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AN ASSESSMENT OF METHODOLOGICAL ALTERNATIVES FOR A REGIONAL FREIGHT MODEL IN THE NYMTC REGION

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16. Abstract

The main objective of this report is to conduct an assessment of the different freight transportation modeling methodologies. The report begins with a definition of the main objectives and scope of the regional freight model, followed by a discussion of the main freight transportation issues in the NYMTC region, and the potential role of the regional freight model. The main methodological alternatives are discussed next. This includes a brief description of the different models and a preliminary assessment of: (a) data requirements, (b) staff requirements; (c) computing power required; (d) adequacy to NYMTC's conditions; (e) practicality; and (f) conceptual validity. The final section presents a summary of the key findings of this project.

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1. INTRODUCTION

The essence of planning is a comprehensive analysis of the impacts of policies, programs and projects upon the system under consideration and its socio-economic environment. In transportation planning, this concept translates into the consideration of the interactions among multiple transportation modes, and between transportation and land use, the economy and the environment. In this overall context, analytical transportation planning relies on the use of models to assess the impacts of the proposed alternatives. In the area of passenger transportation, there is a long-standing analytical tradition of considering interactions among passenger transportation demand and land use and, to a lesser degree, between passenger transportation and the other economic sectors. Unfortunately, freight transportation does not have a comparable history. This situation seems to be the result of a combination of factors ranging from lack of awareness of the importance of freight transportation, to the inherent and staggering complexity of freight movements into, out of, and within urban areas.

However, the confluence of a number of relatively recent trends is pushing freight transportation to the forefront of issues. Economic globalization, electronic commerce and the Internet are profoundly changing the geographic realm and the features of economic markets. Just In Time production systems are stressing the importance of the freight system as the conveyor of high priority goods. Increased awareness among community leaders, environmental professionals and legislators about the health effects of truck traffic pollution is adding pressure for an enhanced consideration of freight transportation as part of the transportation planning process. However high this pressure may be, the effective integration of freight transportation planning faces significant methodological challenges.

Some of the above trends have implications directly related to the scope of this paper. The prospect of e-commerce generating a significant number of small deliveries, most likely in small delivery vans, and the resulting increase in urban congestion, should call for the implementation of effective freight transportation planning processes, that for the most part are absent in the planning studies at Metropolitan Planning Organizations.

The implementation of freight transportation planning is hampered by the lack of appropriate freight transportation modeling methodologies. This is a consequence of a combination of factors, among them:

- the inherent complexity of freight transportation
- the commercially sensitive nature of the data that is required to develop models
- a general lack of interest on the part of practitioners and researchers
- underfunding of freight transportation research and education.

However, due to the combination of the global economic trends discussed at the beginning of this document, a number of Metropolitan Planning Organizations (MPO) are becoming increasingly interested in structuring formal freight transportation planning procedures. As a result, there is renewed interest in the development of the freight transportation models that are needed to support the planning process. This research project is a reflection of such a trend. It originated from the interest of the New York Metropolitan Transportation Council (NYMTC), the MPO of the New York City region, in strengthening its freight transportation modeling capabilities to support its emergent freight transportation planning process.

The main objective of this report is to conduct an assessment of the different freight transportation modeling methodologies. The report begins with a definition of the main objectives and scope of the regional freight model, followed by a discussion of the main freight transportation issues in the NYMTC region, and the potential role of the regional freight model. The main methodological alternatives are discussed next. This includes a brief description of the different models and a preliminary assessment of: (a) data requirements, (b) staff requirements; (c) computing power required; (d) adequacy to NYMTC's conditions; (e) practicality; and (f) conceptual validity. The final section presents a summary of the key findings of this project.

2. OBJECTIVES AND SCOPE OF THE REGIONAL FREIGHT MODEL

Freight transportation planning requires the use of models to conduct analyses of supply and demand for current and future conditions, as part of the forecasting process. These models are intended to provide meaningful depictions of the main components of the system and their interrelationships, so that the transportation agencies can assess the impact upon system performance of various policies, infrastructure improvements, and transportation demand management actions. The models themselves may have different characteristics depending upon the objectives of the planning agency, the fundamental assumptions upon which the models are built, the time frame of the analysis, and the constraints in terms of human resources, technical expertise and data availability.

Successful model building entails a careful evaluation of the factor mentioned above, of the numerous tradeoffs, and of an appropriate choice of the modeling approach most consistent with the agency's objectives. Of utmost importance among these factors is the definition of the anticipated objectives, i.e., the role of the model. Among other things, the objectives of the model directly determine: the desirable level of aggregation, the set of plausible assumptions upon which the model will be developed, and the corresponding implementation and development time.

The definition of objectives requires the examination of the way in which the model will be used by the agency and its anticipated role in the transportation planning process. In the New York Metropolitan Transportation Council (NYMTC), the objectives of the Regional Freight Model (RFM) would be to provide:

- a meaningful depiction of:
    - the relationships among economic activities, commodity flows, and the traffic of freight (multimodal) transportation vehicles (e.g., railcars, trucks) in the NYMTC region;
    - freight transportation supply and demand in the NYMTC region, able to consider the relationship between the regional economy and freight transportation;

- the main layers of freight activity in the NYMTC region (i.e., international imports/exports both marine and air, through movements, long-haul movements both trucking and rail, warehousing/distribution centers, and local deliveries);

❖ a transportation planning tool able to:

- provide reasonably accurate estimates of the relevant variables (e.g., commodity flows, freight related traffic);
- support the planning process of capacity enhancement and system preservation actions for major components of the freight transportation system of the region;
- assess the impacts of intermodal and multimodal freight transportation projects upon the freight transportation system as a whole;

The first objective is intended to ensure that the RFM is able to consider both the flow of commodities, which represent the actual demand, as well as the flow of freight transportation vehicles, which represent the logistic end of the process, i.e., the way in which the freight industry organizes itself to move the commodities. As indicated elsewhere (Ogden, 1992, Holguín-Veras and Thorson, 2000) the focus on the commodities enables the consideration of the economic mechanisms that affect freight demand. Equally important is to consider the resulting traffic of freight transportation vehicles (e.g., trucks, rail cars) because this traffic impacts urban congestion, and the level of service of the freight system as a whole.

The second objective is intended to ensure proper consideration of the interrelationships between transportation activity and the economy as a whole. This is of the utmost importance because one of the most relevant uses of the regional freight model is on the analyses of how different levels of economic activity would impact freight transportation demand and, vice versa, how accessibility impact economic development. This important link must be properly considered in the model building process, though it represents a methodological challenge.

The third objective stresses the importance of the joint consideration of the layers of freight activity taking place in the area. Contrary to the case of small metropolitan planning organizations, in which local truck deliveries may be the only layer of freight activity, in the NYMTC region all possible layers of activity—from international movements to local deliveries—are important, a consequence of the size of the economy of the region, and of being a major freight transportation hub. In this context, it is important to ensure that these layers and their interrelationships are properly taken into account, as much as possible.

The fourth objective pertains to the ability of the model as a forecasting tool. This is a necessary condition of planning models, intended to ensure the applicability of the model to estimate future states of supply and demand.

The fifth objective defines the potential role of the RFM. Models such as the ones used by regional planning agencies, e.g., NYMTC need not focus on operational, or highly localized freight issues (e.g., minor enhancements at a truck terminal). It is likely that the most appropriate role for the RFM would be to serve as a planning tool to be used in the study of major capacity enhancements and major system preservation projects.

The sixth objective highlights the need to consider the intermodal and multimodal nature of freight movements. The NYMTC region is characterized by a freight transportation system of unparalleled complexity and size. The RFM should be able to appropriately model this complex freight transportation system so that it could be used to analyze intermodal/multimodal projects.

The geographic scope of the Regional Freight Model would be, as expected, the NYMTC region. However, since Northern New Jersey is a major center of warehousing and freight re-distribution (the source of 15% of the cargoes coming in/out of the region), it seems evident that Northern New Jersey would have to be modeled jointly with the NYMTC region. The close interaction between these two planning jurisdictions suggests opportunities for collaboration with the surrounding Metropolitan Planning Organizations in New Jersey, Pennsylvania and Connecticut.

3. DEFINITION OF ISSUES, POTENTIAL TOOLS AND ROLE OF REGIONAL FREIGHT MODEL

This section provides an overview of the main issues related to freight transportation planning and identifies different approaches to analyze these issues. It is believed that such identification will provide information about expected uses and benefits of the regional freight model, as well as the relationship of the RFM with the wider spectrum of planning tools and techniques to be used by NYMTC staff.

The section has two main parts. In the first one, a general discussion of freight transportation planning issues is presented. The second part contains the analysis of the specific issues faced by the NYMTC region, as defined by the stakeholders and the research team.

3.1 *Freight transportation issues in general*

Metropolitan Planning Organizations (MPOs) in large urban areas face similar freight transportation issues, though the specific details and social context may be different. This situation enables the definition of general categories of issues, referred here as *families of issues*, that group similar types of problems. In this section, a general definition of families of issues and the corresponding tools and techniques used to study them is provided. The freight transportation issues faced by large MPOs can be classified according to the following families:

I. *Capacity Enhancement*: actions intended to significantly increase transportation supply of the freight transportation system.

II. *System Preservation*: actions aimed at maintaining the infrastructure system in a state of good repair.

III. *Operations*: actions and/or systems that enhance the way in which freight transportation activity or operations are done.

IV. *Transportation Demand Management*: actions intended to encourage changes in demand that would result in a more efficient use of the existing infrastructure.

V. *Policy*: the set of initiatives that are intended to define the way in which long-term objectives are expected to be achieved. For the most part, these objectives are related to regional goals, such as economic development, or to ensure compliance with federal regulations or standards such as the National Environmental Protection Act, the Clean Air Act and others.

Concurrent to the definition of issues, the research team identified the set of *tools* that can be used in the analysis and study of these five families of issues. Rather than being highly technical descriptions, this document provides a general description of the available tools, and their potential role in the freight transportation planning process. The tools considered here are:

3.1.1 Modeling tools

I. *Regional Freight Model (RFM)* refers to a freight model able to produce estimates of freight supply and demand at a regional level for both current and future conditions, as part of the forecasting process.

II. *Market-Specific Freight Models* refer to freight models that focus on a more detailed description of specific markets. These markets could be defined in geographic terms, e.g., a transportation corridor, in terms of specific transportation providers, e.g., express delivery companies; or in terms of specific commodities, e.g., garbage, among many other possibilities.

III. *Operational (Simulation) Models* refer to microscopic models that are detailed enough to analyze operational schemes such as those developed for port facilities (e.g., as in Holguín-Veras and Walton, 1996), or to analyze traffic control schemes (e.g., Rathi and Santiago, 1990).

IV. *Capacity Analysis Models* refer to the analytical or empirical models that are intended to produce estimates of the maximum flows that can be handled under prevailing conditions. Capacity analysis techniques can be coupled with operational models based on simulation (as in Holguín-Veras and Walton, 1996) queuing theory (as in Agerschou and Korsgaard, 1969), or be stand-alone models of semi-empirical nature, such as those described in the Highway Capacity Manual (TRB, 1994, 1997).

3.1.2 Infrastructure analysis

I. *Infrastructure Condition Assessment* refers to the set of techniques that are intended to support the analysis and determination of system preservation decisions. This includes techniques such as: Pavement Management Systems (as described in Haas, Hudson and Zaniewski, 1994); serviceability modeling (as in Carey and Irick, 1960, and Holguín-Veras, 1997); condition assessment procedures, e.g., Pavement Serviceability Rating; and the Infrastructure Needs Assessment Model used by the New York State Department of Transportation in the determination of highway maintenance and rehabilitation priorities.

3.1.3 Impact assessment

I. *Transportation Economics* is concerned with the estimation of impacts in economic terms upon different segments of users, including the assessment of behavioral changes, the definition of (transportation) economic policy, the estimation of real transportation costs and benefits to the economy, and the valuation of externalities, e.g., estimation of health effects of air pollution, among others.

II. *Environmental Assessment* refers to the estimation of impact upon the environment, according to the performance measures used to assess environmental quality.

III. *Locational Analysis* refers to the analysis of potential locations for freight facilities, including the study of zoning restrictions and the like.

3.1.4 Outreach

I. *Stakeholders Input* refers to the process of defining the realm of potential stakeholders, requesting and ensuring their feedback into the policy and the decision making processes. In issues related to freight transportation, the preponderant role of the private freight industry, and the impact that transportation activity has upon local communities, require the implementation of a continuous process of feedback between transportation agencies, community groups and private companies. The vitality of this process of feedback is a required condition for successful implementation of policy and projects.

Table 1 shows the typical planning issues transportation agencies have to contend with. These issues have been classified according to the major groups defined at the beginning of this section. For each of the different issues identified, the set of tools that are likely to be needed have been identified with marks on Table 1.

Table 1: General classification of freight transportation issues and potential tools

	Regional freight model	Market specific freight models	Operational (simulation) models	Capacity analysis	Infrastructure condition assessment	Transportation economics	Environmental assessment	Locational analysis	Stakeholders input
I. Capacity enhancement									
a. Highway	★			★		★	★	★	★
b. Rail lines	★			★		★	★	★	★
c. Ports/rail intermodal/truck/air cargo terminals	★			★		★	★	★	★
d. Warehouse and distribution facilities	★			★		★	★	★	★
e. Multimodal/intermodal connectivity issues	★			★		★	★	★	★
II. System preservation									
a. Highway maintenance and rehabilitation	★				★	★	★		★
b. Rail line maintenance and rehabilitation	★				★	★	★		★
c. Ports and other terminals	★				★	★	★		★
d. Dredging	★				★	★	★		★
III. Operations									
a. Terminal operations/efficiency			★						★
b. Managing curb space			★						★
c. Improving routing - use of highway system			★						★
d. Minimizing conflicts freight vs passenger rail			★						★
e. Use of ITS technologies			★						★
IV. Policy									
a. Taxation		★				★	★		★
b. Vehicle size limitations		★				★	★		★
c. Commercial vehicle bans on roads	★					★	★		★
V. Transportation demand management									
a. Value pricing		★				★	★		★
b. Shifting deliveries to non-peak hours		★				★	★		★
c. Improving modal split		★				★	★		★

3.2 *Main freight transportation issues in the New York region*

The freight issues in the NYMTC region are conditioned by a combination of factors, most notably: (a) lack of efficient rail access to the East of Hudson River; (b) over-reliance on truck traffic; (c) severe traffic congestion; (d) air quality concerns; (e) the high volume of goods to be transported, both for internal consumption and in transit to other regions; (f) a significant flow of high valued goods (e.g., diamonds, fashion apparels); and, (g) lack of easily implementable capacity expansion projects for the freight transportation system. As expected, different agencies have different definitions of what the most important issues are, and the corresponding levels of priority. Rather than attempting to reconcile these differences, this section attempts to define the most important issues—from the regional standpoint—independent of the institutional structure and the associated jurisdictional domains.

A number of recently completed freight transportation studies and professional gatherings have provided different, though insightful, definition of the issues faced by the NYMTC region. One of the most comprehensive listing of issues is the one produced as part of the Freight Forum organized by NYMTC entitled "Freight Movement Issues in the Region: First Steps Toward Implementing Solutions" (NYMTC, 1998) that is referred to as the "1998 Freight Forum." As part of this forum, NYMTC staff gathered inputs from various stakeholders, including private industry representatives, academicians, community representatives and transportation agency officials, by means of focus groups held as part of the forum.

Rather than repeating the contents of the 1998 Freight Forum (the interested reader is referred to NYMTC, 1998) the objective of this section is to focus on the issues most relevant to the definition of the role of the Regional Freight Model (RFM). For that reason, the subset of most relevant issues was extracted from NYMTC 1998 and expanded on the basis of the research team's experience, input from transportation officials, and the review of the different freight studies recently completed in the region.

3.2.1 Summary of issues

There seems to be consensus among transportation officials of the importance of the freight transportation system as a pillar of the economic vitality of the region. Furthermore, there seems to be a widespread recognition that profound changes are taking place in the economy. Among them: (a) a shift from manufacturing to service-based economy; (b) the emergence of the digital economy; (c) the increasing role of high technology and Intelligent Transportation Systems (ITS); (d) the shift from national markets to global markets; and (e) the increased role of Just-In-Time production systems and online demand services via Internet and E-commerce, among others. These changes, in turn, are putting additional strains on a freight transportation system that is already operating under significant constraints. In this context, there is growing concern about: (a) how these changes are going to affect the freight transportation system; and (b) how the capacity constraints of the freight transportation system are going to affect the economic development of the region. There is no consensus on the net effect of the trends discussed above.

It is also evident that the freight system shapes the regional economy. There is ample evidence of the high costs of doing business in New York. Federal Express claims that costs in New York are 30% higher than in the rest of the country (NYMTC, 1998). A panel of business representatives reported that moving a shipment from the container terminals in New Jersey to Manhattan, a straight line distance of 1.5 miles, cost as much as sending a shipment from Connecticut to Ohio, that is a difference of 500 miles (NYC EDC, 2000). This, in turn, is cause for grave concern to city and state officials because it directly affects the economic development of NYC and the region as a whole.

Table 2 lists the main themes/issues identified at the 1998 Freight Forum. The main themes/issues identified at that forum have been complemented with a list of sub-issues, drawn from the research team's experience, from conversations with transportation officials, and from the different freight transportation studies analyzed as part of this project. Theme I focuses on the limitations of the current freight transportation system in the region. Theme II is concerned with the identification of the impacts the freight transportation system has upon the economy and the region as a whole. Theme III considers the impact of the economy as a whole on the freight transportation system. Theme IV is related to the institutional structure.

As shown in Table 2, the lack of a balanced freight transportation system, in which rail freight has a prominent role in the movement of commodities to and from the region, is perceived as a threat to the long-term economic development and air quality in the region. The issues listed under Theme I also highlight the multidimensional complexity of the problem. As shown, the solution to the issues identified would require a coordinated policy that, not only improves the rail connection across the Hudson, but also improves supporting and ancillary activities such as intermodal terminals and high tech warehousing, among others. Table 3 shows the regional issues defined in Table 2 as well as the list of potential tools.

Table 2: Main themes and issues in the NY region

I. "Freight transportation in the region is constrained by a modally imbalanced transportation system"
Inefficient rail connection across the Hudson
Rail facilities disconnected
Rail operations encounter operational conflicts with passenger service
Location of terminal facilities limit regional effectiveness
Limited yard space at current terminals
NYC lacks space for intermodal terminals
Deficient high-tech warehousing in the NY side
Truck traffic is impacted by traffic congestion
Truck traffic is impacted by physical constraints (e.g. geometrics, clearances)
Inadequate parking for trucks in New York City
Port access in NY side is constrained
Need to revitalize the Port of NY
Need to improve efficiency of urban good movements
Congestion is a major access issue to regional airports (JFK, LG)
II. "Inefficient freight transportation impacts the region in different ways"
Degrades infrastructure due to over- reliance on trucks
Adds to costs of goods
Contributes to traffic congestion and air pollution problems
Constrains economic growth and vitality
III. "Freight transportation is affected by changes in the economy"
Shift from a national market to a global market
Shift from manufacturing economy to a service economy
The emerging digital economy
IV. "Attempts to improve freight transportation are constrained by regional planning practices"
Incomplete knowledge base & limited research capability
Uncoordinated land use and transportation planning
Jurisdictional fragmentation

Table 3a: Regional issues and potential tools

	Regional freight model	Market-specific freight models	Operational (simulation) models	Capacity analysis	Infrastructure condition assessment	Transportation economics	Environmental assessment	Land use analysis	Stakeholders input
I. Capacity enhancement									
a. Highway	★			★		★	★	★	★
Inefficient urban good movements									
Congestion impacts access to airports									
Trucking is impacted by congestion									
Trucking is impacted by physical constraints									
b. Rail lines	★			★		★	★	★	★
Inefficient rail connection across Hudson									
Rail freight conflicts with passenger service									
c. Ports/rail intermodal/truck/air cargo terminals	★			★		★	★	★	★
Limited yard space at current terminals									
NYC lacks space for intermodal terminals									
Port access in NY side is constrained									
d. Warehouse and distribution facilities	★			★		★	★	★	★
Deficient high tech warehousing in NY side									
e. Multimodal/intermodal connectivity issues	★			★		★	★	★	★
Rail facilities disconnected									
Location of terminals limit regional effectiveness									
II. System preservation									
a. Highway maintenance and rehabilitation	★				★	★	★		★
Over reliance on trucks degrades infrastructure									
b. Rail line maintenance and rehabilitation	★				★	★	★		★
c. Ports and other terminals	★				★	★	★		★
d. Dredging	★				★	★	★		★
Need deep draft port									

Table 3b: Regional issues and potential tools

	Regional freight model	Market-specific freight models	Operational (simulation) models	Capacity analysis	Infrastructure condition assessment	Transportation economics	Environmental assessment	Lan use analysis	Stakeholders input
III. Operations									
a. Terminal operations/eficiency			★						★
b. Managing curb space			★						★
Inadequate truck parking in NYC									
c. Improving routing - use of highway system			★						★
d. Minimizing conflicts freight vs passenger rail			★						★
e. Use of ITS technologies			★						★
IV. Policy									
a. Taxation		★				★	★		★
b. Vehicle size limitations		★				★	★		★
c. Commercial vehicle bans on roads	★					★	★		★
V. Transportation demand management									
a. Value pricing		★				★	★		★
b. Shifting deliveries to non-peak hours		★				★	★		★
c. Improving modal split		★				★	★		★

As seen in Table 3, and as anticipated at the beginning of the document, the main role of the RFM seems to be supporting the analysis of issues related to the provision of additional freight capacity and major system preservation actions. In this context, the RFM would have an important role to play in:

- the analysis of alternatives to increase the modal share of rail,
- the locational analysis of future intermodal terminals,
- the analysis of capacity enhancement projects at the major freight transportation corridors,
- the assessment of system wide benefits attributed to specific projects,
- enhancing the policy making process by providing an important tool for the analysis of the effectiveness of alternative policies,
- the analyses of how the overall state of the regional economy would affect freight traffic, and conversely, how the overall accessibility would impact economic development and the price of goods.

