyards. This fund currently is only offered to ships being built for international or non-contiguous domestic trades. William Schubert, the Maritime Administrator has said,

> "If the Capital Construction Fund, which includes $1 billion in deposits, is opened to include the construction or reconstruction of vessels to be used in contiguous coastwise domestic trade, short sea shipping would be en-route to a high level of success."

Along with the idea to modify the CCF, the maritime administrator supports the maritime security program and is highly interested in having ship owners continue to re-flag foreign vessels under the U.S. registry. He believes tax incentives may help to promote greater re-flagging. Schubert has said,

> "While MSP is critical to retaining the U.S.-flag fleet engaged in international trades, it cannot be the only initiative that attracts and encourages participation in the U.S.-flag. We are working with industry to increase the number of vessels operating under the U.S.-flag and we are exploring tax reform issues to encourage vessels to enter or remain under the U.S.-flag."

Another idea that has been brought up several times is to have the harbor maintenance tax waived for coastal carriers. This fee is already waived for international cargo moving on feeder barges and domestic cargo moving between the 48 contiguous states and Alaska, Hawaii, and Puerto Rico. This tax program supports the dredging operations within the harbors, but shipping companies contend that it handicaps waterborne commerce in competition with rail and truck.

Globalization has benefits towards financing. It allows the free flow of money around the world. Many countries, such as Germany, have experience in funding shipping ventures. Provided with a rational business case, these countries will find the financing needed for a start up venture.

The U.S. government also has some funding programs. The Title XI program is available to help companies obtain low-cost financing for vessels. The Maritime Administration provides this financing. It provides a U.S. government guarantee of private sector debt financing for vessels constructed in the United States or for modernization of U.S. shipyard facilities. The benefits of the program include up to 87.5 percent financing, construction and mortgage periods, longer-term maturities up to 25 years, fixed or floating rates, and attractive interest rates. Financial viability, economic soundness, operating ability, technical acceptability, and legal compliance are the requirements of the program. A minimum of 12.5 percent equity must be funded or committed prior to any approval by MARAD. The company must maintain positive working capital and net worth. Long-term debt to equity ratio cannot exceed 2:1. Lastly, the standard requirements may be modified based on the project specifics. There are costs associated with this program. There is a $5,000 filing fee. There is an investigation fee of ½ of 1 percent of the first $10 million or 1/8 of 1 percent in excess of $10 million. Finally, there is a guarantee fee of ½ to 1 percent of average amount outstanding obligations, which is based on the borrower's financial condition. The guarantee fee is due at the initial closing and it can be financed (Title XI, 2003). This program is an excellent example of the type of support the industry needs to be successful.

These are the programs and ideas that have been fostered to date. The industry is working hard with the government to try to find more ways in which to promote waterborne transportation. It is essential that the government help to fund and incentivize this concept of shipping. The industry and MARAD has discussed the issue of investment incentives and how best to address the maritime needs through legislation. The following tables list the action items set up to help promote short sea shipping and the industry.

ACTION STEP	WHO	WHEN
Implement short sea construction subsidies to incentivize U.S. Shipbuilding. ISSUE: Determining subsidy level as defining benchmarks for this differential is difficult.	DOT/MARAD	Short-term
Support military build and lease-back of ships by building partnerships with DOD and commercial shippers/carriers.	DOT/MARAD	Short-term
Extend the 30%, 1 year depreciation deduction and 200% accelerated depreciation law beyond 2004 (current expiration).	DOT/MARAD	Short -term

Table 6.07 – Investment Incentive Action Items (Weisbrod, 2002)

ACTION STEP	WHO	WHEN
Implement "Title XI" loan guarantee for short sea projects to incentivize commitment from shippers.	Federal Gov't Private Firms	Mid-term
Expand TEA-21 funds to support pilot programs and demonstration projects – Short Sea Terminals	Federal Gov't MPOs	Mid-term
Utilize CMAQ (Congestion Mitigation and Air Quality) funding if possible to support pilot projects and demonstrations.	State DOT	Short -term
Eliminate the Harbor Maintenance Tax on domestic and international traffic when rehandled by short sea shipping (shallow draft vessels) which do not need dredging.	Ports and their national/regional organizations Barge operators DOT Congressional Committees	Med-term
Create coalition for Short Sea to address labor costs, facilities, terminal charges, and secure support from Congress.	ALL	Short-term
Establish feeder ports, sea highways, and other infrastructure tax incentives to start momentum for change OR propose privately operated domestic feeder ports for more flexible ships.	State DOTs	Short-term
Increase port efficiency, effectiveness and productivity.	Private Sector Industry groups	Mid-term
Invest in Ferry, Tug/Barge, LO/LO and RO/RO, smaller, faster vessels (reduces pollution, no need for dredging).	Private Sector Industry groups	Long-term
Local governments should conduct timely reviews of project proposals; Support Land Zoning/Banking for maritime industry; and support infrastructure investments.	Local governments	NA

Table 6.08 – Ways to Address Maritime Needs Action Items (Weisbrod, 2002)

CHAPTER 7: COST MODEL

OVERVIEW

One of the major obstacles to overcome in the integration of short sea shipping is the shippers' perception of waterborne service. These perceptions have a large impact on the shippers' carrier and mode selection. For the most part, waterborne transport is almost exclusively used by large shippers and could stand to be used more extensively in the future. The main attraction to waterborne transport has been its low cost, not the service, and many shippers want improved service. Short sea shipping would help to bridge this gap. Another problem is the general lack of knowledge about this form of service by potential users. There are also transit-time and dependability disadvantages associated with shipping that come from the greater complexity and more coordination required than simpler truck movements. These disadvantages are not serious problems. The problem with them is that they infect the shippers' perceptions, which results in their likely decision to not want to choose this mode of shipment. Few shippers actually base their mode selection on a total cost basis (Harper and Evers, 1993).

Practice has been to hold an additional buffer stock or additional inventory when dealing with undependable carrier service to protect against stock outs in the event of service failures on part of the carrier. The new age thinking is to reduce inventory. While many managers are concerned with this method, they should take interest with the total costs of logistics as a whole, not just minimizing costs associated with inventory (Coyle, Bardi, Langley, 1996). The key is that added savings to using cheaper transportation may offset increased costs associated with inventory. Shippers are concerned with transit time and transit time reliability. For some shippers, these are considered more important then shipping rates themselves. Although these characteristics seem important to shippers, few actually measure service levels of different carriers in a way meaningful enough to help make decisions. Instead, they rely on their instincts in these areas allowing for potential losses and higher costs.

MODEL DESCRIPTION

This section provides a review of the relevant logistics costs, which should be considered when selecting the mode of transportation or specific carriers where service times, dependability and costs vary among the alternatives. Mode/carrier shipping decisions are made based on meaningful measurements of service levels by few shippers. Preconceived perceptions tend to become the decision makers. These decisions can cause these companies to incur higher costs then wanted if transportation cost savings are sufficient to off set the higher costs associated with longer and less dependable transit times.

A selection of products of different values and weights were chosen and put into a total cost analysis under given assumptions based on industry rates. The assumptions are inputted into the model with product information. The assumptions include the order placement cost, inventory carrying cost percentage, interest expense, annual number of sales (demand), average distance, transit times, and shipping rates. An overview of the total cost concept will be given to describe how the model works. It will also show how managers should evaluate logistic services and how levels of inventory in the system are affected. The cost analysis results were then analyzed and show a potential for a short sea shipping alternative.

Total Logistics Chain Analysis

As mentioned, decisions should not be based solely on one aspect of the value chain such as transportation, but on a total cost basis. The reason for this can be seen in two different scenarios. In one, transportation managers have the responsibility of decreasing transportation costs, which leads them to choose slower modes of transportation. Slower modes of transportation usually translate into larger shipment sizes and increased inventory levels. Larger inventory levels equate to increased inventory costs because there is more inventory on hand during the order cycle and while the goods are in transit. Another factor is the use of buffer stock, which is safety stock that a company will use to prevent stock outs if delivery dates are and shipments are not very reliable. In this scenario, the transportation manager has decreased the transportation cost to help his department, but has increased the inventory carrying costs significantly. The goal was met, but picking the mode of transportation solely on price diminished savings to the company.

A second example is of an inventory manager who is responsible for minimizing inventory carrying costs and puts in place policies that require the transportation managers to use smaller shipment sizes or premium transportation systems. Although the inventory manager has decreased the costs he is associated with, he has increased transportation costs considerably.

The economic relationship between inventory and transportation is generally one of increasing inventory costs with increase in transportation volume capability. Although there are exceptions, in most cases, truckload motor carriers move smaller volumes then rail and rail has smaller shipment sizes then waterborne shipping, therefore truckload motor carriers carry far less volume then water carriers. There are some less-than-truckload (LTL) carriers that actually carry less volume then truckloads and charge a premium for this service. There is an also express service which charge even more for priority or time sensitive shipping. While these facts are generally true, so to is the fact that the larger shipment size carriers tend to be slower and less dependable. This means the cycle time, inventory in transit, and safety stock all increase with these carriers. With the differences in shipping costs and carrier service levels, it is important to look at all aspects together when making decisions.

When looking at a total cost analysis, it is best to begin with the economic order quantity (EOQ). This is the level of inventory to order that minimizes the sum of holding and order costs. EOQ is based on assumptions that can be considered unrealistic, but it is a good reference to use. It is one method that is useful to tell whether lower transportation costs associated with larger shipment sizes are enough to offset higher costs of carrying additional inventory. With the EOQ, one can compare the total relevant costs of each of the transportation modes (Coyle, Bardi, Langley, 1996).

Economic Order Quantity

Below is the formula for the economic order quantity and the derivation of it. The relevant costs in the EOQ are the cost of placing orders and the cost of carrying inventory. This formula does not include the cost of transportation, cost of inventory in transit, or safety stock. This is the downfall of this method, but these factors will be added in later. The EOQ is found by adding the cost of placing orders with the cost of carrying inventory, taking the first derivative, setting it equal to zero, and then solving for the EOQ. The EOQ can be called the default order quantity or default shipment size (Piasecki, 2001).

Q = Optimal Order Quantity (EOQ)
A = Cost of placing an order
R = Annual Rate of Use
V = Value per unit
W = Carrying cost as a percentage of average value of inventory

OC = Order Placement Cost = A(R/Q)
CC = Inventory Carrying Cost = ½(QVW)

$$
\begin{aligned}
OC + CC &= A(R/Q) + \tfrac{1}{2}(QVW) \\
&= ARQ^{-1} + \tfrac{1}{2}(QVW) \\
&=- ARQ^{-2} + \tfrac{1}{2}(VW) = 0 \\
Q^{-2} &= \tfrac{1}{2}(VW/AR) \\
Q^{2} &= 2AR/VW \\
Q &= (2AR/VW)^{1/2}
\end{aligned}
$$

Figure 7.01 – Economic Order Quantity (Coyle, Bardi, Langley, 1996)

The economic order quantity is the quantity of goods that a company would order and thus be shipped. The method of shipment is chosen based on the transportation mode that most closely conforms to the volume to be shipped. The table below shows example values of how the EOQ might come out, the method of shipment, and a few example carriers.

Economic Order Quantity	Mode of Transportation	Example Carriers
<= 100 units	Express	UPS, FedEx
2000 – 3000 units	Less-than-Truckload	Yellow Freight, American
30,000 – 40,000 units	Truckload	USA Truck, JB Hunt
100,000 – 200,000 units	Rail/Waterborne	CSX, Matson Navigation

Table 7.01 – EOQ and Sample Shipping Alternatives (Ozment, 2001)

Therefore, the EOQ can be used to get a ballpark estimate of the best method of shipment, but because it looks at only matching up the EOQ with best shipping methods for that quantity, it doesn't help to realize the cost savings in shipping larger volumes on cheaper forms of transportation. Managers should take the information associated with the economic order quantity and add it to other important factors associated with total cost of the logistics.

Total Costs

Total cost is a more in depth method of determining the best shipping alternative. It takes into account the economic order quantity but takes into account other transportation costs and volume, deliver time, and transit time variances. The following figure describes the total cost formula.

