Application of the Logistics Cost Model: Market Analysis of FastShip

by

William A. Gassman

B.S., Naval Architecture and Marine Engineering
Webb Institute of Naval Architecture, 1994

Submitted to the Department of Ocean Engineering
in Partial Fulfillment of the Requirements for the
Degree of

Master of Science in Ocean Systems Management (13-B)

at the

Massachusetts Institute of Technology

June, 1996

Signature of Author........................ ....
Department of Ocean Engineering

Certified by..
Henry S. Marcus
Professor of Marine Systems

Accepted by..
A. Douglas Carmichael
Professor of Power Engineering
Chairman, Ocean Engineering Departmental Graduate Committee

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Abstract

FastShip aspires to be a transportation innovation that will open an entirely new service option to trans-Atlantic shippers. Assuming the technological aspects of FastShip deliver upon their promises, FastShip offers dramatically superior service at somewhat higher costs than its maritime competition, while providing significantly lower costs with only a small decrease in service quality compared to its air freight competition. These characteristics position FastShip in the shipping market between existing air and ocean services. FastShip, in effect, operates in a large intermediate market niche that is currently serviced quite poorly.

The research work contained in this thesis estimates the potential market of the FastShip innovation by comparing the logistics costs of the FastShip to the logistics costs of both the ocean freight and the air freight competition. This comparison was accomplished using a logistics cost model developed in the research work for this thesis. All of the commodities shipped between the United States and Northern Europe are analyzed in the logistics cost model in order to generate a complete estimate of FastShip's potential market share.

Also included in the logistics cost model is the calculation of stimulated demand. The stimulated demand for the FastShip innovation was calculated using the price elasticities of the commodities. The stimulated demand for cargoes to be shipped via FastShip were included in the estimate of the FastShip's potential market share.

Acknowledgments

I am thankful for the support of FastShip Atlantic, which funded the research for this thesis. In addition, I am indebted to Professor Hank Marcus for his allowing me the privilege to study at MIT and to work with him on this project.

I would also like thank Senior Research Associate, Ray Ausrotas, independent consultant, Kathryn Riepe-Chambers, and graduated CTS student, William Cowart for their help in providing data for this project.

While I have benefited from the assistance of all the above individuals, I alone take responsibility for the views put forth in this thesis and for any errors or omissions it contains.

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1. Introduction

This thesis is a result of research conducted by the Center of Transportation Studies at M.I.T. in the development of the Phase II Market Analysis for the FastShip program. FastShip aspires to be a transportation innovation that will open an entirely new service option to trans-Atlantic shippers. Assuming the technological aspects of FastShip deliver upon their promises, FastShip offers dramatically superior service at somewhat higher costs than its maritime competition, while providing significantly lower costs with only a small decrease in service quality compared to its air freight competition. These characteristics position FastShip in the shipping market between existing air and ocean services. FastShip, in effect, operates in a large intermediate market niche that is currently serviced quite poorly.

The Phase I Market Analysis validated the "Value Creation Model" created by FastShip Atlantic. FastShip's "Value Creation Model" is a logistics cost model assessing the logistics cost advantage of FastShip over conventional ocean and air freight modes under certain situations. This thesis expands and applies the methodology used in the creation of the "Value Creation Model" to assess the potential market share of the FastShip freight mode, based upon 1994 ocean freight and air freight shipping statistics.

The principle advisor for this analysis has been Professor Henry Marcus, Department of Ocean Engineering, with additional contributions and supervision provided by Professor Robert Simpson, Department of Aeronautics and Astronautics, and Ray

Ausrotas, Senior Researcher at the Flight Transportation Laboratory. The underlying research and analysis was conducted by William Gassman, research assistant in the Ocean Systems Management Program. William Cowart provided most of the background material and was responsible for much of the initial work into this project. Kathryn Riepe-Chambers of FastShip provided some of the source materials and data.

2. Phase I Market Analysis

The methodology for comparing the conventional ocean freight and air freight to the revolutionary mode of transportation called FastShip was evaluated and justified in the Phase I Marketing Analysis. The methodology analyzed in Phase I was the logistics cost model, also known as the Value Creation Model. The Phase I model describes the benefits to given customers if the FastShip option is used in shipping cargo. A copy of this model is provided in the Phase I report.

Certain assumptions were used in the Phase I report that made analysis possible. From the FastShip Atlantic proforma, it was determined the FastShip delivery time would be 7 days door to door at a rate of $3,600 per FEU. Also based upon FastShip provided data, the assumed ocean freight delivery time is 21 days at a rate of $1,800 per FEU and the air freight delivery time is 3 days at a rate of $0.60 per pound of cargo shipped.

A wide range of sensitivity analyses were conducted in order to determine the robustness of model results in regard to the parameter assumptions utilized. Unsurprisingly, the parameters that demonstrated the greatest impact on model results were commodity value and inventory carrying charge. Overall, the sensitivity analysis of the Value Creation model demonstrated that the specification and inputs utilized provide an extremely robust, conservative estimate of the benefits of FastShip in the trans-Atlantic market.

2.1 PHASE I FASTSHIP LOGISTICS COST MODEL

The total logistics cost model is based on the "total cost concept" or evaluating the true total cost of transporting commodities. This cost of shipping is not only the freight rate seen by the shipper, but also a variety of other distribution costs. Historically, these costs were uncoordinated and were under the management of different corporate divisions. By 1965, it had been realized that coordination of these costs was necessary to focus on minimizing total logistics costs. Although the problem was identified, it was not common practice to coordinate logistics costs to minimize costs.

Since then, documentation on how to coordinate logistical practices has introduced a potential for the FastShip market. Since companies are more sensitive to decreasing their logistics cost, the introduction of FastShip is a viable alternative to conventional ocean and air shipments. For the purpose of demonstrating their logistical superiority to ocean and air freight for the shipment of certain high value time sensitive (HVTS) cargo, a logistics cost model was prepared. The logistics cost model is in fact a total logistics cost analysis of the benefits to given customers, shipping certain commodities of high value and time sensitive.

3. Methodology for Market Analysis

This thesis sets out to expand the methodology developed in Phase I and to apply it to a variety of different cargoes shipped in the trans-Atlantic market. All of the cargo shipped between Northern Europe and America in 1994 can be categorized into 1,250 different commodity segments. For these 1,250 different commodities, import and export data was incorporated into the logistics cost model so as to model the real potential market for FastShip in the trans-Atlantic trade. The purpose of the FastShip logistics cost model in this thesis is two fold; first, the model demonstrates for which cargoes FastShip has potential market share, and second, the model calculates the increase in demand stimulated by the advent of the FastShip technology, otherwise known as stimulated demand. The following sections discuss the creation of the logistics cost model and methodology of the stimulated demand calculation.

4. FastShip Logistics Cost Model

The crux of this analysis was to construct a logistics cost model for all of the commodities shipped between the United States and Northern Europe. Results of this model can be found in the Results section following this report. Also included with this report is a Glossary defining in great detail each variable and equation used for this model.

It should be emphasized that this model deals with an approximation of the total shipping market of all commodities shipped between Northern Europe and the United

States. The weight and value of cargo that was shipped via air and ocean are known, from which tne number of containers are calculated. Here are a few of the assumptions made in this model.

1. All commodities are assumed to be containerizable. This was done so as to be consistent with all commodities being analyzed in case cargoes typically not containerizable would be containerizable if FastShip existed. As a result, the number of containers that the model calculates to be in the ocean freight market is artificially high.

2. All results given as a percentage of ocean or air freight are percentages of this calculated total, not the actual containerized market totals.

3. Only one commodity was assumed to be shipped in a container at a time. The model does not consider the mixing of different commodities in the same container.

The following headings describe the steps by which the logistics cost model was constructed. Included under these headings are basic explanations of what was calculated and why it was calculated. The equations that were used are not included in this section, but rather are included in the Glossary section of this report.

4.1 MODEL CHARACTERISTICS

The first step in the construction of the model was to collect the data on the commodities. When in operation, FastShip will service the two ports of Philadelphia, United States and Zeebrugge, Belgium; therefore, for the purposes of this analysis it was necessary to identify the quantity and value of all the commodities shipped between these two ports. The Center of Transportation Studies at M.I.T. had access to databases itemizing the weight of cargo and the value of cargo shipped between customs districts in the United States and custom districts in Northern Europe. With this information accessible, it was deemed sufficient to consider FastShip's target markets to exist in custom districts within 500 miles of the port of Philadelphia and in countries within 500 miles of the port of Zeebrugge. A 500 mile radius was chosen because it was assumed that for custom districts outside the 500 mile radius that the speed advantage FastShip offers above ocean freight would be dissipated. Nevertheless, it should be noted that our analysis excludes potential FastShip cargo more than 500 miles from the ports.

The US Imports and Exports Database used for this study defines custom districts as those areas from which cargo either enters or exits the United States; the custom district is not necessarily the area in which the commodity originates from or is destined to go, but rather the point at which the commodity passes through customs.

The US Imports and Exports Database defines European countries in somewhat different terms. The database considers countries to be the area in which the commodity originates from or is destined to go, and not the country the cargo enters into when that cargo reaches Europe. For example, car parts shipped via ocean freight from the United States destined for Paris might be unloaded from the steam ship in Zeebrugge, Belgium. The database uses the cargo's ultimate destination of France and not the country to which it was shipped, in this case Belgium, for listing the cargo transaction.

Import and export schedules are based on the international standard coding system called the Harmonized Commodity Description and Coding System (HS). Under this system, each commodity is assigned a ten digit code, with the first two digits representing the heading position in that chapter, and the second two digits representing subdivisions (subheadings) under that heading. In order to minimize the number of commodities to be dealt with in this analysis, all commodities were categorized by their first four digits. For example, the two digit HS code of 01 represents the heading "Live Animals", or all commodities that fall under the heading "Live Animals". A four digit HS code 0102 represents the subheading of "Bovine Animals, Live", or all commodities that fall within the "Bovine Animal, Live" subheading, under the heading "Live Animals". With a four digit HS code, the number of commodities considered in this model was limited to approximately 1,250.

Using the "US Exports History and US imports History" Database compiled by the Bureau of the Census under the supervision of the US Department of Commerce, the weight and value of ocean going cargo and air going cargo shipped between Customs Districts within 500 miles of Philadelphia and 500 miles of Zeebrugge in 1994 of all commodities under the four digit HS code system was collected and collated.

Other data collected for the necessary calculations of this model included the weight densities of the commodities being shipped. The Bureau of the Census database did not include weight densities of each commodity being shipped, therefore these values were obtained from another source. The source used for this purpose was the United Nations Standard International Trade Classification Index Division Report, *Average Densities by Commodity and Division.* This report did not itemize commodities by the international standard four digit HS coding system; therefore, values were selected for the four digit HS coded commodities based upon items from the United Nation report that seemed to have a similar weight density.

Value density is an important concept for this logistics cost model. Value density can be defined as the value of cargo shipped via a particular transportation mode, be it ocean freight, air freight, or FastShip, divided by the weight of the cargo being shipped. Commodities with high value densities have a high value per unit pound of weight, therefore, are candidates for faster transport alternatives. Using the data entered into the model, ocean freight value densities and air freight value densities were calculated. For specifics on the calculations see the Glossary section and for specifics on results see the Results section.

Another important calculation for the model is the number of containers of each commodity that were shipped via ocean freight and air freight in 1994. This is an estimated value; in real life containers are not necessarily packed only with one specific type of commodity, but often with a combination of different commodities. Also, certain commodities, such as ore and oil, are never shipped in containers. However, for the purpose of this analysis, it was necessary to assume all cargo was containerizable and that all of the same commodity was shipped in the same container to the limit, be it weight limit or volume limit, of however much cargo the container can hold. Although this is a calculated value, the knowledge of the number of containers shipped via ocean freight and air freight can allow FastShip to estimate the number of containers it might capture from ocean freight and air freight. For specifics on the calculations see the Glossary section and for specifics on results see the Results section. For this model, a container is defined as a forty foot equivalent unit high cube container (FEU), a box 40 feet long, 8 feet wide, and 9.5 feet high, with a weight limit of 59,000 pounds that is used for shipping cargo.

4.2 COMMODITY ATTRIBUTES

It should be stressed that the purpose of this market report is to use the logistics cost methodology developed in the Phase I report to develop a Logistics Cost Model for all commodities being shipped between Northern Europe and the United States. Many of the commodity attributes used in the Logistics Cost Model are broad generalizations, thereby potentially causing inaccuracies in the model results of this particular report. It was determined that the methodology of the model and the structure of the model are sound; however, the observation was made that the accuracy of this model's results is a function of the accuracy of the commodity attributes used in this model.

For each commodity certain assumptions had to be made about their attributes so that logistics costs could be calculated. The definition of specific commodity attributes can be found in the Glossary. The annual carrying charge was assumed to be 22.5% for all commodities. This value was obtained from literature as a typical conservative value (Lambert and Stock.) The demand period, shelf life, and salvage value were assumed to be 365 days, 365 days and 90% respectively. However, for certain commodities these values were deemed inadequate; therefore, different values were used. The following table shows what assumptions were made for specific commodities for these three particular attributes.

CMO4	DESCRIPTION	VALUES ASSUMED AND SOURCE
01XX	Live Animals	Shelf Life - 21 days (assumed) Salvage Value - 0.25 (assumed)
02XX	Meat	Shelf Life - 45 days (Restaurant Hospitality, v 78, i 6, June 1994) Salvage Value - 0.25 (assumed)
03XX	Fish	Shelf Life - 45 days (assumed the same as meat) Salvage Value - 0.25 (assumed)
04XX	Dairy/Eggs/Honey	Shelf Life - 60 days (assumed) Salvage Value - 0.25 (assumed)
05XX	Products of Animals	Shelf Life - 45 days (assumed the same as meat) Salvage Value - 0.25 (assumed)
06XX	Live plants / Cut flowers	Shelf Life - 14 days (assumed) Salvage Value - 0.25 (assumed)
0601	Bulbs, tubers, etc.; chicory plants and roots nesoi	Shelf Life - 30 days (assumed) Salvage Value - 0.25 (assumed)
0604	Foliage, grasses, etc. for bouquets, etc.	Shelf Life - 20 days (assumed) Salvage Value - 0.25 (assumed)
07XX	Vegetables	Shelf Life - 45 days (assumed) Salvage Value - 0.25 (assumed)
08XX	Fruits and Nuts	Shelf Life - 45 days (assumed) Salvage Value - 0.25 (assumed)
09XX	Coffee and Spices	Shelf Life - 300 days (Packaging, v 39, i 11, Nov. 1994) Salvage Value - 0.50 (assumed)

CMO4	DESCRIPTION	VALUES ASSUMED AND SOURCE
10XX	Cereals	Shelf Life - 90 days (assumed) Salvage Value - 0.25 (assumed)
11XX	Malt	Shelf Life - 90 days (assumed) Salvage Value - 0.25 (assumed)
12XX	Oil seeds / Grain	Shelf Life - 60 days (assumed) Salvage Value - 0.25 (assumed)
13XX	Gums	Shelf Life - 90 days (assumed) Salvage Value - 0.25 (assumed)
14XX	Vegetable Material	Shelf Life - 90 days (assumed) Salvage Value - 0.25 (assumed)
15XX	Fats	Shelf Life - 180 days (assumed) Salvage Value - 0.25 (assumed)
16XX	Edible prep. of Meat / Fish	Shelf Life - 135 days (assumed) Salvage Value - 0.25 (assumed)
17XX	Sugars	Shelf Life - 365 days (assumed) Salvage Value - 0.25 (assumed)
18XX	Cocoa	Shelf Life - 365 days (assumed) Salvage Value - 0.25 (assumed)
19XX	Flour prep.	Shelf Life - 180 days (assumed) Salvage Value - 0.25 (assumed)
20XX	Plant parts	Shelf Life - 180 days (assumed) Salvage Value - 0.25 (assumed)
21XX	Edible prep.	Shelf Life - 120 days (Packaging Digest, v32, i 8, July 1995) Salvage Value - 0.25 (assumed)
23XX	Animal feed	Shelf Life - 180 days (assumed) Salvage Value - 0.25 (assumed)

CMO4	DESCRIPTION	VALUES ASSUMED AND SOURCE
49XX	Newspapers / Magazines	Shelf Life - 42 days (Advertising Age, v 61, i 33, Aug. 13, 1990) Salvage Value - 0.50 (assumed)
59XX	Impregnated Text Fabrics	Demand Period - 180 days (assumed)
60XX	Crochet Fabrics	Demand Period - 180 days (assumed)
61XX	Apparel - Knit	Demand Period - 180 days (assumed)
62XX	Apparel - Non-knit	Demand Period - 180 days (assumed)
85XX	Electronics / Sound / T.V.	Shelf Life - 180 days (assumed) Salvage Value - 0.90 (assumed)

A decay parameter of less than one represents a commodity that decays dramatically early during its shelf life and less towards the end of its shelf life. A decay parameter of greater than one represents a commodity that decays dramatically late in its shelf life and less during the beginning of its shelf life. Since little data could be found relating shelf life cycles to individual commodities, a value of 4.0 was assumed to be typical. However, for some commodities a decay parameter of less than one is more appropriate. For example, high fashion items and newspapers lose their value quickly, approaching their salvage value very early in their shelf life.