The RFM is also expected to play an important role in the analysis of alternatives to improve urban goods accessibility, such as: (a) removing physical obstacles (e.g., clearances) to commercial vehicle traffic; (b) changes in the truck route system, as well as (c) in the analysis of maintenance and rehabilitation schedules for the major components of the highway system, among many others.

4. METHODOLOGICAL ALTERNATIVES

Standard practices of freight transportation modeling roughly resemble the traditional passenger transportation modeling framework: trip generation, trip distribution, mode split and traffic assignment. In virtually all freight transportation modeling exercises one could identify, explicitly or implicitly, models or sub-models that perform these functions, though in some cases one or more of these functions could be collapsed into a single one.

However, the numerous applications of freight transportation modeling that have taken place over the years have not translated into the development of freight transportation specific models for each and every one of the modeling phases shown above. For the most part, trip generation, mode split and traffic assignment are conducted using the same techniques as in passenger transportation:

- *Trip generation analyses*, both commodity-based and trip-based, are usually conducted using trip generation rates, zonal multiple regression models and similar techniques.
- The standard practice for *Mode split* is to use discrete choice models (e.g., Multinomial Logic models) estimated from cross sectional data from shippers or freight operators, though there is a body of evidence (McFadden, 1986; Abdelwahab and Sargious, 1991; Abdelwahab, 1998; Holguín-Veras, 2001) that indicates the need to jointly model the process of shipment size selection and mode choice. This necessitates the estimation of discrete-continuous models (with shipment size as the continuous variable and mode choice as the discrete variable).
- *Traffic assignment* usually is conducted with the same techniques as in passenger transportation. Doing this, among other things, neglects to take into account the unique features of freight transportation, such as the predominant role of trip chaining.

As seen, the modeling phase for which there have been methodological developments that may be considered specific for freight transportation is the phase of trip distribution. It is important to recognize that there have been significant analytical developments in the areas of spatial price equilibrium models (e.g., Samuelson, 1957; Harker and Friesz, 1986). However, the fundamental assumptions of these models render them applicable to inter-city transportation and applications at a national scale. Given that the focus of this project is on urban goods movements, these models are not discussed here.

This review will, for the most part, focus on models that perform functions similar to trip distribution models, though models from the other phases are referred to when appropriate. The review focuses on three main families: Input-Output models, Spatial Interaction models and Origin-Destination synthesis formulations. No attempt was made to review formulations that involve combinations of models from the families above. This decision, based on practical considerations related to the scope and the resources available to this project, must not be interpreted as a rejection of methodological approaches that try to take advantage of the relative strength of the different models. The research team believes that a lot could be gained from combining the best features of the different formulations. This is an area that offers both an opportunity and a challenge to transportation researchers and academicians.

4.1 *Experience on freight transportation modeling*

The research team was also interested in getting an idea about the methodological alternatives that are currently being used by Metropolitan Planning Organizations (MPOs) and about how satisfied the MPOs were with the freight transportation models developed. To that effect, a selected set of sixteen (16) Metropolitan Planning Organizations (MPOs) were contacted to gather information about their current practices on freight transportation planning and modeling. Five of these planning organizations stated that their were doing freight planning, eight reported that they were not doing freight planning, while three indicated they were not directly involved in freight planning.

The respondents indicated that the typical data they use include: commodity flow surveys, traffic counts to determine vehicle characteristics, and origin-destination trip table data. None of the interviewed agencies were able to specifically identify models they developed for freight modeling. This should explain the reason for the lack of reply for the type of experience each agency had with these models. Two planning organizations reported that they were dealing with a regional model. The other three reported that they were doing local or corridor-based models. None of the contacted planning agencies had any reports or papers that they could share with the research team.

The information gathered is so sparse that it is not possible to assess the usefulness of freight models based on experience of these planning organizations. The first and most obvious reason is the relatively small number of applications of freight transportation modeling, that in itself prevents any meaningful analyses. Furthermore, assessing the effectiveness and accuracy of freight transportation models require a long observation period, in the range of ten to twenty years, to be able to able to determine the difference between forecasts and actual demand. The issue of model accuracy is further complicated by the fact that it is almost impossible to distinguish what could be attributed to the inherent structure and capabilities of the model, and what could be attributed to the actual implementation. In this context, it seems obvious that assessing the real-life effectiveness and accuracy of the different freight transportation modeling methodologies requires a carefully designed scientific study is needed to objectively assess the effectiveness of these plans and their outcomes. Unfortunately, such study was not possible under the scope of work and resources of this investigation.

5. INPUT-OUTPUT MODELS

Input Output (IO) models refer to a family of analytical formulations that represent the inter-linkages among economic sectors as a function of the amount of inputs, in economic terms, required to produce a given output. In simple terms, IO models represent the economic output of an economy as a function of the inputs utilized in the production process. This mathematical relationship enables the estimation of the inputs that are required to achieve a given level of output in an economic sector.

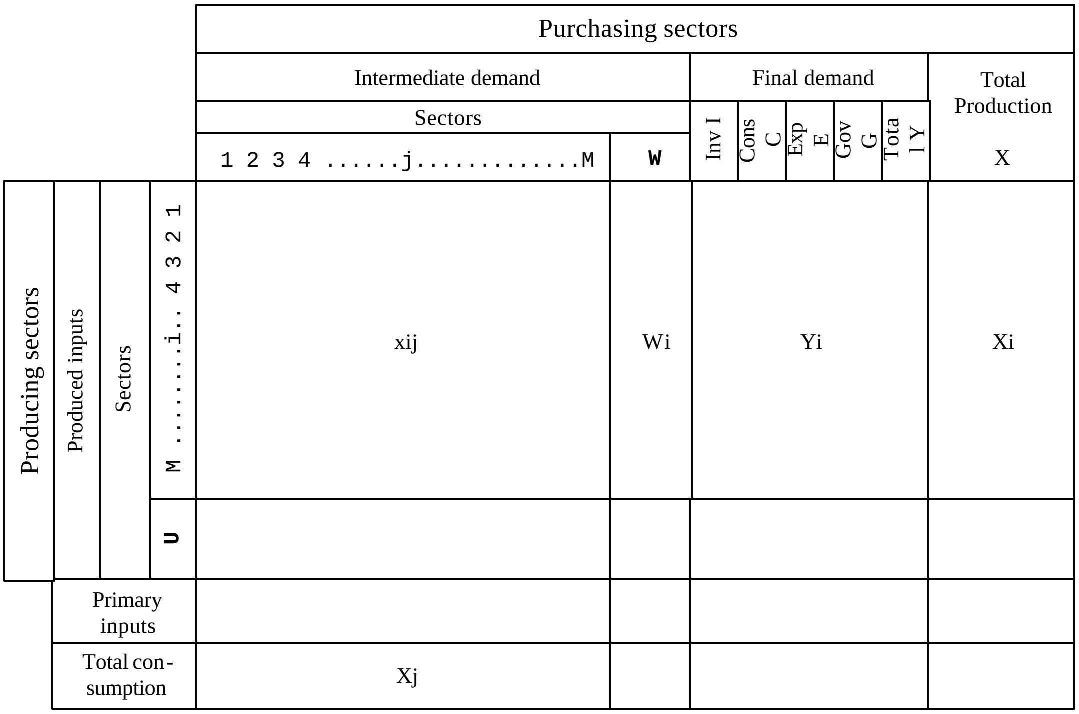
Manufacturing an automobile, for instance, requires a certain amount of energy, steel and other basic inputs. Since the proportions of these inputs are known, for a given economy, it is relatively easy to estimate the amount of inputs that are required to produce a predetermined level of output (referred to as direct requirements). However, this is not the only economic impact. Producing the steel that is required for manufacturing the automobile, in turn, requires inputs from other economic sectors (e.g., energy, iron ore). In this way, producing an unit of output generates an economic effect beyond the direct requirements.

IO models are nothing more than a systematic analytical depiction of these intersectorial flows. Although the idea of systematically studying these intersectorial flows dates back at least two centuries, the basic formulation of the IO model is relatively recent and it is due to Leontieff (1936). In its simplest form, the basic IO model is based on the following assumptions (Kanafani, 1983):

- In a given sector, the products are homogeneous.
- Production technologies within a sector can be represented by the average technology.
- The technology of production can be assumed to be constant.
- There is equilibrium between total supply and total demand.

Central to the concept of Input-Output analysis are the ideas of *total output* (X), *intermediate demand* (W), and *final demand* (Y). These concepts are outlined in Figure 1.

Figure 1: Single region Input-Output matrix



Intermediate demand refers to the flows that a given sector i sends to the other economic sectors j, as follows:

$$W_i = \sum_j x_{ij} \qquad (1)$$

Under the assumptions outlined above, the unit flows from sector i to sector j measured with respect to the output of j, referred to as *technical coefficients*, can be estimated as shown in Equation (2). The technical coefficients are also called *direct requirements* because they measure the proportion of inputs that are directly required from other sectors.

$$a_{ij} = \frac{x_{ij}}{X_j} \qquad (2)$$

When calculated for all economic sectors, the technical coefficients are organized in a matrix of technical coefficients, A. In matrix format, equation (1) can be re-written as:

$$W_i = \sum_j a_{ij} X_j = \mathbf{AX} \qquad (3)$$

In addition to the intermediate demand, each sector is required to meet an additional set of requirements related to: the accumulation sector (I), household consumption (C), net exports (E), and government consumption (G). These additional requirements, termed Final Demands (Y), are to be added to the intermediate demand, as follows:

$$X_i = W_i + Y_i = \sum_j a_{ij} X_j + Y_i \qquad (4)$$

Since the total output of sector j equals the total value of inputs purchased from the other sectors, plus the value of the primary inputs, therefore:

$$\mathbf{X} = \mathbf{AX} + \mathbf{Y} \qquad (5)$$

and,

$$\mathbf{Y} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{X} \qquad (6)$$

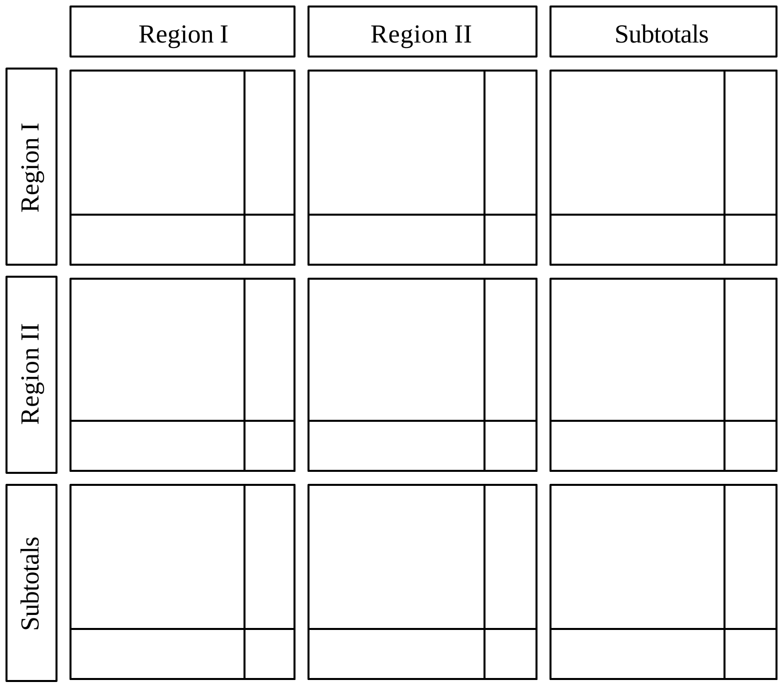
The inverse of the matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is referred to as matrix of direct and indirect requirements because they measure the total amount of output of a sector that is required to produce an unit of output in a sector j. The flows outlined in Figure 1 are all measured in monetary terms, though in certain conditions they could be measured in physical terms.

Although able to appropriately model the economy of a region, the single-region IO model is not able to depict the regional flows of commodities or the associated monetary flows (a consequence of the single-region nature of the model). The IO models that overcome this limitation are the ones referred to as Multi-Regional Input Output Models (MRIO). Since the seminal work of Leontieff (1936) significant developments have taken place on MRIO, most notably Isard (1951), Moses (1955), Chenery (1967), Leontieff (1970) and Polenske (1970).

Common features of the various formulations of MRIOs are: a) the definition of a number of different economic regions; b) the estimation of intersectorial matrices of *technical coefficients* (as in the single region IO); c) the estimation of a matrix of *inter-regional trade flow coefficients* that measure the amount of commodities transported from region to region. The MRIO attempts a full depiction of the interlinkages among economic sectors located in a given geographic region. In general terms, a given region could be subdivided in smaller sub-regions each having its own IO table, as designed by Isard (1951). Figure 2 depicts a multi-regional IO representation of an economy that has been subdivided in two sub-regions (Region I and Region

II). Each of the squares in Figure 2 represents an IO matrix such as the one shown in Figure 1. The square in the lower right represents the IO matrix for the entire region.

Figure 2: A Multi-Regional Input Output Representation



There are three major MRIO formulations (Polenske, 1970): a) the Row Coefficient Model (Polenske, 1970); b) the Column Coefficient Model (Chenery, 1953; Moses, 1955); and c) the Gravity Model (Leontieff and Strout, 1963). The main difference among them is in the way in which the combined effects of technical coefficients and trade flow coefficients are estimated. A summary of key Multi-Regional Input Output Models (Polenske, 1970) is shown in Table 4.

Table 4: Summary of MRIO models

	Row Coefficient	Column Coefficient	Gravity Model
Trade Coefficients	$x_i^{gh} = r_i^{gh} x_i^{go}$	$x_i^{gh} = c_i^{gh} x_i^{oh}$	$x_i^{gh} = \frac{x_i^{go} x_i^{oh}}{x_i^{oo}} q_i^{gh}$
System Equations	$\mathbf{R'}\,\Delta\mathbf{X} = \hat{\mathbf{A}}\,\Delta\mathbf{X} + \Delta\mathbf{Y}$ $(\mathbf{R'} - \hat{\mathbf{A}})\Delta\mathbf{X} = \Delta\mathbf{Y}$ $\Delta\mathbf{X} = (\mathbf{R'} - \hat{\mathbf{A}})^{-1}\Delta\mathbf{Y}$	$\Delta\mathbf{X} = \mathbf{C}(\hat{\mathbf{A}}\,\Delta\mathbf{X} + \Delta\mathbf{Y})$ $(\mathbf{I} - \mathbf{C}\hat{\mathbf{A}})\Delta\mathbf{X} = \mathbf{C}\Delta\mathbf{Y}$ $\Delta\mathbf{X} = (\mathbf{I} - \mathbf{C}\hat{\mathbf{A}})^{-1}\mathbf{C}\Delta\mathbf{Y}$	$\mathbf{T'}\,\Delta\mathbf{X} = \mathbf{S}(\hat{\mathbf{A}}\,\Delta\mathbf{X} + \Delta\mathbf{Y})$ $(\mathbf{T'} - \mathbf{S}\hat{\mathbf{A}})\Delta\mathbf{X} = \mathbf{S}\Delta\mathbf{Y}$ $\Delta\mathbf{X} = (\mathbf{T'} - \mathbf{S}\hat{\mathbf{A}})^{-1}\mathbf{S}\Delta\mathbf{Y}$

Where:

$\Delta\mathbf{X}$ = Change in production (output) of commodity i produced in region g,

$\Delta\mathbf{Y}$ = Change in consumption of commodity i by final users in region g,

$\hat{\mathbf{A}}$ = Block diagonal matrix (nm x nm) with n square matrices (m x m) containing the technical coefficients,

$\mathbf{S}, \mathbf{T}$ = Square matrix (nm x nm) filled with diagonal matrices (m x). The elements t_i^{gh} relate outflows from region g to the production in the region, while the s_i^{gh} elements relate inflows into region g to the consumption in the region,

$\mathbf{R}$ = Square matrix (nm x nm) with elements r_i^{gh} that represent the total production of commodity i in region g that is exported to region h,

$\mathbf{C}$ = Square matrix (nm x nm) with elements c_i^{gh} that describe the fraction of total consumption of commodity i in region h that is imported from region g.

The elements x_i^{go} and x_i^{oh} represent the total amount of commodity i produced in region i, and the total amount of commodity i demanded in region i, respectively.

It is important to briefly discuss the impact of changes in transportation accessibility upon both the technical coefficients and the trade flow coefficients. A fundamental assumption in IO analyses is the assumption of constancy of production technology, which translates into constant technical coefficients. Major changes in transportation accessibility are likely to have a significant impact upon the technical coefficients because they would affect directly the amount of transportation service that is consumed by the other economic sectors. This, in turn, would affect directly the corresponding technical coefficients. Furthermore, major accessibility changes may change the balance of regional trade, therefore affecting the trade flow coefficients. Although a number of formulations (e.g., Liew and Liew, 1979) have attempted to estimate the impacts of transportation improvements on the technical coefficients and trade flow coefficients, this issue remains an open question where there is considerable room for improvement.

5.1 *RIMS II*

Due to the interest of economists and planners to assess the economic impacts of investment projects, a number of research projects have tried to improve the analytical and empirical foundations of Input-Output Analysis. In the United States, important contributions have been made by the Bureau of Economic Analysis (BEA). Since the 1970s BEA has been improving the techniques to estimate regional IO multipliers, developing techniques such as the Regional Industrial Multiplier System (RIMS). In the 1980s, BEA released an enhanced version that is referred to as RIMS II. BEA is confident that RIMS II can estimate regional multipliers for any region comprised of one or more counties, and for combinations of the industries listed in the national IO table. The studies conducted by BEA indicate that the level of accuracy of RIMS II's estimates is similar in order of magnitude to those produced by more expensive surveys.

Another empirical element to take into account is related to the impact of the switch from Standard Industrial Codes (SIC) to the newly developed North America Industry Classification System (NAICS). NAICS and its revisions, expected to be fully implemented in 2002, would change the way in which the national economic accounting is being done. Among other things, NAICS would include specific codes for the digital economy. The implementation of NAICS, while having the potential of producing a minor disruption in the analysis of economic indicators, is not expected to be a major hurdle. The Bureau of the Census has already put together bridge tables (see http://www.census.gov/epcd/ec97brdg/) between SIC and NAICS. In the opinion of the research team this will not be a major issue affecting model development.

5.2 *Input-Output models and freight modeling*

As shown in the previous section, there is a long-standing tradition that links the analysis of intersectorial economic flows with the analysis of the associated commodity flows. In recent years, an increasing number of applications have tried to use the modeling framework described above for freight transportation modeling (e.g., Sorratini and Smith, 2000, Jack Faucett and Associates, Inc. 1999). For the most part, in these applications, an IO table is used to estimate the total amounts of commodities being attracted by a given zone, as a function of the anticipated levels of economic activity. The use of an IO table (estimated on the basis of economic transactions) to estimate the amount of commodities attracted to a given zone, implies the assumption of direct proportionality between the economic transactions reflected in the technical coefficients and the commodity flows reflected in the trade flow coefficients.

The above approach is a simplified version of the formal formulations of IO models described in the first section of this document. While in the MRIO models the focus is on modeling the entire set of economic and commodity flows, the above methodologies use the IO as a commodity attraction model. Such approaches represent an hybrid between the formal MRIO models and the traditional transportation models and they are referred to here as *Hybrid IO formulations*. It is important to highlight that, although conceptually valid, this approach requires a set of IO technical coefficients for each and every one of the transportation analysis zones (which are likely to be different). Since the empirical estimation of this multitude of IO tables is out of the question, such approaches may have to rely on the assumption that the technical coefficients for the individual zones are equal to the regional values. It is not clear at this point, what are the practical implications of such assumption, and whether or not it is conceptually and empirically valid. This seems to be an open question that will need to be addressed by researchers.

The data constraint issue is not a trivial one. It is interesting to contrast the positions of the Bureau of Economic Analysis and that of the private companies that produce estimates of IO technical coefficients. The BEA research has determined that its RIMS II system is able to provide solid estimates of technical coefficients for individual counties (or groups of); while one of the companies that estimate IO technical coefficients is confident that they can estimate IO technical coefficients for individual ZIP codes (or groups of).

5.3 *Data requirements*

5.3.1 For development and calibration

The data requirements for development and calibration depend upon the particular version of the model that is used. Using the formal MRIO formulations require: a) a set of technical coefficients for the different sub-regions; b) a set of interregional trade flow coefficients; and, c) commodity flow data. Hybrid models (e.g., Sorratini and Smith, 2000 and Jack Faucett Associates, 1999), since they use the IO technical coefficients solely for estimation of commodity attractions, do not require the matrix of interregional trade flow coefficients. They do require a matrix of technical coefficients for each transportation analysis zone (if the assumption of a constant technical coefficient matrix is used, a regional technical coefficient matrix would be needed). Hybrid models do require commodity flow data that is used for commodity generation and commodity distribution analyses. In addition, for calibration purposes, it is important to have: a) screenline counts; b) commodity generation (production and attraction) at major freight generators; c) traffic counts at key sections of the network.

5.3.2 To update and fine-tune the model

The process of model development is to be understood as a continuing process of enhancement. This usually involves work in three different areas: a) the fundamental structure of the model, which is a reflection of the behavioral or economic assumptions on which it is based; b) the empirical foundation of the model, i.e., the data that supported the process of calibration and development; and, c) the computational algorithms and data structures that perform the computations and the supporting analytical tasks.

The above implies that updating and fine-tuning a model should be approached from these three different perspectives. Enhancing the fundamental structure of a model is, in essence, part of transportation research. Improving the empirical foundation of the model is, for the most part, of critical importance because without solid data, no further enhancements are possible. Enhancing the computational algorithms and supporting data structures is also important.

In both the traditional MRIOs and the Hybrid formulations, the most important pieces of information are related to: a) the technical coefficient matrices; b) the nature and characteristics of the freight flows in the study area. It is very likely that a successful updating and fine tuning process will entail collecting additional data in these two areas, as well as collecting data on traffic counts.

5.3.3 To forecast

Data requirements for forecasting purposes depend on the particular implementation of the model. In general terms, both MRIO and Hybrid models will need: a) an estimation of the technical coefficient matrix; b) estimates of the economic activity in each zone (final demand); c) estimates of commodity production at each zone.