Q = Optimal Order Quantity (EOQ)
A = Cost of placing an order
R = Annual Rate of Use (demand or sales)
V = Value per unit
W = Carrying cost as a percentage of average value of inventory
r = Transportation rate per 100 pounds (cwt)
wt = Weight per unit
i = Interest rate or cost of capital
t = lead time in days
B = Buffer of inventory (safety stock)

OC = Order Placement Cost
CC = Inventory Carrying Cost
Tr = Transportation Cost
It = Inventory in Transit Cost
SS = Safety Stock Cost

$OC = A(R/Q)$
$CC = \frac{1}{2}(QVW)$
$Tr = rRwt/100$
$It = iVRt/365$
$SS = BVW$

Total Cost (TC) = OC + CC + Tr + It + SS

Total Cost (TC) = $A(R/Q) + \frac{1}{2}(QVW) + rRwt + iVRt/100 + BVW$

Figure 7.02 – Total Logistics Cost (Coyle, Bardi, Langley, 1996)

The order placement cost and inventory carrying cost are the same as before. Transportation cost is the rate per 100 pounds multiplied by the number of 100 pounds units shipped annually. The annual rate of use (R) is considered to be the demand or sales annually. Inventory in transit is the interest charge on goods purchased annually times the number of days the goods are in transit. The safety (buffer) stock is used to prevent stock outs and is calculated by multiplying the buffer stock times value per unit and the carrying cost rate. The carrying cost rate (W) is the cost of holding safety stock.

Buffer stock (B) has traditionally been based on the probability of a stock out occurring. Managers usually place orders sooner than is needed because they don't know how fast they will sell out of a particular good. There are different lead times with different modes and sales during lead time vary throughout the year. For this reason, the standard deviation of lead time is used in the buffer stock equation. One standard deviation of demand added to the mean sales during the lead time yields 84 percent fill-rate. Adding two standard deviations yields about 97.5 percent fill-rate. Transit times also vary. Longer transit times are more risky because stock out is more likely to happen while inventory is held up in transit. For this reason, the equation for buffer stock is based on demand over time, not just variation in demand alone. The equation for buffer stock is in Figure 7.03 (Coyle, Bardi, Langley, 1996).

S_{Dt} = The number of units added to the order point
t = Average transit time
S_t = Standard deviation of transit time
D = Average demand during lead time
S_D = Standard deviation of demand

$$S_{Dt} = ((t)(S_D)^2 + (D)^2(S_t)^2)^{1/2}$$

Figure 7.03 – Buffer Stock Equation (Coyle, Bardi, Langley, 1996)

Assumptions

This analysis evaluates several different products using two different carrier services, truck and short sea shipping. In order to perform the analysis, several assumptions had to be made. For this model, it was assumed the annual sales, demand, or rate of use is considered to be 100,000 units. The cost to place orders is $30.00 per order. The inventory carrying cost is a percentage of the average value of goods therefore the carrying cost factor is 20 percent. The interest expense is 10 percent. The average daily sales is based on 365 days meaning the average daily sales is around 273.97 units. It is assumed the average daily sales will vary by approximately 10 percent (standard deviation of demand). In this model, it is expected that the company will maintain a 97.5 percent fill-rate on orders. This means there needs to be sufficient buffer stock to prevent stock outs. This is done using two standard deviations of buffer stock (Ozment, 2001).

In order to compare the trucking service with the short sea shipping service, there needs to be a standard shipping size and distance so that both can be evaluated on the same terms. It is assumed that the shipment distance is 1,000 miles and that a standard 40,000 lb capacity container will be used. The standard trucking rate for this type of truckload is around \$1.20 per mile. Rates for short sea shipping are not usually rated by the mile, but by the container load shipped. Taking an average of some shipping rates with these shipping characteristics, short sea shipping is rated at \$0.90 per mile. Trucking and short sea shipping also have different transit times and variations in transit time. Short sea shipping, with the use of non-high speed vessels, may take more time on transit and could possibly have a higher variation in transit time. Transit time for trucking and shipping is estimated at 3 and 5 days respectively. Also, variation in transit time is estimated at 1 and 2 days respectively. These variations come into play in calculating the amount of buffer stock. Lastly, the total cost formula use in this model contains variables that require the transportation rate to be in terms of 100 lb units. To find this rate, the rate per mile is multiplied by the distance and divided by the container capacity divided by 100 pounds (ie. \$1.20*1,000/(40,000/100). Therefore the rate per 100 pounds for trucking is \$3.00 and the rate for short sea shipping is \$2.25. The table below represents the assumptions made in this total cost model (Ozment, 2001) (Matson, 2002).

Assumptions:			
Annual Sales	=	100000 units	
Cost to Place Orders	=	$30.00	
Carrying Cost	=	20%	
Interest Expense	=	10%	
Average Daily Sales	=	based on 365 days	
Variation in Daily Sales	=	10% (+/-)	
Service Level (fill-rate)	=	97.5%	
		Motor Carrier	**Short Sea Shipping**
Distance	=	1000 miles	1000 miles
Volume/Container	=	40000 lbs	40000 lbs
Rates	=	$1.20 /mile	$0.90 /mile
Transit Time	=	3 days	4 days
Transit Time Variation	=	1 day (+/-)	2 days (+/-)
Rate/100lbs	=	$3.00	$2.25

Table 7.02 – Total Cost Model Assumptions (Ozment, 2001) (Matson, 2002)

Products Evaluated

For this model, there needed to be a group of products evaluated in order to compare trucking and short sea shipping methods of transportation. Products varied in value and size so that the model will compare the modes of transportation over a group of different products, not just one that is expensive, one that is heavy, or one that is valued more per pound. Products ranged from desktop computers to furniture to ceramic pots, price ranging from as high as $1500.00 per unit to as little as $5.00 per unit. Unit weight from the products ranged from 10 lbs to 250 lbs per unit. The value per unit of the products ranged from $0.50 per pound to $30.00 per pound. The products chosen and their characteristics are shown below.

Sample Product Characteristics				
Description		**Weight(lb)/unit**	**Value/unit**	**Value/lb**
Desktop Computers	35	50	$1,500.00	$30.00
Stereo Speakers	36	50	$350.00	$7.00
Air Purifiers	39	10	$30.00	$3.00
Lazyboy Chairs	25	100	$250.00	$2.50
Refrigerators	35	250	$500.00	$2.00
Fertilizer	28	40	$50.00	$1.25
Office Paper	28	50	$25.00	$0.50
Ceramic Pots	32	10	$5.00	$0.50

Table 7.03 – Sample Products and Characteristics

TOTAL COST MODEL RESULTS

Using the total cost formula, the buffer stock formula, the stated assumptions, and the sample product information shown in Table 7.03, a cost model is created with the results shown in Table 7.04. The lowest cost alternative between trucking and short sea shipping is highlighted in bold face type. The analysis shows that as the value per pound decreases, short sea shipping becomes a more favorable alternative. As the value per pound drops, the savings in transportation costs compensates for the increases in inventory costs. Goods of higher value do not do as well using short sea shipping because of the high costs of inventory in transit and from having to maintain expensive safety stock. The savings in transportation costs using short sea shipping for high value goods is not enough to warrant the use of it. At some point between $3.00 and $7.00 per pound, short sea shipping becomes more economical despite service disadvantages.

Short sea shipping may have a longer transit time, but this can be taken care of by shippers by planning shipment times in advance. This analysis takes into account shippers keeping a safety stock to prevent stock outs. Therefore, though short sea shipping may be considered less dependable in terms of being on time, safety stock can be used and the shipper can still save in total cost. The savings in transportation costs diminishes the added cost of this safety stock substantially.

Product	Value/lb	Mode	Order Quantity	Ordering Cost	Carrying Cost	Transport Cost	Inventory in Trans Cost	Safety Stock	Total Cost
Desktop Computers	$30.00	Truck	800	$3,750	$120,000	$150,000	$123,288	$166,831	**$563,869**
		SSS	800	$3,750	$120,000	$112,500	$164,384	$330,407	$731,040
Stereo Speakers	$7.00	Truck	800	$3,750	$28,000	$150,000	$28,767	$38,927	**$249,444**
		SSS	800	$3,750	$28,000	$112,500	$38,356	$77,095	$259,701
Air Purifiers	$3.00	Truck	4000	$750	$12,000	$30,000	$2,466	$3,337	$48,552
		SSS	4000	$750	$12,000	$22,500	$3,288	$6,608	**$45,146**
Lazyboy Chairs	$2.50	Truck	400	$7,500	$10,000	$300,000	$20,548	$27,805	$365,853
		SSS	400	$7,500	$10,000	$225,000	$27,397	$55,068	**$324,965**
Refrigerators	$2.00	Truck	160	$18,750	$8,000	$750,000	$41,096	$55,610	$873,456
		SSS	160	$18,750	$8,000	$562,500	$54,795	$110,136	**$754,180**
Fertilizer	$1.25	Truck	1000	$3,000	$5,000	$120,000	$4,110	$5,561	$137,671
		SSS	1000	$3,000	$5,000	$90,000	$5,479	$11,014	**$114,493**
Office Paper	$0.50	Truck	800	$3,750	$2,000	$150,000	$2,055	$2,781	$160,585
		SSS	800	$3,750	$2,000	$112,500	$2,740	$5,507	**$126,497**
Ceramic Pots	$0.50	Truck	4000	$750	$2,000	$30,000	$411	$556	$33,717
		SSS	4000	$750	$2,000	$22,500	$548	$1,101	**$26,899**

Buffer Stock (units)

Service Level (fill-rate)	84%	97.5%
Motor Carrier	278	556
Short Sea Shipping	551	1101

Table 7.04 – Total Logistics Costs: Trucking vs. Short Sea Shipping

Changing the rate per mile for short sea shipping has an affect on the outcome of the model. Increasing this price does have a negative effect towards SSS. As Table 7.05 shows, the savings for most products while using short sea shipping drops off around $1.10 per mile. Following the assumptions of this cost model, $1.10 per mile would be similar to a rate of $1100 per container for a 1,000-mile transit distance.

Short Sea Shipping Savings : Cost Model with change in Rate per Mile						
	Rate per Mile					
Product	$0.85	$0.90	$0.95	$1.00	$1.05	$1.10
Desktop Computers	**-$160,922**	**-$167,172**	**-$173,422**	**-$179,672**	**-$185,922**	**-$192,172**
Stereo Speakers	**-$4,007**	**-$10,257**	**-$16,507**	**-$22,757**	**-$29,007**	**-$35,257**
Air Purifiers	$4,657	$3,407	$2,157	$907	**-$343**	**-$1,593**
Lazyboy Chairs	$53,388	$40,888	$28,388	$15,888	$3,388	**-$9,112**
Refrigerators	$150,526	$119,276	$88,026	$56,776	$25,526	**-$5,724**
Fertilizer	$28,178	$23,178	$18,178	$13,178	$8,178	$3,178
Office Paper	$40,339	$34,089	$27,839	$21,589	$15,339	$9,089
Ceramic Pots	$8,068	$6,818	$5,568	$4,318	$3,068	$1,818

Table 7.05 – Cost Model – Savings Change with SSS Price Difference

Another assumption that can change is the type or characteristics of products. In order to try to simulate a change in value of the products, the product characteristics of air purifiers was changed. The value per unit was increased and thus the value per pound was increased. This showed an important relationship as previously stated. As the value per pound of a product increases, the economic advantage of short sea shipping decreases. This analysis showed that the savings from transportation costs diminished around air purifiers with a value between $6.00 and $6.50 per pound. Table 7.06 shows this.