The following is a list of items that were assumed a decay parameter less than 1.0:

CMO4	DESCRIPTION	VALUE ASSUMED
49XX	Newspapers	Decay Parameter = 0.50
59XX	Text Fabrics	Decay Parameter = 0.50
60XX	Crochet Fabrics	Decay Parameter = 0.50
61XX	Apparel - Knit	Decay Parameter = 0.50
62XX	Apparel - Non-Knit	Decay Parameter = 0.50
63XX	Linens	Decay Parameter = 0.50
64XX	Footwear	Decay Parameter = 0.50
65XX	Hats	Decay Parameter = 0.50
66XX	Umbrellas and Walking Sticks	Decay Parameter = 0.50
84XX	Machinery and Machinery parts	Decay Parameter = 0.50
85XX	Electronics	Decay Parameter = 0.50
87XX	Motor Vehicles	Decay Parameter = 0.50
88XX	Balloons and Gliders	Decay Parameter = 0.50
89XX	Boats and Vessels	Decay Parameter = 0.50
90XX	Optical Elements (incl fiber optics)	Decay Parameter = 0.50

Warehouse cost was assumed to be $0.00. The coefficient of variation of daily sales was taken from Lambert and Scott to be 20% for all commodities considered in this model. The storability of the container was assumed to be a conservative value of 100%.

For a more complete definition of all terms under the Commodity Attribute heading see the Glossary.

4.3 MODAL CHARACTERISTICS

The next step in the creation of the logistics cost model was to define the modal characteristics of the ocean freight, air freight, and FastShip. Freight rates were taken to be $1,800 per FEU for ocean freight, $0.60 per pound for air freight, and $3,600 per FEU for FastShip. The standard deviation of transit times were taken to be 3.15 days for ocean freight, 0.5 days for air freight, and 0.5 days for FastShip. Detail explanation of where these values were obtained can be found in the Glossary.

The door to door transit times were assumed as 21 days for ocean freight, 3 days for air freight, and 7 days for FastShip.

4.4 TOTAL LOGISTICS COST CALCULATIONS

In this next step in the creation of the logistics cost model, the logistics costs were calculated for the three modes of transport considered in this analysis; ocean freight, air freight, and FastShip. The logistics costs are the costs incurred by the shipper for shipping a commodity from one destination to another. Besides the freight rate, the shipper must absorb the costs of having cargo sit in a warehouse waiting to be shipped and sitting on a ship/airplane while in transit from origin to destination.

A description of the logistics costs considered in this model follows this paragraph. For more complete definitions and equations see the Glossary section and for results see the Results section. The following logistics costs were calculated for each of the 1,250 commodities being considered, for each of the three modes of transportation being compared (ocean, air, and FastShip.) Also for each mode of transport, the logistics costs were calculated with a value density of ocean going freight and a value density of air freight. The result, was a calculation of logistics costs for each of the commodities considered under the following headings:

Logistics Cost of Ocean Freight with an Ocean Value Density
Logistics Cost of Ocean Freight with an Air Value Density
Logistics Cost of Air Freight with an Ocean Value Density
Logistics Cost of Air Freight with an Air Value Density
Logistics Cost of FastShip with an Ocean Value Density
Logistics Cost of FastShip with an Air Value Density

The total logistics cost of ocean freight with a ocean value density was compared with the FastShip total logistics cost with a value density for all 1,250 commodities being considered in this analysis. The mode of transportation that yielded the lower logistics cost for a particular commodity was deemed the best option for the shipment of that commodity. A similar comparison was performed for air freight and FastShip, however, the air value density was used instead. For example, when considering which mode of transport (ocean versus FastShip) to ship a particular commodity that went by ocean in 1994, the logistics costs of both modes with the ocean value density were compared(logistics cost of ocean freight with an ocean value density vs. logistics cost of FastShip with an ocean value density). The mode with the lower logistics cost was assumed in the model to take all of the cargo via that mode.

The spreadsheet of the model is in Microsoft EXCEL format. A Glossary of terms used in the commodity matrix is included with this report. All other information in this matrix was derived from other sources; for example, the densities of the commodities were taken from the United Nations Standard International Trade Classification Index Division Report. The Glossary describes in detail the source of each term.

4.4.1 DEFINITION OF LOGISTICS COSTS

In general, the shipment of goods by ocean involves larger amounts of cargo, less frequency of shipment, longer transit times, and less reliability than shipment by air. With knowledge of these differences, a list of six factors that contribute to logistics cost can be considered:

1. **Origin Inventory Cost**: The interest charges on goods awaiting shipment

2. **In-Transit Inventory Cost**: The interest charges on goods in transit

3. **Safety Stock Cost:** The interest charges on goods held as safety stock

4. **Perishable Cost**: The loss, damage, or decay of goods between manufacture and sale

5. **Cost of Transportation**: The direct cost paid for shipping a commodity

6. **Origin Warehouse Costs**: The cost paid for warehouse space

The first four costs are directly related to the value of the product to be shipped and therefore are dependent upon the value of the cargo; the more expensive the cargo, the more these costs increase. The fourth is also related to the product's perishability. This value becomes more important as the ratio of product life and transit time approaches one. The fifth varies with the terms of the shipper's contract agreements with his carrier; long term contracts are typically more attractive cost-wise for the shipper than being faced with negotiating prices and terms for each individual shipment. Number five, also, will be related to the speed of the vehicle chosen and the number of units of freight it will carry. A fast moving, low volume vehicle (i.e. air freight) will be considerably more costly to operate on a cost per ton basis than a vehicle with high capacity and lower speed. Number six is a variable cost, dependent upon the country, region and city, the amount of technology employed, whether or not refrigeration is used, and the type of demand for the commodity.

The next few headings will investigate each of these costs in more detail. All of the equations used in explaining these costs are from "The Customer's Perspective: A Logistics Framework" by C.D. Martland, January 1992, and a M.I.T. thesis, *Freight Mode Choice: Air Transport Versus Ocean Transport in the 1990's* by Dale Lewis.

4.4.1.1 ORIGIN INVENTORY COST:

As a manufacturer produces goods, they are accumulated until reaching a quantity that is deemed large enough to make a shipment. When the shipment is made, the quantity on hand becomes zero and, as more goods are manufactured, they again accumulate up to a given value before the next shipment goes out. The average amount of stock on hand is the average shipment size divided by 2. The cost of holding this stock is called the origin inventory cost.

Value density and average shipment size are directly proportional to the origin inventory cost. A doubling in the value of the goods or the size of shipment represents a doubling of the origin inventory cost. For a more complete definition and equation for origin inventory cost see the Glossary.

4.4.1.2 IN TRANSIT INVENTORY COST:

Goods may be sold to a buyer in a variety of ways. The buyer may take delivery of the goods at the manufacturing plant, at his own facility or at some point in between. During the time goods are in transit, they are in effect a moving inventory.

Value density and transit time are directly proportional to the in-transit inventory cost. A doubling in the value of the goods or the transit time of the shipment represents a doubling of the in-transit inventory cost. For a more complete definition and equation for in-transit inventory cost see the Glossary.

4.4.1.3 SAFETY STOCK COST:

Transportation systems are not normally perfectly reliable. The mean transit time may have a standard deviation that ranges from very small to very large. A shipper can protect himself from a stockout by holding a reserve, called a safety stock. Assuming that the distribution between a specific origin and destination pair is normally distributed, the shipper can choose the level of protection from stockout that he desires by choosing a stockout volume that is a multiple of the standard deviation for the particular origin-destination pair.

Value density and the square root of transit time are directly proportional to the safety stock cost. A doubling in the value of the goods represents a doubling of the safety stock cost. For a more complete definition and equation for safety stock cost see the Glossary.

4.4.1.4 PERISHABLE COST:

Products vary greatly in their ability to hold value. Some goods have a short physical life (i.e. fresh flowers) and must be delivered to their destination quickly, or not at all. Other goods have their highest value early in the selling season (i.e. clothes) and are worth less as the season ends.

Other products have life cycles that extend beyond a single season or even a single year. For these goods, it is necessary to make accurate forecasts concerning demand occurring near the end of the cycle, so that the shipper is not left with excess inventory.

Costs due to loss of product value are determined by the change in demand or product condition. The expression for perishable cost has four components:

1. Salvage value at the end of the products life. The greater the salvage value, the lower the perishable cost because more of the value of the commodity is retained at the end of the commodity's shelf life.

2. Value of the good being shipped. Value density is directly proportional to the perishable cost. A doubling in the value of the goods represents a doubling of the perishable cost..

3. The ratio of transit time and the product's life. As the transit time approaches the product's life span, the perishability cost increases. There is an advantage to minimizing the time the goods spent in transit; if the transit time can be decreased (i.e. through an innovation such as FastShip) the logistical cost incurred by having the good decay while in transit may be decreased as well.

4. A decay parameter that determines the rate of decay in the value of the good being shipped. This parameter determines if the good loses its value at a constant rate daily, at a small rate at the beginning of the product's life and at a more dramatic rate near the end of the product's life, or at a large rate at the beginning of the product's life and at a less dramatic rate near the end of the product's life. As was

discussed under *Commodity Attributes*, for this analysis the default value for decay parameters were assumed to be 4.0 or 0.50.

For a more complete definition and equation for perishable cost see the Glossary.

4.4.1.5 COST OF TRANSPORTATION

The cost of transportation is the price charged by the carrier for the movement of goods from origin to destination. It includes all modes (i.e. truck, train, and ship or airplane) involved and the transfers between modes. In general, faster service and smaller cargo volumes result in higher freight rates. The expense of this faster transportation service, may or may not be offset by lower inventory costs.

4.4.1.6 ORIGIN WAREHOUSE COST

The origin warehouse cost is not a constant value; this cost is heavily dependent upon the country, region and city, the amount of technology employed, whether or not refrigeration is used, and the type of demand for the commodity. Deciding upon origin warehouse costs for goods would be very difficult and labor intensive, therefore for this purpose of comparing logistics costs for the three methods of transportation (air freight, ocean freight, and FastShip) the origin warehouse cost was not considered. It was assumed for all three modes of transport (air, ocean, and FastShip) that the cargo would be delivered just in time, therefore, short term origin warehouse costs would be incurred for origin warehouse storage. For the purpose of this model, origin warehouse costs were assumed fixed in the short term, therefore, a conservative value for origin warehouse costs is $0.00.

4.4.1.7 TOTAL LOGISTICS COST:

The total logistics cost is the sum of all of the above costs (origin inventory cost, in-transit inventory cost, safety stock cost, perishable cost, cost of transportation, and origin warehouse costs.) Existing commodity shipping data (i.e. the weight and value of cargo shipped in 1994 via both ocean and air) is used to calculate the value densities used in the logistics cost calculations, therefore, the model can accurately predict which mode of transport a commodity will prefer.

Since ocean freight typically has a lower value density than air freight, it was important to distinguish between the two within each commodity type. The total logistics cost of ocean freight with an ocean value density was compared to the logistics cost of FastShip with an ocean value density. The mode with the lower total logistics cost was chosen as the mode to carry all of the ocean freight that was previously carried via ocean freight in 1994.

A similar process was followed for commodities that were shipped via air freight in 1994. The air freight logistics cost was compared with the FastShip logistics cost, using an air value density, and the lower of the two was assume to carry all of the air freight that was previously carried via air freight in 1994.

For a detailed description of results see the Results section.

4.5 STIMULATED DEMAND

An important economic concept is that of stimulated demand: demand that exists, but that is currently unmet due to an inadequate supply or unfavorable conditions. It is clear that the niche market FastShip hopes to attract will stimulate increased demand for the service for certain commodities being shipped; certain commodities that are sensitive to both the slow speed of ocean freight and the high cost of air freight, will increase their demand for the FastShip service that lies in between.

The Own Price Elasticity (OPE) is use to calculate the stimulated demand for FastShip. If FastShip can ship the commodity faster, at a reduced total logistics cost, the percent decrease in cost causes a percent increase in demand for the commodity. The OPE values were obtained from a variety of sources. Of the 1,250 commodities considered, 448 have OPE's entered into the model. The elasticities for these 448 different commodities were determined through extensive research; a table of the elasticities used and their sources can be found following this report under Elasticities. If the elasticity of a commodity could not be determined, it was assumed. The model was run with two different assumed values for the default OPE; the first OPE was assumed to be unit elastic at -1.0 (*Economics*, Lipsey, Steiner, and Purvis) and the second was assumed to be elastic at -1.4 (*A Survey of Recent Estimates of Price Elasticities of Demand for Transportation*, Oum, Waters, and Yong.) See the section following this report entitled Stimulated Demand for results.

Results for stimulated demand were then obtained by multiplying the percentage decrease in delivered price (the difference between the FastShip logistics cost and the next best competitor) by the derived OPE. This methodology was created in the Phase I of this study. According to the Phase I report, this methodology provides a conservative, lower-bound estimate of the percentage increase in demand for trans-Atlantic shipment stimulated by FastShip.

5. Model Test

Before developing results from the logistics cost model, a test was run to identify the robustness of the model. The test compared the logistics cost of ocean freight to the logistics cost of air freight; whichever mode had a lower logistics cost was assumed to take all of the cargo via that transportation mode. It is important to note that in the Model Test we are assuming that the total market of containers (via ocean and via air) are calculated values; the total number of containers calculated in the model are not the actual number of containers that were shipped in 1994.

For the assumptions for the Commodity Attributes outlined above and for an air freight rate of $0.60 per pound and a maximum weight of a FEU at 26.8 MT (59,000 lbs) the model estimates that 59.6% of the containers that went by air freight in 1994 would go by air freight in the model, at a value of 85.6% of the total value of all air freight in 1994. The remaining 40.4% of the air freight containers was diverted to ocean freight in the model test. This can be attributed to several different reasons:

1. A "winner takes all" situation was assumed where if the logistics cost of air was less than the logistics cost of ocean, then it was assumed all ocean freight and air freight was diverted to air freight, and vice versa for ocean freight.

2. The air freight rate ($0.60 per pound) and the ocean freight rate ($1,800 per FEU) are average values for all commodities being considered. In actuality, for different commodities there are different freight rates. Therefore, by assuming all commodities to have the same average freight rate the model could incorrectly divert certain commodities from air freight to ocean freight.

3. Certain commodities are shipped via air freight for reasons that cannot be explained by the model. One example, might be a manufacturer that ships a low cost, high shelf life item via air freight to avoid the potential stockout scenario in one of its manufacturing facilities. Whereas, the model can capture the logistics cost considerations quite accurately, the model cannot capture non-cost considerations, or costs not associated with the logistics costs.

Despite the fact the Model Test did not calculate all air freight would be diverted to air and all ocean freight would be diverted to ocean, we felt with the limitations of the model listed above, the test showed the model was sufficient. The test showed that 40.4% of the air cargo at 14.4% of the air value was diverted from air to ocean. With improvements made to the Commodity Attributes these figures can be improved.

The model diverted to ocean freight 40.4% of the air freight by weight. This 40.4% of the air freight represented only 24.6% of the total value of the air freight shipped in 1994. This demonstrates the fact that the model test is diverting the low value air freight to ocean freight. Therefore, the model is stating that some lower value cargo that was shipped via air in 1994 may prefer to be shipped via ocean. The model tries to capture the time sensitivity issues of all commodities by incorporating shelf lives, salvage values, and decay parameters. However, some time sensitivity issues are not be addressed in this model, such as emergency shipments and unscheduled deliveries.