The estimation of the future technical coefficient matrix faces a number of obstacles. The obvious one is related to the fact that it is not always easy to predict the future of production technology (that determines the values of the technical coefficients). The second obstacle has to do with the impacts of major accessibility improvements upon the technical coefficients. As indicated before, major transportation accessibility improvements are likely to change the amount of transportation input required by the different economic sectors. This, in turn will have impact upon the technical coefficient matrices that is hard to predict. This is likely to reduce the effectiveness of MRIO formulations. Hybrid formulations, on the other hand, since they use the IO table for the estimation of commodity attractions among economic sectors different than transportation (the role of transportation accessibility is taken into account by network models outside the IO formulation) seems to be more robust to accessibility changes.

5.4 *Staff requirements*

As in any complex undertaking, maintaining an operating a Regional Freight Model based on IO (either an MRIO or a Hybrid model) will require a staff with a basic understanding the economic and modeling principles on which the model is based. As a general rule, the more knowledgeable the staff, the better the modeling process will be. The staff assigned to work with the model should have basic knowledge of:

- Input-Output models;
- freight transportation modeling, freight transportation operations and issues;
- transportation modeling practices;
- transportation network analysis;
- Geographic Information Systems.

The background described above is consistent with a Masters degree on Transportation. It would be advisable, though not required, to have at least one member of the staff with a Master's degree on Transportation, with an emphasis on freight transportation modeling.

Training on how to operate the model is also important. Since it is likely that training on how to operate the Regional Freight Model will be provided to NYMTC staff as part of the model development, this should not be a major issue. In order to ensure that this is the case, NYMTC should include a training component as part of the tasks to be conducted by the model developer(s).

5.5 *Computing power required*

Both MRIOs and Hybrid formulations can run in any top-of-the-line personal computers. In the opinion of the research team, computing power is not a major issue.

5.6 *Appropriateness of the model to NYMTC's needs*

The inherent flexibility of both MRIO and Hybrid IOs is such that it enables both families of models to properly model any region that meets the assumptions outlined at the beginning of this document. The assumption of constant technical coefficients seems to be more of a challenge for MRIO because they consider transportation as one of the economic sectors. Hybrid formulations, because they use the IO table to estimate the attractions for sectors different from transportation seems to be more robust to changes in transportation accessibility. Both MRIOs and Hybrid formulations seem to have the potential to provide adequate representation of NYMTC conditions.

5.7 *Practicality*

The review of the literature seems to indicate that IO formulations can be successfully applied to modeling of freight transportation movements. However, as in any major modeling undertaking, IO formulations (both MRIOs and Hybrid models) do require a significant amount of data. The existence of private companies that focus on assembling both the economic data for IO analysis and commodity flows should translate into cost savings.

However, it should be kept in mind that developing a freight model for a region as complex as NYMTC's is far from being a straightforward exercise. Under the best of circumstances developing the NYMTC freight model would require a significant amount of resources, hard work and extensive collaboration between the consulting companies in charge, NYMTC staff and university researchers. Such collaboration would undoubtedly translate into profound changes in the state-of-the-art and practice of freight transportation modeling.

5.8 *Conceptual validity*

From the conceptual-theoretical standpoint, the MRIO formulations have a solid record. They are firmly grounded in economic principles, which is a reflection of the fact that several Nobel prize winners in Economics have participated in their development. Hybrid formulations, though not having such a stellar record, rely on simple assumptions that are relatively easy to meet. Both MRIOs and Hybrid formulations are considered to be conceptually valid for the normal range of applications.

6. SPATIAL INTERACTION MODELS

The term *spatial interaction models* refers to the family of models that try to describe the trip distribution process as a function of the interactions in space. The term encompasses the family of gravity, opportunities, and direct demand models. There is a long tradition—that stems from the first applications of transportation modeling—of using spatial interaction models to represent destination choice problems. In freight transportation, they have been used both in trip-based as well as in commodity-based modeling.

For the most part, gravity models and the intervening opportunities model are used in the context of the Urban Transportation Modeling System (UTMS)—commonly referred to as the Four Steps process—(i.e., generation, distribution, mode split and traffic assignment). Direct demand models, on the other hand, collapse some of these models into a single analytical formulation.

This section begins with a brief description of the main types of spatial interaction models. The description covers: (a) gravity models; (b) intervening opportunities models; and (c) direct demand models, and is intended to provide the reader with a general idea about the main features of these models. This is followed by sections discussing trip-based and commodity-based models that presents an overall assessment of spatial interaction models and their applicability to NYMTC conditions.

6.1 *Gravity models*

Gravity models, as the name implies, were first derived as transportation models on the basis of analogies with the Law of Gravity in what has been termed the "Socio-Physical" approach. Later on, due to the pioneering work of Wilson (1970) gravity models were found to be supported theoretically by general theories such as Entropy Maximization and Information Minimization.

The family of gravity models is, by far, the most widely used for trip distribution analyses. It is comprised of four variants that differ in the extent in which they consider the system constraints: (a) the *unconstrained gravity model* imposes no constraint on the total number of trips produced and attracted by the transportation analysis zones (TAZs); (b) the *singly constrained gravity model*, either origin or destination-constrained, ensures that the model replicates either the total production or the total number attracted to the TAZs; and (c) the *doubly constrained gravity model* ensures that the model replicates simultaneously the number of trips produced and attracted by the TAZs. The mathematical formulations for the different variants of gravity models are shown in equations (7) to (10).

$$T_{ij} = \alpha O_i D_j F_{ij} \quad \text{(Unconstrained gravity model)} \quad (7)$$

$$T_{ij} = O_i \frac{D_j F_{ij}}{\sum_j D_j F_{ij}} \quad \text{(Origin constrained gravity model)} \quad (8)$$

$$T_{ij} = D_j \frac{O_i F_{ij}}{\sum_j O_i F_{ij}} \quad \text{(Destination constrained gravity model)} \quad (9)$$

$$T_{ij} = A_i O_i B_j D_j F_{ij} \quad \text{(Doubly constrained gravity model)} \quad (10)$$

Where: O_i is the number of trips originating at zone i, D_j is the number of trips with destination in zone j, F_{ij} is an impedance function, and the set of constants $A_i = 1/\sum_j B_j D_j F_{ij}$ and $B_j = 1/\sum_i A_i O_i F_{ij}$ ensure satisfying of the origin and destination constraints.

The calibration process of gravity models entails ensuring that the Trip Length Distribution (TLD), i.e., the distribution of trips for the entire range of values of the impedance function (e.g., distance, time, cost) estimated by the model resembles the observed TLD. This is done by means of different techniques ranging from numerical methods to maximum likelihood. The most frequently used techniques entails the iterative adjustment of the parameters of the impedance function F_{ij}, or the adjustment of the F_{ij} values directly. It is important to highlight that the postulates of economic rationality embedded in the gravity model formulation require that the amount of transportation consumed decreases with increasing values of the impedance function. This requirement, implicitly incorporated into the calibration process, translates into monotonically decreasing trip length distributions. As shall be seen later, this has important implications for freight transportation modeling using gravity model formulations.

6.2 ***Intervening opportunities model***

The intervening opportunities model, first formulated by Stouffer (1940), owes its current formulation to Schneider (1959). In essence, the intervening opportunities model is based on the fundamental assumption that the probability of selecting a destination is a function of the probability of not selecting one of the prior destinations to the trip. If the destinations are organized and numbered in ascending values of the trip impedance, the probability of selecting the mth destination away from the origin i, depends on the probability of not being satisfied by the first, the second… up to the (m-1)th destination. The mathematical formulation of the intervening opportunities model is (Ortúzar and Willumsen, 1994):

$$T_{ij} = O_i \frac{\exp(-\alpha x_{m-1})\exp(-\alpha x_m)}{1-\exp(-\alpha x_m)} \tag{11}$$

Where: x_m is the cumulative attraction up to destination m, α is a calibration parameter.

6.3 ***Direct demand models***

The development of direct demand models has been inspired by general econometric models. For the most part, they attempt to represent transportation demand (either total or by mode) as a function of a set of relevant attributes. The SARC model, shown in equation (12), is an example of a direct demand model:

$$T_{ijk} = f_k (P_i P_j)^{q_{k1}} (I_i I_j)^{q_{k2}} \prod_m (t_{ij}^m)^{a_{km}^1} (c_{ij}^m)^{a_{km}^2} \tag{12}$$

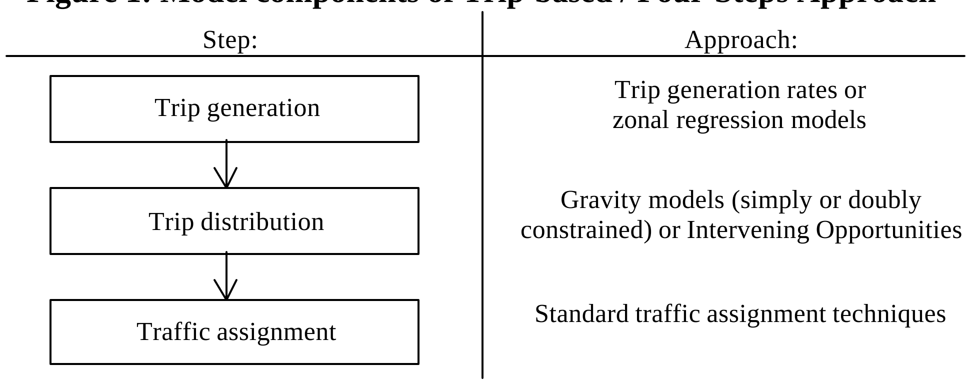
Where: T_{ijk} is the number of trips between origin i and destination j, using mode k; P is the population; I is the Income; t is the travel time; and c is the transportation cost.

Since the spatial distribution models described above could be applied to either commodity flows or vehicle-trips, this report will have two separate sections. The first section will focus on trip-based models, while the second one will focus on commodity-based models.

7. TRIP-BASED SPATIAL INTERACTION MODELS

The typical application of trip-based modeling entails the process depicted in Figure 1 (after Holguín-Veras and Thorson, 2000). It is worth highlighting that—because of their focus on commercial vehicle trips—trip-based models do not have a mode choice modeling phase. This is because the truck trip is in itself the result of a mode selection process that already took place. Besides this feature, the modeling processe resembles the traditional UTMS formulation.

Figure 1: Model components of Trip-based / Four-Steps Approach



There are a number of applications of gravity models to trip-based modeling. In Swan Wooster (1979), three gravity models were calibrated, one for each truck type. Southworth (1982) incorporated truck route circuitry into a gravity model formulation for Chicago. Ogden (1978) analyzed a gravity model of truck trip distribution for various trip purposes. Meyburg (1976) reviewed early gravity model experiments. Button and Pearman (1981) described British work in the 1970s. A more recent formulation is presented in Cambridge Systematics (1996).

As indicated before, the postulates of economic rationality embedded in the gravity model formulation requires a monotonically decreasing TLD (following the pattern exhibited by demand functions). However, as shown in Figures 2 and 3, the TLDs for different types of vehicle are far from exhibiting the expected behavior. The multiple peaks in Figures 2 and 3 clearly indicate that freight transportation demand does not follow the monotonically decreasing pattern expected by gravity models. This behavior directly affects the calibration process of gravity models that, for the most part, is based on monotonically decreasing functions.

As indicated in Jack Faucet and Associates (1999) and Holguín-Veras and Thorson (2000), the pattern discussed above indicates that freight transportation demand follows different principles than the ones implicit in gravity formulations. The multiple peaks in the TLDs are explained by the production-consumption relationships among different economic sectors that are not explained by gravity model formulations.

Figure 2: Trip Length Distribution for Semi-Trailers (Urban trips in Guatemala City)

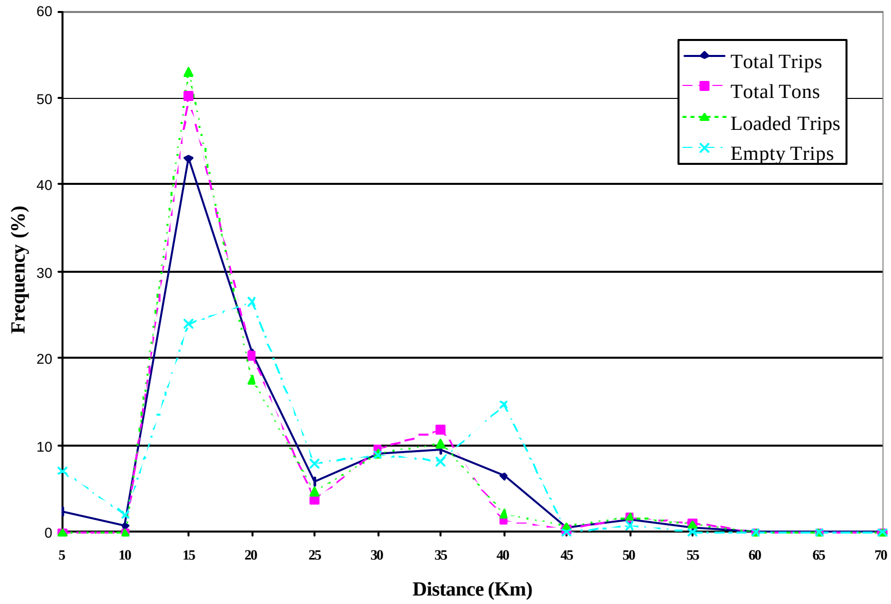
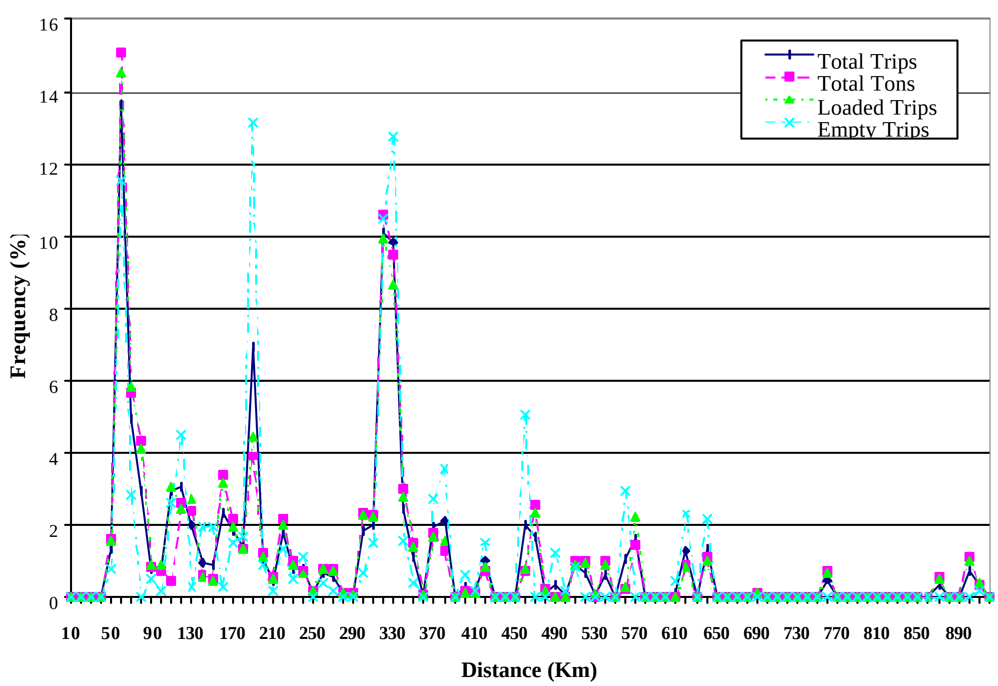


Figure 3: Trip Length Distribution for Semi-Trailers (Intercity trips in Guatemala)



Direct demand models have been applied to freight transportation on numerous occasions, for the most part as part of corridor studies. Since direct demand models rely heavily on econometric formulations, the issue of parameter stability over time is always present. An example of a direct demand model in freight transportation, is due to Slavin (1976):

$$\ln\left(T_{ij} / A_i A_j\right) = -10.7 + 0.41\ln\left[\left(R_i / A_i\right)\left(R_j / A_j\right)\right] + 0.31\ln\left[\left(P_i / A_i\right)\left(P_j / A_j\right)\right] - 1.2\ln\left(t_{ij}\right) \quad (13)$$

Where: T_{ij} = trips between zones i and j; A_i = area of zone i; R_i = retail food employment (shops and restaurants) in zone i; P_i = residential population of zone i; and t_{ij} = travel time in minutes between zone i and j.

The literature search conducted as part of this project did not find any application of intervening opportunities to freight transportation demand modeling. For that reason, and given that direct demand models seem to have been relegated to corridor studies, the assessment of data requirements and adequacy that follows focuses exclusively on gravity models.

7.1 *Data requirements*

7.1.1 For development and calibration

The different spatial interaction models discussed here have, in essence, the same data requirements. For the most part, the calibration process requires:

1. estimations of the observed trip length distributions, though this could be obviated if origin-destination synthesis techniques are used, as in Tamin and Willumsen (1988),
2. traffic counts (and/or screen counts) for the major segments of the network,
3. trip generation estimates.

7.1.2 To update and fine-tune the model

Updating a trip-based distribution model usually requires:

1. updating the trip generation estimates;
2. re-calibrating the model on the basis of new traffic counts

7.1.3 To forecast

The forecasting process entails:

1. updating the trip generation estimates,
2. running the model for the different scenarios of the transportation network and land use.

7.2 *Staff requirements*

Since, for the most part, the typical application of a trip-based distribution model resembles the applications to passenger transportation, the staff requirements are not significantly different from those for passenger transportation. Ideally, the staff should have knowledge of:

- freight transportation modeling;
- freight transportation operations and issues;
- transportation modeling practices;
- transportation network analysis; and
- Geographic Information System (GIS)

7.3 *Computing power required*

Spatial interaction models can run in any top-of-the-line personal computer. In the opinion of the research team, computing power is not a major issue.

7.4 *Appropriateness of the model to NYMTC's needs*

As indicated above, trip-based spatial interaction models focus on modeling the flow of commercial vehicles, which is in itself the result of a mode selection process that already took place. This feature renders these models of limited applicability to situations in which multi-modal competition is significant. Given the importance of multi-modal considerations in freight transportation planning in the NYMTC region, the research team's opinion is that trip-based models are not appropriated because of their limitations in depicting multimodal systems.

7.5 *Practicality*

Trip-based models, when adequate and conceptually valid, are a practical alternative to more complex alternatives. In small urban areas, in which truck transportation is the dominant mode, trip-based models could be a cost-effective approach.

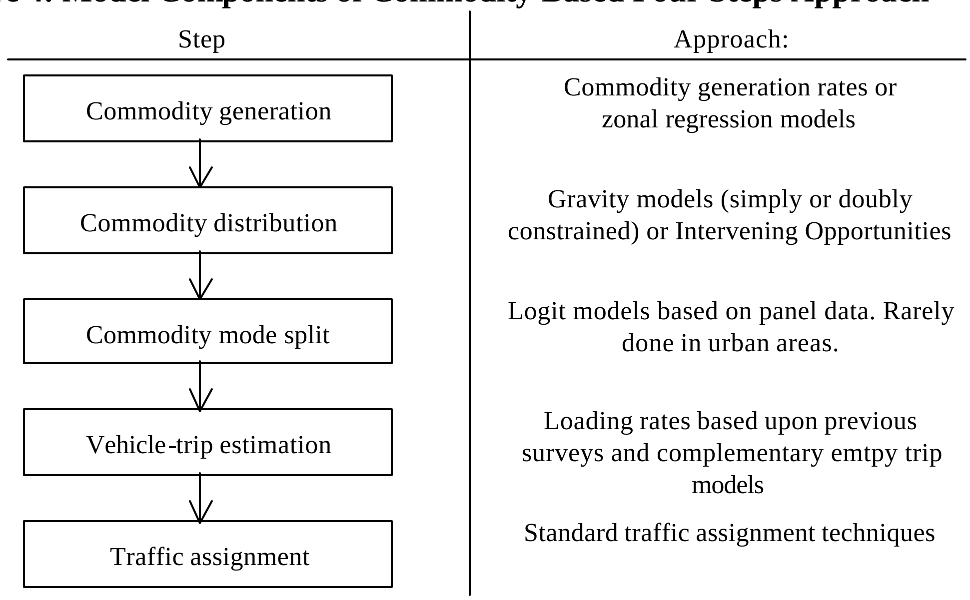
7.6 *Conceptual validity*

In general terms, trip-based spatial interaction models are conceptually valid and have been successfully applied to the analyses of numerous transportation projects. The fundamental question, however is not the conceptual validity of the model, but how applicable they are to a given planning context. As indicated above, the opinion of the research team is that they are not applicable to complex systems such as NYMTC's.

8. COMMODITY-BASED SPATIAL INTERACTION MODELS

Commodity based models, in general, attempt to replicate the process that takes place in real life. As part of this process, a set of models is developed as to capture the different components. In a rather simplistic manner, the general process is depicted in Figure 4. As shown in Figure 4, commodity-based applications require more submodels than their counterparts in trip-based modeling (after Holguín-Veras and Thorson, 2000). This is because: (a) they explicitly take into account the mode choice process; and (b) they require vehicle loading models to estimate the number of vehicle-trips from the commodity flows.

Figure 4: Model Components of Commodity-Based Four Steps Approach



A review of the literature on freight modeling shows that one of the most comprehensive treatment of the subject is provided by NCHRP 260, *Application of Statewide Freight Demand Forecasting Techniques* (Memmott and Roger Creighton Associates, 1983). The techniques described in NCHRP 260 include the application of commodity flow databases, the allocation of origins and destinations to the county level using employment shares by industry sector, and the use of input-output tables to allocate destinations for commodities based on consumption shares. All of these techniques were used in the Southern California Association of Governments (SCAG) external model. There have been a number of more recent efforts to apply commodity flow techniques to statewide modeling by Parsons Brinckerhoff Quade & Douglas, Inc (1998), Donnelly, *et al.* (1999), Souleyrotte, *et al.* (1996), Souleyrotte, *et al.* (1998), and Horowitz and Farmer (1998). Fischer and Ang-Olson (1999) list additional studies using commodity flow analysis and input-output modeling techniques. The commodity-based approach is well suited for representing freight movements to and from manufacturers, and movements into or out of the region as noted by Krishanan and Hancock (1997) in modeling Massachusetts statewide freight transportation flows using Geographic Information Systems (GIS) software. Huang and Smith (1998) in analyzing Wisconsin used two main approaches to allocate the external trips to the external station, the Boundary Balancing Method (BBM) and the Global Shortest Path Method (GSPM).