Air Purifier Change in Value			
Weight(lb)/unit	Value/unit	Value/lb	Savings
10	$30.00	$3.00	$4,657
10	$35.00	$3.50	$3,974
10	$40.00	$4.00	$3,292
10	$45.00	$4.50	$2,610
10	$50.00	$5.00	$1,928
10	$55.00	$5.50	$1,245
10	$60.00	$6.00	$563
10	$65.00	$6.50	**-$119**
10	$70.00	$7.00	**-$801**

Table 7.06 – Cost Model – Savings Change with Change in Product Value

In this cost model, the order quantities are assumed to be the same for the two alternatives. This means the inventory carrying cost is the same for each. One fact that is somewhat unrealistic about this model is the fact that for products like refrigerators, it would take over 600 orders to match the demand. This is because the order size is assumed to be only one truckload/container. For items like Lazyboy chairs, it would require 250 orders. Changing this cost analysis to take into account changing order quantities to 20 trailers per order makes this model more accurate. In this case, for refrigerator products, a shipper would only have to make around 30 orders per year instead of 600. With that said, there is no difference in the results of the analysis. The mode selection stays the same. This is because transport costs, inventory in transit costs, and safety stock costs do not use order quantity in their calculation. Increasing order quantity increases cycle stock only. The differences between transportation costs and costs associated with inventory in transit and safety stock remain the same.

Essentially, although there are many assumptions put in place on this cost model, the bottom line is that short sea shipping can ship lower value products economically. There is also potential for these types of shipments. Table 7.07 shows an excerpt from the 2002 Commodity Flow Survey provided by the Bureau of Transportation Statistics. It is a list of two digit Standard Classification of Transported Goods(SCTG). Taking the value of the goods shipped in 2002 and dividing that by the tons shipped gives the average value per pound of the different commodities. This analysis shows that many of the goods are under $3.00 per pound. This means that there are many more products out there that are excellent candidates for short sea shipping.

Within the different groups of products in Table 7.07, there are many different products. This analysis takes an average value per pound. Realistically, there are products within these groups that may not have such a low value per pound. Distance each of the products must be shipped is also different. Products with a short distance of transit may not be best candidates for short sea shipping. Though there are products like this, this analysis at least shows that there are many other products that could be candidates and those companies could take a hold of the opportunity to reduce their total logistics costs using short sea shipping.

The problem remains that there are still many managers out there that are choosing their mode of transportation on the basis of their perceptions or transportation costs. They and their companies are loosing out on the opportunity to access significant savings using total cost methods to help make decisions. Short sea shipping is a viable alternative for many different companies.

Code	SCTG Description	Value 2002 (millions $)	Tons 2002 (thousands)	Value/lb $/lb
	All Commodities (2)	**8,483,123**	**11,572,780**	
1	Live animals and live fish	7,200	6,549	0.55
2	Cereal grains	55,927	578,637	0.05
3	Other agricultural products	129,890	277,547	0.23
4	Animal feed and products of animal origin, n.e.c	55,251	240,003	0.12
5	Meat, fish, seafood, and their preparations	204,869	85,019	1.20
6	Milled grain products and preparations, and bakery products	119,718	116,018	0.52
7	Other prepared foodstuffs and fats and oils	362,312	463,363	0.39
8	Alcoholic beverages	115,772	93,698	0.62
9	Tobacco products	77,163	5,793	6.66
10	Monumental or building stone	2,451	16,851	0.07
11	Natural sands	4,611	466,338	0.00
12	Gravel and crushed stone	12,643	1,775,181	0.00
13	Nonmetallic minerals n.e.c	12,680	186,322	0.03
14	Metallic ores and concentrates	15,741	116,050	0.07
15	Coal	24,085	1,255,082	0.01
17	Gasoline and aviation turbine fuel	233,563	840,400	0.14
18	Fuel oils	109,618	507,540	0.11
19	Coal and petroleum products, n.e.c.	74,693	431,255	0.09
20	Basic chemicals	152,069	497,049	0.15
21	Pharmaceutical products	426,753	22,825	9.35
22	Fertilizers	34,079	214,227	0.08
23	Chemical products and preparations, n.e.c	234,355	109,819	1.07
24	Plastics and rubber	343,386	147,035	1.17
25	Logs and other wood in the rough	5,178	86,316	0.03
26	Wood products	140,006	321,143	0.22
27	Pulp, newsprint, paper, and paperboard	102,406	139,895	0.37
28	Paper or paperboard articles	105,890	72,508	0.73
29	Printed products	136,886	34,418	1.99
30	Textiles, leather, and articles of textiles or leather	506,992	53,306	4.76
31	Nonmetallic mineral products	143,106	910,259	0.08
32	Base metal in primary or semifinished forms and in finished basic shapes	253,678	325,992	0.39

Table 7.07 – Shipment Characteristics by Two-Digit Commodity for the United States: Preliminary 2002 (BTS, 2003)

CHAPTER 8: CONCLUSIONS

SUMMARY

The research in this paper has provided an in-depth theoretical and analytical look at all aspects of short sea shipping. This report has given an outlook at the future of international trade and the effects within the U.S. not only in terms of the economy but the physical sense of gridlock, air pollution, and national security. This helped to recognize the current affects of trucking and shows just how serious this issue is.

Current uses of short sea shipping, such as the Detroit-Windsor Truck Ferry, the New York-New Jersey Port Inland Distributions Network, and the Pacific Coast Shuttle are excellent examples and they allow us to look at the way in which they operate so that more SSS start-ups can begin. Though the Pacific Coast Shuttle was abandoned it had great operating characteristics. The lessons learned can be noted and used in the future. The growth of the PIDN will be exciting to watch, as well as a model to pay attention to for use in other areas of the country.

As well as looking at U.S. uses of short sea shipping, this research looked at the utilization of it within Europe. Europe appears to be more experienced with this form of shipping, but at the same time has had a head start. Though still relatively young, their network has proven its worth and is another realistic model that should continue to be followed. Their wide use of feeder services is noted.

With the advent of short sea shipping in the United States, there will be a birth of newer, faster, modernized shipping vessels will be utilized. High speed, "Fast Ferries", constructed almost entirely from fabricated aluminum will surface and help to reach the service transit times the users are looking for. This will only make short sea shipping that much more competitive with trucking. Though these vessels are more expensive, there are some lifetime savings in maintenance and efficiency.

Integration of short sea shipping will not be easy, but discussion has started and a "Memorandum of Cooperation" has been signed by the United States, Canada, and Mexico. This is great news, but it also brings to light age-old issues with domestic and international shipping policy within the United States, most notably the argument over the Jones Act. Integration will also involve a good amount of government support.

This report experimented with a simulation cost model, which showed that for a large group of low value products, short sea shipping is a great potential alternative. Logistics managers need to look beyond their perceptions of waterborne transportation and look at the total cost analysis. The idea of keeping "no inventory" is "no good". The cost model shows that by keeping a small buffer stock and using short sea shipping, there are transportation savings to be gained.

U.S. waterborne trade, transportation, and the U.S. economy in general are dependent on the efficient flow of goods and people through U.S. ports and inland waterways (Transportation, 2001). This is why it is so important to have an efficiency supply chain for goods coming into this country. With the increase in trade, congestion could decrease the quantity of goods that are physically able to enter and exit the country. By revitalizing our maritime transportation system with short sea shipping, we are allowing our economy to grow in the future, thus increasing our economic security. It will also allow us to build our reserve civilian and military shipping fleets making us more prepared and capable in crisis. Furthermore, SSS will help to remove some dangerous cargoes from populated areas and provide an additional tool in combating terrorism.

This initiative started by the Maritime Administration is a good one. It will help our economy because it will allow us to handle the larger flow of trade this country will be taking on. It will save the government from having to build and pay for new and expensive highways systems. It will relieve the already congested main corridors of this country, such as I-95 on the east coast. Short sea shipping will promote more environmentally friendly methods of transportation, prevent emission pollution, and help slow down ozone depletion. It will also make the roads a safer place. Trucks are large, heavy vehicles, which in accidents kill hundreds per year. This method of shipment is also safer for the user's goods shipped, since there is far less of a chance of the cargo being in an accident. There are many positive views of short sea shipping. It does much more then just move goods from point A to point B. It is the next development of our country's port and coastal infrastructure. This topic is very exciting considering the ability to be able to watch it being planned out and taking form, plus we could all do with less trucks and congestion on our highways!

RECOMMENDATIONS FOR FUTURE WORK

To further improve the simulation cost model, additional research into other facets of short sea shipping should be examined. There needs to be greater research on mode of transportation shipping rates and how these rates are affected by distance and quantity shipped. Furthermore, additional research into other possible savings gained by use of short sea shipping would help to promote this method of waterborne transport. Additionally, the logistics of the transport of goods to and from the port should be looked at so that the entire value chain is picked apart to locate the different cost drivers between modes.

Further study could also be in the area of financing the newer fleet of short sea shipping ships or the financing of port and terminal changes that would be used to accommodate short sea shipping. Port design changes are expensive and this is an area that will need to be investigated more sooner than later.

Additionally, there needs to be greater study in terms of the government's domestic and international shipping policy. The economic impact of repealing the Jones Act needs to be researched extensively. This is a very big issue and currently there is no real data that is agreed upon by the opponents and proponents of the Act.

WORKS CITED

American Maritime Officers, "MARAD laws must not be compromised if U.S. coastal system goes international", 2002. (AMO, 2002)

Austal Ships, "High-Speed Aluminum Vessels", Presentation by Alan Lerchbacker (CEO) at Short Sea Shipping Conference, November 4-6, 2003. (Austal Ships, 2003)

Austal Ships, http://www.austal-ships.com, 2004. (Austal, 2004)

Baniak, John, "The Development and Evolution of the I-95 Corridor Coalition: Think Regionally, Act Locally", presented with Nancy Ross, 2003. (Baniak, 2003)

Berkowitz, Richard, "Breakout Group Results, Group A: Shippers' Needs", discussion comments from the first Short Sea Shipping Conference, November 12-13, 2002. (Berkowitz, 2002)

Bollinger/Incat, "U.S. Shipyards, Shipbuilding, & Technology", Presentation by Bollinger and Incat at Short Sea Shipping Conference, November 4-6, 2003. (Bollinger/Incat, 2003)

Brogren, Klas, "Cruise and Ferry Info", September 2002. (Brogren, 2002)

Bureau of Transportation Statistics, "2002 Commodity Flow Survey, Preliminary United States Data", December 2003. (BTS, 2003)

Bureau of Transportation Statistics, "National Transportation Statistics 2002", January 2003. (BTS, 2003)

Bureau of Transportation Statistics, "Transportation Annual Statistics 1997", http://books.nap.edu/books/0309061792/html/125.html#pagetop, 1997. (BTS, 1997)

Bureau of Transportation Statistics, "Transportation Statistics Annual Report 2001", 2001. (Transportation, 2001)

Columbia Coastal, http://www.columbia-coastal.com, 2004. (Columbia Coastal, 2004)

Coyle, John, Edward Bardi, and C. John Langley, "The Management of Business Logistics", Sixth Edition, 1996. (Coyle, Bardi, Langley, 1996)

Detroit-Windsor Truck Ferry, http://www.truckferry.com, 2002. (Truckferry, 2002)

Durr, Eric, "Port of Albany 1st Participant in Barge Distribution Network", The Port in the News, http://www.portofalbany.com, December 2002. (Durr, 2002)

Edmonson, R.G., "Short Sea Shipping: A Work in Progress", Journal of Commerce, September 08, 2003. (Edmonson, 2003)

Europa, "Short Sea Shipping Success Stories", http://europa.eu.int/comm/transport /maritime/sss/policy_succes_en.htm, 2004. (Europa, 2004)

European Commission, "Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions," COM(1999) 317 final, June 1999. [European Commission, 1999]

EU Commission, "Transport Demand of Certain Freight Flows", CFF, 1998. [EU Commission, 1998]

European Communities, "European Transport Policy for 2010: Time to Decide", 2001. (European Communities, 2001)

Federal Highway Administration, "Traffic Congestion Challenges", http://fhwa.dot.gov, 2002. (FHWY, 2002)

Federal Motor Carrier Safety Administration, Motor Carrier Inspection Database, http://ai.volpe.dot.gov/mcspa.asp, 2001. (FMCSA, 2001)

General Accounting Office, Report to the Honorable John McCain on the Economic Impact of the Jones Act, March 6, 1998. (GAO, 1998)

Harper, Donald and Philip T. Evers, Transportation Journal, "Competitive Issues in Intermodal Railroad-Truck Service", Volume 32, Number 3, 1993. (Harper and Evers, 1993)