6. Results of Sample Runs

Results of the FastShip logistics cost model can be found in the attached Results section in tabular form. From this data certain observations can be made. From the model, it can be observed that commodity value has the greatest impact on a particular good's logistics cost. Product density, storability, and travel reliability also exert an effect on the logistics cost, but to a lesser extent than the cargo value. The time sensitivity (decay parameter and shelf life) also demonstrated significant effects when varied under certain combinations of commodity and service characteristics.

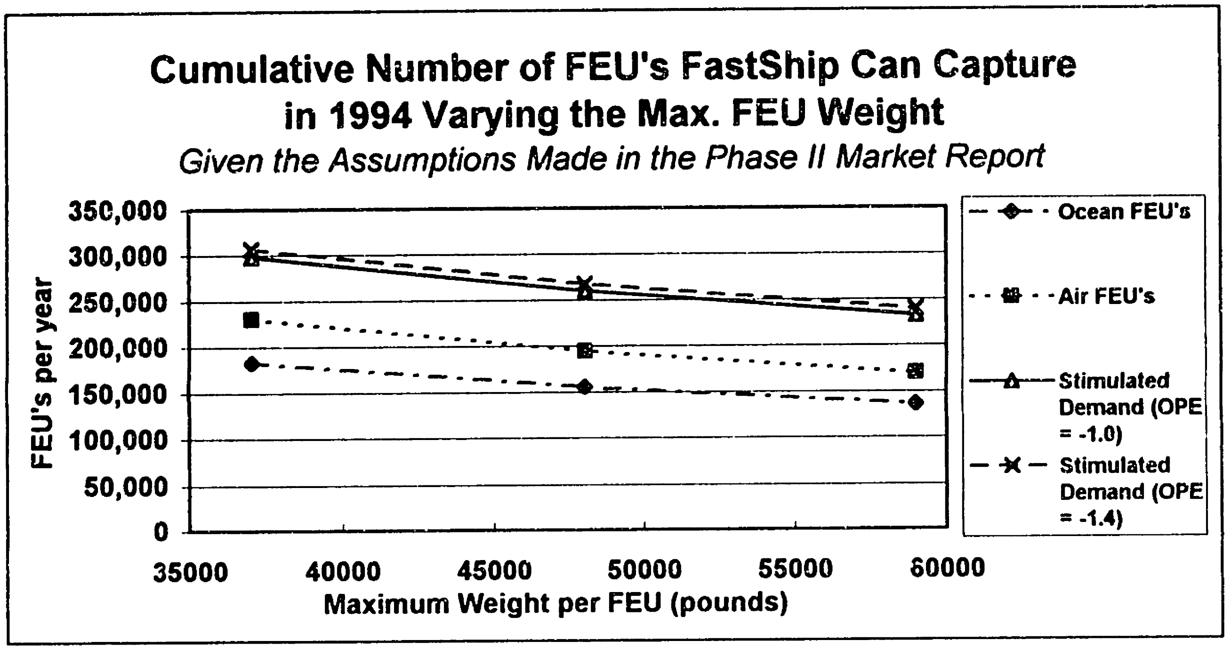
Once again, it should be stressed that the purpose of this market report is to use the logistics cost methodology developed in the Phase I report to develop a Logistics Cost Model for all commodities being shipped between Northern Europe and the United States. Many of the commodity attributes used in the Logistics Cost Model are broad generalizations, thereby potentially causing inaccuracies in the model results of this particular report. We feel the methodology of the model and the structure of the model are sound; however, we feel the accuracy of this model's results is a function of the accuracy of the commodity attributes used in this model.

6.1 SENSITIVITY ANALYSIS

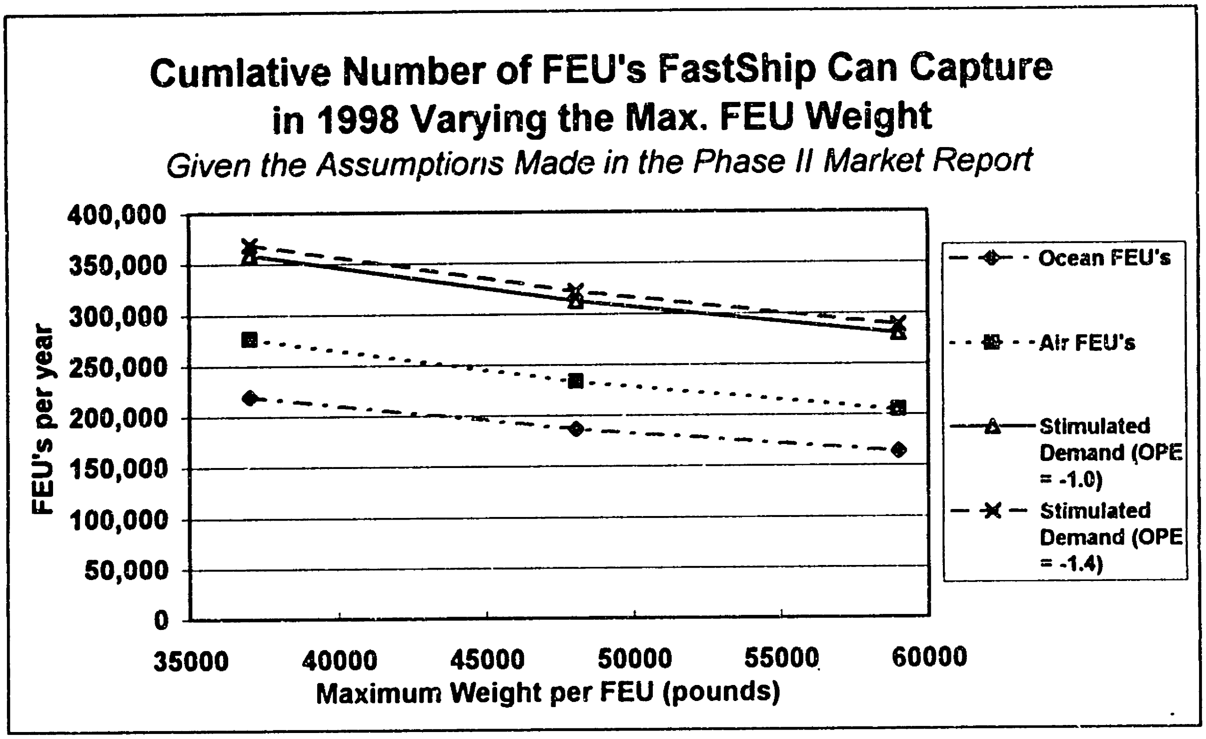
6.1.1 VARIATION IN MAXIMUM ALLOWABLE WEIGHT OF AN FEU

The calculation of the number of FEU's shipped for each commodity was to divide the number of pounds of the commodity that was shipped by either the maximum allowable weight of the FEU (59,000 lbs) or the product of total volume of the FEU and the commodity density, whichever is smaller. If product of the commodity's density and the volume of a FEU was greater than the maximum allowable weight, the container is said to "weight out", or the maximum weight is realized before all of the volume of the container is used. If the product of FEU volume and density was less than the maximum allowable weight, the container is said to "cube out", or all of the container volume is used before the maximum weight of the container is achieved. The densities used for this report do not include empty space in the container when fully loaded or the packaging associated with a particular type of commodity; for example the density of a computer entered into this model is the density of the computer itself, and not the computer with the associated packaging and boxing material. As a result, the densities in this model are very heavy, causing most containers to weight out before they cube out. For a maximum weight of 59,000 pounds per FEU, the average weight per FEU is 57,897 pounds. For this reason, a sensitivity analysis was performed to look at the consequence the average weight of the FEU has on the potential market share FastShip hopes to capture.

The lower bound of maximum allowable weight of an FEU was taken as the industry average weight of a standard forty foot high cube container; 16.8 MT or 37,030 pounds per FEU (Kathryn Riepe Chambers). A third data point was taken at a midpoint value of 48,050 pounds or 21.8 MT per FEU.

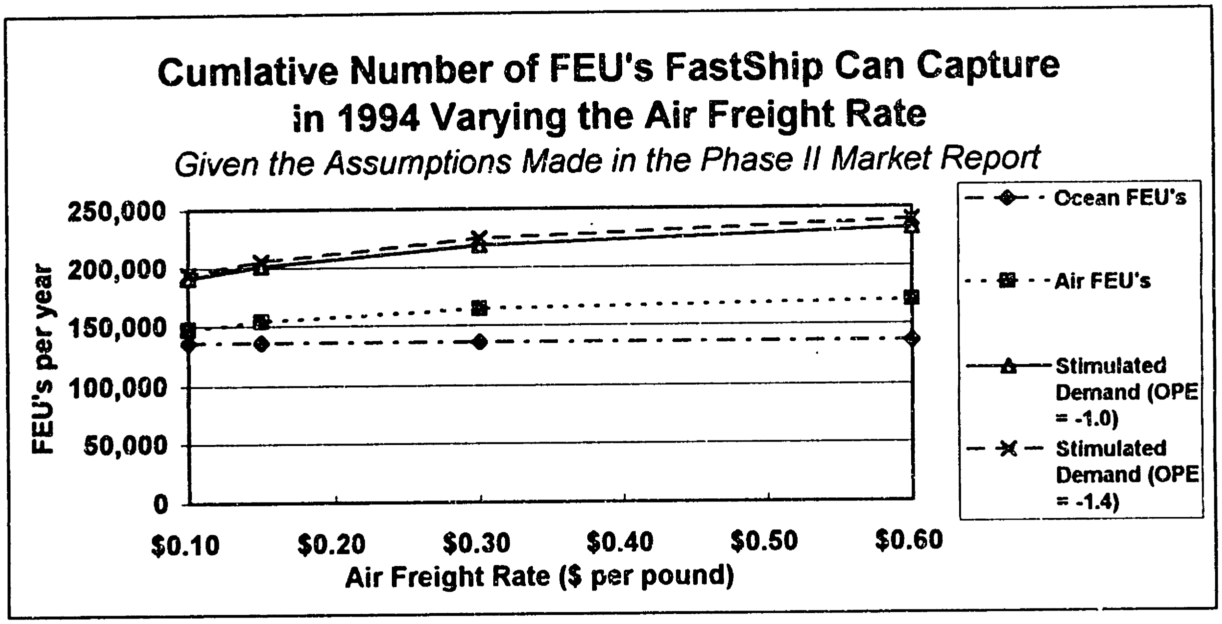


This data is applicable for the year 1994; however, FastShip will not be in service until 1998 at the very earliest. In order to forecast the potential market for FastShip in 1998, cargo shipping growth rates were assumed. For ocean going cargo, an ocean going cargo growth rate of 4.6% per year compounded annually was used (Mercer Management.) For air going cargo (non overnight delivery service), an air going cargo growth rate of 5.0% per year compounded annually was used (Kathryn-Riepe Chambers.) The graph of the resultant market share FastShip can expect to capture is as follows:

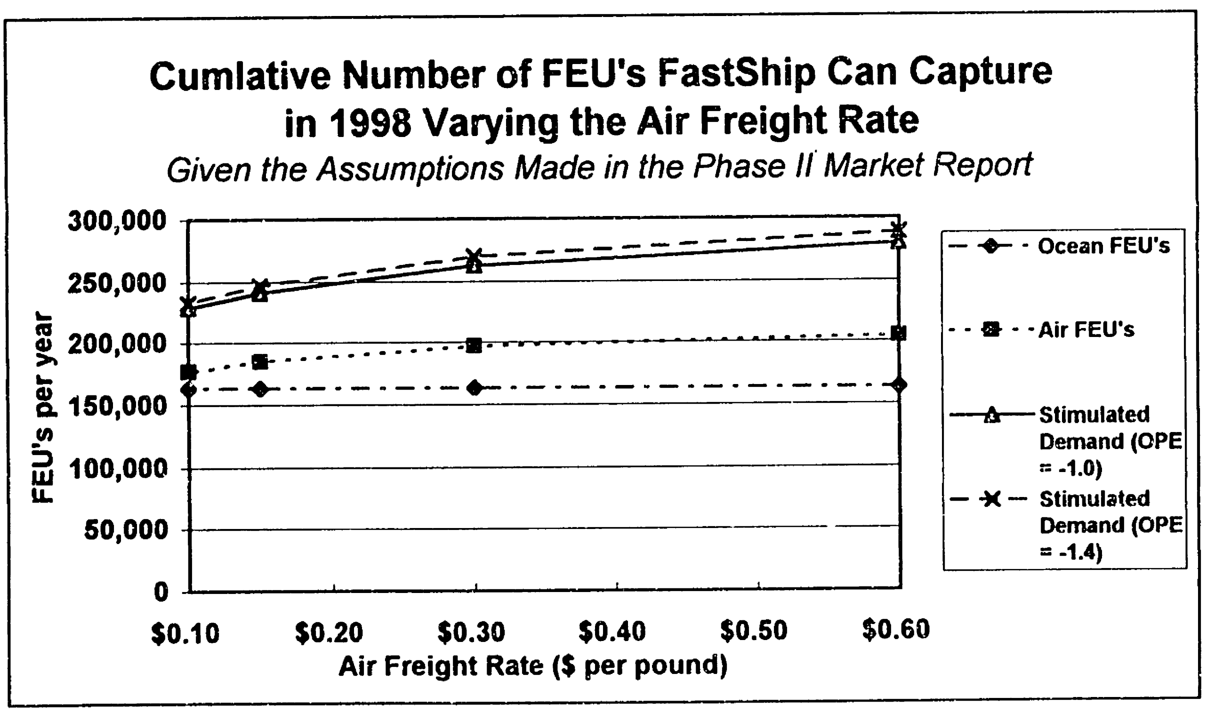


6.1.2 POTENTIAL AIR RESPONSE: DECREASED AIR FREIGHT RATE

With the introduction of the FastShip innovation, air and ocean services will most probably adjust their service so as to present a competitive alternative to FastShip in an effort to drive FastShip out of the shipping market. Not much improvement can be made to the air freight transit time, since it already operates at its minimum margins. The improvement air freight will make in its service in a competitive response to FastShip will be in its freight rates. Therefore, for this model a sensitivity analysis was carried out for air freight rates. The model was run at a range of different air freight rates assuming all other assumptions in the model were the same. The result is as follows:

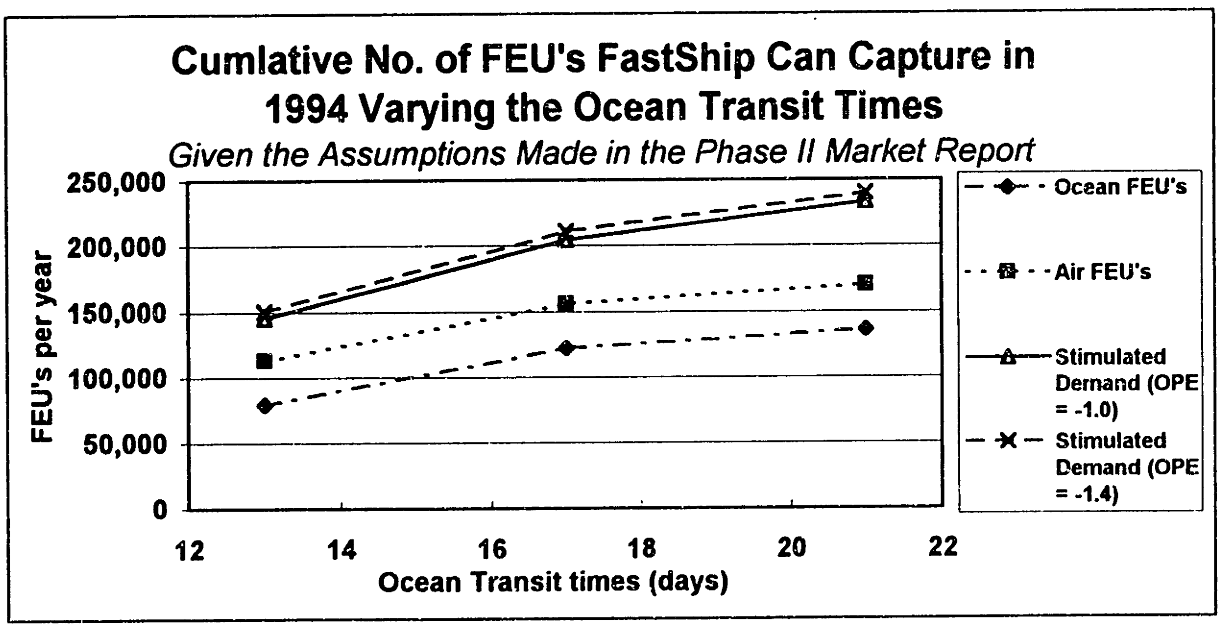


This data is applicable for the year 1994; however, FastShip will not be in service until 1998 at the very earliest. Using the same growth rates assumptions as before, the graph of the resultant market share FastShip can expect to capture is as follows:

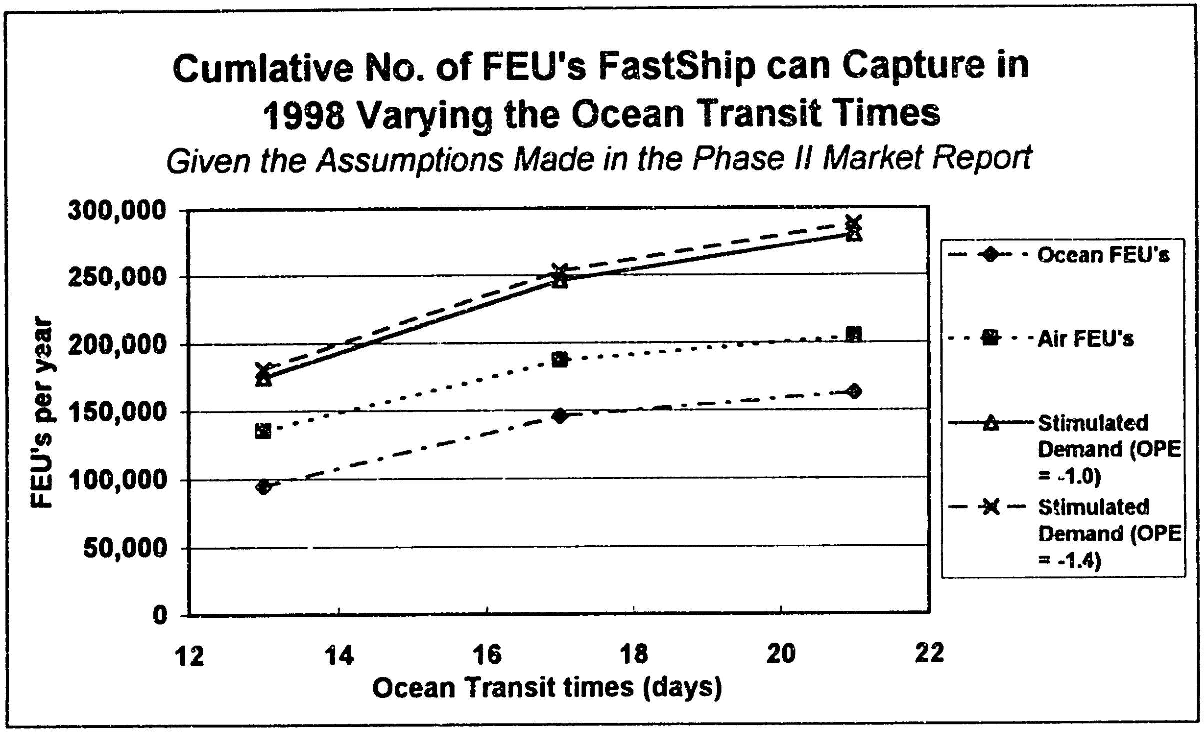


6.1.3 POTENTIAL OCEAN RESPONSE: DECREASED TRANSIT TIMES

Unlike air freight, not much improvement can be made to the ocean freight rate; ocean freight rates are already low. Therefore, improvements in the ocean freight rate will pose a marginal competitive threat to FastShip. The improvement ocean freight will make in its service in a competitive response to FastShip will be in its transit times. Therefore, for this model a sensitivity analysis was carried out for ocean transit times. The standard deviation of the ocean transit time was assumed to be the constant at 3.15 days. The model was run at a range of different ocean transit times assuming all other assumptions in the model were the same. The result is as follows:



Using the same growth assumptions as before, the graph of the resultant market share FastShip can expect to capture in 1998 is as follows:



7. Results of Model with 60 knot and 20 knot FastShips

FastShip can ship containers between points in Europe and points in the United States in seven days. This is dramatically faster than comparative ocean freight which can ship a container between the same points in 21 days. FastShip realizes this improvement in transit times with a variety of technological and scheduling improvements as follows:

1. The FastShip is a vessel that can travel with a speed of 40 knots, approximately twice as fast as a conventional containership today. As a result, the FastShip can transit the Atlantic Ocean in half the time.

2. The FastShip vessel is much more reliable than conventional containerships. The FastShip will be able to deliver cargoes to destinations with half a day standard

deviation, as opposed to a 3.15 day standard deviation typical of conventional containerships. Because FastShip is more reliable, trucks and railroad service can coordinate their service better with the vessel service, leaving less cargo on the dock to wait to be picked up for delivery. With improved reliability, and thereby improved intermodal coordination, the FastShip service time is improved.

3. The FastShip innovation can save time over typical containership service with their ability to load and unload containers quickly. The FastShip will be equipped with a stern ramp that will allow container access directly to the dock. To load the vessel, the containers will be arranged on large metal pallets that will be pulled onto the FastShip using tractors. This will allow all the cargo can be loaded onto the vessel at once. Similarly for unloading, a tractor will pull the pallets loaded with cargo off the vessel, thereby unloading the vessel in one maneuver. This translates into a substantial time advantage over conventional containerships which require cranes to hoist individual containers over the side shell plating of the vessel in order to load and unload the vessel. For conventional containerships, the loading and unloading process can be time consuming and dangerous.

The distance from Zeebrugge, Belgium to Philadelphia, United States is approximately 4,100 miles. A typical ocean containership traveling at 20 knots can make the voyage in 7 days. FastShip, traveling at 40 knots, can make the trans-Atlantic voyage in 3.5 days. However, FastShip will still deliver cargo from origin to destination 14 days faster than ocean freight. Of these 14 days, FastShip realizes only a 3.5 day advantage over ocean freight on the trans-Atlantic leg of the shipment. The primary advantage of

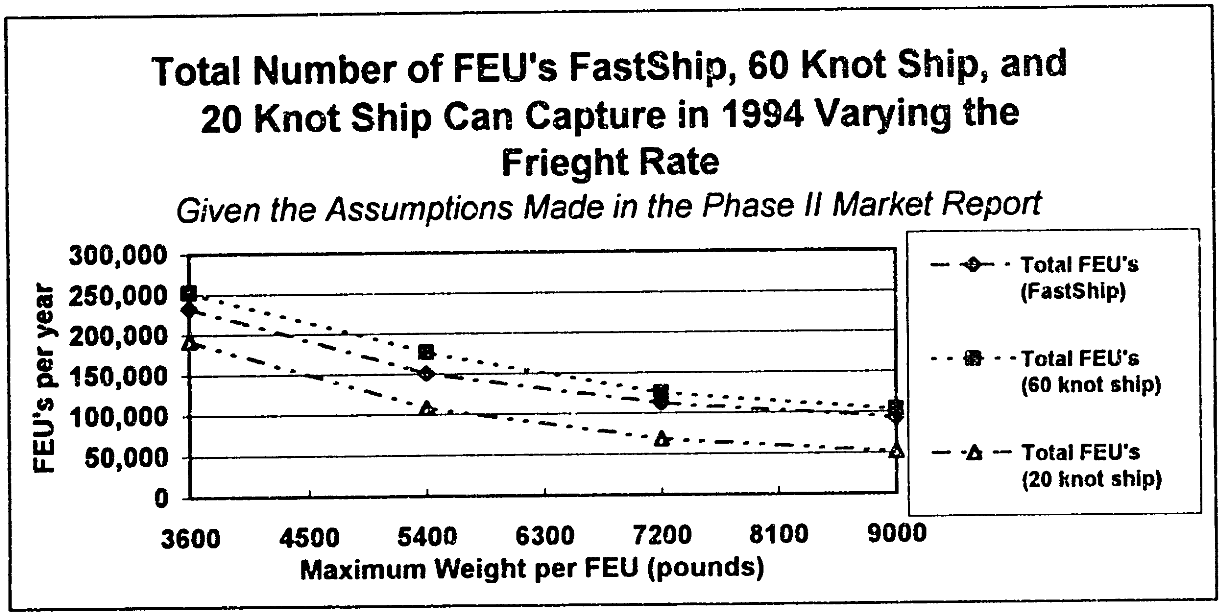
FastShip lies in land transportation; FastShip has a 10.5 day advantage over ocean freight in transporting the container over land legs of the shipment.

The speed of the FastShip vessel affects the time advantage FastShip can realize over conventional containership service. However, we can see that the time savings FastShip realizes in the trans-Atlantic leg of the container shipment is a small percentage of the total time advantage FastShip has over conventional containerships. For the purpose of testing the speed advantage of the FastShip vessel, the model was run again for two different types of vessels; a FastShip alternative that travels faster than FastShip and a FastShip alternative that travels slower than FastShip.

Arbitrarily, we chose to straddle the existing FastShip vessel speed of 40 knots with a FastShip equivalent vessels traveling 20 knots and 60 knots. The resultant transit times are as follows:

	Trans-Atlantic Transit Time		Land-Leg Transit Time		Total Transit Time
40 knot vessel (FastShip)	3.5	+	3.5	=	7
20 knot vessel	7.1	+	3.5	=	10.6
60 knot vessel	2.3	+	3.5	=	5.8

For this analysis, we assumed that all assumptions made for the FastShip vessel held true for the two alternative FastShips. For example, we figured that service frequency would remain at 156 shipments per year (3 shipments per week). We also continued to assume a 0.5 day standard deviation of the door-to-door transit times. The only variable we changed for this analysis was the door-to-door transit times for the containerized cargo. The results are plotted in the chart below:



Tabular results are as follows:

Freight Rates ($/FEU)	Total FEU's to 40 knot vessel (FastShip)	Total FEU's to 60 knot vessel	Total FEU's to 20 knot vessel
$2,700	311,555	347,497	251,902
$3,600	232,938	252,250	192,060
$5,400	150,721	176,780	108,328
$7,200	112,294	124,737	68,313
$9,000	93,820	103,032	51,818

The market shares for FastShip and the FastShip alternatives found in the table and chart above are the total number of containers these vessels can capture in an environment where they are competing against ocean and air freight only and not against each other. The total values above include cargo diverted from ocean freight, cargo diverted from air freight, and stimulated demand from ocean and air freight, with a default own price elasticity of -1.0.

From the chart above, we can observe the relationship between the FastShip vessel transit times and the overall market potential for the FastShip innovation in 1994. We can see that for a $3,600 per FEU freight rate, the overall market share potential for FastShip increases a mere 8.3% for a vessel speed increase from 40 knots to 60 knots. From the resultant chart we can see that for a 60 knot FastShip vessel to capture the same amount of containers in 1994 as the standard 40 knot FastShip, the freight rate can be raised to approximately $4,050 per FEU. This would seem to indicate that the advantage of increasing the speed of the FastShip vessel is negligible; an extraordinary increase in vessel speed (50%) yields a marginal increase in potential market share (8.3%) or an increase in freight rate to be charged for the same market share (12.5%).

It is also observed, that if the freight rate is constant at $3,600 pr FEU, the potential market share of the FastShip decreases 17.5% for the slower, 20 knot vessel. However, if the freight rate is decreased to $3,000 per FEU the potential market share of the 20 knot FastShip vessel is the same as the standard 40 knot FastShip.

Therefore, it may be in FastShip Atlantic's best interest to investigate the feasibility of investing in a FastShip vessel with a average cruising speed of less than 40 knots. The economic savings of building and operating such a vessel with lower power and speed requirements may out weigh those time saving benefits of the 40 knot FastShip vessel. A more thorough economic analysis is required to decide upon an optimum speed for the FastShip vessel that balances the economic benefits of the time savings of the faster vessel with the slower, less powerful ship.

8. Conclusions

The purpose of this thesis was to use the logistics cost methodology to create the Logistics Cost Model. Whereas we are confident this model can accurately assess the potential market share of the FastShip in the trans-Atlantic container trade, there are limits to this model and the results developed in this thesis.

8.1 LIMITATIONS OF THE MODEL

It should be emphasized that this model calculates the total number of containers shipped between countries in Northern Europe and Custom Districts within 500 miles of Philadelphia instead of using actual values of containers shipped. This was necessary to estimate the potential market share of FastShip; however, it does not necessarily wholly represent the true containerizable market.

The model considers the cargo FastShip captures from Ocean and Air freight that would have otherwise would have been shipped from a different port other than Zeebrugge or Philadelphia, provided the port of entry is with the 500 radius of Philadelphia or Zeebrugge. However, the model does not consider the potential cargo FastShip can obtain outside the 500 limits from Philadelphia and Zeebrugge. For example, cargo entering Miami from Zeebrugge being shipped to Baltimore is not considered in this analysis because Miami is not within 500 miles of Philadelphia, although the ultimate destination of Baltimore is within 500 miles of Philadelphia.

Another limitation of the model is the 500 mile limit established around Philadelphia and Zeebrugge. According to the US Import and Exports Database used for this study, custom districts are those areas in the United States in which cargo either enters or exits the United States. As a result cargoes entering the United States outside 500 miles of Philadelphia and destined to go to points inside the 500 mile radius are not considered in the model. Because of this, the model approximates the potential US market; the model does not perfectly represents the true domestic potential of FastShip. Further analysis would need to be done to estimate the amount by which the model over-estimates/under-estimates the domestic market share of FastShip.

In the European sector the model is more accurate; the model shows cargoes originating from or destined to enter discrete countries. The weight and value of the cargo is not listed in the country of entry into/exit from the Northern European region, but rather the country to/from which it is ultimately destined to go.

Another problem is that all the commodities being analyzed are being analyzed under a 4 digit code. As a result, different commodities with different commodity characteristics that happen to fall under the same 4 digit commodity code are being treated in the same way. This is especially evident in the assignment of densities; different commodities were assigned the same density if they fell under the same 4 digit code heading.

The ocean freight rate and the air freight rate are assumed to be constant for all commodities; ocean freight is assumed to be $1,800 per FEU and air freight is assumed to be $0.60 per pound shipped. In reality the freight rate is very much dependent upon the commodity being shipped and the speed in which the commodity is delivered. However, the simplifying assumptions made here are sufficient for this preliminary analysis. Future modifications to the model could take such factors into account.

The Commodity Attributes used for the calculations in this Market Report are very arbitrary and require further investigation before a more accurate assessment of the potential of the FastShip can be made. There is very little comprehensive data available on the shelf lives, salvage values, and decay parameters of the more than 1,200 commodities being analyzed in this model. As a result, each individual commodity would need to be analyzed separately and shelf lives, salvage values, and decay parameters would need to be assessed for each commodity individually. The problem is further exacerbated by the fact the commodities are grouped by 4 digit commodity code; several different commodities, each with different Commodity Attributes, might be grouped under the same 4 digit coding.

While the logistics cost model considers the origin inventory cost, the model does not consider the destination inventory cost. The destination inventory cost was not considered in the methodology used in the Phase I Market Report. In order to maintain consistency between the two reports this logistics cost was omitted from this thesis as well.

The model strictly calculates logistics cost and omits the potential cost savings a shipper might realize with improvements made to the entire production chain. The stimulated demand calculations captures the increase in freight stimulated by the FastShip innovation with a lower logistics cost. However, there are other stimulated markets not captured by the model. For example, The introduction of the FastShip innovation might encourage companies to improve their supply chain management system. A manufacturing company that originally had shipped its product via ocean freight, can now optimize its production system to more closely reflect true demand, since lead times will be reduced by two weeks. In addition, dramatic changes in being able to respond to customer needs might result in an increase in revenues over and above our stimulated demand analysis.

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10. Glossary

10.1 INPUTS OF THE MODEL

CMO4: The four digit harmonized code based on the international Harmonized Commodity Description and Coding System (HS) developed by the Customs Cooperation Council in Brussels. The HS is intended as a universally accepted product nomenclature classification of goods for the administration of customs programs. Each commodity is assigned a ten digit code, with the first two digits representing the heading position in that chapter, and the second two digits representing the subdivisions (subheadings) under the heading. In order to minimize the number of commodities to be dealt with in this analysis, all commodities were categorized by their first four digits.