Commodity-based models generally start with a known region-to-region table of commodity flow tonnage that is determined based on economic output forecasts and established regional trade patterns. The focus tends to be on the producers and consumers of goods. These inbound and outbound flows are then disaggregated to the zonal level based on economic data that reflects the intensity of production and consumption and its use by Rockliffe, *et al.* (1998). Economic data and input-output tables are used to estimate the quantity of each commodity that is produced and consumed in each geographic unit in the model. By knowing the commodity being shipped, it becomes possible to link producers of a good with its consumers through knowledge of these economic relations. Commodity flows must be converted to truck trips once they are allocated to origins and destinations. This can be accomplished by using different approaches ranging from the use of average payloads to more elaborate empty trip models. Using average payloads has been justly criticized in the literature because it neglects to take into account the empty trips (that cannot be directly explained as a direct function of the commodity flows) and the role of the trip chains. This has resulted in a number of formulations such as: Noortman and Van Es (1978), Hautzinger (1984) and Holguín-Veras and Thorson (2001), that attempt explicit modeling of the empty trips and/or commercial vehicle trip chains.

8.1 *Data requirements*

A commodity-based approach generally requires 2-digit SIC employment data at the zonal level. The availability of commodity flow data and forecasts and familiarity with the use of these data at the MPO level is critical; it is also a concern that will affect the feasibility of any commodity-based approach. Commodity flow data at the inter-regional level is becoming more widely available. The U.S. Bureau of the Census now collects the Commodity Flow Survey (CFS) every five years which provides both 2-digit and 4-digit Standard Commodity Classification Code (STCC) detail with cross tabulations of both tonnage and value of shipments by mode, shipment size, length of haul, and destination.

In the 1993 CFS, data were available in national, state, and National Transportation Analysis Region (NTAR) summaries. In the 1997 CFS, tabulations for the 50 largest metropolitan areas were added. There are also commercial sources of commodity flow data with additional modal and geographic detail estimated as a value-added service. Commercial forecasts of commodity flows are also available. Methods for forecasting 2-digit level county-to-county flows are also available using data from the Bureau of Economic Analysis Regional Economic Information Service forecasts in conjunction with base-year flow information from the CFS.

A commodity-based approach could be used to model secondary goods distribution, although secondary flows are not always well represented in commodity flow databases. Rockliffe, *et al.* (1998) provided guidelines to gather freight data.

8.1.1 For development and calibration

The definition of the data requirements for commodity based models is complicated because they are frequently developed in combination with other models, e.g., Input-Output models. However, since the other modeling approaches have been discussed in other sections of this report, this section focuses exclusively on commodity-based spatial interaction models. For the most part, the calibration process requires:

1. estimations of the observed trip length distributions (not needed if origin-destination synthesis techniques are used),
2. traffic counts (and/or screen counts) for the major segments of the network,
3. trip generation estimates,
4. estimates of economic activity at each TAZ (e.g., employment by SIC codes),
5. estimates of empty trips.

8.1.2 To update and fine tune the model

Updating a trip-based distribution model usually requires:

1. updating the trip generation estimates,
2. re-calibrating the model on the basis of new traffic counts.

8.1.3 To forecast

The forecasting process entails:

1. updating the trip generation estimates;
2. running the model for the different scenarios of the transportation network and land use.

8.2 *Staff requirements*

As in trip-based spatial interaction models, the staff requirements are no significantly different to those for passenger transportation. Ideally, the staff should have knowledge of:

- freight transportation modeling,
- freight transportation operations and issues,
- transportation modeling practices,
- transportation network analysis,
- Geographic Information System (GIS).

8.3 *Computing power required*

Spatial interaction models can run in any top-of-the-line personal computer. In the opinion of the research team, computing power is not a major issue.

8.4 *Appropriateness of the model to NYMTC's needs*

In the opinion of the research team, commodity-based spatial interaction models are appropriate for NYMTC’s needs. This is because they: (a) enable the consideration of the cargoes’ economic characteristics; (b) are able to consider multiple transportation modes, and the associated mode choice processes. However, as shown in Figures 2 and 3, the trip length distributions at the core of spatial interaction models tend not to follow the expected pattern from the postulates of economic rationality. This limitation is fundamentally the same for both trip-based and commodity based models.

8.5 *Practicality*

Commodity based spatial interaction models use similar methodologies to the ones in passenger transportation, for which there is a wide variety of software tools and techniques available. This situation facilitates the implementation and development process, though special attention must be paid to the consideration of the unique features of freight transportation demand. As shown in the literature review, there are plenty of applications of these models that provides testimony of the practicality of their implementation.

8.6 *Conceptual validity*

Commodity-based spatial interaction models are supported by general theories (e.g., Entropy Maximization) and by a fairly long tradition in transportation planning. The model themselves are conceptually valid, though the appropriateness of a particular application would depend upon the local conditions.

9. ORIGIN-DESTINATION TRIP MATRIX ESTIMATION

The estimation of future freight transportation supply and demand is undertaken with the help of network and freight demand models. When modeling freight demand, basic data is sought to enable the analyst to appropriately model the decision processes associated with freight demand. In this context, freight origin-destination (OD) matrices are among the most important pieces of information. OD matrices can be estimated from: a) direct samples, and, b) secondary data sources such as traffic counts, i.e., *OD synthesis*. OD synthesis tries to overcome the limitations of direct sampling methods by using traffic counts –linear combinations of the OD flows–to estimate the OD matrices.

The objective of OD synthesis formulations is to estimate the trip matrix that is consistent with a given set of secondary information (e.g., traffic counts, screen counts). While the traditional role of traffic assignment in the modeling process is to find out the traffic that corresponds to a given origin-destination matrix, the objective of OD synthesis is to obtain an OD matrix that "corresponds" to a given set of traffic conditions and other secondary information. Among other things, a successful application of OD synthesis may result in significant savings in data collection costs.

The first part of this section presents a review of theories and methods used for estimating Origin-Destination (OD) trip matrices in general. A variety of models developed for estimating O-D trip tables based on traffic volumes are described. The review of O-D estimation theories and methods in this section is mainly taken from the detailed review presented in Lei (1998) and Sivanandan and Nanda (1998). Section 2 reviews O-D trip matrix estimation methods specifically developed for freight. Section 3 addresses issues related to the resources needed for the development, implementation, operation, and maintenance of the developed models.

9.1 *Classification of OD trip matrix estimation models*

9.1.1 Conventional analysis and Quick Response Models

Statistical surveys, such as home interviews, license plate surveys and roadside surveys were employed to obtain O-D trip tables before the 1970's. In Lei (1998), the methods that use such survey data to determine real trip distributions are called *"conventional analysis."* Prior to World War II, information on the distribution of urban traffic was obtained using roadside interviews. In fact, the first large-scale cordon count (data collection for O-D analyses) was conducted in Chicago in 1916 (Easa, 1993a). The main drawback of these surveys conducted through sampling, was the failure to capture the real trip information. Moreover, with rapid changes in transportation demands due to the evolution of society, time, manpower, money and effort required to perform these surveys became almost prohibitive. Thus, the results of conventional analyses became quickly outdated due to the land-use changes. More importantly, in most cases, an assignment of this O-D matrix to the network cannot reproduce observed link flows. Three main types of models considered in the conventional analysis are Fratar models, opportunity models, and gravity models. These are evaluated by Easa (1993a), and the reader is referred to this paper for a detailed illustration of characteristics, advantages and limitations of these models.

Cheaper and quicker-response theory and methods for synthesizing trip tables from more conveniently available information have been developed since the 1970's, mainly due to the increased need for studying smaller urban areas in more detail,. In Lei (1998), these relatively new models have been classified into 3 sub-groups, basically according to the purpose of these models:

- National Cooperative Highway Research Program (NCHRP) Simplified Techniques,
- Traffic Count-Based Models, Self-Calibrating Gravity Models, Partial Matrix Techniques, models using GIS data,
- Heuristic Methods and Facility Forecasting Techniques.

Lei (1998) also identifies some special application models, for example, freeway trip distribution, pedestrian trip distribution and special-purpose trip-distribution models. Examples of special-purpose trip-distribution models include choice models (employing individual travelers instead of the zones as the unit of observation), continuous models (that ignore the zones altogether when the changes in land-use patterns are small), simultaneous models (that simultaneously analyze trip distributions and other planning steps). The differences among these subgroups are not discussed in detail, but the papers by Easa (1993b), Sivanandan (1991), and Sivanandan *et al.* (1996) provide a detailed review.

9.1.2 Traffic count-based models

The O-D trip table estimation problem on a given network is in fact a dynamic problem which evolves over time. There were several attempts to employ analytical traffic flow processes on transportation networks by studying some density function that satisfies certain differential or difference equations of the *continuation type* (Lyrintzis *et al*. 1994, Zhang *et al.* 1995), or by using dynamic programming (DP) approaches (Jacobson *et al*. 1995). However, this dynamic system is very hard to model to obtain a desired solution which replicates the real-world conditions. In order to obtain O-D trip tables from count-based information, the traffic flow is usually considered in its static (time-independent) or stationary state. This simplified static approach can be supported by adopting the *user-equilibrium principle* which attempts to reach a flow pattern which is independent of time when the system satisfies the equilibrium condition. In addition, the stationary modeling of dynamic systems can be thought of as a first step toward problem simplification which helps the modeler to discover a more detailed structure of the problem.

Among all types of "easily derived traffic data," link volumes in a network (traffic counts), contains the most important information about O-D distributions. A variety of analytic models have been developed to establish O-D trip tables based on traffic counts along with other information. Based on the theory used, these models may be divided into the following types (Easa, 1993b and CTR, 1995):

9.1.3 Gravity-based models

These models are often called Parameter Calibration models, and represent the original idea of establishing trip distributions using a "gravity-based approach". In fact, Tamin and Willumsen (1988, 1992) developed a formulation of this type of models to freight OD matrix estimation problems. In gravity-based models, the entries of the O-D matrix are assumed to be a function of traffic counts and other parameters. Regression techniques and the flow conservation law are applied to calibrate the parameters such that the differences between observed volumes and established volumes are minimized. These models are divided into two major classes:

- Linear regression models (Low, 1972; Holm *et al.,* 1976; Gaudry and Lamarre, 1978; Smith and McFarlane, 1978)
- Nonlinear regression models (Robillard, 1975; Hogberg, 1976).

Among the linear regression models, all models except the one developed by Holm et al. (1976) adopt a proportional all-or-nothing assignment. Other major differences between these models stem from the differences in variable definitions and parameter selections. Among the non-linear models, Robillard's model uses a proportional assignment technique and Hogberg's model uses all-or-nothing assignment. None of these models consider user-equilibrium assignment principle.

9.1.4 Entropy models

In addition to the gravity-based models discussed above, some models used observed link flows, instead of trips, to estimate link OD matrices. This was based on the attempt to make full use of the information contained in the link volumes. Thus, minimum information and maximum entropy models included in this group can also be converted to a type of gravity model. In the information minimization approach, an attempt is made to select a trip table that adds as little knowledge as possible to the information contained in the general equation for the trip table estimation from the link counts. In the maximum entropy models, the probability of a particular trip distribution occurring is assumed to be proportional to the number of states (entropy or disorder) of the system. Thus, the most likely trip matrix is defined as the one having the greatest number off microstates associated with it. Both approaches can be seen as equivalent, since in both approaches, the derived O-D table can be seen as the most likely one that is consistent with observed information, such as length and free speed of the links contained in the link flows. Willumsen (1978) and Van Zuylen *et al*. (1978, 1980) are the researchers who developed this approach. In addition to the extensive testing of this approach, many improvements and combinations with other theories have also been performed since it has been first proposed by Willumsen (1978). These results have been summarized in the review paper of Easa (1993b) and CTR (1995).

9.1.5 Statistical models

These models attempt to estimate OD trip tables directly from the prior information using statistical techniques. They take the inaccuracies on the observed O-D flows, row and column sums and traffic counts into account. This group includes the least square estimation approaches including alternative least square estimation models proposed by Carey *et al.* (1981), McNeil and Hendrickson (1985), and Cascetta (1984), generalized least square estimation (CGLS) model

(McNeil 1983), and constrained maximum-likelihood (CML) models (Geva, 1983; Spiess, 1987, Walting and Maher (1992), Walting and Grey 1991). Matrix Estimation Using Structure Explicitly (MEUSE), proposed by Bierlaire and Toint (1995) using both historic data and parking data as input, can also be included in this subgroup. The main advantage of these models is the fact that they take the stochastic nature of the problem into consideration. However, these models are not as popular in practice as the equilibrium and entropy models.

9.1.6 Equilibrium models

These models are based on the principle of the user optimization of traffic flow, called the "Equilibrium Principle" or "Wardrop's Principle" (Wardrop, 1952). These include LINKOD (Nguyen, 1977, Gur *et al.*, 1980), SMALD (Kurth *et al.*, 1979), and LP (Sivanandan, 1991; Sherali *et al.*, 1994a-b). The User-Equilibrium Principle, also known as Wardrop's First Principle was originally used to motivate the traffic flow assignment process. Wardrop's First Principle requires that all routes having positive flows between any O-D pair should have equal traffic cost, and this cost must not exceed the traffic cost on any other unused route between this O-D pair. Mathematically, *estimating the O-D trip tables from link volumes can be thought of as an inverse problem of transportation assignment.* Therefore, the equilibrium based O-D matrix estimation problem may be described as determining an O-D matrix such that, when this matrix is user-optimally assigned to the network, it reproduces the observed O-D travel times. Since the correspondence between equilibrium link flow patterns and equilibrium O-D travel times for the standard equilibrium problem is "one-to-one" (Yang *et al.*, 1992), it consequently reproduces the observed link flows.

Nguyen (1977) shows that, if the set of observed link flows is at equilibrium, the solution matrix can be found by solving the optimization problem which exploits Wardrop's user-equilibrium principle for route choice. Nguyen's theoretical model was implemented as part of a Federal Highway Administration Project in which the LINKOD system of models was developed (Turnquist and Gur, 1979, Gur *et al.*, 1980). The LINKOD system is comprised of two major components: SMALD and ODLINK. SMALD (Kurth *et al.*, 1979), is a small-area trip distribution model that determines a trip table for the sub-area. This trip table is used to overcome the under-specification problem of Nguyen's formulation and has been extensively tested and verified by Han, Dowling, Sullivan and May (1981), Han and Sullivan (1983), Dowling and May (1984). To obtain a unique O-D matrix, a target O-D matrix $\bar{t}_{ij}$ is assumed to be available. Different criteria have been suggested for choosing among all the O-D matrices that produce the observed link flows in the existing literature. The LINKOD model adopts two requirements, namely, the reproduction of the observed O-D travel times and the reproduction of the observed link flows (Gur *et al.*, 1980). These two requirements that are equivalent when the observed network is in equilibrium will not hold when the set of observed link flows is not an equilibrium solution (Yang *et al.*, 1992). In addition to the original model, another OD estimation model that chooses the most likely matrix among the optimal solution, is suggested by Jornsten and Nguyen (1980).

In the literature, it has been shown that both OD estimation models developed by Nguyen have a bi-level programming structure that poses computational difficulties for large-scale networks (Fisk, 1989; Fisk and Boyce, 1983). To remedy these difficulties, Leblanc and Farhangian (1982) suggested a partial dualization method for solving the first model proposed by Nguyen (Sheffi, 1985). This partial dualization method involves updating a Lagrange multiplier by iteratively solving a Lagrangian minimization problem. A similar method for solving the model proposed later was also suggested by Jornsten and Nguyen (1980) and Nguyen (1984). Both of these methods require iteratively solving the original mathematical program proposed by Nguyen (1977), and are computationally demanding. Yang *et al*. (1991) have shown how to integrate existing methods, such as the generalized least-squares technique with an equilibrium traffic assignment approach using a Stackelberg leader-follower optimization model. An attempt is made for addressing the uncertainties in both the target O-D matrix and in the traffic link counts. A heuristic solution method is then proposed due to the inherent difficulty in solving moderate to large-sized problems of this type using exact solution techniques.

It has been shown by Yang *et al*. (1991) that Nguyen's bi-level optimization models can be transformed into a single convex program. When the observed link flow pattern is in equilibrium, the original model is demonstrated to be equivalent to a reduced system of linear equations. By exploiting the properties of the system's feasible region, simpler methods, such as a least square technique, can be used to obtain an O-D matrix that, when user-optimally assigned to the network, will reproduce the observed link flows.

9.1.7 Linear Programming Models

The models mentioned above are based on improving and modifying Nguyen's systems. Other models based directly on the user-optimal principle are also developed. One of them is to apply Linear Programming (LP) theory to estimate O-D trip tables from the observed link detailed studies on LP models presented in Sherali *et al*. (1994a), Sivanandan (1991), and Lei (1998). A famous example of the application of linear programming theory and technique to solve transportation problems is given by Dantzig (1951) by adapting his simplex method to solve (Hitchcock's) transportation problem.

Linear Programming methods used to study O-D distributions in the 1970s (Colston and Blunden, 1970) were not successful in practice. An alternative linear programming approach has been proposed by Sivanandan (1991), and Sherali *et al*. (1994a-b). This approach is based on a non-proportional assignment and user-equilibrium principle. Sherali and Sivanandan investigated on how large these penalty coefficients should be for the purpose of achieving desired solutions. They also used a Column Generation Algorithm (CGA) instead of using the (standard) Simplex Method to reduce the computational effort for practical problems. They have tested these models on a real network of Northern Virginia.

The LP models developed by Sherali *et al.* (1994a) have also been improved to address the case of missing link volumes that are not always available in practice (Sherali *et al*., 1994b). The idea used in this situation is to update the travel time/cost by solving some linear and nonlinear programming sub-problems iteratively. Both the original and improved versions have been tested and evaluated on some real networks (Sivanandan *et al*., 1996).

9.1.8 Artificial Intelligence based models

Popular artificial intelligence based (AI) techniques such as, neural networks and fuzzy sets are employed to estimate OD trip matrices. The main advantage of AI based techniques is due to the fact that they try to mimic the way human brain works.

9.1.9 Neural Network-based models

Neural networks are based on the concepts derived from the research, which mimics the learning behavior of the human brain. These are basically pattern recognition techniques that can synthesize OD matrices, given a set of traffic flow data as input. Muller and Reinbardt (1990) introduced the neural network approach to determine O-D trip table from traffic counts. The most obvious shortcoming of neural network based models is the large amounts of data needed for the training of the neural net and for validation phases. While dealing with large networks, this can be a very serious problem due to the lack of real-data. Yang, Akiyama and Sasaki (1992) adopted a feed-forward neural network for synthesizing O-D flow for a four-way intersection and a short freeway segment. Recently, Chin, Hwang and Pei (1994) also proposed a neural network model for generating O-D information from flow volumes. Although these models are relatively new and there still exists a need for further testing, they can be quite promising.

9.1.10 Fuzzy weight models

Another recent approach for OD trip-table estimation has been the utilization of fuzzy weights to obtain O-D trip tables. Instead of the "all-or-nothing" assumption made in most models discussed above, Fuzzy Weight approaches apply some kind of "fuzziness" to the link data (Xu and Chan, 1993a-b). Fuzziness indicates probability, but it is quite different in nature. The model has been tested for different types of fuzziness on the network of the Eastern Highway Corridor. Although initial test results were promising, additional case studies and experimentation are needed for further evaluation.

9.2 *O-D Estimation models and freight modeling*

Although there is a vast body of literature on the subject of OD synthesis, covering a variety of different problems, the estimation of freight OD matrices, in general, has received relatively little attention from researchers and transportation professionals. After a comprehensive search, only four publications were found: Tamin and Willumsen (1988, 1992), List and Turnquist (1994), Holguín-Veras (2000) and Crainic et al. (2001).

List and Turnquist (1994) proposed an O-D estimation method for synthesizing truck flow patterns from partial and fragmentary observations. This is a linear programming formulation which attempts to minimize the objective function which is the weighted sum of all deviations from the observed values, given the user-defined choice of variables for the truck classes and network zone structure, network definition and link use coefficients provided by the traffic assignment algorithm. This model uses different forms and combinations of data, including link volume, classification counts, cordon counts of trucks entering and exiting the study area, and partial O-D observations. The link use coefficients for each O-D pair are determined using Dial's probabilistic path assignment algorithm.

More specifically, this new method extends the early research efforts in three major ways. First, unlike previous models dealing with O-D trip matrix estimation in general, the model proposed by List and Turnquist (1994) incorporates multiple vehicle classes. It employees a three-tier classification scheme in the form of commercial vans, medium trucks (two axle, six tire and three-axle single units), and heavy truck (trucks with four or more axles, and all tractor trailers). Second, it provides control parameters to allow introduction of both varying degrees of confidence in different observations of link volumes and classification counts. Finally, this new method has a more general formulation that is designed to accept data in forms other than link counts. Moreover, this more general formulation allows the model to deal with multi-period problems and to accommodate network use restrictions such as, no trucks or no heavy trucks. This model generates multi-truck class O-D flow matrices. This model has been tested using a network of the Bronx in New York City. The study area has been divided into 20 internal zones, and seven external zones were added to represent flows to and from major traffic generators. Three time periods namely, a.m. and p.m. peaks, and midday were considered. Three truck classes (light, medium, and heavy trucks) were used. One of the major efforts of this study was the resolution of inconsistencies in the data used. According to List and Turnquist, among the possible reasons for some of the inconsistencies are the problems with the survey forms used, the timing of data collection, the estimation of flow proportions by time of the day, and others. The developed model used to generate nine OD matrices and associated link flows for the test network. These results along with possible use of this model in the future were also presented in the paper.