Incat Australia, http://www.incat.com.au, 2004. (Incat, 2004)

I-95 Corridor Coalition, "Alleviating Congestion", http://www.i95coalition.org, 2003. (I-95, 2003)

I-95 Intermodal Leadership Forum, "Highway White Paper", 1998. (Highway, 1998)

I-95 Intermodal Leadership Forum, "Water White Paper", 1998. (Water, 1998)

Journal of Commerce, Port Import/Export Reporting Service (PIERS), June 2001. (Journal of Commerce, 2001)

LSU National Ports & Waterways Institute, "Advanced Technologies for Coastal Shipping System (Cargo, Vessels, Ports)", Presentation, August 1999. (LSU, 1999)

Mapquest, http://www.mapquest.com, January 2004. (Mapquest, 2004)

Marine Transportation System National Advisory Council, "Challenges and Opportunities for the U.S. Marine Transportation System", June 28, 2001. (Advisory Council, 2001)

MariNova Consulting Ltd., "Atlantic Canada Short Sea Shipping Background Study", Dr. Mary R Brooks co-author, 2003. (MariNova, 2003)

Maritime Administration, Title XI Ship Financing Program, Presentation by the Maritime Administration, November 2003. (Title XI, 2003)

Marshall, Rolf, "The Challenge of Transportation Congestion", Presentation for Short Sea Shipping Conference, 2002. (Marshall, 2002)

Master, Mates, and Pilots' Wheelhouse Weekly, "Matson Replaces West Coast Water Service with Rail Service", Volume 4, Number 46, November 17, 2000. (MM&P, 2000)

Matson Navigation Company, Inc., http://www.matson.com, January 2004. (Matson, 2004)

Matson Navigation Company, Inc., "Matson's Pacific Coast Shuttle", Presentation given at First SSS Conference, November 2002. (Matson, 2002)

McKinley, James C., "Port Authority Project to Shift Some Cargo Traffic to Albany", The Port in the News, http://www.portofalbany.com, December 2002. (McKinley, 2002)

Modern Bulk Transporter Magazine, "Truck Ferry Receives Award of Excellence", July 1, 2003. (Modern Bulk Transporter, 2003)

Mottley, Robert, "New York-New Jersey's inland alternative", American Shipper, http://www.americanshipper.com, June 2001. (Mottley, 2001)

National Highway Traffic Safety Administration, "Traffic Safety Facts 2000", U.S. Department of Transportation, 2001. (Safety Admin, 2001)

O'Neill, Beverly, "Testimony of The Honorable Beverly O'Neill, Mayor, City of Long Beach, Long Beach, California", Subcommittee on Highways, Transit, and Pipelines, Committee on Transportation and Infrastructure, U.S. House of Representatives, http://www.house.gov/transportation/highway/05-07-03/oneill.html, May 7, 2003. (O'Neill, 2003)

Ozment, John, "Demand for Intermodal Transportation in Arkansas", National Transportation Library, April 2001. (Ozment, 2001)

Piasecki, Dave, "Optimizing Economic Order Quantity (EOQ)", Solutions, http://www.inventoryops.com/economic_order_quantity.htm, January 2001. (Piasecki, 2001)

Port Authority of New York & New Jersey, "Port Inland Distribution Network", Short Sea Shipping Conference 2003 Presentation, November 2003. (Port NY&NJ, 2003)

Scandlines, http://www.scandlines.dk, 2004. (Scandlines, 2004)

Schubert, William G., "2002 Maritime Transportation Systems Short Sea Shipping Conference", Maritime Administrator Remarks, November 12, 2002. (Schubert, 2002)

Seafarers Log, "Short Sea Shipping Offers many Benefits", April 2003. (Seafarers, 2003)

Shipping Conference, November 2002. (Wilbur, 2002)

T-T Line, https://www.t-tline.de, 2004. (T-T Line, 2004)

Texas Transportation Institute, "Urban Mobility Study 2002", 2002. (TTI, 2002)

U.S. Environmental Protection Agency, http://www.epa.gov, 2003. (EPA, 2003)

U.S. Environmental Protection Agency, Coastal Wetlands of the Great Lakes, http://www.epa.gov/grtlakes/, October 1998. (EPA, 1998)

U.S. Environmental Protection Agency, "Transportation Mode Comparison – Energy – Environment – Efficiency', Emission Control Lab, http://www.mvr.usace.army.mil/navdata/tr-comp.htm. (Emissions, 2004)

Vokac, Adam, "The Role of LIF Technology in Maritime Economics & Exhaust Emissions", 2003. (Vokac, 2003)

Ward, Gene, "To Fix the Economy, Junk the Jones Act", http://starbulletin.com/97/12/05/editorial/viewpointf.html, December 5, 1997. (Ward, 1997)

WEFA, a subsidiary of the Primark Corporation. Lawrence R. Klein, 1980 Nobel Laureate in Economics, founded Wharton Econometric Forecasting Associates in 1963. (WEFA, 2001)

Wilbur Smith Associates, "Latin America Trade & Transportation Study", Short Sea Shipping Conference, November 12, 2002. (Wilbur, 2002)

Xinhua News Agency, "Train-Ferry Links Guangdong and Hainan", http://www.china.org.cn, November 20, 2002. (Xinhua, 2002)

Zubaly, Robert B., "Applied Naval Architecture", First Edition, 1996. (Zubaly, 1996)

46 U.S.C. 883, 19 CFR 4.80 and 4.80(b). (46 U.S.C. app. 883)

WORKS CONSULTED

Bureau of Transportation Statistics, "1997 Commodity Flow Survey", December 1999.

Commission of the European Communities, "Directive of the European Parliament and of the Council on Intermodal Loading Units", COM(2003) 155 final, July 4, 2003.

Dohring, Shawn, "Shipping Produce via Ocean with CA: The Shipper's ROI", Perishables Handling Quarterly, Issue No. 97, February 1999

European Short Sea Network, http://www.shortsea.info/front/frameset.asp, October 2003.

Federal Highway Administration, "U.S. Freight: Economy in Motion", Publication No. FHWA-PL-98-034, May 1988.

Grimaldi, Dott Emanuele, "The Evolving Picture of Short Sea Shipping in Europe", IAME 2000 Conference, September 13, 2000.

I-95 Corridor Coalition, "Understanding the Geographic Growth of the I-95 Corridor Coalition: Implications for the Analysis of Passenger Travel in the Corridor Region"

I-95 Intermodal Leadership Forum, "Freight Rail White Paper", 1998.

I-95 Intermodal Leadership Forum, "Rail Financing White Paper", 1998.

I-95 Intermodal Leadership Forum, "Security White Paper", 1998.

Jonkman, William H., Short Sea Shipping: Highways of the Sea", Port of Rotterdam, November 2002.

Larson, Parker E., "The Technology and Economic Feasibility of Offshore Liquefied Natural Gas Receiving Terminals in the United States", Massachusetts Institute of Technology, Department of Ocean Engineering, June 2003.

Luo, Meifeng, and Grigalunas, Thomas, "A Spatial-Economic Multimodal Transportation Simulation Model for U.S. Coastal Container Ports", July 18, 2002.

Port of Hamburg, http://www.mainport-hamburg.de, October 2003.

Reiss, Dan, "Breakout Group Results: Group C: Modal Share/Public Benefits", Short Sea Shipping Conference, November 12-13, 2002.

Richardson, Paul F., "Short Sea Shipping", Paul F Richardson Associates, Inc., Marine Board Spring Meeting, May 2003

Ryffel, Markus, Critical Success Factors in European Short Sea Shipping", May 2003.

Taylor, D. A., "Merchant Ship Construction", Third Edition, 1992.

Taylor, Rod B., " Short Sea Shipping in an Ontario Context", A Discussion paper, September 12, 2003.

U.S. Maritime Administration, http://www.marad.dot.gov, October 2003.

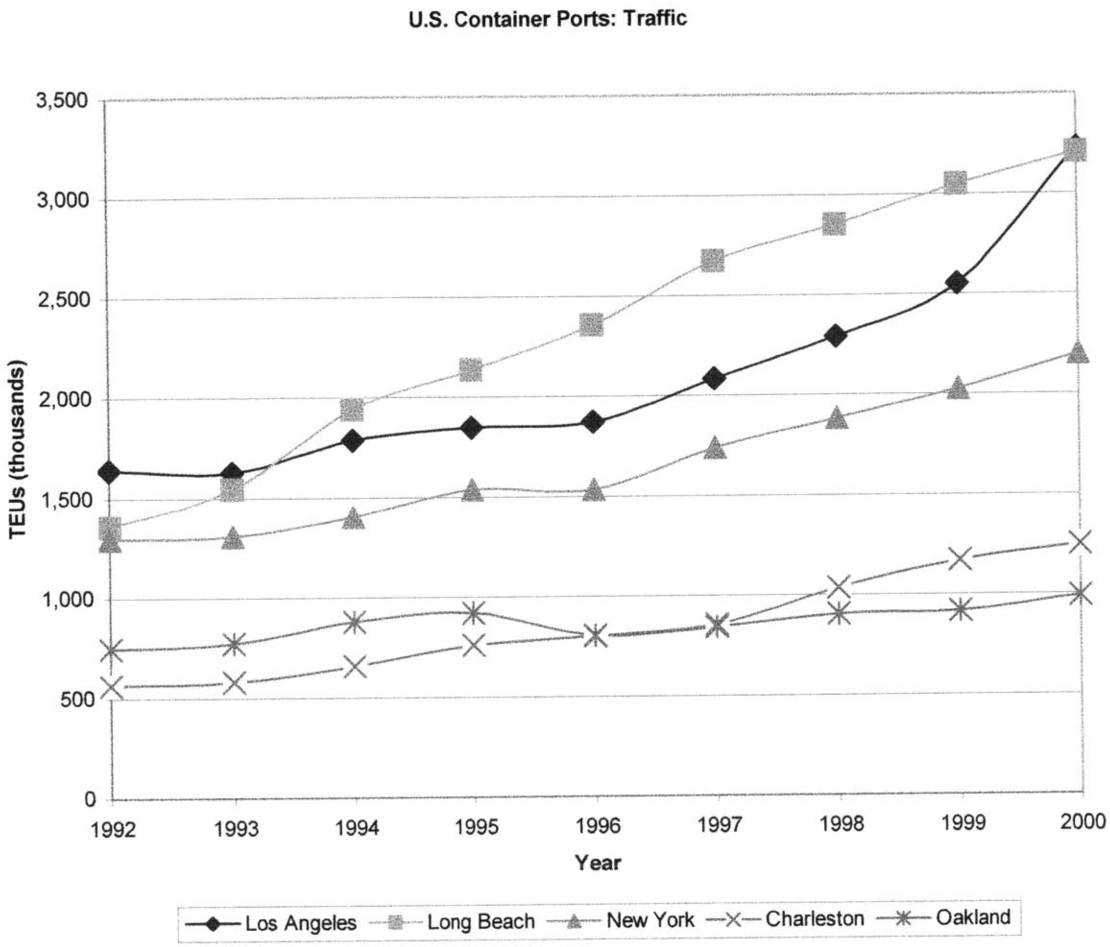
Wanamaker, Bill, "The Trucking Variable in the Short Sea Equation", Intermodal and Government Traffic operations, American Trucking Associations.