DESCRIPTION: Description of the commodity groups as designated by the Customs Cooperation Council.

DENSITY: The weight density of the commodity in pounds per cubic foot; this value was obtained from the United Nations Standard International Trade Classification Index Division Report, *Average Densities by Commodity and Division.*

CARDS: The number of invoices for a given commodity entering and exiting the United States from Europe through the Customs Department. The scope of United States trade is limited to a 500 miles radius from Philadelphia and the scope of European trade is limited to a 500 mile radius from Zeebrugge, Belgium. These cities are chosen because they are the two proposed FastShip ports.

TOTAL WEIGHT: Total weight, in pounds, of cargo entering and exiting the United States to Europe, both by ocean (cargo ships) and by air (cargo plane). See CARDS for the boundaries from which cargo is entering and exiting the United States and Europe.

TOTAL VALUE: Total value of cargo, in US dollars, entering and exiting the United States to Europe, both by ocean and by air. See CARDS for the boundaries from which cargo is entering and exiting the United States and Europe.

VALUE DENSITY: Total value of cargo divided by the total weight of the cargo, or US dollars per metric ton of commodity.

OCEAN WEIGHT: Total weight of cargo, in pounds, entering and exiting the United States to Europe via ocean. This value is obtained from the United States Department of Commerce. See CARDS for the boundaries from which cargo is entering and exiting the United States and Europe.

OCEAN VALUE: Total value of cargo, in US dollars, entering and exiting the United States to Europe via ocean. This value is obtained from the United States Department of Commerce. See CARDS for the boundaries from which cargo is entering and exiting the United States and Europe.

OCEAN VALUE DENSITY: Value of cargo shipped by ocean divided by the weight of cargo shipped by ocean, or US dollars per metric ton of commodity.

AIR WEIGHT: Total weight of cargo, in pounds, entering and exiting the United States to Europe via air. This value is obtained from Customs Department information. See CARDS for the boundaries from which cargo is entering and exiting the United States and Europe.

AIR VALUE: Total value of cargo, in US dollars, entering and exiting the United States to Europe via air. This value is obtained from Customs Department information. See CARDS for the boundaries from which cargo is entering and exiting the United States and Europe.

AIR VALUE DENSITY: Value of cargo shipped by air divided by the weight of cargo shipped by ocean, or US dollars per metric ton of commodity.

FEU's SHIPPED (ANNUALLY): This is a calculated number; not all cargo is shipped by itself in a container, but rather different types of commodities or shipped together in one container. However, for the purpose of this model, the cargo was isolated to individual containers. This calculation also assumes all containers are hi-cubed (40 feet long, by 8 feet wide, by 9.5 feet wide), forty foot containers that are modified by a stowage factor.

DENSITY: The density of the commodity in pounds per cubic foot; this value was obtained from the United Nations Standard International Trade Classification Index Division Report, *Average Densities by Commodity and Division.*

VALUE DENSITY: Total value of cargo divided by the total weight of the cargo.

CUBIC VALUE: Value of the cargo per unit volume. Cubic value is calculated by multiplying density and value density.

TONS PER FEU: Maximum allowable weight, in metric tons, the container can carry. This is approximately 26.8 metric tons. This value is cited in the MIT thesis *Freight Mode Choice: Air Transport Versus Ocean Transport in the 1990s*, by Dale Lewis.

POUNDS PER FEU: Maximum allowable weight, in pounds, the container can carry. This is 59,000 pounds.

VALUE PER FEU: Value of the container if it were carrying the subject commodity exclusively. This was calculated by multiplying value density and the total pounds per FEU.

ANNUAL CARRYING CHARGE: A percentage of the value per FEU that represents the inventory carrying charge for the container. For this model, all commodities shipped were assumed to have a 22.5% annual carrying charge, which is consistent with most current studies. It may in fact be somewhat conservative, as several studies in the literature (Lambert and Stock) indicate that typical values range from 20% to 25%, with the latter being more common.

DEMAND PERIOD: The number of days in a year the commodity is in demand.

SHELF LIFE: The number of days in a year the commodity will survive in storage until the commodity is reduced to its salvage value.

SALVAGE VALUE: The value a commodity retains after its useful shelf life. This value is expressed as a percentage of its original value:

DECAY PARAMETER: Exponent determining the rate at which the commodity will decay in value. A decay parameter of 1.0 represents a linear downward decay in the value of a commodity over a product life. For decay parameters greater than 1.0, the decay is concave, with little decay over the first time segment of the product's life, and with maximum decay over the final time segment of the product's life. A decay parameter of 4.0 was assumed appropriate for refrigerated cargo since little decay occurs at the beginning of the commodities life and dramatic decay occurs at the end of the life. A decay parameter of 0.5 was assumed appropriate for clothing and fashion since dramatic decay occurs at the beginning of the life cycle (i.e. to satisfy a fashion trends) and little decay occurs at the end of the life.

WAREHOUSE COST: The cost of warehousing, beyond the inventory cost, prior to loading the cargo on the vessel or after unloading the cargo off the vessel. It was assumed for all three modes of transport (air, ocean, and FastShip) that the cargo would be delivered just in time, therefore, short term warehouse costs would be incurred for warehouse storage. For the purpose of this model, warehouse costs were assumed fixed in the short term, therefore, a conservative value for warehouse costs is $0.00.

DAILY SALES: The number of FEU's shipped annually divided by the demand period, typically 365 days per year.

COEFFICIENT OF VARIATION OF DAILY SALES: The percentage by which the daily sales of containers may vary by. Since individual commodities were aggregated from ten digit HS coding to 4 digit, it became difficult to enter individual coefficients of variation. From Lambert and Scott, a good value for coefficient of variation is 20%, therefore, for all commodities in this model, this value was assumed.

STANDARD DEVIATION OF DAILY SALES: The daily amount of containers the daily sales of containers may vary by. This is calculated by multiplying the daily sales and the coefficient of variation of daily sales.

STOCK OUT STANDARD DEVIATION: The number of standard deviation of sales per resupply period needed to be held as safety stock in order to minimize stock out costs and inventory safety stock costs.

STORABILITY: The percentage of the container that is utilized as useful storage space. A 100% storability is conservative since FastShip containers usually weight out before they cube out.

10.2 MODAL CHARACTERISTICS: OCEAN FREIGHT

FREIGHT RATE: The freight rate of ocean going containers, forty feet long, 9.5 feet high, and 8 feet wide. This value was taken to be $1,800 per FEU for all commodities. This value was obtained from a market scope analysis by Mercer Management for FastShip Atlantic.

TRANSIT TIME: The average number of days it takes a typical air shipper to ship an FEU from a destination 500 miles from Zeebrugge, Belgium to a destination 500 miles from Philadelphia, United States. This value includes transit time to and from points of shipment, loading time, and ocean transit time. This value is taken as 21 days for all commodities. This value was determined by Mercer Management for FastShip Atlantic.

STANDARD DEVIATION OF TRANSIT TIME: The number of days the transit time of a container may vary by. This value is taken as 3.15 days for all commodities. This value was taken from studies performed by Kathryn Chambers for FastShip Atlantic.

SERVICE FREQUENCY: The number of shipments via ocean in a given demand period. For ocean freight, this value was taken as 52, or one shipment per week. This value was taken from studies performed by Kathryn Chambers for FastShip Atlantic.

AVERAGE SHIPMENT SIZE: The average number of containers shipped via ocean per shipment. This is calculated by dividing the total number of FEU's shipped annually by the service frequency per year of ocean freight. This value was taken from studies performed by Kathryn Chambers for FastShip Atlantic.

10.3 MODAL CHARACTERISTICS: AIR FREIGHT

FREIGHT RATE: The freight rate of air going containers, forty feet long, 9.5 feet high, and 8 feet wide. This value was obtained by charging $0.60 per pound of freight shipped in a FEU. The air freight rate is calculated as $0.60 per pound times the number of pounds shipped in each container.

TRANSIT TIME: The average number of days it takes a typical air shipper to ship an FEU from a destination 500 miles from Zeebrugge, Belgium to a destination 500 miles from Philadelphia, United States. This value includes transit time to and from points of shipment, loading time, and air transit time. This value is taken as 3 days for all commodities. This value was determined by Mercer Management for FastShip Atlantic.

STANDARD DEVIATION OF TRANSIT TIME: The number of days the transit time of a container may vary by. This value is taken as 0.5 days for all commodities. This value was taken from studies performed by Kathryn Chambers for FastShip Atlantic.

SERVICE FREQUENCY: The number of shipments via air in a given demand period. For air freight, this value was taken as 365, or one shipment per day. This value was taken from studies performed by Kathryn Chambers for FastShip Atlantic.

AVERAGE SHIPMENT SIZE: The average number of containers shipped via air per shipment. This is calculated by dividing the total number of FEU's shipped annually by the service frequency per year of air freight. This value was taken from studies performed by Kathryn Chambers for FastShip Atlantic.

10.4 MODAL CHARACTERISTICS: FASTSHIP FREIGHT

FREIGHT RATE: The freight rate of FastShip going containers, forty feet long, 9.5 feet high, and 8 feet wide. This value was taken to be $3,600 per FEU for all commodities. This taken from FastShip Atlantic's proforma for the FastShip.

TRANSIT TIME: The average number of days it takes a typical air shipper to ship an FEU from a destination 500 miles from Zeebrugge, Belgium to a destination 500 miles from Philadelphia, United States. This value includes transit time to and from points of shipment, loading time, and FastShip transit time. This value is taken as 7 days for all commodities. This was taken from FastShip Atlantic's proforma for the FastShip.

STANDARD DEVIATION OF TRANSIT TIME: The number of days the transit time of a container may vary by. This value is taken as 0.5 days for all commodities. This was taken from FastShip Atlantic's proforma for the FastShip.

SERVICE FREQUENCY: The number of shipments via FastShip in a given demand period. For FastShip freight, this value was taken as 156, or three shipments per week. This was taken from FastShip Atlantic's proforma for the FastShip.

AVERAGE SHIPMENT SIZE: The average number of containers shipped via FastShip per shipment. This is calculated by dividing the total number of FEU's shipped annually by the service frequency per year of FastShip freight. This was taken from FastShip Atlantic's proforma for the FastShip.

10.5 LOGISTICS COST: OCEAN FREIGHT WITH OCEAN VALUE DENSITY

PERISHABLE COST/FEU: Commodities vary greatly in their ability to hold value over time. Some goods have a short physical life (i.e. fresh flowers) and must be delivered to their destination quickly, or not at all. Other goods have their highest value early in the selling season (i.e. clothes) and are worth less as the season ends.

Other products have life cycles that extend beyond a single season or even a single year. For these goods, it is necessary to make accurate forecasts concerning demand occurring near the end of the cycle, so that the shipper is not left with excess inventory.

Costs due to loss of product value are determined by the change in demand or product condition. The expression for perishable cost has four components:

1. Salvage value at the end of the product's life
2. Value of the good being shipped
3. The ratio of transit time and the product's life
4. A parameter that determines the rate of decay in the value of the good being shipped. This parameter determines if the good loses its value at a constant rate daily ($k = 1.0$), or at a small rate at the beginning of the product's life and at a more dramatic rate near the end of the product's life ($k > 1.0$).

Value decay as related to time spent in-transit may be expressed as:

(value/FEU(**ocean value density**))*(1 - (salvage%))

or

(1-salvage%)*(value/FEU(**ocean value density**)*((transit time(**ocean**)) / (shelf life))^(decay parameter))

Whichever is smaller

ORIGIN INVENTORY COST/FEU: As a manufacturer produces goods, they are accumulated until reaching a quantity (x) that is deemed large enough to make a shipment. Where the shipment is made, the quantity on hand becomes zero and, as more goods are manufactured, they again accumulate up to a quantity (x) before the next shipment goes out. The average amount of stock on hand is x/2. The cost of holding x/2 is:

(annual carrying charge%)*(demand period/365)*(value/FEU(**ocean value density**))*(avg shipment size(**ocean**)/2) / (number of FEU's ship'd annually)

ORIGIN WAREHOUSE COST/FEU: The cost incurred by having the cargo sit in a warehouse during shipment. Since our model assumes just in time shipping, this value will be zero. However, if warehouse costs are incurred, the origin warehouse cost is calculated from this equation:

(pounds/FEU)*(avg shipment size(**ocean**)/2)*(warehouse cost) / (number of FEU's ship'd annually)

IN-TRANSIT INVENTORY COST/FEU: Goods may be sold to a buyer in a variety of ways. The buyer may take delivery of the goods at the manufacturing plant, at his own facility or at some point in between. During the time goods are in-transit, they are in effect a moving inventory. The cost for this in-transit inventory for shipments of size (x) is the shipment size times the value per unit times the interest rate per day. This can be expressed as:

(value/FEU(**ocean value density**))*(annual carrying charge%)*(demand period/365)*((transit time (**ocean**))/(demand period))

DISTRIBUTION SAVINGS/FEU: A savings may be realized by a shipper that reorganizes his shipping network to maximize the benefits of the FastShip service. However, for the purpose of keeping this model conservative, it was assumed the customer would not realize a distribution savings.

SAFETY STOCK COST/FEU: Transportation systems are not normally perfectly reliable. The mean transit time may have a standard deviation that ranges from very small to very large. A shipper can protect himself from a stockout by holding a reserve, called a safety stock. Assuming that the distribution between a specific origin and destination pair is normally distributed, the shipper can choose the level of protection from stockout that he desires by choosing a stockout volume that is a multiple of the standard deviation for the particular origin-destination pair.

The amount of safety stock calculated is based upon the amount of stock needed to satisfy 68% of all probabilities that the safety stock will be demanded assuming a normal distribution (Feeter and Dalleck, *Decision Models for Inventory Management*). This value is calculated from this equation:

(value/FEU(**ocean value density**))*(stock out cost standard deviation)*((annual carrying charge%)/(FEU's ship'd annually))*SQRT((transit time(**ocean**))*(standard deviation of daily sales)^2+(daily sales)^2* (standard deviation of transit time (**ocean**)))

FREIGHT RATE/FEU: As was discussed above.

TOTAL LOGISTICS COST/FEU (ocean freight / ocean value density) : The total cost the shipper must bear for shipping the cargo via ocean freight. This is calculated by summing up the PERISHABLE COST/FEU, ORIGIN INVENTORY COST/FEU, ORIGIN WAREHOUSE COST/FEU, IN-TRANSIT INVENTORY COST/FEU, SAFETY STOCK COST/FEU, and FREIGHT RATE/FEU.

10.6 LOGISTICS COST: OCEAN FREIGHT WITH AIR VALUE DENSITY

PERISHABLE COST/FEU: Commodities vary greatly in their ability to hold value over time. Some goods have a short physical life (i.e. fresh flowers) and must be delivered to their destination quickly, or not at all. Other goods have their highest value early in the selling season (i.e. clothes) and are worth less as the season ends.

Other products have life cycles that extend beyond a single season or even a single year. For these goods, it is necessary to make accurate forecasts concerning demand occurring near the end of the cycle, so that the shipper is not left with excess inventory.

Costs due to loss of product value are determined by the change in demand or product condition. The expression for perishable cost has four components:

1. Salvage value at the end of the product's life

2. Value of the good being shipped

3. The ratio of transit time and the product's life

4. A parameter that determines the rate of decay in the value of the good being shipped. This parameter determines if the good loses its value at a constant rate daily ($k = 1.0$), or at a small rate at the beginning of the product's life and at a more dramatic rate near the end of the product's life ($k > 1.0$).