Tamin and Willumsen (1988, 1992) propose two different methods for estimating freight O-D tables from traffic counts. The first method employs a traditional doubly-constrained gravity model (GM) used in freight demand studies. According to the authors, the deterrence function used by the GM model to represent different responses to the generalized cost traveling between two points can also be employed to represent the differences in types of freight commodities and their effects on freight flows. The second model is based on the gravity-opportunity (GO) model developed by Wills (1978, 1986). This model uses standard forms of the GM and intervening opportunities model as special cases. Tamin and Willumsen (1988, 1992) also dealt with various estimation methods used to estimate the unknown parameters of GM and GO models to ensure that the models estimate link flows as close as possible to the observed data. They experimented with non-linear least-squares and maximum-likelihood estimation methods. The formulation was tested in a case study from Indonesia (Bali).

As a result of tests, the GO model is shown to perform as the best model matching the traffic counts. However, the model cannot guarantee the production of the O-D matrix, which gives the best fit to the observed O-D matrix. In the Bali case, GM model is shown to be more robust and computationally less expensive thus, it is recommended over the GO model.

The "Integrative Freight Market Simulation" (IFMS) has been recently proposed by Holguín-Veras (2000). The research and development of this framework is currently funded by the National Science Foundation (NSF) Exploratory Transport Industries (ETI) program (2000). The IFMS is based on the assumption that urban good movements are to modeled as a market in equilibrium in which the different players, i.e., trucking companies, maximize profits. For that reason the IFMS considers, in a game-theoretical formulation, the fundamental interactions between the key participants (i.e., producers, consumers and freight companies). The IFMS is based on a bi-level formulation with two different problems. The first problem, formulated as a Cournot-Nash equilibrium problem, entails the estimation of the transportation service (i.e., amount of loaded and empty trips that will be contributed to the market) provided by the different clusters of companies in order to maximize profits. The second problem involves a multi-vehicle routing problem that is intended to estimate the origin-destination patterns that, while consistent with the Cournot-Nash solution, also meet the other system constraints. In essence, the proposed framework would attempt the estimation of the trips made by freight transportation providers in the study area, such that: (I) freight transportation companies maximize profits while market equilibrium conditions are met; (II) the user requirements are met, i.e., the commodities produced by and attracted to each TAZ are transported; (III) the resulting trip chains are consistent with trip chain patterns captured in travel diaries, or alternatively, from known Trip Length Distributions (TLDs); and (IV) the resulting commercial vehicle traffic is consistent with secondary data sources, e.g., ITS traffic data.

Conditions I and II are termed *primary constraints*, i.e., constraints that must be met. Conditions III to IV, referred to as *secondary constraints*, are those that could be relaxed under certain circumstances. Condition I ensures proper consideration of the interactions among freight providers in the supply market. Condition II ensures consideration of user requirements. Conditions III and IV are information constraints expected to bound the solution.

Crainic *et al.* (2001) recently introduced a model for adjusting freight demand matrices to observed flows for a multimodal multicommodity transportation planning process and described an algorithm to solve the corresponding bi-level optimization problem. The formulation they developed is based on the assumption that the freight flows in the area follow the System Equilibrium, i.e., the minimization of the total travel time in the network. This assumption is still to be corroborated in real life. They implemented the proposed algorithm using STAN, an interactive-graphic transportation planning package designed for national or regional strategic analysis and planning of multimode multiproduct freight transportation. Data from an actual application is used to characterize the performance of the proposed methodology.

The demand matrix adjustment process presented in Crainic *et al*. (2001) attempts to modify the values of an initial OD matrix such that the assignment of the adjusted OD matrix onto the network produces link and transfer values as close as possible to the observed values. As noted by several other researchers, this type of problem formulation can potentially produce infinite number of optimal solutions. However, demand matrices may already exist for previous years, and one generally tries to ensure that the adjusted matrix is similar to the initial (historical) matrix. Naturally, this goal can be achieved by introducing an additional term that minimizes the square of the difference between the cell values of the adjusted and historical matrix.

Crainic *et al*. (2001) formulated the above problem as a bi-level matrix optimization problem that can be solved by a steepest descent type of algorithm. At every iteration, this algorithm solves an assignment problem using a demand matrix obtained from the main step, except the initialization step which employs an initial demand matrix that can be supplied by the user. The flows obtained from the assignment level are then compared with the observed flows in order to adjust the existing OD matrix such that the differences between the observed and assigned flows are minimized. The algorithm was tested by varying numbers of origin destination pairs, as well as by perturbing the demand and its amplitude. In general, very good results are reported. The authors warn about certain problems, including the non-uniqueness of the solutions and potentially very large problem size. The former problem has to be carefully addressed during developing the analysis network and by meticulous analysis of results.

For freight modeling, the major issue remains, however, the selection of the correct modeling approach. Should we use quick-response models based on traffic counts, or gravity-based models discussed above? On the other hand, can the equilibrium-based models, which are proven to be attractive to model overall traffic flows in a network, be used for freight modeling? The following section briefly summarizes pros and cons of each approach. However, final decision should be made based on a careful analysis of available data and behavioral assumptions of route choice specifically developed for freight movements. This appears to be an interesting area of research for freight O-D estimation.

9.3 Data requirements

Among all types of easily derived data, traffic counts (link volumes) in a network perhaps contain the most important information about O-D distributions. In the case of freight, this will be link counts of freight volumes for each link in the network. However, it is important to emphasize the fact that obtaining freight volumes for each link can be a major challenge in practice. Moreover, based on the previous discussions, it is not sufficient to know just the freight traffic on each link, but it is also important to categorize vehicles according to certain major vehicle classes. However, it is known, the link counts and freight vehicle types are not readily available for certain parts of the New York City network.

In the past, some of the O-D data issues mentioned above were remedied by using incomplete link volumes. The use of incomplete link volumes can be one way of dealing with missing data issues. For calibration purposes, it is important to have a target O-D trip table at least for the base year because most of the models discussed above might not yield unique solutions. Thus, there might be more than one O-D table that will produce the observed link flows. This is, of course, a problem in terms of ensuring the accuracy of model results and it can be remedied by using a target O-D table, preferably an O-D table for the base year. However, it is well known that this is a very labor-intensive process, which requires substantial financial and time commitment. Moreover, the confidential nature of freight data creates another roadblock that will make it difficult to obtain the O-D trip table data for the base year. However, the quality of the target trip table is even more important in terms of the accuracy of model results. The errors in the target O-D table can cause errors in the final results of the model. Thus, it is important to understand the error structure in the existing trip table. For the NY-NJ metropolitan area, these practical issues can even be more challenging due to the large scale of the network to be modeled.

9.4 Staff requirements

The development, implementation, calibration, and validation of these models require high levels of mathematical and operations research skills, in addition to the understanding of freight transportation issues and modeling. In addition to an in-house staff with preferably a Ph.D. in operations research or a related field, it is necessary to work with researchers from academic institutions, that have researchers familiar with these modeling issues, to ensure the successful use of these trip table estimation models as applied to freight modeling. No special training is required as long as the above conditions are satisfied.

The same person who develops the model can also operate and maintain it. However, new data needed for continuous updating of the model can require additional labor, unless new technology such as E-Z pass can be used to automatically collect data. Even if the link count and O-D data are readily available, at least one data management and processing person might be needed on a regular basis.

9.5 Computing power required

The experience with O-D estimation models, especially “linear programming” models, is that computational power and memory requirements for solving these models are quite high. As a matter of fact, the LP model developed by Sherali *et al*. (1994a-b) and tested by Peng (1998) for the Pulaski, Virginia network required extensive computational time. However, it is not possible to make a credible estimation of computational requirements for future models based on the previous model runs since these computers were substantially less powerful than the current computers. Although, computation power of computers continues to increase according to Moore’s law every year, it is clear that the size of the network, the type of formulation, the efficiency of the implementation of the solution algorithms, and the required accuracy of the final solution will basically dictate the computational requirements.

9.6 Appropriateness of the model to NYMTC's needs

It has been noted that (Jack Faucett and Associates, 1999) some of the O-D synthesis models have limitations in depicting the relationship between freight flows and economic activity. Formulations such as Tamin and Willumsen (1988, 1992) and Holguín-Veras (2000), because of their reliance on external estimates of production and attractions, should be able to take into account the role of economic activity upon production and attraction of commodities. However, the formulation of Tamin and Willumsen has not been applied to urban areas, and the formulation of Holguín-Veras is still in process of research and development. It is clear, however, that O-D synthesis techniques can be quite useful in providing a good idea about local traffic patterns, and/or as complements to other freight demand models.

9.7 Practicality

The review of the literature and our previous research experience prove that O-D estimation models can be successfully used to predict (synthesize) O-D trip tables. More research is needed to better test these models in the context of freight flows using real-world data. The application of these models to freight is in fact an active and open research area that needs to be further pursued. The question of practicality should go with the questions of usefulness and cost. Although the answer to the usefulness question depends on the sophistication of the model adopted as well as its calibration using real-world data, the issue of cost mainly depends on the cost of collecting and processing link count and OD data. It is well known that these O-D estimation models can give erroneous results if the calibration data is not reliable.

9.8 Conceptual validity

For the most part, freight origin-destination techniques are fairly well supported by either network optimization principles (i.e., List and Turnquist, 1994; Crainic et al., 2001), entropy maximization theory (i.e., Tamin and Willumsen, 1988, 1992), and economic principles (i.e., Holguín-Veras, 2000). For that reason, their conceptual validity is not in question.

10. SUMMARY OF FINDINGS

The main findings of this report can be summarized in Table 5. As shown, the performance of the different families of models according to the different dimensions of analysis is presented in a tabular format. These are: (a) data requirements for calibration and development; (b) data requirements for forecasts; (c) staff requirements in terms of knowledge; (d) computing power required; (e) appropriateness for NYMTC's needs; (f) practicality; and (g) conceptual validity.

The reader must be aware of some fundamental limitations of Table 5:

- Although Table 5 represent the consensus of the research team, it is important to highlight that specific applications could lead to significantly different conclusions, depending upon the local conditions.
- As indicated before, the performance of the different families of models has been assessed on the basis of the assumption that they are not used in combination, or in complement of, models from other families. Much could be gained from using models from the different families to represent different components of the freight transportation system. The opinion of the research team is that imaginative modeling, which undoubtedly would involve taking advantage of the relative strengths of the different models, could go a long way towards enhancing the descriptive and forecasting ability of a given modeling system.

The analysis of Table 5 reveals a number of common features among the different modeling alternatives. In all cases, traffic data is needed for calibration purposes. This in itself may be a challenge due to the limited traffic data collection process that is taking place in the New York City metropolitan region. The need for traffic counts for calibration purposes should stress the need for expanding the traffic data collection taking place in the area.

Similarly, the majority of the modeling approaches considered here require basic origin-destination data (in some cases by type of vehicle and in others by commodity) for calibration and validation purposes. Given the size of the region and the complexity of the multiple layers of freight activity taking place, the data collection process may be a challenging and expensive task. This process may significantly benefit from exploiting the best features of the different surveying approaches. En-route surveys, such as those periodically conducted by the Port Authority of New York and New Jersey, are a cost-effective alternative. However, given their choice-based nature (because they focus on specific modes after the mode choice process has taken place) they need proper statistical handling to avoid bias in the parameter estimation processes. Destination-based surveys (i.e., at warehouses) and origin-based surveys (e.g., Commodity Flow Survey that targets shippers) provide useful information about the nature of freight transportation demand. Origin-based surveys do not have the same limitation (of being choice-based) as the others. In any case, a judicious combination of the above techniques may be instrumental in bringing down the data collection costs. However, this necessitates solid sample design and expert econometric modeling so that the potential biases introduced by en-route and destination-based data is eliminated.

The research team does not think that computing power is a major issue. If the zoning system is adequately defined thus avoiding an excessive level of detail, the computations required by the different modeling frameworks discussed here should be able to be carried out by top-of-the-line personal computers, or in the worst case by a top-of-the-line workstation.

Almost all the modeling alternatives require, or could benefit from, solid estimates of the nature and characteristics of freight generation in the different Transportation Analysis Zones (TAZs). This is an area where research is urgently needed. As an indication of the lack of knowledge in this significant topic, it is important to point out that among the 914 different land uses listed in the Trip Generation Manual (ITE, 1992)—the authoritative source on the subject of trip generation—only <u>four</u> provide estimates of commercial vehicle trip generation. The generation of municipal solid waste (that represent a significant portion of the truck traffic) is still an open question.

Equally important is to gather data about the level of economic activity taking place in the TAZs (e.g., employment, type of businesses), and about the nature and characteristics of the logistics of urban good movements. Among other things, this knowledge would support: (a) the estimation of freight generation; and (b) the estimation of the overall patterns of movements in the area (i.e., logistic relationships among long-haul movements, truck warehouses and short-haul movements in the NYMTC area).

In addition to the items discussed above, IO formulations require knowledge of the matrix of technical coefficients for the different TAZs. As discussed in the IO chapter of this report, this poses both methodological and empirical challenges. However, under some simplifying assumptions it may be possible to use the coefficients estimated for the larger NYMTC area.

Table 5 provides an indication of the relative magnitude of costs involved. This performance indicator attempts to rank the different modeling frameworks considered from the most expensive, marked with "+++++," to the least expensive, i.e., "+." Unfortunately, the scope of this project prevented a more formal assessment process.

OD synthesis approaches, though not deemed appropriate for being the core of the Regional Freight Model, may play an important role as complementary models. Among other things, these methodologies may be instrumental in providing estimates of commercial vehicle traffic in portions of the transportation network other than the primary network. They could also assist in the process of filling the gaps that currently exists in the available data.

Regardless of the modeling framework chosen, there will no be substitute for experience. At the end, the validity and usefulness of the model rely heavily on how appropriate its basic assumptions are and how well the model represents the system under analysis. This necessitates a careful calibration process in which both the internal (within the subcomponents of the model and with the supporting data) and the external consistency (between the model and reality) of the model is assessed.

The issue of how reliable the model is will always be present. Most models are calibrated and used for forecasts under the assumption that the parameters of the model are going to be stable over time. This is nothing more than a leap of faith forced by the inherent limitations of the forecasting process. However, the uncertainty in the forecasting process can be mitigated by a continuous process of update and re-calibration. Though not a complete solution, a continuous process of validation goes a long way in reducing the amount of uncertainty in the forecasts. This, together with the use of techniques such as Scenario Planning, reduces the reliance on a single forecast by considering multiple (future) scenarios and how they affect the process of selecting the preferred alternatives.

All of the above elements determine the staff requirements. Ideally, the NYMTC staff assigned to work on the model should have a basic knowledge of freight transportation logistics and operations. This would enable them to critically review the outputs and basic assumptions of the models. The staff should also have a basic knowledge of freight transportation modeling techniques, network analysis and Geographic Information Systems. Staff training may be a major issue due to the fact that freight transportation demand modeling is still in its infancy. For that reason, more than in passenger transportation modeling, there is an urgent need for a continuing research and development process.

The process of development and research would undoubtedly benefit from partnerships involving the private industry, the Federal Government, and research universities. Partnerships with the private industry, in the form of an Advisory Group, would ensure NYMTC and the model developers that the Regional Freight Model adequately captures the fundamental processes taking place in the regional freight transportation system. At the same time, collaborative agreements with the Federal Government (i.e., Bureau of Transportation Statistics, Federal Highway Administration) may provide cost sharing, ensure top-level support and review of the modeling process, and overall enhance the quality of both the data collected and the Regional Freight Mode itself.

A partnership between NYMTC and the local research universities could prove fundamental in ensuring the continuing development and enhancement of the NYMTC freight model. Such partnerships are standard practice in Europe and have been successfully applied in some American cities (e.g., between the Chicago Area Transportation Study and the University of Illinois at Chicago Circle Campus). By virtue of such arrangements, university researchers and NYMTC staff would work hand-in-hand in enhancing the fundamental structure of the NYMTC freight model, its empirical foundation, as well as the computational algorithms. In this *modus operandi*, the research universities will act as research extension of NYMTC. This undoubtedly will translate into major contributions to the state-of-the-art and practice of freight transportation modeling.

Table 5: Summary of Findings

	Input-Output		Spatial Interaction		
	Multi-Regional IO	Hybrid IO formulations	Trip-based	Commodity-based	OD synthesis
Data requirements:					
a) for calibration	Technical coefficients Commodity flow data Screenline counts Traffic counts Employment data Interregional trade flow coefficients Characteristics of major generators	Technical coefficients Commodity flow data Screenline counts Traffic counts Employment data Characteristics of major generators	Trip length distributions OD data Screenline counts Traffic counts Employment data Characteristics of major generators	Trip length distributions Commodity flow data Screenline counts Traffic counts Employment data Characteristics of major generators	Trip generation or commodity generation Traffic counts Employment data Characteristics of major generators
b) for forecasting	Technical coefficients Economic activity Commodity production	Technical coefficients Economic activity Commodity production	Economic activity Trip generation	Economic activity Commodity generation	Economic activity
Staff requirements (knowledgeable in)	IO modeling Freight modeling Network analysis GIS Freight logistics in the area	IO modeling Freight modeling Network analysis GIS Freight logistics in the area	Freight modeling Network analysis GIS Freight logistics in the area	Freight modeling Network analysis GIS Freight logistics in the area	Freight modeling Network analysis GIS Freight logistics in the area
Costs	+++++	+++	++	+++	+
Computing power	Top-of-the-line PC	Top-of-the-line PC	Top-of-the-line PC	Top-of-the-line PC	Top-of-the-line PC
Appropriateness to NYMTC's conditions	Not appropriate if major changes in accessibility	Appropriate	Not appropriate	Appropriate	Not appropriate

Note:
The modeling frameworks have been ranked by their expected development and maintenance costs, where "+++++" indicates "Most expensive" and "+" is "Least expensive"

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References

Abdelwahab, W.M. and Sargious, M.A. 1991, 'A Simultaneous Decision-Making Approach to Model the Demand for Freight Transportation,' *Canadian Journal of Civil Engineering*, Vol.18, No. 3, pp. 515-520.

Abdelwahab, W.M. 1998, 'Elasticities of Mode Choice Probabilities and Market Elasticities of Demand: Evidence from a Simultaneous Mode Choice/Shipment Size Freight Transport Models,' *Transportation Research. Part E: Logistics & Transportation Review*, Vol. 34, No. 4, pp. 257-266

Agerschou, H. and Korsgaard, J. 1969, 'Systems Analysis for Port Planning,' *Dock Harbor Authority*, vol. 49, pp. 411-415.

Barbour, R. and Fricker, D.J. 1990, 'Balancing Link Counts at Nodes Using a Variety of Criteria: An application in Local Area Traffic Assignment,' *Transportation Research Record*, No.1220: 33-39.

Barbour, R. and Fricker, D.J. 1993, 'Estimating an Origin Destination Table Using A Method Based on Shortest Augmenting Paths,' Proceeding of the Transportation Research Board-Annual Meeting.

Bazaraa, M.S., Jarvis, J.J and Sherali, H.D. 1990, 'Linear Programming and Network Flows,' Second Edition, John Wiley & Sons, Inc. New York.

Beagon, D.F. 1990, 'Maximum Entropy Matrix Estimation (ME2),' Memorandum Center Transportation Plannubg Staff, Boston, Massachusetts.

Booch, G. 1991, 'Object-Oriented Design with Applications,' Addison-Wesley Publishing Co., Massachusetts.

Booch, G. and Bryan, D. 1994, 'Software Engineering with Ada,' Third Edition, The Benjamin & Cummings Publishing Co., Redwood, California.

Brenniger-Goethe, M., Jornsten, K.O and Lundgren, J.T. 1989, 'Estimation of Origin-Destination Matrix from Traffic Counts Using Multiobjective Programming Formulations,' *Transportation Research*, No. 23B-4, pp.257-265.

Bromage, E. J. 1988, 'The Highway Emulator – Release 3.0, Traffic Analysis and Design Group,' Central Transportation Planning Staff, Boston, Massachusetts.

Button K.J. and Pearman, A.D. 1981, 'The Economics of Urban Freight Transport,' *Macmillan*, London, pp.218.

Cambridge Systematics, Inc. 1996, 'Quick Response Freight Manual,' *Final Report of the Federal Highway Administration*, September.

Carey, M., Hendrickson, C. and Siddharthan, K. 1981, 'A Method for Direct Estimation of Origin/Destination Trip Matrices,' *Transportation Science*, No.15-1, pp.32-49.

Cascetta, E. 1984, 'Estimation of Trip Matrices From Traffic Counts and Survey Data: A Generalized Least Squares Estimator,' *Transportation Research Board*, No.18B-4/5, pp.289-299.

Chenery, H.B. 1967, 'Interdependence of Investment Decisions,' *American Economic Association,* Readings in Welfare Economics, pp. 336-371.

Chin, S. H., Hwang and Pei, T. 1994, ' Using Neural Networks to Synthesize Origin-Destination Flows in Traffic Circle,' *Transportation Research Board*, Washington, D.C., No.940353, 1994.

Colston, M. and Blunden, W.R. 1970, 'On the Duality of Desire Line and Land Use Models,' *Australian Road Res. Board*, No.4-1, pp.170-183.

Crainic, T.G., Dufour, G., Florian, M., Larin, D. and Leve, Z. 2001, 'Demand Matrix Adjustment for Multimodal Freight Networks,' *80^{th} Annual Conference of the Transportation Research Board*, CD-ROM, Washington, D.C., 2001.

Davis, G.A., and Nihan, N.L. 1991, 'Stochastic Process Approach to the Estimation of Origin-Destination Parameters from Time Series of Traffic Counts,' *Transportation Research Board*, Record No.1328, pp.36-42.

Dial, R. 1971, 'A Probabilistic Multipath Traffic Assignment Model Which Obviates Path Enumeration,' *Transportation Research Board*, No.5, pp. 83-111.

Donnelly, R., Costinett, P. and Hunt, J.D. 1999, 'The Oregon Statewide Integrated Land Use-Transport Models,' *Travel Model Improvement Program Annual Meeting*, April.

Easa, S.M. 1991, 'Trip Assignment in Practice: Overview and Guidelines for Users,' *Journal Transportation Engineers*, ASCE, No.117-6, pp. 602-623.

Easa, S.M. 1993a, 'Urban Transportation in Practice, I: Conventional Analysis,' *Journal Transportation Engineers,* ASCE, No.119-6, pp.793-815.