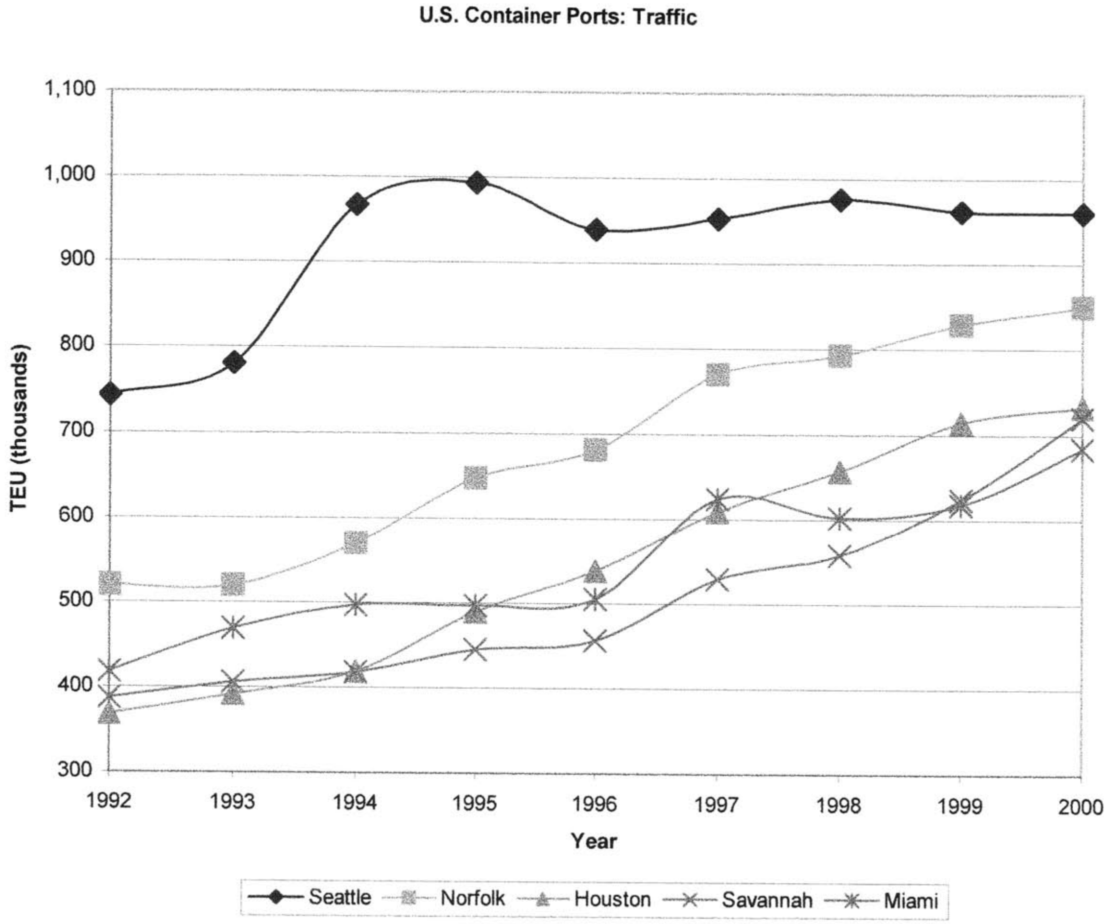
Weisbrod, Roberta, "Freight Ferries: Taking a Fresh Approach", Short Sea Shipping Conference, November 12-13, 2002.

Zubaly, Robert B., "Applied Naval Architecture", First Edition, 1996

APPENDIX A

U.S. Container Port Traffic Trends in TEUs (1992-2000)


U.S. Container Ports: Traffic
3,500
3,000
2,500
2,000
1,500
1,000
500
0
TEUs (thousands)
1992
1993
1994
1995
1996
1997
1998
1999
2000
Year
Los Angeles
Long Beach
New York
Charleston
Oakland


U.S. Container Ports: Traffic
1,100
1,000
900
800
700
600
500
400
300
TEU (thousands)
1992
1993
1994
1995
1996
1997
1998
1999
2000
Year
Seattle
Norfolk
Houston
Savannah
Miami

APPENDIX B

Excerpt from Atlantic Canada Short Sea Shipping Background Study

Short Sea Shipping Operations

A mere sample of short sea operations in the Baltic Sea is included below.

Baltic Sea

Unifeeder

Danish-based Unifeeder Container Services A/S, one of the largest European feeder services, provides feeder services between seven mainline ports in North Europe and 14 ports in Scandinavia. In 1999, it carried around 800,000 TEU on its fleet of 28 vessels ranging in size from 320-700 TEU.

Team Lines

Team Lines is Finnish-owned, but managed in Hamburg. It operates an extensive feeder network, relaying containers via Hamburg to ports in Norway, Sweden, Finland, Russia, Latvia, Lithuania and Poland. In 2002, about 92% of team Line's business was feeder business for mainline operators, with the remaining being short sea containers carried on its own account. It operates with weekly sailings on most routes, although frequency is increased when demand warrants. Expansion has taken place recently to St. Petersburg and Tallinn. The company operates 25 vessels ranging in size from 250-550 TEU.

DFDS

DFDS Tor Line A/S is primarily a ro-ro operator on the North Sea and Baltic Sea. The parent company DFDS A/S was founded in 1866 and is listed on the Copenhagen Stock Exchange. DFDS operates services from Sweden to the U.K., Denmark-U.K., U.K. - Latvia and Lithuania, Sweden - Netherlands, coastal Norway, Denmark - Poland and Sweden - Lithuania. 2,066 people are employed at sea and ashore. Its fleet includes 53 roro, lo-lo, ro-pax, container and sideport vessels, operating in 19 market areas. About 70% of the volumes are transported on trailers; other cargo carriers are used for bulk customers' in its "industrial logistic transport system".

According to its promotional material, DFDS Tor Line has developed five general transport systems designed to satisfy the market's requirements by utilising ro-ro technology in full; the Trailer system, the Cassette system, the Automotive system, the Lift-unit system and a system for handling Special Cargo.

DFDS concentrates on passenger shipping and ro-ro liner shipping. According to its 2002 *Annual Report*, its "customer concept" is:

Ro-pax concepts can be introduced on passenger routes where a cruise ferry concept is not sustainable and on certain freight routes. DFDS intends to supplement ro-ro liner shipping with lo-lo liner shipping...

Ports

The Baltic Sea is one of the most dynamic regions in the world for short sea shipping, simply because goods and people need to use shipping to get goods from Scandinavia to markets in both northern and southern Europe, as land-based routes through Russia are still long and cumbersome. In recent years, the entry of the former Baltic republics into the EU in 2004 has spurred investment in shipping links.

Gothenburg (www.portgot.se)

Gothenburg offers a unique combination of deep sea, intercontinental and Baltic shipping services. It handled 33.4m tonnes of cargo in 2002, including 750,000 TEUs. It also has a twinning arrangement with the Port of Halifax, and is a port that Halifax could emulate.

The port boasts 8 sailings per day in the Nordic region, 6 per day to continental Europe, 2 per day to the U.K., 3 per week to North America, 4 per week to the Far East and 1 per week to the Middle East.

Forest products are a very important commodity to Gothenburg and a unique cargo handling system was developed by the port, Stora-Enso and Cobelfret. It uses the Stora-Enso cassette, a then-unique loading system, and a shuttle operation linking it to the Belgian port of Zeebrugge.

Lubeck (www.lhg-online.de)

Lubeck is located on the Baltic coast of Germany and is Germany's largest Baltic port, handling about 25m tonnes of cargo per year. It has more than 120 ship calls per week to more than 20 destinations, from 5 specialized terminals.

Two terminals, in particular are noteworthy. Through its subsidiary Combispeed, the Hamburg terminal operator, HHLA (www.hhla.de/) developed Container Terminal Lubeck (CTL), which is designed to channel containers arriving on ro-ro and lo-lo vessels from the Baltic region to points in Europe and overseas via Hamburg. Feeder vessels are loaded and unloaded in four hours and there will eventually be up to 12 intermodal blocktrains that will run between CTL and HHLA's Hamburg terminal. The CTL terminal will eventually handle 500,000 TEU per annum.

North Europe / North Sea

A sample of short sea operations in North Europe and the North Sea is described below.

Stena Line Freight (www.stenaline.co.uk)

Stena Line is the largest short sea operator in the world. In 2002, it handled 1.1m units, with a turnover of 2.8b SEK. In 2001 it was de-listed from the Swedish Stock Exchange and taken private.

Stena Line Freight's network coupled with Scandlines and one other partner currently amounts to 18 routes to and from Ireland, Northern Ireland, England, Wales, Scotland, Holland, Germany, Sweden, Denmark, Norway and Poland. Stena Line operates 13 routes, Scandlines AB four routes, (Helsingborg-Helsingör, Trelleborg-Travemünde, Trelleborg-Sassnitz, Trelleborg-Rostock) and Stena Tor Line one route, (Göteborg-Harwich). The company tends to concentrate on vessel operations and serving the trucking industry rather than door-door service.

Stena has pursued an investment policy aimed at market domination. It continuously invests in new tonnage and has introduced bold new technology into the marketplace. Its two HSS designs, for 1,500 and 900 passengers, are arguably the biggest advance in ferry design in the past ten years, although Incat has sold more copies of its high speed catamarans. Stena's philosophy was to replace conventional vessels with high speed vessels at twice the cost, but offer better productivity in terms of turnaround and higher speeds.

Cobelfret (www.cobelfret.com)

Coblefret, based in Antwerp, was founded in 1928. It has 1,100 employees and its 2001 turnover was EURO 668m. The company operates ro-ro and lo-lo lines between the British Isles, Scandinavia and continental Europe.

In addition to its bulk shipping and terminal infrastructure, "Cobelfret Ferries operates a core fleet of 19 vessels, specifically designed for the short sea ro-ro trade, occasionally supplemented by time chartered tonnage, that can quickly and easily accommodate all types of rolling equipment, containers and dangerous goods".

Services operate between: Zeebrugge-Purfleet U.K), Rotterdam-Purfleet, Zeebrugge-Immingham, Rotterdam-Immingham, Zeebrugge-Dagenham and Zeebrugge-Gothenburg. It offers door-door service across Europe, using its own fleet of 60 trucks, 400 rail cars and 3 ro-ro river barges.

Cobelfret also has an interest in C2C Lines (www.c2clines.com/), a joint venture with ECS European Containers N.V., of Zeebrugge. It operates between Europe and Ireland, specifically the ports of Zeebrugge, Belgium and Radicatel, France and both Waterford and Warrenpoint in Ireland.

Geest Line (www.geest.nl/)

Geest North Sea Line is a short sea specialist based in Rotterdam. The company operates a fleet of 6 x 300+ TEU ships in service between Rotterdam's short sea terminal and Tilbury, Hull and Grangemouth. Along with Quality Freight Ltd, it has a 60% interest in Geest Ireland Ltd., and operates services to Drogheda, Belfast and Waterford, the latter of which it operates with Norfolk Line. It provides door-door intermodal service to Germany, Switzerland, Italy, Austria, Spain, Holland, Belgium, Denmark, Luxemburg, Hungary, Czech Republic, Slovakia and parts or the former Yugoslavia. In 2002, it carried over 200,000 containers, or 450,000 TEU on its various services. It is Rotterdam's third largest customer after Maersk Sealand and P&O Nedlloyd.

Geest has ordered 2 x 804 TEU vessels, which will be delivered in 2004/05. Unique in the industry, they are designed to handle 45' high cube containers in 90' holds, to enable the company to compete with 13.6m European-spec road trailers. They will also be far bigger than any others used in the North Sea.

Geest Line is an enthusiastic supporter of the EU's Marco Polo programme, and its goal of reducing road congestion. Its philosophy in terms of U.K. port selection is to minimize road haulage distances. The company is also examining the potential for new services to the Iberian Peninsula, for which it expects to receive some assistance. It does, however, have some concerns about a new German road tax of EUR 0.15 per km, which will impact on intermodal traffic using German highways and add 12-15% to the cost of haulage.

Ports

Hamburg (www.mainport-hamburg.de)

From the Port of Hamburg's perspective, the short sea shipping sector is strong and growing. In terms of the distribution of cargo to its hinterland, short sea shipping and inland waterways account for 23%, with short sea occupying the smallest share at only 11%. Nevertheless, transhipment of containers accounted for 5.5m tonnes of cargo in 2001, with Finland being the biggest market at 27%, Sweden next at 23% and Norway at 12%.

Hamburg has an extensive network of short sea services, with 128 departures per week to various destinations, including 24 to Sweden, 23 to Finland, 22 to Norway, 15 to Russia, 11 to Poland and 9 to Denmark. A new concept is the shuttle developed by one of its terminal operators, HHLA, as described above in the section on Lubeck.