Value decay as related to time spent in-transit may be expressed as:

(value/FEU(**air value density**))*(1 - (salvage%))

or

(1-salvage%)*(value/FEU(**air value density**)*((transit time(**ocean**)) / (shelf life))^(decay parameter))

Whichever is smaller

ORIGIN INVENTORY COST/FEU: As a manufacturer produces goods, they are accumulated until reaching a quantity (x) that is deemed large enough to make a shipment. Where the shipment is made, the quantity on hand becomes zero and, as more goods are manufactured, they again accumulate up to a quantity (x) before the next shipment goes out. The average amount of stock on hand is x/2. The cost of holding x/2 is:

(annual carrying charge%)*(demand period/365)*(value/FEU(**air value density**))*(avg shipment size(**ocean**)/2) / (number of FEU's ship'd annually)

ORIGIN WAREHOUSE COST/FEU: The cost incurred by having the cargo sit in a warehouse during shipment. Since our model assumes just in time shipping, this value will be zero. However, if warehouse costs are incurred, the origin warehouse cost is calculated from this equation:

(pounds/FEU)*(avg shipment size(**ocean**)/2)*(warehouse cost) / (number of FEU's ship'd annually)

IN-TRANSIT INVENTORY COST/FEU: Goods may be sold to a buyer in a variety of ways. The buyer may take delivery of the goods at the manufacturing plant, at his own facility or at some point in between. During the time goods are in-transit, they are in effect a moving inventory. The cost for this in-transit inventory for shipments of size (x) is the shipment size times the value per unit times the interest rate per day. This can be expressed as:

(value/FEU(**air value density**))*(annual carrying charge%)*(demand period/365)*((transit time (**ocean**))/(demand period))

DISTRIBUTION SAVINGS/FEU: A savings may be realized by a shipper that reorganizes his shipping network to maximize the benefits of the FastShip service. However, for the purpose of keeping this model conservative, it was assumed the customer would not realize a distribution savings.

SAFETY STOCK COST/FEU: Transportation systems are not normally perfectly reliable. The mean transit time may have a standard deviation that ranges from very small to very large. A shipper can protect himself from a stockout by holding a reserve, called a safety stock. Assuming that the distribution between a specific origin and destination pair is normally distributed, the shipper can choose the level of protection from stockout that he desires by choosing a stockout volume that is a multiple of the standard deviation for the particular origin-destination pair.

The amount of safety stock calculated is based upon the amount of stock needed to satisfy 68% of all probabilities that the safety stock will be demanded assuming a normal distribution (Feeter and Dalleck, *Decision Models for Inventory Management*). This value is calculated from this equation:

(value/FEU(**air value density**))*(stock out cost standard deviation)*((annual carrying charge%)/(FEU's ship'd annually))*SQRT((transit time(**ocean**))*(standard deviation of daily sales)^2+(daily sales)^2*(standard deviation of transit time (**ocean**)))

FREIGHT RATE/FEU: As was discussed above.

TOTAL LOGISTICS COST/FEU (ocean freight / air value density) : The total cost the shipper must bear for shipping the cargo via ocean freight. This is calculated by summing up the PERISHABLE COST/FEU, ORIGIN INVENTORY COST/FEU, ORIGIN WAREHOUSE COST/FEU, IN-TRANSIT INVENTORY COST/FEU, SAFETY STOCK COST/FEU, and FREIGHT RATE/FEU.

10.7 LOGISTICS COST: AIR FREIGHT WITH AIR VALUE DENSITY

PERISHABLE COST/FEU: Commodities vary greatly in their ability to hold value over time. Some goods have a short physical life (i.e. fresh flowers) and must be delivered to their destination quickly, or not at all. Other goods have their highest value early in the selling season (i.e. clothes) and are worth less as the season ends.

Other products have life cycles that extend beyond a single season or even a single year. For these goods, it is necessary to make accurate forecasts concerning demand occurring near the end of the cycle, so that the shipper is not left with excess inventory.

Costs due to loss of product value are determined by the change in demand or product condition. The expression for perishable cost has four components:

1. Salvage value at the end of the product's life
2. Value of the good being shipped
3. The ratio of transit time and the product's life
4. A parameter that determines the rate of decay in the value of the good being shipped. This parameter determines if the good loses its value at a constant rate daily (k = 1.0), or at a small rate at the beginning of the product's life and at a more dramatic rate near the end of the product's life (k > 1.0).

Value decay as related to time spent in-transit may be expressed as:

(value/FEU(**air value density**))*(1 - (salvage%))

or

(1-salvage%)*(value/FEU(**air value density**)*((transit time(**air**)) / (shelf life))^(decay parameter))

Whichever is smaller

ORIGIN INVENTORY COST/FEU: As a manufacturer produces goods, they are accumulated until reaching a quantity (x) that is deemed large enough to make a shipment. Where the shipment is made, the quantity on hand becomes zero and, as more goods are manufactured, they again accumulate up to a quantity (x) before the next shipment goes out. The average amount of stock on hand is x/2. The cost of holding x/2 is:

(annual carrying charge%)*(demand period/365)*(value/FEU(**air value density**))*(avg shipment size(**air**)/2) / (number of FEU's ship'd annually)

ORIGIN WAREHOUSE COST/FEU: The cost incurred by having the cargo sit in a warehouse during shipment. Since our model assumes just in time shipping, this value will be zero. However, if warehouse costs are incurred, the origin warehouse cost is calculated from this equation:

(pounds/FEU)*(avg shipment size(**air**)/2)*(warehouse cost) / (number of FEU's ship'd annually)

IN-TRANSIT INVENTORY COST/FEU: Goods may be sold to a buyer in a variety of ways. The buyer may take delivery of the goods at the manufacturing plant, at his own facility or at some point in between. During the time goods are in-transit, they are in effect a moving inventory. The cost for this in-transit inventory for shipments of size (x) is the shipment size times the value per unit times the interest rate per day. This can be expressed as:

(value/FEU(**air value density**))*(annual carrying charge%)*(demand period/365)*((transit time (air))/(demand period))

DISTRIBUTION SAVINGS/FEU: A savings may be realized by a shipper that reorganizes his shipping network to maximize the benefits of the FastShip service. However, for the purpose of keeping this model conservative, it was assumed the customer would not realize a distribution savings.

SAFETY STOCK COST/FEU: Transportation systems are not normally perfectly reliable. The mean transit time may have a standard deviation that ranges from very small to very large. A shipper can protect himself from a stockout by holding a reserve, called a safety stock. Assuming that the distribution between a specific origin and destination pair is normally distributed, the shipper can choose the level of protection from stockout that he desires by choosing a stockout volume that is a multiple of the standard deviation for the particular origin-destination pair.

The amount of safety stock calculated is based upon the amount of stock needed to satisfy 68% of all probabilities that the safety stock will be demanded assuming a normal distribution (Feeter and Dalleck, *Decision Models for Inventory Management*). This value is calculated from this equation:

(value/FEU(**air value density**))*(stock out cost standard deviation)*((annual carrying charge%)/(FEU's ship'd annually))*SQRT((transit time(**air**))*(standard deviation of daily sales)^2+(daily sales)^2* (standard deviation of transit time (**air**)))

FREIGHT RATE/FEU: As was discussed above.

TOTAL LOGISTICS COST/FEU (air freight / air value density) : The total cost the shipper must bear for shipping the cargo via ocean freight. This is calculated by summing up the PERISHABLE COST/FEU, ORIGIN INVENTORY COST/FEU, ORIGIN WAREHOUSE COST/FEU, IN-TRANSIT INVENTORY COST/FEU, SAFETY STOCK COST/FEU, and FREIGHT RATE/FEU.

10.8 LOGISTICS COST: AIR FREIGHT WITH OCEAN VALUE DENSITY

PERISHABLE COST/FEU: Commodities vary greatly in their ability to hold value over time. Some goods have a short physical life (i.e. fresh flowers) and must be delivered to their destination quickly, or not at all. Other goods have their highest value early in the selling season (i.e. clothes) and are worth less as the season ends.

Other products have life cycles that extend beyond a single season or even a single year. For these goods, it is necessary to make accurate forecasts concerning demand occurring near the end of the cycle, so that the shipper is not left with excess inventory.

Costs due to loss of product value are determined by the change in demand or product condition. The expression for perishable cost has four components:

1. Salvage value at the end of the product's life

2. Value of the good being shipped

3. The ratio of transit time and the product's life

A parameter that determines the rate of decay in the value of the good being shipped. This parameter determines if the good loses its value at a constant rate daily (k = 1.0), or at a small rate at the beginning of the product's life and at a more dramatic rate near the end of the product's life (k > 1.0).

Value decay as related to time spent in-transit may be expressed as:

(value/FEU(**ocean value density**))*(1 - (salvage%))
or
(1-salvage%)*(value/FEU(**ocean value density**)*((transit time(**air**)) / (shelf life))^(decay parameter))
Whichever is smaller

ORIGIN INVENTORY COST/FEU: As a manufacturer produces goods, they are accumulated until reaching a quantity (x) that is deemed large enough to make a shipment. Where the shipment is made, the quantity on hand becomes zero and, as more goods are manufactured, they again accumulate up to a quantity (x) before the next shipment goes out. The average amount of stock on hand is $x/2$. The cost of holding $x/2$ is:

(annual carrying charge%)*(demand period/365)*(value/FEU(**ocean value density**))*(avg shipment size(**air**)/2) / (number of FEU's ship'd annually)

ORIGIN WAREHOUSE COST/FEU: The cost incurred by having the cargo sit in a warehouse during shipment. Since our model assumes just in time shipping, this value will be zero. However, if warehouse costs are incurred, the origin warehouse cost is calculated from this equation:

(pounds/FEU)*(avg shipment size(**air**)/2)*(warehouse cost) / (number of FEU's ship'd annually)

IN-TRANSIT INVENTORY COST/FEU: Goods may be sold to a buyer in a variety of ways. The buyer may take delivery of the goods at the manufacturing plant, at his own facility or at some point in between. During the time goods are in-transit, they are in effect a moving inventory. The cost for this in-transit inventory for shipments of size (x) is the shipment size times the value per unit times the interest rate per day. This can be expressed as:

(value/FEU(**ocean value density**))*(annual carrying charge%)*(demand period/365)*((transit time (**air**))/(demand period))

DISTRIBUTION SAVINGS/FEU: A savings may be realized by a shipper that reorganizes his shipping network to maximize the benefits of the FastShip service. However, for the purpose of keeping this model conservative, it was assumed the customer would not realize a distribution savings.

SAFETY STOCK COST/FEU: Transportation systems are not normally perfectly reliable. The mean transit time may have a standard deviation that ranges from very small to very large. A shipper can protect himself from a stockout by holding a reserve, called a safety stock. Assuming that the distribution between a specific origin and destination pair is normally distributed, the shipper can choose the level of protection from stockout that he desires by choosing a stockout volume that is a multiple of the standard deviation for the particular origin-destination pair.

The amount of safety stock calculated is based upon the amount of stock needed to satisfy 68% of all probabilities that the safety stock will be demanded assuming a normal distribution (Feeter and Dalleck, *Decision Models for Inventory Management*). This value is calculated from this equation:

(value/FEU(**ocean value density**))*(stock out cost standard deviation)*((annual carrying charge%)/(FEU's ship'd annually))*SQRT((transit time(**air**))*(standard deviation of daily sales)^2+(daily sales)^2* (standard deviation of transit time (**air**)))

FREIGHT RATE/FEU: As was discussed above.

TOTAL LOGISTICS COST/FEU (air freight / ocean value density) : The total cost the shipper must bear for shipping the cargo via ocean freight. This is calculated by summing up the PERISHABLE COST/FEU, ORIGIN INVENTORY COST/FEU, ORIGIN WAREHOUSE COST/FEU, IN-TRANSIT INVENTORY COST/FEU, SAFETY STOCK COST/FEU, and FREIGHT RATE/FEU.

10.9 LOGISTICS COST: FASTSHIP WITH RESPECT TO OCEAN

PERISHABLE COST/FEU: Commodities vary greatly in their ability to hold value over time. Some goods have a short physical life (i.e. fresh flowers) and must be delivered to their destination quickly, or not at all. Other goods have their highest value early in the selling season (i.e. clothes) and are worth less as the season ends.

Other products have life cycles that extend beyond a single season or even a single year. For these goods, it is necessary to make accurate forecasts concerning demand occurring near the end of the cycle, so that the shipper is not left with excess inventory.

Costs due to loss of product value are determined by the change in demand or product condition. The expression for perishable cost has four components:

1. Salvage value at the end of the product's life
2. Value of the good being shipped
3. The ratio of transit time and the product's life
4. A parameter that determines the rate of decay in the value of the good being shipped. This parameter determines if the good loses its value at a constant rate daily ($k = 1.0$), or at a small rate at the beginning of the product's life and at a more dramatic rate near the end of the product's life ($k > 1.0$).

Value decay as related to time spent in-transit may be expressed as:

(value/FEU(**ocean value density**))*(1 - (salvage%))
or
(1-salvage%)*(value/FEU(**ocean value density**)*((transit time(**FastShip**)) / (shelf life))^(decay parameter))
Whichever is smaller

ORIGIN INVENTORY COST/FEU: As a manufacturer produces goods, they are accumulated until reaching a quantity (x) that is deemed large enough to make a shipment. Where the shipment is made, the quantity on hand becomes zero and, as more goods are manufactured, they again accumulate up to a quantity (x) before the next shipment goes out. The average amount of stock on hand is x/2. The cost of holding x/2 is:

(annual carrying charge%)*(demand period/365)*(value/FEU(**ocean value density**))*(avg shipment size(**FastShip**)/2) / (number of FEU's ship'd annually)

ORIGIN WAREHOUSE COST/FEU: The cost incurred by having the cargo sit in a warehouse during shipment. Since our model assumes just in time shipping, this value will be zero. However, if warehouse costs are incurred, the origin warehouse cost is calculated from this equation:

(pounds/FEU)*(avg shipment size(**FastShip**)/2)*(warehouse cost) / (number of FEU's ship'd annually)

IN-TRANSIT INVENTORY COST/FEU: Goods may be sold to a buyer in a variety of ways. The buyer may take delivery of the goods at the manufacturing plant, at his own facility or at some point in between. During the time goods are in-transit, they are in effect a moving inventory. The cost for this in-transit inventory for shipments of size (x) is the shipment size times the value per unit times the interest rate per day. This can be expressed as:

(value/FEU(**ocean value density**))*(annual carrying charge%)*(demand period/365)*((transit time (**FastShip**))/(demand period))

DISTRIBUTION SAVINGS/FEU: A savings may be realized by a shipper that reorganizes his shipping network to maximize the benefits of the FastShip service. However, for the purpose of keeping this model conservative, it was assumed the customer would not realize a distribution savings.

SAFETY STOCK COST/FEU: Transportation systems are not normally perfectly reliable. The mean transit time may have a standard deviation that ranges from very small to very large. A shipper can protect himself from a stockout by holding a reserve, called a safety stock. Assuming that the distribution between a specific origin and destination pair is normally distributed, the shipper can choose the level of protection from stockout that he desires by choosing a stockout volume that is a multiple of the standard deviation for the particular origin-destination pair.

The amount of safety stock calculated is based upon the amount of stock needed to satisfy 68% of all probabilities that the safety stock will be demanded assuming a normal distribution (Feeter and Dalleck, *Decision Models for Inventory Management*). This value is calculated from this equation:

(value/FEU(**ocean value density**))*(stock out cost standard deviation)*((annual carrying charge%)/(FEU's ship'd annually))*SQRT((transit time(**FastShip**))*(standard deviation of daily sales)^2+(daily sales)^2* (standard deviation of transit time (**FastShip**)))

FREIGHT RATE/FEU: As was discussed above.

TOTAL LOGISTICS COST/FEU (FastShip freight / ocean value density) : The total cost the shipper must bear for shipping the cargo via ocean freight. This is calculated by summing up the PERISHABLE COST/FEU, ORIGIN INVENTORY COST/FEU, ORIGIN WAREHOUSE COST/FEU, IN-TRANSIT INVENTORY COST/FEU, SAFETY STOCK COST/FEU, and FREIGHT RATE/FEU.

10.10 LOGISTICS COST: FASTSHIP WITH RESPECT TO AIR

PERISHABLE COST/FEU: Commodities vary greatly in their ability to hold value over time. Some goods have a short physical life (i.e. fresh flowers) and must be delivered to their destination quickly, or not at all. Other goods have their highest value early in the selling season (i.e. clothes) and are worth less as the season ends.

Other products have life cycles that extend beyond a single season or even a single year. For these goods, it is necessary to make accurate forecasts concerning demand occurring near the end of the cycle, so that the shipper is not left with excess inventory.

Costs due to loss of product value are determined by the change in demand or product condition. The expression for perishable cost has four components:

1. Salvage value at the end of the product's life
2. Value of the good being shipped
3. The ratio of transit time and the product's life
4. A parameter that determines the rate of decay in the value of the good being shipped. This parameter determines if the good loses its value at a constant rate daily (k = 1.0), or at a small rate at the beginning of the product's life and at a more dramatic rate near the end of the product's life (k > 1.0).