Easa, S.M. 1993b, 'Urban Transportation in Practice, II: Quick Response and Special Topics,' *Journal Transportation Engineers*, ASCE, No.119-6, pp 816-834.

Erlander, S., Nguyen, S and Stewart, N.F. 1979, 'On the Calibration of the Combined Distribution-Assignment Model,' *Transportation Research* Board, No.13-B, pp. 259-267.

Fischer, M., Ang-Olson. and La**,** A. 1999, 'A Model of External Urban Truck Trips Based on Commodity Flows,' *Proceeding of the Transportation Research Board 79th Annual Meeting*, Washington D.C., January 9-13. 2000.

Fisk, C. S. 1988, 'On Combining Maximum Entropy Trip Estimation with User Optimal Assignment,' *Transportation Research Board*, No. 22-B, pp. 69-79.

Fisk, C. S. 1989, 'Trip Matrix Estimation from Link Traffic Counts: The Congested Network Case,' *Transportation Research*, No. 23B, pp.331-336.

Fisk, C. S. and Boyce, D.E. 1983, 'A Note on Trip Matrix Estimation from Link Traffic Count Data,' *Transportation Research Board*, No.17B, pp.245-250.

Gaudry, M. and Lamarre, L. 1978, 'Estimating Origin-Destination Matrices from Traffic Counts: A Simple Linear Intercity Model for Quebec,' *Publication Ctr. For Transp.*, No 105, University of Montreal, Montreal, Quebec.

Gaudry, M. and Lamarre, L. 1979, 'Estimating Origin-Destination Matrices from Traffic Counts: A Simple Linear Intercity Model for Quebec,' *The Logistics and Transportation Review*, No. 15, pp. 631-642.

Gur, J., M. Turnquist, M., Schneider, L., Leblanc. and D. Kurth, D. 1980, 'Estimation of an Origin Destination Trip Table on Observed Link Volumes and Turning Movements Vol. 1,' *Technical Report*, FHWA, Rept. FHWA/RD-80/034.

Haas, R., Hudson, R.W and Zaniewski, J. 1994, 'Modern Pavement Management Systems,' Robert *E. Krieger Publishing Co,* Malabar, Florida.

Han, A. F., Dowling, R.G., Sullivan, E.C., and May, A.D. 1981, 'Deriving Origin-Destination Information from Routinely Collected Traffic Counts, Volume II: Trip Table Synthesis for Multipath Networks,' Institute for Transportation Studies, University of California, Berkeley, rr81-9.

Han, A.F and Sullivan, E.C. 1983, 'Trip Table Synthesis for CBD Networks: Evaluation of the LINKOD Model,' *Transportation Research Record*, No 944, pp.106-112.

Harker, P. and Friesz, T. 1986, 'Prediction of Intercity Freight Flows, I: Theory,' *Transportation Research Part B*, Vol. 20B, No. 2, pp. 139-153.

Hautzinger, H. 1984, 'The Prediction of Interregional Goods Vehicle Flows: Some New Modeling Concepts,' *Ninth International Symposium on Transportation and Traffic Theory,* VNU Science Press, pp. 375-396.

Hogberg, P. 1976, 'Estimation of Parameters in Models for Traffic Prediction: A Non-Linear Regression Approach,' *Transportation Research*, No.10, pp. 263-265.

Holguin-Veras, J. 2000, 3rd Progress Report prepared for NYMTC, New York.

Holguin-Veras, J. 2000, 'Integrative Market Freight Simulation,' *Proceedings of the 3rd IEEE ITSC Conference*, Dearborn, Michigan.

Holguín-Veras, J. 2001, 'Revealed Preference Analysis of the Commercial Vehicle Choice Process,' *Journal of Transportation Engineering, American Society of Civil Engineers.*

Holguín-Veras, J. 1997, 'Alternative Modeling Framework for Pavement Serviceability Analysis,' *Journal of Transportation Engineering A.S.C.E.*, Vol.123, No. 6, pp. 478-483.

Holguín-Veras, J. and Walton, C.M. 1996, 'On the Development of a Computer System to Simulate Port Operations Considering Priorities,' *Proceedings of the 1996 Winter Simulation Conference (Ed. Charnes, J.M., Morrice, D.J., Brunner, D.T. and Swain, J.J.),* The Institute of Electrical and Electronic Engineers, New Jersey, pp. 1471-1478.

Holguín-Veras, J. and Thorson, E. 2000, 'An Investigation of the Relationships Between the Trip Length Distributions in Commodity-Based and Trip-Based Freight Demand Modeling,' *Transportation Research Record*, No. 1707, September 2000, pp. 37-48.

Holguín-Veras, J. and Thorson, E. 2001, 'Modeling Commercial Vehicle Empty Trips with A First Order Trip Chain Model,' (forthcoming in Transportation Research Part B).

Holm, T., Jensen, S.K., Nielsen, A.C., Johnsen, B.and Ronby, G. 1976, 'Calibrating traffic models on traffic census results only,' Traffic Engineering and Control, pp. 137-140, April, 1976.

Horowitz, A. J. and Farmer, D.D. 1998, 'A Critical Review of Statewide Travel Forecasting Practice,' *Transportation Research Board 78th Annual Meeting,* Washington D.C., January, 1998.

Huang, W. and Smith, Jr R.L. 1998, 'Development of a Truck Travel Demand Model for Wisconsin Using Commodity Flow Survey Data,' *Transportation Research,* Record No. 1685, and the Research Board 78th Annual Meeting, Washington D.C., January. 1998.

Isard, W. 1951, 'Interregional and Regional Input-Output Analysis: A Model for a Space Economy,' *Review of Economic Statistics*, Vol. 33, No. 4.

Jack Faucett Associates. 1999, 'Research and Development of Destination, Mode, and Routing Choice Models for Freight,' *Final Report Prepared for DOT SBIR Office*, DTS-22, May 20, 1999.

Jacobson, I., Christerson, M., Jonsson, P and Overgaard, G. 1995, 'Object-Oriented Software Engineering, A User Approach,' *Revised Printing, Addison-Wesley,* New York.

Kanafani, A. 1983, 'Transportation Demand Analysis, Chapter 10: Commodity Transportation Demand,' *McGraw Hill*, New York, pp. 279-316.

Kennington, J.L. and Helgason, R.V. 1980, 'Algorithms for Network Flow Programming,' John Wiley & Sons, New York.

Krishanan, V. and K. L. Hancock, K.L. 1997, 'Highway Freight Flow Assignment in Massachusetts Using Geographic Information Systems,' *Transportation Research Record No.1625 and the Transportation Research Board 77th Annual Meeting,* Washington D.C., January 11-15, 1997.

Kurth, D.M., Schneider. and Gur, Y. 1979, 'Small Area Trip Distribution Model,' *Transportation Research Record,* Washington, D.C., *No.* 728, pp. 35-40.

Ladson, L.S. 1970, 'Optimization Theory for Large Scale Systems,' MacMillan.

Lei, P. 1998, 'A Linear Programming Method for Synthesizing Origin-Destination Trip tables from Traffic Counts for Inconsistent Systems,' *Master Thesis, VPI,* Blacksburg, VA, 1998.

Leontief, W. 1936, 'Quantitative Input-Output Relations in the Economic System of the United States,' *Review of Economic Statistics*, Vol. 18, No. 3.

Leontief, W. 1970, 'Input-Output Economics,' *Oxford University Press*, New York

Leontief, W. and Strout, A. 1963, 'Multi-Regional Input-Output Analysis in Structural Interdependence and Economic Development,' *(Ed by A. Barna), McMillan,* London.

Liew, C.K. and Liew, C.J. 1979, 'Use of a Multiregional Variable Input-Output Model to Analyze the Impacts of Transportation Costs,' *Transportation Research Record,* No. 747, pp. 5-12.

List, G.F. and Turnquist, M.A. 1994, 'Estimating Truck Travel Patterns in Urban Areas,' *Transportation Research Board*, No.1430, pp. 1-9.

Low, D.E 1972, 'A New Approach to Transportation Systems Modeling,' *Traffic Quarterly,* No.26, pp.391-404.

Maher, M.J. 1983, 'Inferences on Trip Matrices From Observations on Link Volumes: A Bayesian Statistical Approach,' Transportation Research, No.17B-6, pp. 435-447.

McFadden, D., Winston, C. and Boersch-Supan, A. 1986, 'Joint Estimation of Freight Transportation Decisions Under Non-random Sampling,' *Analytical Studies in Transport Economics*, A. Daugherty, A, Cambridge University Press.

Memmott, F.W. and Roger Creighton Associates, Inc. 1983, 'Application of Statewide Freight Demand Forecasting Techniques,' NCHRP 260, *Transportation Research Board*, Washington D.C, September 1983.

Meyburg, A.H. 1976, 'Modeling in the Context of Urban Goods Movement Problems,' Fisher, G.P. (Ed), *2nd Conference on Goods Transportation in Urban Areas*, Engineering Foundation, New York, pp. 127-168.

Moses, L. 1955, 'The Stability of Interregional Trade Patterns and Input-Output Analysis,' *American Economic Review*, Vol. 45, No. 5, pp. 803-831.

Murchland, J. 1977, 'The Multi-proportional Problem,' Research Note JDM 263, University College, London,.

Nguyen, S. 1977, 'Estimating an OD Matrix from Network Data: A Network Equilibrium Approach,' *University of Montreal Publication*, No. 60.

Nguyen, S. 1984, 'Estimation Origin-Destination Matrices from Observed Flows,' Transportation Planning Models, Editor: M. Florian, Elsever Science Publishers B.V, Netherlands, pp.363-380.

Noortman, H.J. and Van Es, J. 1978, 'Traffic Model Manuscript for the Dutch Freight Transportation Model.'

New York City Economic Development Corporation 2000, 'Cross Harbor Freight Movement Major Investment Study,' *Draft Final Report*, Edwards and Kelcey Engineers, Inc. and others, May 2000.

New York Metropolitan Transportation Council 1998, 'Freight Movement Issues in the Region: First Steps Toward Implementing Solutions,' *Final Summary of the 1998 Freight Forum*, New York Metropolitan Transportation Council, Howard/Stein-Hudson, Inc., March 13, 1998.

Ogden, K.W. 1992, 'Urban Goods Movement,' *Ashgate Publishing Limited* ISBN 1-85742-029-2, England.

Ogden, K.W. 1978, 'The Distribution of Truck Trips and Commodity Flow in Urban Areas: A Gravity Model Analysis,' *Transportation Research*, No. 12-2, pp. 131-137.

O'Neill, W.A. 1987, 'Origin-Destination Trip Estimation Using Traffic Counts,' PhD dissertation, University of New York at Buffalo, New York.

Ortúzar, J.D. and Willumsen, L.G. 1994, 'Modeling Transport,' *John Wiley and Sons*, 1994.

Parsons Brinckerhoff Quade & Douglas, Inc. 1998, 'The Second Generation Michigan Statewide Truck Travel Demand Forecasting Model,' *Draft for Review for the Travel Demand Analysis Section*, Michigan Department of Transportation, September 21, 1998.

Pohl, I. 1993, 'Object-Oriented Programming Using C++,' The Benjamin/Cummings Publishing Co., Redwood City, California.

Polenske, K. 1970, 'A Multiregional Input-Output Model for the United States,' *Harvard Economic Research Program*, Cambridge, MA

Rathi, A.K. and Santiago, A.J. 1990, 'Urban Network Traffic Simulation: Traf-Netsim Program,' *Journal of Transportation Engineering American Society of Civil Engineers,* Vol. 116, No. 6, pp. 734-743

Robillard, P. 1975, 'Estimating the O-D Matrix from Observed Link Volumes,' *Transportation Research*, No. 9, pp.123-128.

Rockliffe, N., Wigan, M. and Quinlan, H. 1998, 'Developing a Database of Nationwide Freight Flows for Australia,' *Transportation Research Board, 77th Annual Meeting*, Washington, D.C., January 11-15, 1998.

Samuelson, P. 1952, 'Spatial Price Equilibrium and Linear Programming,' *American Economic Review*, No. 42, pp. 283-303.

Schneider, M. 1959, 'Gravity Models and Trip Distribution Theory,' *Regional Science Association and papers,* Vol. 1, pp. 51-56.

Sherali, D.R., Sivanandan, R. And A.G. Hobeika, A.G. 1994a, 'A Linear Programming Approach for Synthesizing Origin Destination (O-D) Trip Tables from Link Traffic Volumes', *Transportation Research Board, No.*28B, pp.213-233.

Sherali, D., R. Sivanandan, R., Hobieka, A.G and Narayanan, A. 1994b, 'Estimating Missing Link Volumes in a Traffic Network-A Linear Programming Approach,' *Presentation at the TRB Annual Meeting*, Washington, D.C.

Shewey, P.J.H. 1983, 'An Improved Algorithm for Matching Partial Registration Numbers,' *Transportation Research*, No. 17B, pp. 391-397.

Sivanandan, R. 1991, 'A Linear Programming Approach for Synthesizing Origin-Destination Trip Tables From Link Traffic Volumes,' *PhD Dissertation,* Virginia Polytechnic Institute & State University, Blacksburg, Virginia.

Sivanandan, R., Narayanan, A. and Lei, P. 1996, 'Review and Evaluation of Models That Produce Trip Tables From Ground Counts,' *VTRC Report. 96-IR2,* Virginia Transportation Research Council, Charlottesville.

Sivanandan, R. and Nanda, D. 1998, 'A Method to Enhance the Performance of Synthetic Origin-Destination (O-D) Trip Table Estimation Methods,' *VTRC Report No. 98-CR 23, Transportation Research Council*, Charlottesville, Virginia.

Slavin, H.L. 1976, 'Demand for Urban Goods Vehicle Trips,' *Transportation Research Record* No.591, pp. 32-37.

Sorratini, J. and Smith, R.L. 2000, 'Development of a Statewide Truck Trip Forecasting Model Based on Commodity Flows and Input-Output Coefficients,' *Transportation Research Record*, No. 1707, pp. 49-55.

Souleyrotte, R., Maze, T. H., Pathak, S. and Smadi, A. 1996, 'Statewide Freight Demand Modeling: A Multi-Commodity Layered Approach,' Center for Transportation Research and Education, Ames, Iowa, 1996.

Souleyrotte, R., Maze, T. H., Strauss, T., Preissig, D. and Smadi, A. 1998, 'A Freight Planning Typology,' *Transportation Research Record* No.1613, August 1998.

Southworth, F. 1982, 'Logistic Demand Models for Urban Goods Movement: in Fisher, G.P. and Meyburg, A.H. (Eds.),' *4th Engineering Foundation Conference on Goods Transportation in Urban Areas*,Engineering Foundation, New York, 1982, pp. 189-204.

Southworth, F. 1982, 'The Spatial Accessibility of Truck Terminals in the Presence of Multi-destination Truck Circuits.' Civil Engineering Department, University of Illinois at Urbana-Champaign, USA, pp.15.

Stouffer, A. 1940, 'Intervening Opportunities: A Theory Relating Mobility and Distance,' *American Sociological Review*.

Stroustrup, B. 1993, 'The C++ Programming Language,' Second Edition, Addison-Weslsey, MA.

Swan Wooster Engineering Co Ltd. 1979, 'Evaluation of Urban Trucking Rationalization in Vancouver – Phase 1 and 2,' *Transport Canada*, Montreal, Canada, 1979.

Tamin, O.Z. and Willumsen, L.G. 1988, 'Freight Demand Model Estimation From Traffic Counts,' *Proceeding of the PTRC Annual Meeting*, University of Bath. Reprinted in Simplified Transport Demand Modeling, Ortúzar, J, Ed. PTRC, 1992.

Tamin, O.Z and Willumsen, L.G. 1990, 'Transport Demand Model Estimation from Traffic Account, 1989-1990.

Transportation Research Board. 1994-1997, 'Highway Capacity Manual,' *TRB Special Report,* No. 209, Washington, D.C.

Turnquist, M. and Gur, J. 1979, 'Estimation of Trip Tables from Observed Link Volumes,' *Transportation Research Board*, Washington, D.C., Record No.730, pp1-6, 1979

US DOT 1990, 'Moving America: New Directions, New Opportunities, A Statement of National Transportation Policy: Strategies for Action,' Washington, D.C.

Van Vilet, D. and Willumsen, L.G. 1981, 'Validation of ME2 Model for Estimating Trip Matrices from Traffic Counts,' *Proceeding of the Eighth International Symposium on Transportation and Traffic Theory*, Editors: V.F. Hurdle, E. Hauer and Stuart, G.M, University of Toronto Press, pp. 640-655.

Van Zuylen, H.J. 1978, 'The Information Minimization Method: Validity and Applicability to Transport and Planning in New Developments in Modelling Travel Demand and Urban Systems,' G.R.H Jansen et al., Eds. Saxon, Farnborough.

Van Zuylen, H.J. and L.G. Willumsen, L.G. 1980, 'The Most Likely Trip Matrix Estimated from Traffic Counts,' *Transportation Research*, No.14B, pp.291-293.

Walting, D.P. and Maher, M.J. 1992, 'A Statistical Procedure for Estimating a Mean Origin-Destination Matrix from a Partial Registration Plate Survey,' Transportation *Research Board*, No.26 B, pp.171-193.

Walting, D.P. and Grey, D.R. 1991, 'Analysis of Partial Registration Plate Data Using a Model with Poisson Input and Output,' *Proceedings of the International Conference on Mathematics in Transport Planning and Control,* Institute of Mathematics and Its

Applications at the University of Wales College of Cardiff, Oxford University Press,. September 1989.

Wigan, M. and N. Rockliffe, N. 1998, 'Freight Survey Requirements for Urban Areas,' *Transportation Research Board 77th Annual Meeting*, Washington D.C., January 11-15, 1998.

Wilson, A. 1970, 'Entropy in Urban and Regional Modeling,' *Pion*, London.

Wills, M. 1978, 'Non-Linear Estimation of Origin-Destination Flows and Gravity Model Parameters from Traffic Counts on Links,' Department of Geography, University of British Columbia, Mimeographed Notes.

Wills, M.J. 1986, 'A Flexible Gravity Opportunity Model for Trip Distribution. Transportation Research, No.20B-2, pp. 89-111.

Willumsen, L.G. 1978, 'Estimation of an O-D Matrix from Traffic Counts – A Review,' *Working Papers 99 and Institute of Transportation Studies*, University of Leeds, England.

Winston, C. 1985, 'Conceptual Development in the Economics of Transportation: An Interactive Survey,' *Journal of Economic Literature*, Vol. XXIII, pp.57-94, March 1985.

Xu, W. and Y. Chan. 1993, 'Estimating an Origin-Destination Matrix with Fussy Weights, Part II: Case Studies,' Transportation Planning and Technology, No.12, pp.145-163.

Yang, H., Iida, Y and Sasaki, T. 1991, 'An Analysis of Reliability of an Origin-Destination Trip Matrix Estimated from Traffic Counts,' *Transportation Research Board*, No.25B-5, pp.351-363.

Yang, H. T., Akiyama and Sasaki, T. 1992, 'A Neural Network Approach to the Identification of Real Time Origin Destination from Traffic Counts,' *International Conference on* Artificial Intelligence Application in Transportation Engineering, pp.253-269.

2020 Transportation Program 1988, 'Beyond Gridlock: The Future of Mobility as the Public Sees it,' Advisory Committee on Highway Policy, Washington, D.C.

APPENDIX I: LITERATURE REVIEW ON FREIGHT TRANSPORTATION DEMAND MODELING

Background

One of the objectives of this research project is to review existing freight models. Determining the range applicability or transferability of existing models is critical to identifying the appropriateness of the models for the New York Metropolitan Region given its unique location and transportation demands.

In general, freight transportation models have been built on either of two platforms: 'vehicle (trip)-based' or 'commodity-based' modeling. As the names suggest, these platforms model vehicle trips (the number of trips) and commodity type typically by size and weight respectively. Common to both approaches are trip generation, trip distribution and traffic assignment. The processes for both the approaches are shown in Figures 1 and 2 (after Holguin-Veras and Thorson, 2000a).

Figure 1: Model components of trip-based approaches

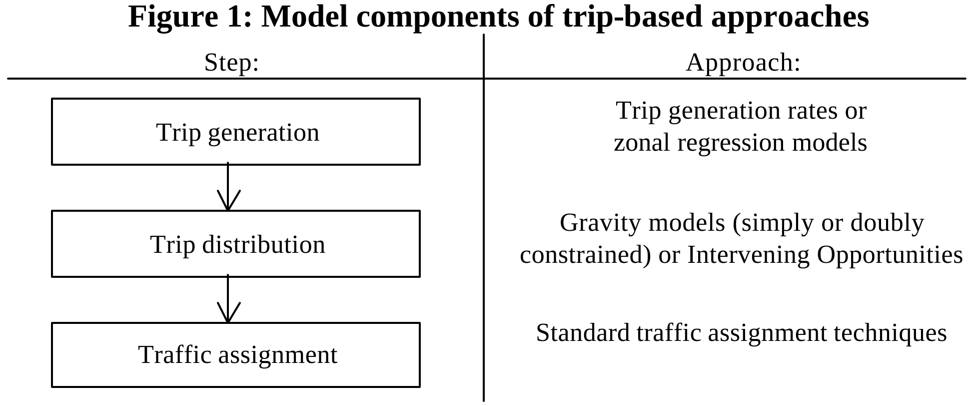
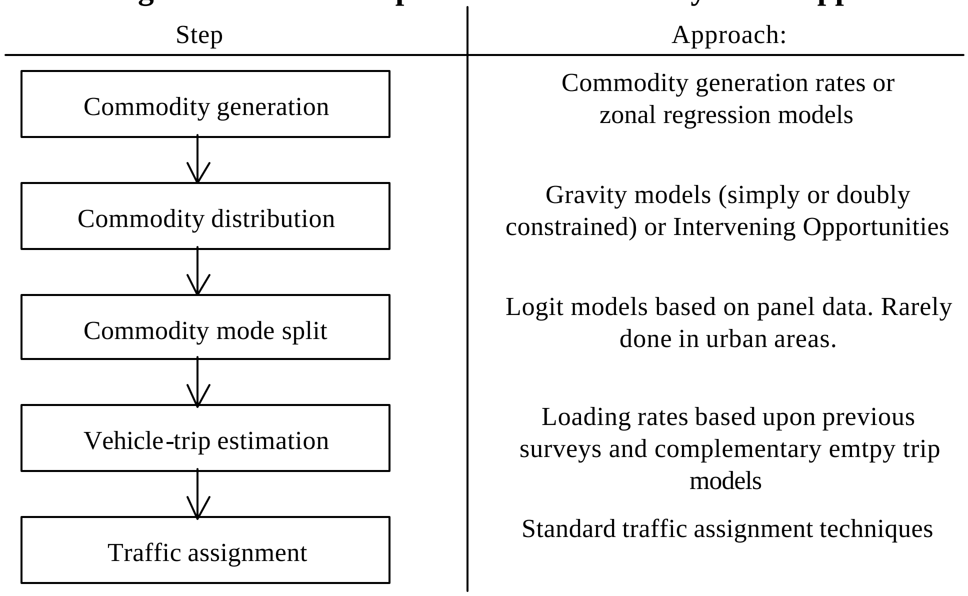


Figure 2: Model components of Commodity based approaches



This appendix presents the various trip and commodity base identified from a comprehensive literature search on the freight models used in various parts of the US. In the next section, the general forms and procedures of trip and commodity based models are presented, followed by comparisons between the two approaches in terms of advantages and disadvantages. A listing of the different freight models by state, are presented and briefly discussed. The developers of these models are also presented in the listing. A class of freight models where freight flows are modeled as a function of interaction between shippers and carriers by Freisz et al (1983 & 1986) are presented next. Subsequently, recommendations by Jack Faucett Associates following a nationwide freight model development study to MPOs are summarily presented. The final section of this appendix is divided into two subsections. The first of these is a subsection on issues in freight planning while the second is a response summary to a survey conducted across 56 MPOs. The questionnaire was designed to examine the extent to which freight planning methodology at the MPOs conducting freight planning addressed the listed freight planning issues. Additional comments from the survey respondents are also included in this final section.