Rotterdam

Rotterdam is the second largest port in the world after Singapore, handling over 322m tonnes per year. Handling 6.5m TEUs per annum, it is now the eighth largest container port in the world, after Hong Kong, Singapore, Pusan, Shanghai, Kaohsiung and Shenzhen.

Cargo is distributed to Rotterdam's extensive hinterland by feeder, short sea, ro-ro, barge, train and road. Feeder and short sea container movements accounted for 2.2m TEUs in 2000. Its short sea and feeder connections are breathtakingly complex, as the following map illustrates:
Rotterdam shot sea services

In 1994, Rotterdam began the development of a Short Sea Terminal to improve terminal operations, lower the cost and improve quality. It now occupies 30 ha and has a 1.9 km quay wall. In addition to the UK, Ireland and Scandinavia, Rotterdam operates regular services to countries including Spain, Greece, Italy, the Baltic States and ports in North Africa.

Mediterranean

The Mediterranean short sea sector has experienced phenomenal growth. *Containerisation International 2003 Yearbook* lists 68 carriers serving 63 ports in its intra-Med section. The sector includes ro-ro, ro-pax, con-ro and fully cellular container feeder ships. Major hub ports handling more than 2m TEU have emerged at Gioia Tauro and Algeciras, with smaller ones in the 1m+ TEU category at Malta and Piraeus. Fast new ro-ro and ro-pax services have been inaugurated between Greece and Italy to bypass political trouble spots in the former Yugoslavia. Considerable growth also taken place in north-south trades between southern Europe and North Africa, particularly Tunisia and Algeria. The EU's priority, however, seems to be to remove road traffic along the Mediterranean coast and to encourage the development east-west trade. It is expected that the region's secondary ports will play a strong role,

> *If you deliver the cargo to the port closest to where it is originating from or consigned to, then you reduce the burden on the busier ports, many of which are not coping, and you also remove a burden from the roads.*[66]

Short Sea Services

Superfast (www.superfast.com)

Superfast is considered the pioneer of the new fast ro-pax generation of vessels. In 1995, it introduced two new ferries, *Superfast I* and *II*, between Patras, Greece and Ancona, Italy, cutting travel time from 36 to 20 hours. Other Adriatic services operate between Ancona-Igoumenitsa (15 hours), Bari-Patras and Bari-Igoumenitsa (9.5 hours).

Superfast has a fleet of eight vessels. They are characterised by their high speed and enormous vehicle capacity. The smallest vessels have passenger capacities of 1,400, and vehicle capacity of 850, with a speed of 27 knots. The latest and biggest vessels have passenger capacity of 626, vehicle capacity of 900 and 30.4 knots. The company has four new ships on order that will have passenger capacity of 1,550, 900 vehicles and 31.25 knots.

In 2001, Superfast introduced its concept to the Baltic, operating between Rostock, Germany and Hanko, Finland. In 2002, it commenced operations between Zeebrugge, Belgium and Rosyth (Edinburgh), in Scotland.

Medex (www.mesco.com)

Malta-based Medex runs three services, using vessels of 300 TEU-1,200 TEU, from Valencia/Barcelona to the Black Sea, Valencia/Barcelona to Egypt, Lebanon and Syria; and Valencia/Barcelona to Leghorn and Tunisia. The Black Sea service calls at Gioia Tauro and the others two call at Malta.

Medex has evolved a strategy to develop short sea liner business on the back of its feeder network. They use surplus space on their vessels to carry short sea cargo.

Societe des Autoroute Maritime du Sud (SAMS)

Four Mediteranean-based companies (Sudcargos, SNCM, CMA CGM and Marfret) have formed a pool in that intends to establish a maritime link between Marseilles/Fos, France and Savona/Vado, Italy. They are looking for an Italian partner (Tarros Line), and the funding approved by the Marco Polo program needs to be supplemented by other sources. The company plans to charter an 80-truck capacity ro-ro vessel. Trailers will be targeted initially, and containers will be carried on mafis. Its goal is to reduce traffic congestion around the French- Italian border.

Grimaldi (www.grimaldi.napoli.it/)

The Grimaldi Group, which was founded in 1945, is a roll on/roll off specialist and owns one of the largest fleets of ro/ro multipurpose and car carrier vessels in the world. It is a major operator of ferry services in the Mediterranean. The Grimaldi Group has a fleet of about 40 owned and chartered vessels and offers regular liner services covering North Europe, the Mediterranean, West/Central Africa and South America for the transport of cars, vans, trucks and other commercial vehicles, all types of containers, general cargo and project cargo. It also owns Atlantic Container Line, the transatlantic ro-ro and container line.

Grimaldi's Mediterranean ferry services cater to both passengers/cars and cargo. For instance, its new vessel, *Eurostar Valencia* is deployed on a weekly rotation between Salerno, Valencia, Salerno, Tunis, Malta and Salerno. Its short sea network, which includes new links between Spain and Italy, and for which the company gives credit to the EC's PACT program, includes seven routes served by five ships, and is completely in tune with the EU short sea shipping policy. Grimaldi's Mediterranean short sea schedule is as follows:

Salerno - Valencia - Salerno x per week
Livorno - Valencia - Livorno x per week
Palermo - Valencia - Palermo weekly
Salerno - Malta - Salerno weekly
Civitavecchia - Valencia - Civitavecchia weekly
Salerno - Palermo - Salerno weekly
Salerno - Tunia - Salerno weekly
Grimaldi Ferries routes

Ports

Gioia Tauro

One of the world's most phenomenal port developments, Gioia Tauro, did not exist until 1995. Medcenter in Gioia Tauro, located in southern Italy, ranked 19th in the world in 2000, handling over 2.6m TEU. Occupying 74 hectares, it has eight berths, 14 post-Panamax cranes, 2,450 m of quay length, with up to 15m of water alongside and 3,000m of on-dock rail. Medcenter is owned by Contship Italia in partnership with Ecklemann-Eurokai of Hamburg. It is a classic transhipment hub, located virtually in the centre of the Mediterranean.

Gioia Tauro is now facing increased competition from several other Italian ports, not just older ones such as Naples and Genoa but also newer ones like Taranto, Caligari and Marsaxlokk on the island of Malta. It is also now beginning to look beyond transhipment, which represents an estimated 65% of its traffic base, and expanding its role as a gateway for containers moving to Italy and southern Europe.

APPENDIX C

Excerpts from National Transportation Statistics 2002

TABLE 1-50: Tonnage of Top 50 U.S. Water Ports, Ranked by Total Tons[a]

	1990		2000		
	Rank	Total tons (Millions)	Rank	Total tons (Millions)	Percent change 1990-2000
South Louisiana, LA	1	194.2	1	217.8	12.1%
Houston, TX	3	126.2	2	191.4	51.7%
New York, NY and NJ	2	140.0	3	138.7	-1.0%
New Orleans, LA	6	62.7	4	90.8	44.7%
Corpus Christi, TX	7	62.0	5	83.1	34.0%
Beaumont, TX	23	26.7	6	82.7	209.2%
Huntington, WV	34	17.3	7	76.9	344.1%
Long Beach, CA	10	52.4	8	70.1	33.8%
Baton Rouge, LA	5	78.1	9	65.6	-16.0%
Texas City, TX	12	48.1	10	61.6	28.1%
Plaquemine, LA	8	56.6	11	59.9	5.9%
Lake Charles, LA	16	40.9	12	55.5	35.8%
Mobile, AL	15	41.1	13	54.2	31.7%
Pittsburgh, PA	19	35.5	14	53.9	51.9%
Los Angeles, CA	13	46.4	15	48.2	4.0%
Valdez, AK	4	96.0	16	48.1	-49.9%
Tampa, FL	11	51.6	17	46.5	-9.9%
Philadelphia, PA	14	41.8	18	43.9	4.8%
Norfolk Harbor, VA	9	53.7	19	42.4	-21.1%
Duluth-Superior, MN and WI	17	40.8	20	41.7	2.2%
Baltimore, MD	18	39.5	21	40.8	3.3%
Portland, OR	21	27.5	22	34.3	25.0%
St. Louis, MO and IL	22	27.1	23	33.3	23.0%
Freeport, TX	40	14.5	24	31.0	113.8%
Portland, ME	51	10.8	25	29.3	172.3%
Pascagoula, MS	24	26.5	26	28.7	8.4%
Paulsboro, NJ	27	23.3	27	26.9	15.2%
Seattle, WA	30	21.6	28	24.2	12.0%
Chicago, IL	28	22.5	29	23.9	6.2%
Marcus Hook, PA	25	25.9	30	22.6	-12.7%
Port Everglades, FL	42	14.1	31	22.5	59.1%
Tacoma, WA	31	21.4	32	22.3	4.0%
Port Arthur, TX	20	30.7	33	21.4	-30.3%

TABLE 1-50: Tonnage of Top 50 U.S. Water Ports, Ranked by Total Tons[a] (Continued)

	1990		2000		
	Rank	Total tons (Millions)	Rank	Total tons (Millions)	Percent change 1990-2000
Charleston, SC	54	9.7	34	21.1	117.3%
Boston, MA	29	21.9	35	20.8	-5.3%
Jacksonville, FL	36	15.1	36	19.7	30.3%
Savannah, GA	44	13.6	37	19.7	45.0%
Richmond, CA	32	21.2	38	19.5	-8.0%
Memphis, TN	47	12.4	39	18.3	47.8%
Anacortes, WA	35	15.4	40	18.0	17.1%
Detroit, MI	33	17.7	41	17.3	-2.5%
Indiana Harbor, IN	37	14.7	42	16.2	10.3%
Honolulu, HI	50	11.3	43	15.8	39.3%
Cleveland, OH	41	14.4	44	14.4	0.2%
Cincinnati, OH	46	12.6	45	14.3	13.6%
Lorain, OH	43	14.0	46	14.2	1.5%
San Juan, PR	39	14.5	47	13.9	-4.4%
Newport News, VA	26	24.9	48	13.8	-44.6%
Toledo, OH	38	14.7	49	13.3	-9.2%
Two Harbors, MN	48	12.3	50	13.1	6.2%
Total top 50		1,877.9		2,217.3	18.1%
All ports		2,163.9		2,461.6	13.8%

[a] Tonnage totals include both domestic and foreign waterborne trade.

NOTES
In 1990, Grays Harbor, Washington, ranked 45th (12.8 tons) and Ashtabula, Ohio, ranked 49th (11.9 tons).
Numbers may not add to totals due to rounding.

SOURCES
1990: U.S. Army Corps of Engineers, *Waterborne Commerce of the United States, Calendar Year 1990, Part 5, National Summaries* (New Orleans, LA: 1993), table 5-2.
2000: Ibid., *Waterborne Commerce of the United States, Calendar Year 2000, Part 5, National Summaries* (New Orleans, LA: 2002), tables 1-1 and 5-2.