Value decay as related to time spent in-transit may be expressed as:

(value/FEU(**air value density**))*(1 - (salvage%))
or
(1-salvage%)*(value/FEU(**air value density**)*((transit time(**FastShip**)) / (shelf life))^(decay parameter))
Whichever is smaller

ORIGIN INVENTORY COST/FEU: As a manufacturer produces goods, they are accumulated until reaching a quantity (x) that is deemed large enough to make a shipment. Where the shipment is made, the quantity on hand becomes zero and, as more goods are manufactured, they again accumulate up to a quantity (x) before the next shipment goes out. The average amount of stock on hand is x/2. The cost of holding x/2 is:

(annual carrying charge%)*(demand period/365)*(value/FEU(**air value density**))*(avg shipment size(**FastShip**)/2) / (number of FEU's ship'd annually)

ORIGIN WAREHOUSE COST/FEU: The cost incurred by having the cargo sit in a warehouse during shipment. Since our model assumes just in time shipping, this value will be zero. However, if warehouse costs are incurred, the origin warehouse cost is calculated from this equation:

(pounds/FEU)*(avg shipment size(**FastShip**)/2)*(warehouse cost) / (number of FEU's ship'd annually)

IN-TRANSIT INVENTORY COST/FEU: Goods may be sold to a buyer in a variety of ways. The buyer may take delivery of the goods at the manufacturing plant, at his own facility or at some point in between. During the time goods are in-transit, they are in effect a moving inventory. The cost for this in-transit inventory for shipments of size (x) is the shipment size times the value per unit times the interest rate per day. This can be expressed as:

(value/FEU(**air value density**))*(annual carrying charge%)*(demand period/365)*((transit time (**FastShip**))/(demand period))

DISTRIBUTION SAVINGS/FEU: A savings may be realized by a shipper that reorganizes his shipping network to maximize the benefits of the FastShip service. However, for the purpose of keeping this model conservative, it was assumed the customer would not realize a distribution savings.

SAFETY STOCK COST/FEU: Transportation systems are not normally perfectly reliable. The mean transit time may have a standard deviation that ranges from very small to very large. A shipper can protect himself from a stockout by holding a reserve, called a safety stock. Assuming that the distribution between a specific origin and destination pair is normally distributed, the shipper can choose the level of protection from stockout that he desires by choosing a stockout volume that is a multiple of the standard deviation for the particular origin-destination pair.

The amount of safety stock calculated is based upon the amount of stock needed to satisfy 68% of all probabilities that the safety stock will be demanded assuming a normal distribution (Feeter and Dalleck, *Decision Models for Inventory Management*). This value is calculated from this equation:

(value/FEU(**air value density**))*(stock out cost standard deviation)*((annual carrying charge%)/(FEU's ship'd annually))*SQRT((transit time(**FastShip**))*(standard deviation of daily sales)^2+(daily sales)^2* (standard deviation of transit time (**FastShip**)))

FREIGHT RATE/FEU: As was discussed above.

TOTAL LOGISTICS COST/FEU (FastShip freight / air value density) : The total cost the shipper must bear for shipping the cargo via ocean freight. This is calculated by summing up the PERISHABLE COST/FEU, ORIGIN INVENTORY COST/FEU, ORIGIN WAREHOUSE COST/FEU, IN-TRANSIT INVENTORY COST/FEU, SAFETY STOCK COST/FEU, and FREIGHT RATE/FEU.

10.11 LOGISTICS COSTS: SUMMARY

OCEAN TOTAL LOGISTICS COST / FEU: The cost of shipping an FEU of a particular commodity via ocean freight. The FEU is assumed to be carrying cargo with a value density equal to the average value density of the cargo that travel via ocean freight in 1994.

AIR TOTAL LOGISTICS COST / FEU: The cost of shipping an FEU of a particular commodity via air freight. The FEU is assumed to be carrying cargo with a value density equal to the average value density of the cargo that travel via air freight in 1994.

FASTSHIP TOTAL LOGISTICS COST / FEU WITH RESPECT TO OCEAN: The cost of shipping an FEU of a particular commodity via FastShip. The FEU is assumed to be carrying cargo with a value density equal to the average value density of the cargo that travel via ocean freight in 1994. This value is compared to the "Ocean Total Logistics Cost/FEU" to assess the advantage FastShip has over ocean freight.

FASTSHIP TOTAL LOGISTICS COST / FEU WITH RESPECT TO AIR: The cost of shipping an FEU of a particular commodity via FastShip. The FEU is assumed to be carrying cargo with a value density equal to the average value density of the cargo that travel via air freight in 1994. This value is compared to the "Air Total Logistics Cost/FEU" to assess the advantage FastShip has over air freight.

FEU's TAKEN FROM OCEAN BY FASTSHIP: If the "FastShip Total Logistics Cost/FEU with Respect to Ocean" is less than the "Ocean Total Logistics Cost/FEU" then all of the commodity that was shipped via ocean in 1994 is assume to go by FastShip in the model. If there is a number in this cell, this is the number of FEU's FastShip will divert from ocean freight. If the cell is blank, then FastShip did not divert any of the commodity from ocean freight.

VALUE TAKEN FROM OCEAN BY FASTSHIP: If the "FastShip Total Logistics Cost/FEU with Respect to Ocean" is less than the "Ocean Total Logistics Cost/FEU" then all of the commodity that was shipped via ocean in 1994 is assume to go by FastShip in the model. If there is a number in this cell, this is the value of the commodity FastShip will divert from ocean freight. If the cell is blank, then FastShip did not divert any of the commodity from ocean freight.

FEU's TAKEN FROM AIR BY FASTSHIP: If the "FastShip Total Logistics Cost/FEU with Respect to Air" is less than the "Air Total Logistics Cost/FEU" then all of the commodity that was shipped via air in 1994 is assume to go by FastShip in the model. If there is a number in this cell, this is the number of FEU's FastShip will divert from air freight. If the cell is blank, then FastShip did not divert any of the commodity from air freight.

VALUE TAKEN FROM AIR BY FASTSHIP: If the "FastShip Total Logistics Cost/FEU with Respect to Air" is less than the "Air Total Logistics Cost/FEU" then all of the commodity that was shipped via air in 1994 is assume to go by FastShip in the model. If there is a number in this cell, this is the value of the commodity FastShip will divert from air freight. If the cell is blank, then FastShip did not divert any of the commodity from air freight.

REMAINING FEU's SHIPPED VIA OCEAN: If the "FastShip Total Logistics Cost/FEU with Respect to Ocean" is greater than the "Ocean Total Logistics Cost/FEU" then all of the commodity that was shipped via ocean in 1994 is assume to remain an ocean freight commodity. If there is a number in this cell, this is the number of FEU's shipped via ocean freight in 1994. If the cell is 0.0, then either none of the commodity was shipped via ocean in 1994 or FastShip diverted the commodity.

VALUE OF REMAINING CARGO SHIPPED VIA OCEAN: If the "FastShip Total Logistics Cost/FEU with Respect to Ocean" is greater than the "Ocean Total Logistics Cost/FEU" then all of the commodity that was shipped via ocean in 1994 is assume to remain an ocean freight commodity. If there is a number in this cell, this is the total value of the commodity shipped via ocean freight in 1994. If the cell is 0.0, then either none of the commodity was shipped via ocean in 1994 or FastShip diverted the commodity.

REMAINING FEU's SHIPPED VIA AIR: If the "FastShip Total Logistics Cost/FEU with Respect to Air" is greater than the "Air Total Logistics Cost/FEU" then all of the commodity that was shipped via air in 1994 is assume to remain an air freight commodity. If there is a number in this cell, this is the number of FEU's shipped via air freight in 1994. If the cell is 0.0, then either none of the commodity was shipped via air in 1994 or FastShip diverted the commodity.

VALUE OF REMAINING CARGO SHIPPED VIA AIR: If the "FastShip Total Logistics Cost/FEU with Respect to Air" is greater than the "Air Total Logistics Cost/FEU" then all of the commodity that was shipped via air in 1994 is assume to remain an air freight commodity. If there is a number in this cell, this is the total value of the commodity shipped via air freight in 1994. If the cell is 0.0, then either none of the commodity was shipped via air in 1994 or FastShip diverted the commodity.

10.12 STIMULATED DEMAND CHARACTERISTICS

OWN PRICE ELASTICITY 1: The percent change in demand for a percent change in price. The Own Price Elasticity (OPE) is used to calculate the stimulated demand for FastShip. If FastShip can ship the commodity faster, and therefore at a reduced logistics cost, the percent decrease in cost causes a percent increase in demand for the commodity. The OPE values were obtained from a variety of sources. If the elasticity of a commodity could not be determined, it was assumed to be unit elastic at -1.0 (*Economics*, Lipsey, Steiner, and Purvis).

SOURCE OF OPE: The source from which the OPE for a given commodity was taken.

OWN PRICE ELASTICITY 2: An optional column; if another OPE is given for the commodity it is inputted in this column to be averaged with the first OPE.

OWN PRICE ELASTICITY - BEST: The average OPE of OPE1 and OPE2. This was the OPE used for stimulated demand calculations

10.13 STIMULATED DEMAND CALCULATIONS

TOTAL NUMBER OF FEU's SHIPPED VIA OCEAN IN 1994: The total number of containers full of a given commodity shipped between Europe and America in the year 1994 via ocean freight.

CHANGE IN DEMAND FOR OCEAN TO FASTSHIP (FEU's): The increase in demand for shipments of a given commodity previously shipped by ocean with the introduction of FastShip. This is calculated from the equation:

(own price elasticity)*(total number of FEU's shipped via ocean freight)*((total logistics cost (**FastShip**)-total logistics cost (**ocean**))/(total logistics cost (**ocean**)))

If the equation cell reads "NEGATIVE" then the FastShip freight fails to create a positive increase in demand.

PERCENT CHANGE IN DEMAND: The percent increase in demand for shipments of a given commodity previously shipped by ocean with the introduction of FastShip. This is calculated from the equation:

IF (change in demand for FEU's shipped (**FastShip**)) > 0 THEN (change in demand for FEU's(**FastShip**)) / (total number of FEU's shipped(**ocean**))

If the equation cell reads "FALSE" then the FastShip freight fails to spark the stimulated demand.

TOTAL NUMBER OF FEU's SHIPPED VIA AIR IN 1994: The total number of containers full of a given commodity shipped between Europe and America in the year 1994 via air freight.

CHANGE IN DEMAND FOR AIR TO FASTSHIP (FEU's): The increase in demand for shipments of a given commodity previously shipped by air with the introduction of FastShip. This is calculated from the equation:

(own price elasticity)*(total number of FEU's shipped via ocean freight)*((total logistics cost **(FastShip)**-total logistics cost **(air)**)/(total logistics cost **(air)**))

If the equation cell reads "NEGATIVE" then the FastShip freight fails to create a positive increase in demand.

PERCENT CHANGE IN DEMAND: The percent increase in demand for shipments of a given commodity previously shipped by air with the introduction of FastShip. This is calculated from the equation:

IF
(change in demand for FEU's shipped **(FastShip)**) > 0
THEN
(change in demand for FEU's **(FastShip)**) / (total number of FEU's shipped **(air)**)

If the equation cell reads “FALSE” then the FastShip freight fails to spark the stimulated demand.

WEIGHT OF STIMULATED DEMAND FROM OCEAN FREIGHT: The increased amount of cargo demanded due to stimulated demand, in terms of pounds. This is calculated from the equation:

percent change in demand **(ocean)** * **ocean** weight

If the equation cell reads “NONE” then there is no positive change in the demand for the commodity shipped via ocean.

WEIGHT OF STIMULATED DEMAND FROM AIR FREIGHT: The increased amount of cargo demanded due to stimulated demand, in terms of pounds. This is calculated from the equation:

percent change in demand **(air)** * **air** weight

If the equation cell reads “NONE” then there is no positive change in the demand for the commodity shipped via air.

TOTAL PERCENTAGE INCREASE IN FREIGHT DEMAND: The total increase in the demand for the given commodity with the advent of the FastShip service. This is calculated from the equation:

(weight of stimulated demand from **ocean** freight + weight of stimulated demand from **air** freight) / total weight

11. Results

Results

Assumptions:

The decay parameter is varied for different commodities
The air freight rate is 60 cents/pound of cargo
The maximum weight of a FEU is 26.8 MT (59,000 lbs)

1994 Values

DIVERTED CARGO		STIMULATED DEMAND CARGO			
		OPE = -1.0		OPE = -1.4	
From Ocean to FastShip (FEU)	**From Air to FastShip (FEU)**	**Dmd. Stim. from Ocean**	**Dmd. Stim. from Air**	**Dmd. Stim. from Ocean**	**Dmd. Stim. from Air**
136,412	33,818	40,985	21,723	44,062	25,824

1998 Values

DIVERTED CARGO		STIMULATED DEMAND CARGO			
		OPE = -1.0		OPE = -1.4	
From Ocean to FastShip (FEU)	**From Air to FastShip (FEU)**	**Dmd. Stim. from Ocean**	**Dmd. Stim. from Air**	**Dmd. Stim. from Ocean**	**Dmd. Stim. from Air**
163,297	41,106	49,063	26,404	52,746	31,389

* Growth rate of ocean freight is taken as 4.6% per year (Mercer Management)
** Growth rate of air freight is taken as 5.0% per year (FastShip Atlantic)

1994 Total Demand for FastShip | OPE = -1.0	1994 Total Demand for FastShip | OPE = -1.4	1998 Total Demand for FastShip | OPE = -1.0	1998 Total Demand for FastShip | OPE = -1.4
232,938	240,116	279,871	288,539

Results

Assumptions:

The decay parameter is varied for different commodities
The air freight rate is 60 cents/pound of cargo
The maximum weight of a FEU is 21.8 MT (48,050 lbs)

1994 Values

DIVERTED CARGO		STIMULATED DEMAND CARGO			
		OPE = -1.0		OPE = -1.4	
From Ocean to FastShip (FEU)	From Air to FastShip (FEU)	Dmd. Stim. from Ocean	Dmd. Stim. from Air	Dmd. Stim. from Ocean	Dmd. Stim. from Air
155,563	38,611	40,901	25,105	43,955	29,837

1998 Values

DIVERTED CARGO		STIMULATED DEMAND CARGO			
		OPE = -1.0		OPE = -1.4	
From Ocean to FastShip (FEU)	From Air to FastShip (FEU)	Dmd. Stim. from Ocean	Dmd. Stim. from Air	Dmd. Stim. from Ocean	Dmd. Stim. from Air
186,223	46,932	48,962	30,515	52,618	36,267

* Growth rate of ocean freight is taken as 4.6% per year (Mercer Management)
** Growth rate of air freight is taken as 5.0% per year (FastShip Atlantic)

1994 Total Demand for FastShip | OPE = -1.0	1994 Total Demand for FastShip | OPE = -1.4	1998 Total Demand for FastShip | OPE = -1.0	1998 Total Demand for FastShip | OPE = -1.4
260,180	267,966	312,632	322,040

Results

Assumptions:

The decay parameter is varied for different commodities
The air freight rate is 60 cents/pound of cargo
The maximum weight of a FEU is 16.8 MT (37,030 lbs)

1994 Values

DIVERTED CARGO		STIMULATED DEMAND CARGO			
		OPE = -1.0		OPE = -1.4	
From Ocean to FastShip (FEU)	From Air to FastShip (FEU)	Dmd. Stim. from Ocean	Dmd. Stim. from Air	Dmd. Stim. from Ocean	Dmd. Stim. from Air
182,905	47,558	37,584	30,250	40,593	35,973

1998 Values

DIVERTED CARGO		STIMULATED DEMAND CARGO			
		OPE = -1.0		OPE = -1.4	
From Ocean to FastShip (FEU)	From Air to FastShip (FEU)	Dmd. Stim. from Ocean	Dmd. Stim. from Air	Dmd. Stim. from Ocean	Dmd. Stim. from Air
218,954	57,807	44,991	36,769	48,593	43,725

* Growth rate of ocean freight is taken as 4.6% per year (Mercer Management)
** Growth rate of air freight is taken as 5.0% per year (FastShip Atlantic)

1994 Total Demand for FastShip | OPE = -1.0	1994 Total Demand for FastShip | OPE = -1.4	1998 Total Demand for FastShip | OPE = -1.0	1998 Total Demand for FastShip | OPE = -1.4
298,297	307,029	358,521	369,080