Forms and Procedures of the Freight Models

Vehicle (Trip)-based Models

Trip-based models, as the name implies, focus on modeling vehicle-trips. Since the focus is on vehicle-trips, which presupposes that the mode selection and the vehicle selections were already done, trip-based models do not need mode split or vehicle loading models. Trip-based models have some advantages. First and foremost, traffic data is relatively easy to get. Furthermore, an increasing number of Intelligent Transportation Systems (ITS) applications are able to track the movements of vehicles through, at least, segments of the highway networks, thus increasingly becoming an important source of traffic data. Second, since the focus is on the vehicle-trip, considering empty trips does not present any major problem (Ogden, 1992; Holguin-Veras and Thorson, 2000a).

In Jack Faucett Associates, (1999b) trip-based models are described as an approach in which truck trips are generated directly, usually as a function of different land uses and trip data from trip diaries or shipper surveys. The trip rates are calculated as a function of socio-economic data (trips per employee) or land use data (trip per acre) leading to generation of trips. The generated trips are then distributed using some form or other of spatial interaction models, most commonly a form of gravity model. The gravity model is typically calibrated using trip length frequency distributions obtained from trip diaries.

The Quick Response Freight Manual (QRFM), developed by Cambridge Systematic, Inc. (1996) is an example of trip-based models. Although trip based models have been in existence for a long time, QRFM, the procedure provides model parameters and data sources. The model consists of the following steps:

1. Obtaining data on economic activity for traffic analysis zones (including employment by type and the number of households);
2. Applying trip generation rates to estimate the number of commercial vehicle trips for each traffic analysis zone;
3. Estimation of commercial vehicle volumes at external stations;
4. Estimation of the number of commercial vehicle trips between pairs of traffic analysis zones or external stations;
5. Estimation of the mode share for each trip;
6. Loading the O-D trip to the network; and
7. Comparison of control VMT with estimated VMT.

In a truck flow study based on the QRFM, whose objective was to investigate the impacts of different degree of geographic resolution on traffic assignment, the trip generation was based on trip rates specified in the QRFM was applied successfully by Marker and Goulias (1998). Trip distribution was done using the gravity model employing parameters specified in the same manual. Traffic assignment was based on user equilibrium as formulated in TransCAD.

List and Turnquist (1995) developed a formulation for estimating multi-class truck trip matrices for truck flows in urban areas with the capability for a wide variety of input data. O-D matrices were estimated from truck traffic counts, O-D synthesis. The technique assumes that the links in the analysis network consist of at least three attributes: (1) a "directional flag;" (2) a use label (e.g. truck class); and (3) a travel time which may vary according to the time of day. In addition, the technique assumes the study area is divisible into non-overlapping zones, each zone having a 'centroid', whereat trips originate and/or terminate. The input data are of three types namely: (1) link volumes or classification counts, (2) partial O-D estimates for various zones, including time periods and truck classification, and (3) origin/termination information. In essence, Nine O-D matrices were estimated for three time periods (6:00-10:00 A.M., 10:00 A.M.-3:00 P.M., and 3:00-8:00 P.M.) and three truck classifications (van, medium truck, and heavy truck). Bronx, New York City, was the test bed used for the study.

Tamin and Willumsen (1992) propose two different methods for estimating freight O-D tables from traffic counts. The first method uses traditional doubly constrained gravity model (GM) used in freight demand studies. According to the authors, the deterrence function used by GM model to represent different responses to the generalized cost traveling between two points can also be employed to represent the differences in types of freight commodities and their effects on freight flows. The second model is based on the gravity-opportunity (GO) model developed by Wills (1978, 1986). This model uses standard forms of the GM and intervening opportunities model as special cases. Tamin and Willumsen (1992) also dealt with various estimation methods used to estimate the unknown parameters of GM and GO models to ensure that the models estimate link flows as close as possible to the observed data. They experimented with non-linear least squares and maximum likelihood estimation methods. The formulation was tested in a case study from Indonesia.

As a result of tests, GO model is shown to perform as the best model matching the traffic counts. However, the model cannot guarantee the production of the O-D matrix, which gives the best fit to the observed O-D matrix. In Bali case, GM model is shown to be more robust and computationally less expensive thus, it is recommended over GO model.

The "Integrative Freight Market Simulation" (IFMS) has been recently proposed by Holguín-Veras (2000). The research and development of this framework is currently funded by the National Science Foundation (NSF) Exploratory Transport Industries (ETI) program (2000). The IFMS is based on the assumption that urban good movements are to modeled as a market in equilibrium in which the different players, i.e., trucking companies, maximize profits. For that reason the IFMS considers, in a game theoretical formulation, the fundamental interactions between the key participants (i.e., producers, consumers and freight companies). The IFMS is based on a bi-level formulation with two different problems. The first problem, formulated as a Cournot-Nash equilibrium problem, entails the estimation of the transportation service (i.e., amount of loaded and empty trips that will be contributed to the market) provided by the different clusters of companies in order to maximize profits. The second problem involves a multi-vehicle routing problem that is intended to estimate the origin-destination patterns that, while consistent with the Cournot-Nash solution, also meet the other system constraints. In essence, the proposed framework would attempt the estimation of the trips made by freight transportation providers in the study area, such that: (I) freight transportation companies maximize profits while market equilibrium conditions are met; (II) the user requirements are met, i.e., the commodities produced by and attracted to each TAZ are transported; (III) the resulting trip chains are consistent with trip chain patterns captured in travel diaries, or alternatively, known Trip Length Distributions (TLDs); and (IV) the resulting commercial vehicle traffic is consistent with secondary data sources, e.g., ITS traffic data.

Conditions I and II are termed *primary constraints*, i.e., constraints that must be met. Conditions III to IV, referred to as *secondary constraints*, are those that could be relaxed under certain circumstances. Condition I ensures proper consideration of the interactions among freight providers in the supply market. Condition II ensures consideration of user requirements. Conditions III and IV are information constraints expected to bound the solution.

Crainic *et al* (2001) recently introduced a model for adjusting freight demand matrices to observed flows for multimodal multicommodity transportation planning process and described an algorithm to solve the corresponding bi-level optimization problem. They implemented the proposed algorithm using STAN, an interactive-graphic transportation planning package designed for national or regional strategic analysis and planning of multimode multiproduct freight transportation. Data from an actual application is used to characterize the performance of the proposed methodology.

The demand matrix adjustment process presented in Crainic et al (2001) attempts to modify the values of an initial OD matrix such that the assignment of the adjusted OD matrix onto the network produces link and transfer values as close as possible to the observed values. As noted by several other researchers, this type of problem formulation can potentially produce infinite number of optimal solutions. However, demand matrices may already exist for previous years, and one generally tries to ensure that the adjusted matrix is similar to the initial (historical) matrix. Naturally, this goal can be achieved by introducing an additional term that minimizes the square of the difference between the cell values of the adjusted and historical matrix.

Crainic et al. (2001) formulated the above problem as a bi-level matrix optimization problem that can be solved by a steepest descent type of algorithm. At every iteration, this algorithm solves an assignment problem using a demand matrix obtained from main step, except the initialization step which, employs an initial demand matrix that can be supplied by the user. The flows obtained from the assignment level are then compared with the observed flows in order to adjust the existing OD matrix such that the differences between the observed and assigned flows are minimized. The algorithm was tested by varying number of origin destination pairs as well as by perturbing the demand and its amplitude. In general, very good results are reported. The authors warn about certain problems including the non-uniqueness of the solutions and potentially very large problem size. Especially, the former problem has to be very carefully addressed while developing the analysis network and by meticulous analysis of results.

Although of significant methodological value, origin-destination synthesis approaches such as the one described above have a significant limitation: the technique has no embedded behavioral relationships that explain trip distribution, and forecast can only be done by factoring base year trip characteristics, Jack Faucett and Associates, (1999b). This limitation restricts the range of applicability of such approaches to situations in which no major changes in land use are anticipated.

All the studies reviewed above treat trips as aggregated in a zonal level such as a TAZ, county, state, etc. Watson (1975), however, presents an approach where each firm or industrious agency is viewed as a unit that has attributes of employee, floor acreage, etc. The trips from these agencies can be regressed to these attributes. This disaggregate approach is attractive due to its capability to capture the attributes that influence the trip generation and attraction. This approach, however, is not adopted in practice, probably due to its extensive data need to develop these models.

Commodity-based Models

Commodity-based models focus on modeling the amount of freight measured in tons, or any other unit of weight. It is accepted that the focus on the cargoes enables commodity based models to capture more accurately the fundamental economic mechanisms driving freight movements, which are largely determined by the cargoes' attributes (e.g., shape, unit weight). The role of the economic characteristics of the cargoes have been demonstrated theoretically, in the context of optimal pricing, in Holguin-Veras and Jara-Diaz (1999) and, empirically in McFadden et al. (1986), Aldelwahab and Sargious (1991), Aldelwahab (1998), and Holguin-Veras (2000c).

Commodity based modeling is comprised of the following process: Commodity generation models are used to estimate the total number of tons produced and attracted by each zone in the study area, otherwise the TAZ. Next, in the distribution phase, the tonnage moving between each origin-destination pair is estimated using gravity models and other forms of spatial interaction models. The mode split component, intended to estimate the number of tons moved by the various modes, is done by applying discrete choice models and/or panel data from focus groups of business representatives or freighters (as in Cutler at al. 2000). Finally, in the traffic assignment phase of commodity-based models, a combination of vehicle loading models and complementary models that capture empty trips, applied to origin-destination matrices by mode, are used to assign vehicle trips to the network. (as in Hautzinger, 1984 and, Holguin-Veras and Thorson, 2000c).

Jack Faucett Associates (1999b) summarizes commodity based modeling as follows: The starting point is a known region-to-region table of commodity flow tonnage based on economic output forecasts and established regional trade patterns. The region-to-region flows, depicting inbound and outbound flow patterns, are disaggregated to the zonal level based on economic data, reflective of the intensity of production and consuming industries. Economic data and input-output tables are used to estimate the quantity of each commodity produced and consumed within each geographic unit. Knowing the commodity being shipped, it becomes possible to link producers of a good with its consumers through these economic relationships. Once commodity flows are assigned to origins and destinations, they are converted to truck trips or vehicle trips.

Trip-based vs. Commodity-based freight models

Advantages and disadvantages

The advantages and disadvantages of each of trip-based and commodity-based modeling approaches are discussed in detail in Holguin-Veras and Thorson (2000a). First, the advantages of trip-based models: They focus on a unit (the vehicle-trip) for which there is a significant amount of data in the form of traffic counts, screen counts, etc. Furthermore, an increasing number of Intelligent Transportation System (ITS) applications are able to track the movements of vehicles through, at least, segments of the highway networks, thus increasingly becoming an important source of traffic data. Also, since the focus is on the vehicle-trip, considering empty trips does not present any major problem in terms of the number of units of vehicles that traverse a given route.

Second, disadvantages of trip-based models: Their applicability to situations in which multiple freight transportation modes are to be considered is questionable given that the vehicle-trip, itself the result of a mode choice and vehicle selection process is not captured by counts along a route. Additionally, given that the economic and behavioral mechanism of freight demand is associated with the actual commodities being freighted, the identification and determination of these mechanisms in vehicle-based models becomes more difficult.

On the other hand, commodity-based models focussing on modeling the amount of freight measured in tons, or any comparable unit of weight, capture more accurately the fundamental economic mechanisms driving freight movements, which are largely determined by the cargoes' attributes (e.g., shape, specific weight, volume).

However, commodity based models are unable to capture empty trips, which are part and parcel of freight logistic decisions, Holguin-Veras and Thorson (2000a, 2000b). This limitation arises from the fact that empty trips are not directly explained by commodity-based modeling approaches. Since it is widely accepted that the focus on the cargoes enables commodity based models to capture more accurately, the fundamental economic mechanisms driving freight movements, which are largely determined by the cargoes' attributes, these models are strengthened by complementary models. (as in Noortman and van Es (1978), Hautzinger (1994) and, Holguin-Veras and Thorson (2000b).

Table 1 Listing of Freight Models, Process and Model Classification

Commodity-based models

Model	Developer	Modeling process	Model Attributes
Kentucky statewide traffic model	Wilbur Smith Associates (1997)	Commodity tonnage (truck tonnage) Disaggregation based on population for production and attraction separately Truck flow conversion Internal-internal gravity model Total truck table balance Total truck table Calibration	
Iowa statewide freight model	Souleyrette et al. (1998)	Commodity O-D flow (no trip generation) Disaggregation (based socio-economic indicators) Trip distribution Trip assignment	Commodity treated separately based on a same methodology
Massachusetts statewide freight model	Krishnan and Hancock (1997)	Commodity flow with O-D (no generation) Disaggregation Truck flow conversion Trip assignment Validation	Commodities treated differently based on a same methodology

Trip-based models

	Marker and Goulias (1998)	Trip generation Gate trip Gravity model distribution Assignment	
Wisconsin Statewide Freight Model	Huang and Smith (1998)	Commodity flow with O-D Truck flow conversion Disaggreation (based on population) Trip distribution (gravity model) Trip assignment Validation	Commodities treated differently based on a same methodology

NYMTC Issues and Freight Models

The objective of the work presented in this section is to determine the applicability and transferability of the freight models reviewed to the New York Metropolitan Council's area of jurisdiction. The freight models considered in the discussion in this section are trip-based models and, commodity based models C1, C2, and C3. As identified before, the following are consideration in modeling regional freight:

- Highways
- Rail lines
- Ports/rail intermodal/truck/air cargo terminals
- Warehouse and distribution facilities
- Multimodal/intermodal connectivity issues
- Highway maintenance and rehabilitation
- Rail line maintenance and rehabilitation
- Ports and other terminals
- Dredging
- Commercial vehicle bans on roads

The different types of regional freight models, the trip-based, C1, C2, and C3 can be extended to cover every of the above. Table 3 highlights the model types suited address the issues of the NYMTC region.

Table 2 Modeling Issues in the NYMTC region and plausible freight models

	Regional Freight Model			
	Trip-based	C-Based 1	C-Based 2	C-Based 3
I. Capacity enhancement				
a. Highway	X	X	X	X
Not efficient urban good movements				
Congestion impacts access to airports				
Trucking is impacted by congestion				
Trucking is impacted by physical constraints				
b. Rail lines	X	X	X	X
No efficient rail connection across Hudson				
Rail freight conflicts with passenger service				
c. Ports/rail intermodal/truck/air cargo terminals	X	X	X	X
Limited yard space at current terminals				
NYC lacks space for intermodal terminals				
Port access in NY side is constrained				
d. Warehouse and distribution facilities	X	X	X	X
Deficient high tech warehousing in NY side				
e. Multimodal/intermodal connectivity issues	X			
Rail facilities disconnected				
Location of terminals limit regional effectiveness				
II. System preservation				
a. Highway maintenance and rehabilitation	X	X	X	X
Over reliance on trucks degrades infrastructure				
b. Rail line maintenance and rehabilitation	X	X	X	X
c. Ports and other terminals	X	X	X	X
d. Dredging	X	X	X	X
Need deep draft port				
III. Operations				
a. Terminal operations/efficiency				
b. Managing curb space				
Inadequate truck parking in NYC				
c. Improving routing - use of highway system				
d. Minimizing conflicts freight vs passenger rail				
e. Use of ITS technologies				
IV. Policy				
a. Taxation				
b. Vehicle size limitations				
c. Commercial vehicle bans on roads	X	X	X	X
V. Transportation demand management				
a. Value pricing				
b. Shifting deliveries to non-peak hours				
c. Improving modal split				

Recommendations of freight model development from a nationwide freight model study

In conducting the research and development on the various freight models instituted in different parts of the country, a survey and workshop were conducted to MPOs, results of which are documented in Jack Faucett Associates (1999b). The summary of conclusions and recommendations of the report include that:

- Of all the modules proposed for the freight models (for destination, mode, route choice respectively), the destination choice module attracted the highest interest. While there was only minor interest in the mode choice module, MPOs did identify a number of policy questions that require multi-modal analysis.
- There was widespread support for the inclusion of commodity information in freight models. A majority of the MPO participants believe commodity flows drive freight transportation demand, which should be captured in the models if they are to be consistent with reality. In addition, most of the MPOs expressed interest in economic development issues that are linked to trade transportation and other inter-regional freight transportation issues.
- The MPOs all agreed that the modeling tools needed to be integrated with existing and future regional travel demand models. All MPO participants desire to use freight models as part of the RTP process and in conformity determination. These require integration with the. There was near unanimous agreement that the point of integration with regional travel demand should be at the network assignment stage.
- Modular architecture was preferred by the participants
- Most MPOs were not unwilling to purchase data sets that would support model development.
- There was major concern on the availability of data disaggregated to metropolitan level, for validation of truck transportation models. Most MPOs have very limited truck count programs.
- There was some concern about the need for 2-digit SIC employment data at the TAZ level. Most of the MPOs were comfortable with using industry establishment databases in conjunction with single-digit TAZ level data. However, at least one MPO expressed concerns about the reliability of this technique to forecast in high growth areas.

The Survey and Results

A survey was conducted across MPOs to identify the extent of their incorporating freight modeling and planning into their decision-making process. Their experience was deemed useful in the development process of a NYMTC freight model in determining the applicability and accuracy as well as limitations of those models. The experience would also be beneficial in making decisions for both the central business district (CBD) and the non-CBD NYMTC.

Primarily, phone interviews were conducted in two stages (See Table 3 for the list of questions asked during the telephone interviews): First, phone calls were made to the 56 MPOs listed in Table 4. Those not reached or interviewed by the first round of calls were contacted a second time. During the second round of calls, other MPOs not in the previous list of 56 were also contacted for interview.

Table 3 The Questionnaire

1. Does your agency do freight planning?
2. If yes, what issues do the freight planning deal with? Capacity enhancement System preservation Operations Transportation demand management Policy Strategic, tactical, operational? Regional, corridor, local?
3. What kind of models have you developed for each issue? Commodity based model Trip based model Input-output Others, please specify
4. What types of data do you use and what are the data sources?
5. Are your experiences with the models good or bad?
6. How does your MPOs gather input from stakeholders?

Table 4 MPOs contacted for Interview

Agency	*Response*	*No Response*
1.Twin Cities Area Metropolitan Council		X
2. Baltimore Regional Council of Governments		X
3.DVRPC+A39	X	
4.Mr. Walter Brooks Regional Planning Commission		X
5.North Central Texas Council of Governments	X	
6.Chicago Area Trans. Study	X	
7.Houston-Galveston Area Council	X	
8.San Diego Association of Governments	X	
9.Southwestern Pennsylvania Regional Planning Commission	X	
10.The Florida Metro. Plan. Organization		X
11.Central Transportation Planning Staff, Boston		X
12.Metropolitan Washington Council of Governments		X
13.Capital District Transportation Council	X	
14.Southeast Michigan Council of Governments	X	
15.Metropolitan Transportation Commission		X
16.Atlanta Regional Commission	X	
17.Puget Sound Regional Council	X	
18.West Michigan Shoreline Regional Development Commission		X
19.Grand Valley Metro Council	X	
20.Genesee County Metropolitan Planning Commission	X	
21.Battle Creek Area Transportation Study		X
22.Region 2 Planning Commission		X
23.Tri-County Regional Planning Commission		X
24.Southwestern Michigan Commission	X	
25.Saginaw County MPO		X
26.Bay County Planning Department	X	
27.Kalamazoo Area Transportation Study		X
28.Macatawa Area Coordinating Council		X
29.Toledo Metropolitan Area Council of Governments		X
30.Lee-Russell Council of Governments		X
31.Birmingham Regional Planning Commission	X	
33.North Central Alabama COG		X
34.Northwest Alabama Council of Governments		X
35.Volusia County Metropolitan Planning Org.		X
36.Ft. Lauderdale Urbanized Area MPO		X
37.Lee County Metropolitan Planning Org.		X
38.Gainesville Urbanized Area MPO		X
39.Jacksonville Urbanized Area MPO		X
40.Miami-Dade County Metropolitan Planning Org	X	
41.Panama City Urbanized Area	X	
42.Charlotte County-Punta Gorda MPO		X
43.Tallahassee-Leon County MPO		X
44.Augusta Regional Transportation Study Policy Committee		X
45.Ohio-Kentucky-Indiana Regional COG		X

Table 4 MPOs contacted for Interview (Continued)

Agency	*Response*	*No Response*
46.Evansville Urban Transportation Study		X
47.Charlotte Transportation Advisory Committee		X
48.Gastonia Transportation Advisory Committee		X
49.Greensboro Transportation Advisory Committee		X
50.Jacksonville Transportation Advisory Committee		X
51.Anderson Area Transportation Study		X
52.Berkeley-Charleston-Dorchester COG		X
53.Central Midlands Regional Planning Council		X
54.Chattanooga Hamilton County RPO		X
55.Knoxville-Knox County Metropolitan Planning Commission		X
56.Nashville Area MPO		X
57.New Jersey Transportation Planning Authority	X	
58.Maricopa Association of Governments	X	
59.Boston Metropolitan Planning Organization		X
60.Memphis-Shelby County Office of Planning and Development		X
61.Indianapolis Division of Planning		X
62.Denver Regional Council of Governments		X
63.Portland-Vancouver, Metro		X

Of the MPOs contacted 20 were interviewed representing some 36% of those contacted (See Table 5 for interviewees). The measure of reasons for a 'no-response' was not included in the scope of this project. 8 of these 20 agencies indicate they do freight planning directly with an additional 3 doing so indirectly. 7 of the agencies do all of regional, corridor and local freight modeling while 6 reported no freight planning. Only Chicago, Delaware and New Jersey TPA model freight by looking at strategic, tactical and operational issues. Macriopa on the other hand only models strategic issues. All the other agencies do not model freight explicitly as strategic, tactical or operational. None of the agencies interviewed have developed models for any of these issues although in terms of data, 8 agencies have trip-based data, with another 6 having both commodity and vehicular flow data. Only Chicago Area Transportation Study had reports and papers to share with this investigation.