TABLE 1-51: Growth of Freight Activity in the United States: Comparison of the 1993 and 1997 Commodity Flow Surveys

Mode of transportation	Value: 1993 (billion $ 1997)	Value: 1997 (billion $ 1997)	Value: Percent change	Tons: 1993 (millions)	Tons: 1997 (millions)	Tons: Percent change	Ton-miles: 1993 (billions)	Ton-miles: 1997 (billions)	Ton-miles: Percent change
TOTAL all modes	6,360.8	6,944.0	9.2	9,688.5	11,089.7	14.5	2,420.9	2,661.4	9.9
Single modes, total	5,376.3	5,719.6	6.4	8,922.3	10,436.5	17.0	2,136.9	2,383.5	11.5
Truck[a]	4,791.0	4,981.5	4.0	6,385.9	7,700.7	20.6	869.5	1,023.5	17.7
For-hire truck	2,858.1	2,901.3	1.6	2,808.3	3,402.6	21.2	629.0	741.1	17.8
Private truck[b]	1,910.4	2,036.5	6.6	3,543.5	4,137.3	16.8	235.9	268.6	13.9
Rail	269.2	319.6	18.7	1,544.1	1,549.8	0.4	942.6	1,022.5	8.5
Water	67.1	75.8	13.1	505.4	563.4	11.5	272.0	261.7	–3.8
Shallow draft	44.3	53.9	21.7	362.5	414.8	14.4	164.4	189.3	15.2
Great Lakes	1.3	1.5	15.4	33.0	38.4	16.4	12.4	13.4	8.2
Deep draft	21.5	20.4	–4.9	109.9	110.2	0.2	95.2	59.0	–38.0
Air (includes truck and air)	151.3	229.1	51.4	3.1	4.5	42.6	4.0	6.2	55.5
Pipeline[c]	97.8	113.5	16.1	483.6	618.2	27.8	S	S	S
Multiple modes, total	720.9	945.9	31.2	225.7	216.7	–4.0	191.5	204.5	6.8
Parcel, U.S. Postal Service or courier	612.8	855.9	39.7	18.9	23.7	25.4	13.2	18.0	36.8
Truck and rail	90.4	75.7	–16.3	40.6	54.2	33.5	37.7	55.6	47.5
Truck and water	10.2	8.2	–19.4	68.0	33.2	–51.2	40.6	34.8	–14.4
Rail and water	4.0	1.8	–55.2	79.2	79.3	0.1	70.2	77.6	10.5
Other multiple modes	3.5	4.3	22.0	18.9	26.2	38.6	S	18.6	S
Other/unknown modes, total	263.6	278.6	5.7	540.5	436.5	–19.2	92.6	73.4	–20.7

KEY: S = data are not published because of high sampling variability or other reasons.

[a] Truck as a single mode includes shipments that went by private truck only, for-hire truck only, or a combination of both.

[b] Private truck refers to a truck operated by a temporary or permanent employee of an establishment or the buyer/receiver of the shipment.

[c] Excludes most shipments of crude oil.

NOTE
Numbers and percents may not add to totals due to rounding.

SOURCE
U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, Census Bureau, *1997 Economic Census, Transportation, 1997 Commodity Flow Survey* (Washington, DC: December 1999), table 1b; the Bureau of Transportation Statistics converted the value of 1993 commodities from 1993 current dollars to 1997 constant dollars using Bureau of Economic Analysis chain-type price deflators.

TABLE 1-64: Roadway Congestion Index (Continued)

Population group	Urban area	1982	1985	1990	1995	1996	1997	1998	1999	2000	Percent change[a] Short-term 1994-2000 Percent	Rank	Long-term 1982-2000 Percent	Rank
Medium	Jacksonville, FL	0.75	0.81	0.94	1.04	1.02	1.01	1.01	1.00	1.02	0	5	27	24
Large	Kansas City, MO-KS	0.50	0.58	0.63	0.72	0.75	0.76	0.77	0.79	0.81	11	41	31	37
Small	Laredo, TX	0.55	0.56	0.56	0.53	0.56	0.60	0.63	0.61	0.56	2	8	1	1
Large	Las Vegas, NV	0.69	0.78	[R]1.06	1.12	1.12	1.11	1.13	1.18	1.23	10	35	54	71
Very large	Los Angeles, CA	1.29	1.31	1.59	1.52	1.56	1.54	1.58	1.58	1.59	9	31	30	35
Medium	Louisville, KY-IN	0.78	0.78	0.80	[R]0.99	[R]1.01	1.05	1.08	1.09	1.09	12	44	31	37
Medium	Memphis, TN-AR-MS	0.71	0.70	0.88	0.96	0.98	0.98	0.99	0.98	1.00	6	17	29	30
Large	Miami-Hialeah, FL	0.95	0.99	1.20	1.25	1.23	1.23	1.22	1.23	1.28	6	17	33	45
Large	Milwaukee, WI	0.71	0.80	[R]0.93	0.94	0.99	1.01	1.02	1.05	1.08	17	63	37	54
Large	Minneapolis-St. Paul, MN	0.66	0.76	0.89	1.06	1.08	1.13	1.18	1.20	1.22	18	65	56	74
Medium	Nashville, TN	0.83	[R]0.82	0.85	0.93	0.93	[R]0.96	0.97	[R]0.98	0.98	8	26	15	12
Large	New Orleans, LA	0.92	0.97	0.94	0.99	0.96	0.97	1.00	0.99	0.97	-2	4	5	3
Very large	New York, NY-Northeastern, NJ	0.77	[R]0.86	0.99	1.04	1.08	1.13	1.14	1.15	1.16	14	51	39	57
Large	Norfolk - Newport News-Virginia Beach, VA	[R]0.84	[R]0.89	[R]0.91	[R]0.91	[R]0.94	[R]0.95	0.96	0.97	0.96	5	13	12	7
Large	Oklahoma City, OK	0.65	0.71	0.73	0.82	0.84	0.85	0.86	0.88	0.87	10	35	22	18
Medium	Omaha, NE-IA	0.62	0.70	0.75	0.81	0.84	0.85	0.87	0.90	0.90	10	35	28	27
Large	Orlando, FL	0.82	0.93	0.95	0.97	1.00	[R]1.03	1.05	[R]1.07	1.11	15	59	29	30
Small	Pensacola, FL	0.61	0.69	0.84	0.88	0.86	0.88	0.87	0.88	0.92	5	13	31	37
Very large	Philadelphia, PA-NJ	0.82	0.87	0.94	[R]1.00	[R]1.01	[R]1.05	[R]1.08	[R]1.10	1.10	10	35	28	27
Large	Phoenix, AZ	0.95	0.98	1.01	1.08	1.14	1.12	1.16	1.21	1.27	23	74	32	42
Large	Pittsburgh, PA	0.70	0.73	0.75	0.76	0.76	0.76	0.78	0.78	0.77	3	9	7	6
Large	Portland-Vancouver, OR-WA	0.81	0.90	[R]1.02	1.15	1.20	1.22	1.22	1.24	1.27	15	59	46	65
Medium	Providence-Pawtucket, RI-MA	[R]0.71	0.83	0.89	0.84	[R]0.86	0.89	0.93	0.95	0.98	16	61	27	24
Medium	Richmond, VA	0.67	0.73	0.75	0.78	0.80	0.81	0.83	0.83	0.83	4	11	16	13
Medium	Rochester, NY	0.51	0.57	0.69	0.77	0.77	0.76	0.77	0.78	0.80	6	17	29	30
Large	Sacramento, CA	0.76	0.88	1.05	1.12	1.17	1.14	1.18	1.20	1.25	13	48	49	68
Small	Salem, OR	0.56	0.64	0.79	0.77	0.79	0.82	0.86	0.85	0.87	8	26	31	37
Medium	Salt Lake City, UT	0.66	0.71	0.84	1.04	[R]1.04	1.01	1.01	1.00	0.97	-3	1	31	37
Large	San Antonio, TX	0.69	[R]0.78	0.74	0.87	0.89	0.92	[R]0.97	[R]1.03	1.05	24	75	36	48
Large	San Bernardino-Riverside, CA	0.78	0.90	[R]1.14	1.16	1.18	1.16	1.20	1.24	1.26	14	51	48	67
Large	San Diego, CA	0.79	0.90	1.19	[R]1.17	[R]1.17	[R]1.18	[R]1.20	1.25	1.32	16	61	53	70
Very large	San Francisco-Oakland, CA	1.06	1.17	1.35	1.34	1.35	1.36	1.37	1.39	1.45	14	51	39	57

TABLE 1-64: Roadway Congestion Index (Continued)

Population group	Urban area	1982	1985	1990	1995	1996	1997	1998	1999	2000	Percent change[a] Short-term 1994-2000 Percent	Rank	Long-term 1982-2000 Percent	Rank
Large	San Jose, CA	1.07	1.13	1.24	1.13	1.11	1.11	1.13	1.19	1.34	19	67	27	24
Large	Seattle-Everett, WA	1.07	1.17	1.21	R1.10	R1.12	R1.16	R1.19	R1.22	1.23	14	51	16	13
Small	Spokane, WA	0.68	0.71	0.74	0.76	0.78	0.80	0.81	0.83	0.82	5	13	16	13
Large	St. Louis, MO-IL	0.87	0.94	0.91	1.00	1.01	1.02	R1.02	1.03	1.03	4	11	16	13
Medium	Tacoma, WA	0.75	0.78	0.91	R1.12	R1.13	1.15	1.18	1.19	1.20	10	35	45	64
Large	Tampa-St. Petersburg-Clearwater, FL	R1.07	R1.12	R1.10	R1.16	R1.14	R1.11	R1.11	R1.12	1.13	-3	1	6	4
Medium	Tucson, AZ	R0.78	0.76	0.89	R0.95	0.97	1.00	1.04	1.05	1.06	11	41	28	27
Medium	Tulsa, OK	0.73	0.75	0.76	0.77	0.79	0.80	0.82	0.83	0.87	12	44	14	11
Large	West Palm Beach - Boca Raton-Delray Beach, FL	0.57	0.65	0.84	0.99	1.00	1.02	1.06	1.11	1.15	17	63	58	75
Very large	Washington, DC-MD-VA	0.99	1.13	1.24	1.32	1.32	1.33	1.35	1.34	1.35	1	6	36	48
	75-Area Average	R0.82	R0.89	R1.01	R1.06	R1.08	R1.10	R1.12	R1.14	1.15	11		33	
	Very Large Area Average	R0.95	R1.03	R1.17	R1.19	R1.21	R1.23	R1.25	R1.26	1.28	11		33	
	Large Area Average	R0.76	0.83	R0.93	R1.01	R1.03	1.05	R1.07	1.09	1.12	13		36	
	Medium Area Average	0.68	R0.73	R0.83	R0.90	R0.92	R0.94	R0.95	R0.97	0.98	10		30	
	Small Area Average	R0.61	R0.66	R0.72	R0.75	R0.76	R0.78	R0.80	R0.81	R0.81	7		20	

KEY: R = revised. Very large urban areas – over 3 million population. Large urban areas – over 1 million and less than 3 million population. Medium urban areas – over 500,000 and less than 1 million population. Small urban areas – less than 500,000 population.

[a] Rank is based on the calculated point change with the lowest number corresponding to a rank of 1.

NOTES

The Roadway Congestion Index (RCI) is a measure of vehicle travel density on major roadways in an urban area. An RCI exceeding 1.0 indicates an undesirable congestion level, on an average, on the freeways and principal arterial street systems during the peak period. The cities shown represent the 50 largest metropolitan areas, as well as others chosen by the states sponsoring the Texas Transportation Institute's study on mobility.

SOURCE

1982 - 2000: Texas Transportation Institute, *The 2002 Annual Urban Mobility Report* (College Station, TX: 2002) from Internet site http://mobility.tamu.edu as of Aug. 1, 2002.