Competitive Response: Ocean Freight

Assumptions:

Assumptions of Commodity Attributes are the same as the Phase II Market Report
The decay parameter is varied for different commodities
The maximum weight of a FEU is 26.8 MT (59,000 lbs)

1994 Values

	DIVERTED CARGO		STIMULATED DEMAND CARGO			
			OPE = -1.0		OPE = -1.4	
Ocean Transit Time	**From Ocean to FastShip (FEU)**	**From Air to FastShip (FEU)**	**Dmd. Stim. from Ocean**	**Dmd. Stim. from Air**	**Dmd. Stim. from Ocean**	**Dmd. Stim. from Air**
21	136,412	33,818	40,985	21,723	44,062	25,824
17	122,004	33,818	26,674	21,723	28,724	25,824
13	79,072	33,818	10,658	21,723	11,567	25,824

1998 Values

	DIVERTED CARGO		STIMULATED DEMAND CARGO			
			OPE = -1.0		OPE = -1.4	
Ocean Transit Time	**From Ocean to FastShip (FEU)**	**From Air to FastShip (FEU)**	**Dmd. Stim. from Ocean**	**Dmd. Stim. from Air**	**Dmd. Stim. from Ocean**	**Dmd. Stim. from Air**
21	163,297	41,106	49,063	26,404	52,746	31,389
17	146,050	41,106	31,931	26,404	34,385	31,389
13	94,656	41,106	12,759	26,404	13,847	31,389

* Growth rate of ocean freight is taken as 4.6% per year (Mercer Management)
** Growth rate of air freight is taken as 5.0% per year (FastShip Atlantic)

Ocean Transit Time	**1994 Total Demand for FastShip | OPE = -1.0**	**1994 Total Demand for FastShip | OPE = -1.4**	**1998 Total Demand for FastShip | OPE = -1.0**	**1998 Total Demand for FastShip | OPE = -1.4**
21	232,938	240,116	279,871	288,539
17	204,219	210,370	245,491	252,930
13	145,271	150,281	174,925	180,998

Competitive Response: Air Freight

Assumptions:

Assumptions of Commodity Attributes are the same as the Phase II Market Report
The decay parameter is varied for different commodities
The maximum weight of a FEU is 26.8 MT (59,000 lbs)

1994 Values

	DIVERTED CARGO		STIMULATED DEMAND CARGO			
			OPE = -1.0		OPE = -1.4	
Air Freight Rate	From Ocean to FastShip (FEU)	From Air to FastShip (FEU)	Dmd. Stim. from Ocean	Dmd. Stim. from Air	Dmd. Stim. from Ocean	Dmd. Stim. from Air
$ 0.60	136,412	33,818	40,985	21,723	44,062	25,824
$ 0.30	136,412	27,671	40,985	13,650	44,062	16,605
$ 0.15	136,412	17,664	40,985	5,826	44,062	7,358
$ 0.10	136,412	11,013	40,985	2,202	44,062	2,834

1998 Values

	DIVERTED CARGO		STIMULATED DEMAND CARGO			
			OPE = -1.0		OPE = -1.4	
Air Freight Rate ($/pound)	From Ocean to FastShip (FEU)	From Air to FastShip (FEU)	Dmd. Stim. from Ocean	Dmd. Stim. from Air	Dmd. Stim. from Ocean	Dmd. Stim. from Air
$ 0.60	163,297	41,106	49,063	26,404	52,746	31,389
$ 0.30	163,297	33,634	49,063	16,592	52,746	20,183
$ 0.15	163,297	21,471	49,063	7,082	52,746	8,944
$ 0.10	163,297	13,386	49,063	2,677	52,746	3,445

* Growth rate of ocean freight is taken as 4.6% per year (Mercer Management)
** Growth rate of air freight is taken as 5.0% per year (FastShip Atlantic)

Air Freight Rate ($/pound)	1994 Total Demand for FastShip | OPE = -1.0	1994 Total Demand for FastShip | OPE = -1.4	1998 Total Demand for FastShip | OPE = -1.0	1998 Total Demand for FastShip | OPE = -1.4
$ 0.60	232,938	240,116	279,871	288,539
$ 0.30	218,718	224,750	262,586	269,861
$ 0.15	200,887	205,496	240,912	246,458
$ 0.10	190,612	194,321	228,423	232,875

Cargo Taken from Ocean and Air by FastShip

Maximum Weight of an FEU = 59,000 lbs

Total Market

Number of Ocean FEU's	2,451,472
Number of Air FEU's	38,285
Total Number of FEU's Shipped	2,489,757

Note: These are calculated totals, not actual values

No. of FEU's from Ocean to FastShip	136,412
Percent of Total (Ocean + Air)	5.48%
Percent of Ocean	5.56%
No. of FEU's from Air to FastShip	33,818
Percent of Total (Ocean + Air)	1.36%
Percent of Air	88.33%
Tot. No. of FEU's from O&A to FastShip	170,230
Percent of Total (Ocean + Air)	6.84%

Value of Cargo from Ocean to FastShip	$	37,476,631,220.00
Percent of Total (Ocean + Air)		30.10%
Percent of Ocean		59.97%
Value of Cargo from Air to FastShip	$	35,032,449,167.00
Percent of Total (Ocean + Air)		28.14%
Percent of Air		56.50%
Tot. Value of Cargo from O&A to FastShip	$	72,509,080,387.00
Percent of Total (Ocean + Air)		58.24%

Cargo Taken from Ocean and Air by FastShip

Maximum Weight of an FEU = 48,050 lbs

Number of Ocean FEU's	2,988,985
Number of Air FEU's	44,994
Total Number of FEU's Shipped	3,033,979

Note: These are calculated totals, not actual values

No. of FEU's from Ocean to FastShip	155,563
Percent of Total (Ocean + Air)	5.13%
Percent of Ocean	5.20%
No. of FEU's from Air to FastShip	38,611
Percent of Total (Ocean + Air)	1.27%
Percent of Air	85.81%
Tot. No. of FEU's from O&A to FastShip	194,174
Percent of Total (Ocean + Air)	6.40%

Value of Cargo from Ocean to FastShip	$	36,058,621,588.00
Percent of Total (Ocean + Air)		28.96%
Percent of Ocean		57.70%
Value of Cargo from Air to FastShip	$	30,604,565,713.00
Percent of Total (Ocean + Air)		24.58%
Percent of Air		49.36%
Tot. Value of Cargo from O&A to FastShip	$	66,663,187,301.00
Percent of Total (Ocean + Air)		53.55%

Cargo Taken from Ocean and Air by FastShip

Maximum Weight of an FEU = 37,030 lbs

Total Market

Number of Ocean FEU's	3,860,597.58
Number of Air FEU's	56,218.87
Total Number of FEU's Shipped	3,916,816.45

Note: These are calculated totals, not actual values

No. of FEU's from Ocean to FastShip	182,905
Percent of Total (Ocean + Air)	4.67%
Percent of Ocean	4.74%
No. of FEU's from Air to FastShip	47,558
Percent of Total (Ocean + Air)	1.21%
Percent of Air	84.59%
Tot. No. of FEU's from O&A to FastShip	230,463
Percent of Total (Ocean + Air)	5.88%

Value of Cargo from Ocean to FastShip	$	34,109,820,898.00
Percent of Total (Ocean + Air)		27.40%
Percent of Ocean		54.58%
Value of Cargo from Air to FastShip	$	28,376,443,625.00
Percent of Total (Ocean + Air)		22.79%
Percent of Air		45.77%
Tot. Value of Cargo from O&A to FastShip	$	62,486,264,523.00
Percent of Total (Ocean + Air)		50.19%

Stimulated Demand Created by FastShip

Maximum Weight of an FEU = 59,000 lbs
Default Elasticity = -1.0

No. of FEU's Stimulated from Ocean	40,985
Percent of Total (Ocean + Air)	1.65%
Percent of Ocean	1.67%
No. of FEU's Stimulated from Air	21,723
Percent of Total (Ocean + Air)	0.87%
Percent of Air	56.74%
Total No. of FEU's Stimulated	62,708
Percent of Total (Ocean + Air)	2.52%

Value of Cargo Stimulated from Ocean	$ 13,461,344,983.36
Percent of Total (Ocean + Air)	10.81%
Percent of Ocean	21.54%
Value of Cargo Stimulated from Air	$ 15,144,516,482.64
Percent of Total (Ocean + Air)	12.17%
Percent of Air	24.43%
Total Value of Cargo Stimulated	$ 28,605,861,466.00
Percent of Total (Ocean + Air)	22.98%

Stimulated Demand Created by FastShip

Maximum Weight of an FEU = 59,000 lbs
Default Elasticity = -1.4

No. of FEU's Stimulated from Ocean	44,062
Percent of Total (Ocean + Air)	1.77%
Percent of Ocean	1.80%
No. of FEU's Stimulated from Air	25,824
Percent of Total (Ocean + Air)	1.04%
Percent of Air	67.45%
Total No. of FEU's Stimulated	69,886
Percent of Total (Ocean + Air)	2.81%

Value of Cargo Stimulated from Ocean	$ 14,325,218,250.75
Percent of Total (Ocean + Air)	11.51%
Percent of Ocean	22.92%
Value of Cargo Stimulated from Air	$ 17,541,320,597.59
Percent of Total (Ocean + Air)	14.09%
Percent of Air	28.29%
Total Value of Cargo Stimulated	$ 31,866,538,848.34
Percent of Total (Ocean + Air)	25.60%

Stimulated Demand Created by FastShip

Maximum Weight of an FEU = 48,050 lbs
Default Elasticity = -1.0

No. of FEU's Stimulated from Ocean	40,901
Percent of Total (Ocean + Air)	1.35%
Percent of Ocean	1.37%
No. of FEU's Stimulated from Air	25,105
Percent of Total (Ocean + Air)	0.83%
Percent of Air	55.80%
Total No. of FEU's Stimulated	66,007
Percent of Total (Ocean + Air)	2.18%

Value of Cargo Stimulated from Ocean	$ 11,712,082,578.03
Percent of Total (Ocean + Air)	9.41%
Percent of Ocean	18.74%
Value of Cargo Stimulated from Air	$ 14,554,671,809.00
Percent of Total (Ocean + Air)	11.69%
Percent of Air	23.47%
Total Value of Cargo Stimulated	$ 26,266,754,387.03
Percent of Total (Ocean + Air)	21.10%

Stimulated Demand Created by FastShip

Maximum Weight of an FEU = 48,050 lbs
Default Elasticity = -1.4

No. of FEU's Stimulated from Ocean	43,955
Percent of Total (Ocean + Air)	1.45%
Percent of Ocean	1.47%
No. of FEU's Stimulated from Air	29,837
Percent of Total (Ocean + Air)	0.98%
Percent of Air	66.31%
Total No. of FEU's Stimulated	73,792
Percent of Total (Ocean + Air)	2.43%

Value of Cargo Stimulated from Ocean	$ 12,456,146,814.66
Percent of Total (Ocean + Air)	10.01%
Percent of Ocean	19.93%
Value of Cargo Stimulated from Air	$ 16,860,303,292.55
Percent of Total (Ocean + Air)	13.54%
Percent of Air	27.19%
Total Value of Cargo Stimulated	$ 29,316,450,107.21
Percent of Total (Ocean + Air)	23.55%

Stimulated Demand Created by FastShip

Maximum Weight of an FEU = 37,030 lbs
Default Elasticity = -1.0

No. of FEU's Stimulated from Ocean	37,584
Percent of Total (Ocean + Air)	0.96%
Percent of Ocean	0.97%
No. of FEU's Stimulated from Air	30,250
Percent of Total (Ocean + Air)	0.77%
Percent of Air	53.81%
Total No. of FEU's Stimulated	67,834
Percent of Total (Ocean + Air)	1.73%

Value of Cargo Stimulated from Ocean	$ 9,310,701,633.05
Percent of Total (Ocean + Air)	7.48%
Percent of Ocean	14.90%
Value of Cargo Stimulated from Air	$ 13,629,478,217.99
Percent of Total (Ocean + Air)	10.95%
Percent of Air	21.98%
Total Value of Cargo Stimulated	$ 22,940,179,851.03
Percent of Total (Ocean + Air)	18.43%

Stimulated Demand Created by FastShip

Maximum Weight of an FEU = 37,030 lbs
Default Elasticity = -1.4

No. of FEU's Stimulated from Ocean	40,593
Percent of Total (Ocean + Air)	1.04%
Percent of Ocean	1.05%
No. of FEU's Stimulated from Air	35,973
Percent of Total (Ocean + Air)	0.92%
Percent of Air	63.99%
Total No. of FEU's Stimulated	76,566
Percent of Total (Ocean + Air)	1.95%

Value of Cargo Stimulated from Ocean	$ 9,915,801,130.36
Percent of Total (Ocean + Air)	7.96%
Percent of Ocean	15.87%
Value of Cargo Stimulated from Air	$ 15,790,631,886.98
Percent of Total (Ocean + Air)	12.68%
Percent of Air	25.47%
Total Value of Cargo Stimulated	$ 25,706,433,017.35
Percent of Total (Ocean + Air)	20.65%

Test Case: Ocean Freight versus Air Freight

Maximum Weight of an FEU = 59,000 lbs

	FEUs Shipped	% Calculated Ocean Cargo	% Calculated Air Cargo	% Total Calculated Cargo
Ocean Cargo (calculated)	2,451,472			98.46%
Air Cargo (calculated)	38,285			1.54%
Total Calculated Cargo	2,489,757			
Ocean Cargo (model result)	2,466,945	100.63%		99.08%
Air Cargo (model result)	22,812		59.58%	0.92%
Total Modeled Cargo	2,489,757			100.00%

	Total Value	% Calculated Ocean Cargo	% Calculated Air Cargo	% Total Calculated Cargo
Ocean Cargo (calculated)	$ 62,491,001,383			50.20%
Air Cargo (calculated)	$ 62,001,336,814			49.80%
Total Calculated Cargo	$ 124,492,338,197			
Ocean Cargo (model result)	$ 71,446,308,296	114.33%		57.39%
Air Cargo (model result)	$ 53,046,029,901		85.56%	42.61%
Total Modeled Cargo	$ 124,492,338,197			100.00%

Test Case: Ocean Freight versus Air Freight

Maximum Weight of an FEU = 48,050 lbs

	FEUs Shipped	% Calculated Ocean Cargo	% Calculated Air Cargo	% Total Calculated Cargo
Ocean Cargo (calculated)	2,988,985			98.52%
Air Cargo (calculated)	44,994			1.48%
Total Calculated Cargo	3,033,979			
Ocean Cargo (model result)	3,008,277	100.65%		99.15%
Air Cargo (model result)	25,703		57.12%	0.85%
Total Modeled Cargo	3,033,979			100.00%

	Total Value	% Calculated Ocean Cargo	% Calculated Air Cargo	% Total Calculated Cargo
Ocean Cargo (calculated)	$ 62,491,001,383			50.20%
Air Cargo (calculated)	$ 62,001,336,814			49.80%
Total Calculated Cargo	$ 124,492,338,197			
Ocean Cargo (model result)	$ 71,426,554,027	114.30%		57.37%
Air Cargo (model result)	$ 53,065,784,170		85.59%	42.63%
Total Modeled Cargo	$ 124,492,338,197			100.00%

Test Case: Ocean Freight versus Air Freight

Maximum Weight of an FEU = 37,030 lbs

	FEUs Shipped	% Calculated Ocean Cargo	% Calculated Air Cargo	% Total Calculated Cargo
Ocean Cargo (calculated)	3,860,598			98.56%
Air Cargo (calculated)	56,219			1.44%
Total Calculated Cargo	3,916,816			
Ocean Cargo (model result)	3,886,323	100.67%		99.22%
Air Cargo (model result)	30,493		54.24%	0.78%
Total Modeled Cargo	3,916,816			100.00%

	Total Value	% Calculated Ocean Cargo	% Calculated Air Cargo	% Total Calculated Cargo
Ocean Cargo (calculated)	$ 62,491,001,383			50.20%
Air Cargo (calculated)	$ 62,001,336,814			49.80%
Total Calculated Cargo	$ 124,492,338,197			
Ocean Cargo (model result)	$ 71,415,218,045	114.28%		57.37%
Air Cargo (model result)	$ 53,077,120,152		85.61%	42.63%
Total Modeled Cargo	$ 124,492,338,197			100.00%