TABLE 1-65: Annual Highway Congestion Cost

Population group	Urban area	Annual congestion cost per capita ($)						Annual congestion cost ($ millions)					
		1998 Value	1999 Value	2000 Value	1998 Rank	1999 Rank	2000 Rank	1998 Value	1999 Value	2000 Value	1998 Rank	1999 Rank	2000 Rank
Medium	Albany-Schenectady-Troy, NY	[R]70	[R]90	115	65	64	62	35	45	60	63	63	62
Medium	Albuquerque, NM[R]	415	435	380	17	19	32	240	260	225	39	41	45
Small	Anchorage, AK[R]	20	20	20	73	73	74	5	5	5	73	73	72
Large	Atlanta, GA[R]	575	530	635	5	9	8	1,615	1,515	1,885	9	9	9
Medium	Austin, TX[R]	385	470	550	18	14	13	265	330	400	37	35	30
Small	Bakersfield, CA[R]	50	50	60	68	71	70	20	20	25	67	67	67
Large	Baltimore, MD[R]	315	335	395	27	31	25	675	720	860	19	19	19
Small	Beaumont, TX[R]	70	70	105	65	68	65	10	10	15	69	71	70
Medium	Birmingham, AL[R]	235	240	285	42	45	40	155	160	190	48	49	47
Very large	Boston, MA[R]	435	470	525	15	14	14	1,310	1,425	1,595	10	10	10
Small	Boulder, CO[R]	0	0	45	74	74	72	0	0	5	74	74	72
Small	Brownsville, TX[R]	0	0	0	74	74	75	0	0	0	74	74	75
Large	Buffalo-Niagara Falls, NY[R]	50	75	95	68	67	67	55	80	105	60	60	60
Small	Charleston, SC[R]	170	195	220	51	50	47	75	85	100	57	58	61
Medium	Charlotte, NC	[R]315	[R]345	410	27	27	23	[R]195	[R]215	265	45	46	41
Very large	Chicago, IL-Northwestern, IN	[R]480	[R]480	505	9	13	17	[R]3,855	[R]3,880	4,095	3	3	3
Large	Cincinnati, OH-KY	[R]315	[R]335	395	27	31	25	[R]400	[R]430	505	26	26	27
Small	Cleveland, OH[R]	170	175	165	51	55	58	315	330	315	31	35	38
Small	Colorado Springs, CO[R]	175	195	235	50	50	44	75	85	110	57	58	59
Large	Columbus, OH[R]	335	365	330	24	26	37	345	380	345	29	30	34
Small	Corpus Christi, TX[R]	30	50	50	72	71	71	10	15	15	69	70	70
Large	Dallas-Fort Worth, TX[R]	505	705	695	8	2	3	1,830	2,650	2,640	8	4	5
Large	Denver, CO	[R]540	[R]560	640	7	8	7	[R]985	[R]1,045	1,225	14	17	16
Very large	Detroit, MI	[R]470	[R]465	475	13	16	20	[R]1,880	[R]1,865	1,905	7	8	8
Medium	El Paso, TX-NM[R]	85	140	185	63	59	55	55	90	120	60	57	57
Small	Eugene-Springfield, OR[R]	45	90	115	70	64	62	10	20	25	69	67	67
Small	Fort Myers-Cape Coral, FL[R]	110	110	105	59	61	65	30	30	30	64	65	65
Large	Fort Lauderdale-Hollywood-Pompano Beach, FL[R]	305	395	520	32	22	16	455	590	810	25	23	20
Medium	Fresno, CA[R]	145	180	215	54	54	49	80	100	120	56	56	57
Medium	Hartford-Middletown, CT[R]	140	190	215	55	52	49	90	120	140	55	54	52
Medium	Honolulu, HI[R]	265	275	225	36	40	46	185	190	155	47	47	50

TABLE 1-65: Annual Highway Congestion Cost (Continued)

		Annual congestion cost per capita ($)						Annual congestion cost ($ millions)					
Population group	Urban area	1998 Value	1999 Value	2000 Value	1998 Rank	1999 Rank	2000 Rank	1998 Value	1999 Value	2000 Value	1998 Rank	1999 Rank	2000 Rank
Very large	Houston, TX	[R]595	[R]705	675	4	2	4	[R]1,905	[R]2,320	2,285	6	6	7
Large	Indianapolis, IN[R]	335	335	385	24	31	29	340	340	395	30	33	31
Medium	Jacksonville, FL[R]	260	265	285	37	42	40	220	225	245	42	44	42
Large	Kansas City, MO-KS[R]	160	200	175	53	48	56	220	275	245	42	40	42
Small	Laredo, TX	55	[R]55	25	67	70	73	10	[R]10	5	69	71	72
Large	Las Vegas, NV[R]	275	310	345	35	36	36	305	355	415	32	31	29
Very large	Los Angeles, CA	[R]1,070	[R]1,095	1,155	1	1	1	[R]13,345	[R]13,770	14,635	1	1	1
Medium	Louisville, KY-IN[R]	350	395	400	21	22	24	290	330	335	36	35	36
Medium	Memphis, TN-AR-MS	[R]235	[R]245	290	42	44	38	[R]230	[R]240	285	40	42	39
Large	Miami-Hialeah, FL	[R]475	[R]505	600	11	10	10	[R]990	[R]1,060	1,365	13	16	11
Large	Milwaukee, WI[R]	230	265	285	44	42	40	300	350	390	33	32	33
Large	Minneapolis - St. Paul, MN	[R]420	[R]485	495	16	12	18	[R]980	[R]1,130	1,220	15	14	17
Medium	Nashville, TN[R]	285	345	395	33	27	25	190	235	275	46	43	40
Large	New Orleans, LA	[R]185	[R]200	195	48	48	52	[R]205	[R]220	215	44	45	46
Very large	New York, NY-Northeastern, NJ	[R]380	[R]420	450	19	20	21	[R]6,215	[R]6,900	7,660	2	2	2
Large	Norfolk-Newport News-Virginia Beach, VA[R]	250	270	230	39	41	45	360	400	345	28	29	34
Large	Oklahoma City, OK[R]	110	140	115	59	59	62	115	145	125	53	50	54
Medium	Omaha, NE-IA[R]	180	190	200	49	52	51	105	115	125	54	55	54
Large	Orlando, FL[R]	465	455	575	14	18	11	520	520	690	24	25	24
Small	Pensacola, FL[R]	135	165	165	56	56	58	40	50	50	62	62	63
Very large	Philadelphia, PA-NJ	[R]260	[R]280	290	37	39	38	[R]1,180	[R]1,280	1,325	12	12	13
Large	Phoenix, AZ[R]	350	460	525	21	17	14	865	1,185	1,360	16	13	12
Large	Pittsburgh, PA	[R]135	[R]155	130	56	58	60	[R]245	[R]280	235	38	38	44
Large	Portland-Vancouver, OR-WA[R]	355	390	445	20	24	22	525	580	670	23	24	25
Medium	Providence-Pawtucket, RI-MA	[R]250	[R]310	365	39	36	35	[R]225	[R]280	335	41	38	36
Medium	Richmond, VA[R]	200	205	195	46	47	52	125	130	125	51	53	54
Medium	Rochester, NY[R]	45	70	75	70	68	69	30	45	50	64	63	63
Large	Sacramento, CA[R]	280	315	385	34	35	29	375	430	540	27	26	26
Small	Salem, OR[R]	105	105	130	61	62	60	20	20	25	67	67	67
Medium	Salt Lake City, UT[R]	135	160	190	56	57	54	120	145	170	52	50	48
Large	San Antonio, TX[R]	245	335	380	41	31	32	300	415	475	33	28	28

Continued next page

TABLE 1-65: Annual Highway Congestion Cost (Continued)

Population group	Urban area	Annual congestion cost per capita ($)						Annual congestion cost ($ millions)					
		1998 Value	1999 Value	2000 Value	1998 Rank	1999 Rank	2000 Rank	1998 Value	1999 Value	2000 Value	1998 Rank	1999 Rank	2000 Rank
Large	San Bernardino-Riverside, CA[R]	480	490	575	9	11	11	670	685	810	20	22	20
Large	San Diego, CA[R]	310	400	480	31	21	19	820	1,080	1,295	17	15	15
Very large	San Francisco-Oakland, CA	[R]570	[R]630	795	6	6	2	[R]2,285	[R]2,535	3,210	4	5	4
Large	San Jose, CA[R]	475	565	635	11	7	8	780	945	1,065	18	18	18
Large	Seattle-Everett, WA	[R]620	[R]675	660	2	4	5	[R]1,225	[R]1,345	1,315	11	11	14
Small	Spokane, WA[R]	75	90	90	64	64	68	25	30	30	66	65	65
Large	St. Louis, MO-IL[R]	325	345	395	26	27	25	645	695	805	22	21	22
Medium	Tacoma, WA	[R]220	[R]290	280	45	38	43	[R]130	[R]175	170	49	48	48
Large	Tampa-St Petersburg-Clearwater, FL[R]	[R]350	[R]375	380	21	25	32	[R]650	[R]715	745	21	20	23
Medium	Tucson, AZ[R]	195	210	220	47	46	47	130	140	150	49	52	51
Medium	Tulsa, OK[R]	100	105	170	62	62	57	75	80	135	57	60	53
Large	W Palm Bch-Boca Raton-Delray Bch, FL[R]	315	345	385	27	27	29	300	340	395	33	33	31
Very large	Washington, DC-MD-VA	[R]620	[R]655	655	2	5	6	[R]2,170	[R]2,320	2,325	5	6	6
	75-Area Average[a,R]	433	471	507				56,055	61,555	67,355			
	Very Large Area Average[a,R]	572	615	648				35,975	38,945	41,675			
	Large Area Average[a,R]	344	380	424				16,580	18,580	21,165			
	Medium Area Average[a,R]	218	248	273				3,170	3,650	4,075			
	Small Area Average[a,R]	90	102	115				330	380	440			

KEY: R = revised. Very large urban areas - over 3 million population. Large urban areas - over 1 million and less than 3 million population. Medium urban areas - over 500,000 and less than 1 million population. Small urban areas - less than 500,000 population.

[a] For the year 2000, data was obtained from table A-9 from the Texas Transportation Institute's *The 2001 Annual Urban Mobility Report* referenced below. For other years, the averages were calculated using data obtained from the web site.

NOTES

The cities shown represent the 50 largest metropolitan areas, as well as others chosen by the states sponsoring the Texas Transportation Institute study on mobility.

The cost of congestion is estimated with a value for each hour of travel time and each gallon of fuel. For a more detailed explanation of the formulas used, see the source document.

The source, for the year 2001, decided to only publish congestion cost per capita, contrary to previous years when the source would publish data for eligible drivers, as well as per capita. To account for this change, the entire table has been updated to reflect the data based on congestion cost per capita.

SOURCE

1998-2000: Texas Transportation Institute, *The 2001 Annual Urban Mobility Report* (College Station, TX: 2001) obtained from Internet site http://mobility.tamu.edu as of Aug. 6, 2002.

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TABLE 3-6: National Transportation and Economic Trends

	1960	1965	1970	1975	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001
Passenger-miles (billions)	1,327	1,630	2,170	2,561	2,895	3,326	3,946	4,333	4,483	4,623	4,749	4,904	U	U
Index (1980 = 100)	46	56	75	88	100	115	136	150	155	160	164	169	U	U
Ton-miles (billions)	1,562	1,854	2,207	2,285	2,989	2,949	3,196	3,648	3,725	3,682	3,710	3,814	U	U
Index (1980 = 100)	52	62	74	76	100	99	107	122	125	123	124	128	U	U
Population[a] (millions)	181	194	205	216	228	238	250	263	266	268	270	273	R282	285
Index (1980 = 100)	79	85	90	95	100	R105	110	116	117	118	119	120	R124	125
Industrial Production Index[b] (1992 = 100)	37	50	59	63	80	88	99	114	120	128	R135	R139	R146	P140
Gross Domestic Product														
Current$ (billions)	527	720	1,040	1,635	2,796	4,213	5,803	7,401	7,813	8,318	8,792	R9,274	R9,825	10,082
Index (1980 = 100)	19	26	37	58	100	151	208	265	279	R297	R313	R332	R351	361
Chained 1996 $ (billions)	2,377	3,029	3,578	4,084	4,901	5,717	6,708	7,544	7,813	8,160	8,509	R8,859	R9,191	9,215

KEY: P = preliminary; R = revised; U = data are not available.

[a] Annual estimates as of July 1. Includes Armed Forces abroad.

[b] Industrial Production Index covers manufacturing, mining, and utilities.

SOURCES

Passenger-miles:
1960-99: Summation of all modes from the passenger-miles table in chapter 1.

Ton-miles:
1960-99: Summation of all modes from the ton-miles table in chapter 1.

Population:
1960-99: U.S. Department of Commerce, Census Bureau, *Statistical Abstract of the United States, 2000* (Washington, DC: 2001), table 2.
2000-01: U.S. Department of Commerce, Census Bureau, *USA Statistics in Brief, supplement to Statistical Abstract of the United States*, available at Internet site http://www.census.gov/statab/www/part1.html as of April 2001.

Industrial Production Index:
1960-2001: Council of Economic Advisors, *Economic Report of the President* (Washington, DC: February 2002), table B-51.

Gross Domestic Product:
1960-97: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business* (Washington, DC: August 1998), table 1, pp. 147-148 and table 2A, pp. 151-152.
1998-2001: Ibid., http://www.bea.gov/bea/dn/gdplev.xls as of Sept. 20, 2002.