A summary of responses obtained for each of the questions by the various MPOs is provided in the following section. Discussions of the responses are also provided. Additionally, exhibits of responses and additional information provided by the MPOs are appended.

Table 5 Answers to the Question: Does Your Agency Do Freight Planning?

Agency	*Does your agency do freight planning?*
1.Delaware Valley Regional Planning Commission	Yes
2.Capital District Transportation Council	No
3.East-West Coordinating Council	No
4.Genesse County Metropolitan Planning Commission	Not directly.
5.Grand Valley Metro Council	No.
6.North Central Texas Council of Governments	Yes.
7.The Atlanta Regional Commission	Yes.
8.Bay County Planning Department	No.
9.Columbus Consolidated Government	No.
10.Miami-Dade County Metropolitan Planning Organization	Not directly.
11.Puget Sound Regional Council	Yes.
12.Regional Planning Commission of Greater Birmingham	No.
13.San Diego Association of Governments	No.
14.Southwestern Michigan Commission	No.
15.Southwestern Pennsylvania Commission	Yes.
16.Southeast Michigan Council of Governments	Not directly.
17.Chicago Area Transportation Study	Yes
18.New Jersey Transportation Planning Authority	Yes
19.A42Maricopa Association of Governments	Yes
20.Houston-Galveston Area Council	No.

Table 7 Answers to the Question: What Issues Does the Freight Planning Model Deal With

Agency	***If yes, what issues does the freight planning model deal with?***
1.Delaware Valley Regional Planning Commission	Deals with all of the mentioned issues directly. Do not deal with demand management in the common sense. Rather, they interested in shifting the mode by which freight is delivered
2.Capital District Transportation Council	Took into account freight movement in transportation plan.
3.East-West Coordinating Council	N/A
4.Genesse County Metropolitan Planning Commission	Some truck modeling, primarily dealing with passenger cars.
5.Grand Valley Metro Council	Highway access issues.
6.North Central Texas Council of Governments	Capacity enhancement, operations, and policy issues. Have discussed demand management.
7.The Atlanta Regional Commission	This agency conducts freight planning, mostly on the modeling side. Primary tool is TRANPLAN
8.Bay County Planning Department	N/A
9.Columbus Consolidated Government	N/A
10.Miami-Dade County Metropolitan Planning Organization	We produced recommendations to improve the transportation system for freight.
11.Puget Sound Regional Council	Efficient transportation of goods inland Using rail and truck. Inter-modalism and truck capacity.
12.Regional Planning Commission of Greater Birmingham	N/A
13.San Diego Association of Governments	We plan on analyzing the local region for its ability to carry freight.
14.Southwestern Michigan Commission	We monitor freight, but do not deal with any planning.
15.Southwestern Pennsylvania Commission	Policy, including transportation improvements. Capacity enhancement as well, concerning the transportation network.
16.Southeast Michigan Council of Governments	We promote policy that improves freight transport.
17.Chicago Area Transportation Study	We have looked at connectors, capacity requirements for the handling of projected growth in intermodal traffic.
18.New Jersey Transportation Planning Authority	All the issues
19.Maricopa Association of Governments	All the issues
20.Houston-Galveston Area Council	N/A

Note: The highlighted MPOs do freight planning directly

Table 8 Answers to the Questions: Are the Issue s Strategic, Tactical, or Operational?

Agency	*Strategic, tactical, operational?*
1.Delaware Valley Regional Planning Commission	N/A
2.Capital District Transportation Council	N/A
3.East-West Coordinating Council	N/A
4.Genesse County Metropolitan Planning Commission	N/A
5.Grand Valley Metro Council	N/A
6.North Central Texas Council of Governments	N/A
7.The Atlanta Regional Commission	N/A
8.Bay County Planning Department	N/A
9.Columbus Consolidated Government	N/A
10.Miami-Dade County Metropolitan Planning Organization	N/A
11.Puget Sound Regional Council	N/A
12.Regional Planning Commission of Greater Birmingham	N/A
13.San Diego Association of Governments	N/A
14.Southwestern Michigan Commission	N/A
15.Southwestern Pennsylvania Commission	N/A
16.Southeast Michigan Council of Governments	N/A
17.Chicago Area Transportation Study	All
18.New Jersey Transportation Planning Authority	All
19.Maricopa Association of Governments	Strategic
20.Houston-Galveston Area Council	N/A

Table 9 Answers to the Questions: Are the Issues Regional, Corridor, or Local in Nature?

Agency	*Regional, corridor, local?*
1.Delaware Valley Regional lanning Commission	All three
2.Capital District Transportation Council	Regional basis
3.Cast-West Coordinating Council	None
4.Genesse County Metropolitan Planning Commission	N/A
5.Grand Valley Metro Council	Local and corridor issues
6.North Central Texas Council of Governments	All three
7.The Atlanta Regional Commission	Corridor and local
8.Bay County Planning Department	N/A
9.Columbus Consolidated Government	N/A
10.Miami-Dade County Metropolitan Planning Organization	Corridor and local
11.Puget Sound Regional Council	All three
12.Regional Planning Commission of Greater Birmingham	N/A
13.San Diego Association of Governments	Local
14.Southwestern Michigan Commission	N/A
15.Southwestern Pennsylvania Commission	All three
16.Southeast Michigan Council of Governments	All three
17.Chicago Area Transportation Study	All three
18.New Jersey Transportation Planning Authority	All three
19.Maricopa Association of Governments	Regional
20.Houston-Galveston Area Council	N/A

Table 10 Answers to the Question: What Kind of Models Have You Developed for Each Issue?

Agency	***What kind of models have you developed for each issue?***
1.Delaware Valley Regional Planning Commission	N/A
2.Capital District Transportation Council	N/A
3.East-West Coordinating Council	N/A
4.Genesse County Metropolitan Planning Commission	N/A
5.Grand Valley Metro Council	N/A
6.North Central Texas Council of Governments	N/A
7.The Atlanta Regional Commission	N/A
8.Bay County Planning Department	
9.Columbus Consolidated Government	N/A
10.Miami-Dade County Metropolitan Planning Organization	N/A
11.Puget Sound Regional Council	N/A
12.Regional Planning Commission of Greater Birmingham	N/A
13.San Diego Association of Governments	N/A
14.Southwestern Michigan Commission	N/A
15.Southwestern Pennsylvania Commission	N/A
16.Southeast Michigan Council of Governments	N/A
17.Chicago Area Transportation Study	N/A
18.New Jersey Transportation Planning Authority	N/A
19.Maricopa Association of Governments	N/A
20.A10Houston-Galveston Area Council	N/A

Table 10 Answers to the Question: What Types of Data Do You Use and What Are the Data Sources?

Agency	*What types of data do you use and what are the data sources?*
1.Delaware Valley Regional Planning Commission	Commodity Flow Survey, Truck Inventory User Survey, Traffic Counts
2.Capital District Transportation Council	Vehicle Information, such as vehicle Characteristics and also roadway Characteristics
3.East-West Coordinating Council	N/A
4.Genesse County Metropolitan Planning Commission	We would like to have both commodity and OD data.
5.Grand Valley Metro Council	We will be interested in gathering Commodity and trip data.
6.North Central Texas Council of Governments	We have both commodity and trip data.
7.The Atlanta Regional Commission	Truck trip tables from a survey that was, Conducted in the mid 90's
8.Bay County Planning Department	N/A
9.Columbus Consolidated Government	We have OD data.
10.Miami-Dade County Metropolitan Planning Organization	We are concerned with trip data, whereas the state is concerned with commodity data.
11.Puget Sound Regional Council	We have both commodity and trip data.
12.Regional Planning Commission of Greater Birmingham	N/A
13.San Diego Association of Governments	We are collecting base year data & trip generation data. Data collection includes vehicle classification and counts.
14.Southwestern Michigan Commission	N/A
15.Southwestern Pennsylvania Commission	N/A
16.Southeast Michigan Council of Governments	Collect freight information through freight surveys.
17.Chicago Area Transportation Study	We only use project, or study-specific data. We also get large amounts of general purpose data from the WSJ, the trade publications and the company annual reports
18.New Jersey Transportation Planning Authority	Truck data from multiple sources
19.Maricopa Association of Governments	Truck movement data
20.Houston-Galveston Area Council	N/A

Table 11 Answers to the Question: Do you Have Any Reports/Paper You Can Send Us?

Agency	*Do you have any reports / papers you can send us?*
1. Delaware Valley Regional Planning Commission	No
2. Capital District Transportation Council	No
3. East-West Coordinating Council	No
4. Genesse County Metropolitan Planning Commission	No
5. Grand Valley Metro Council	No
6. North Central Texas Council of Governments	No
7. The Atlanta Regional Commission	No
8. Bay County Planning Department	No
9. Columbus Consolidated Government	No
10.Miami-Dade County Metropolitan Planning Organization	No
11.Puget Sound Regional Council	No
12.Regional Planning Commission of Greater Birmingham	No
13.San Diego Association of Governments	No
14.Southwestern Michigan Commission	No
15.Southwestern Pennsylvania Commission	No
16.Southeast Michigan Council of Governments	No
17.Chicago Area Transportation Study	Yes
18.New Jersey Transportation Planning Authority	No
19.Maricopa Association of Governments	No
20.Houston-Galveston Area Council	No

List of References

1. Abdelwahab, W.M. and M.A. Sargious (1991) "A Simultaneous Decision-Making Approach to Model the Demand for Freight Transportation" Canadian Journal of Civil Engineering, Vol (18) 3, pp. 515-520.
2. Abdelwahab, W.M. (1998) "Elasticities of Mode Choice Probabilities and Market Elasticities of Demand: Evidence from a Simultaneous Mode Choice/Shipment Size Freight Transport Models" Transportation Research. Part E: Logistics & Transp Review Vol. 34(4) pp 257-266
3. Cambridge Systematics, Inc. (June 19, 1995), Characteristics and Changes in Freight Transportation Demand: A Guidebook for Planners and Policy Analysts, Prepared for NCHRP Project 8-30,
4. Cambridge Systematics, Inc. (September 1996), Quick Response Freight Manual, Final Report, prepared for the Federal Highway Administration,.
5. Cutler M., L. Grenseback, R.E. Paquette, D. Beagan, K. Proussaloglou, N. Jonnalagadda, M. Williamson, J. Schrieber (January 9-13, 2000), The Assessment of Market Demand for Cross-Harbor Rail Freight Service in the New York Metropolitan Region, 79th TRB Annual Meeting, Washington D.C.
6. Fischer M., J. Ang-Olson, and A. La, (January 9-13, 2000), A Model of External Urban Truck Trips Based on Commodity Flows, 79th TRB Annual Meeting, Washington D.C..
7. Friesz T.L., J.A. Gotteried, and Morlok, (May 1986), A Sequential Shipper-Carrier Network Model for Predicting Freight Flow, Transportation Science, Vol. 20, No. 2
8. Friesz T.L., Tobin, and Patrick T. Harker, (1983), Predictive Intercity Freight Network Models: The State of the Art; Transportation Research, Vol. 17A, No. 6, pp. 409-417
9. Hautzinger, H. (1984) "The Prediction of Interregional Goods Vehicle Flows: Some New Modeling Concepts," Ninth International Symposium on Transportation and Traffic Theory, VNU Science Press, pp. 375-396
10. Holguín-Veras, J. and S. Jara-Díaz. (January 1999), Optimal Space Allocation and Pricing for Priority Service at Container Ports. Transport Research Part B 33(2), pp. 81-106
11. Holguin-Veras J. and E. Thorson (a), (January 9-13, 2000), An Investigation of the Relationships Between the Trip Length Distributions in Commodity-based and Trip-based Freight Demand Modeling, Presented at the 79th Annual Meeting of Transportation Research Board, Washington, D.C.
12. Holguin-Veras J. and E. Thorson (b), (2000), "Modeling Commercial Vehicle Empty Trips with a First Order Trip Chain Model", Technical Report published by the University Transportation Research Center Region II.

13. Holguín-Veras, J., (May 2000), Revealed Preference Analysis of the Inter-vehicle Competition in the Trucking Industry, (being reviewed by the Journal of Transportation Engineering, American Society of Civil Engineers

14. Holguín-Veras, J. (October 2000), A Framework for an Integrative Freight Market Simulation. Invited Paper. Forthcoming at the IEEE 3rd Annual Intelligent Transportation Systems Conference ITSC-2000, Dearborn Michigan.

15. Huang W.-J. and R.L. Smith, Jr., (January 10-14, 1999), Development of a Truck Travel Demand Model for Wisconsin Using Commodity Flow Survey Data, 78th Annual Meeting of Transportation Research Board, , Washington D.C.

16. Jack Faucett Associates (a), (February 22-23, 1999), Issue Paper, Freight Transportation Modeling Workshop,.

17. Jack Faucett Associates (b), (May 20, 1999), Research and Development of Destination, Mode, and Routing Choice Models for Freight, Final Report, Prepared for DOT SBIR Office, DTS-22

18. KJS Associates and Parsons Brinckerhoff (a), (February 1996), Statewide Travel Demand Model Update and Calibration Phase, Truck Trip Model, Chapter 10.

19. KJS Associates and Parsons Brinckerhoff (b), (February 1996), Statewide Travel Demand Model Update and Calibration Phase II, Commodity Flow Data, Chapter 3

20. Kanafani, A. (1983) "Transportation Demand Analysis," Chapter 10: Commodity Transportation Demand, pp. 279-316, McGraw Hill, New York.

21. Krishnan V. and K. Hancock, (January 11-15, 1998), Highway Freight Flow Assignment in Massachusetts Using Geographic Information Systems, 77th Annual Meeting of Transportation Research Board, Washington, D.C.

22. List, George F. and Mark A. Turnquist, (1995), "Estimating Truck Travel Patterns in Urban Areas," Transportation Research Record 1430.

23. List G.F. and M.A. Turnquist; A GIS-Based Approach for Estimating Truck Flow Patterns in Urban Setting, Journal of Advanced Transportation, Vol. 29, No. 3, pp. 281-298.

24. Marker J.T. Jr. and K.G. Goulias, (January 11-15, 1998), Truck Traffic Prediction Using the Quick Response Freight Model Under Different Degrees of Geographic Resolution: A GIS Application in Pennsylvania, 77th Annual Meeting of Transportation Research Board, Washington D.C.

25. McFadden, D., C. Winston and A. Boersch-Supan, (1986), "Joint Estimation of Freight Transportation Decisions Under Non-random Sampling," Analytical Studies in Transport Economics, edited by A. Daugherty (Cambridge University Press).

26. Morris A.G., A.L. Kornhauser, and M.J. Kay, (January 10-14, 1998), Getting the Goods Delivered in Dense Urban Areas, A Snapshot of the Last Link of the Supply Chain, 78th Annual Meeting of the Transportation Research Board, Washingtom D.C.

27. Noortman, H.J. and J. van Es (1978), "Traffic Model. Manuscript for the Dutch Freight Transporte Model"

28. Pendyala R.M., V.N. Shankar, and R.G. McCullough, (January 9-13, 2000), Freight Travel Demand Modeling: A Synthesis of Approaches and Development of a Framework, 79th Annual Meeting of the Transportation Research Board, Washington, D.C.

29. Souleyrette R., T.H. Maze, T. Strauss, D. Preissig, and A.G. Smadi, (January 11-15, 1998), A Freight Planning Typology, 77th Annual Meeting of the Transportation Research Board, Washingtom D.C.

30. Souleyrette R.R., Z.N. Hans, and S. Pathak, (November 1996), Statewide Transportation Planning Model and Methodology Development Program, Final Report to Iowa Department of Transportation and Midwest Transportation Center.

31. Watson P.L., (1975), Urban Goods Movement, A Disaggregate Approach, D.C. Health and Company

32. Wilbur Smith Associates, (April 1997), Kentucky Statewide Traffic Model Final Calibration Report, prepared for Kentucky Transportation Center and Kentucky Transportation Cabinet

33. Williamson M., J.A. Schrieber, and M.R. Cutler, (January 9-13, 2000), Use of Commodity Flow Data in Freight Transportation Planning, 79th TRB Annual Meeting, Washington D.C.

AN ASSESSMENT OF METHODOLOGICAL ALTERNATIVES FOR A REGIONAL FREIGHT MODEL IN THE NYMTC REGION

Appendix II: Compendium of Freight Data Sources

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Prepared for

NEW YORK METROPOLITAN TRANSPORTATION COUNCIL (NYMTC)

New York
May 30, 2001

APPENDIX II: COMPENDIUM OF FREIGHT DATA SOURCES

In the effort to develop a freight model for the NY metropolitan area, an evaluation of relevant available data sources was undertaken. This appendix identifies and categorizes the main data sources. In order to increase the usefulness of the information included in this appendix, a standard format has been adopted from the Directory of Transportation Data Sources (USDOT/BTS 1996). The key features of this appendix are:

- It provides the *geographical* coverage for the data sources. They are divided into categories of national, regional, state, local, metropolitan, county, facility-airport, marine port, etc.
- It defines the corresponding transportation modes. The different mode categories included are: multi-modal, highway, air, pipeline, rail and waterway.
- To the extent possible, it identifies the list of *attributes* in each data set. However, one has to note that there are also changes in data definitions and consistency.
- Many of the sources listed here are classified according to their potential *use*. The categories used are: model building, statistical analysis, establish sample base for survey, growth factors, VMT related, forecasts and network related.
- It identifies the *collecting agency*, the *contact person* and the *means* of contact.
- The Freight Transportation Data Sources provide a *usefulness*-ranking category. The classification used is: very useful, useful, marginal and specialized.
- It provides additional information about the data sources (e.g., *source of the information* and *abstract*).
- In addition, most sources include detailed information about *content*, *methodology*, *significant features and/or limitations*, *distribution media*, *availability* and price and *web site.*

Freight Transportation Data Sources

Table of Contents

1982 Benchmark Input-Output Accounts of the United States Publication

MODE: Demographics, Flows, etc., Multi-mode	**GEOGRAPHY**: National	**USEFULNESS**: Marginal	USE WITH MANUAL: Growth factor
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: 1982 Benchmark Input-Output Accounts of the United States Publication			
Abstract: This publication shows the distribution of transportation service output (including rail, truck, water, air, pipeline, and other transportation services) to using industries and final purchasers. Among the using industries are transportation industries defined by mode. The commodities used as inputs by these transportation industries are also identified. These accounts also provide detailed information on the consumption of specified commodities. The input-output workfile that is available for benchmark years includes information for over 8,000 commodities.			
Source of Data: Department of Commerce/Bureau of Economic Analysis.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1982	
First Developed: 1958		**Update Frequency**: Every 5 Years	
Media: Tape, Disk, Hardcopy		**Sponsoring Organization**: Department of Commerce, Bureau of Economic Analysis, Interindustry Economic Division	
Availability: Tape, Disk: DOC/Bureau of Economic Analysis, Interindustry Economics Division, BE-51, Washington, DC 20230; telephone, (202)606-5585. Price varies by table requested., Printed Source: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)783-3238. Price, $19.			
Contact for Additional Information: Ann Lawson Chief, DOC/Bureau of Economic Analysis, Interindustry Economics Division (202) 606-5584			

1987 Census of Transportation Geographic Area Series (TC87-A-1) Publication

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state, metropolitan	**USEFULNESS**: Marginal	USE WITH MANUAL: Establish sampling base for survey
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: 1987 Census of Transportation Geographic Area Series (TC87-A-1) Publication			
Abstract: Presents data for establishments with payroll from selected transportation for the United States, each state, District of Columbia, and selected metropolitan statistical areas (MSA's). Presents general statistics on number of establishments, revenue, payroll, and employment by varied transportation classifications. Data are also provided on revenue and employees per establishment, and on revenue and payroll per employee. Comparative statistics showing percent changes in revenue and payroll between 1982 and 1987 are also shown for some kind-of-business classifications.			
Source of Data: 1987 Economic Census; 1987 Census of Transportation (transportation companies).			
Attributes:			
Geographic Coverage of Data: National, Stratified by State, Selected Metropolitan Statistical Areas	**Time span of Data Source**: January 1, 1987 - December 31, 1987		
First Developed: 1991	**Update Frequency**: Every Five Years		
Media: Tape, Hardcopy	**Significant Features and/or Limitations**: Covers selected transportation industries as defined in Division E of the Standard Industrial Classification (SIC) Manual. Includes all establishments with one or more paid employees primarily engaged in these classifications: SIC 42, motor freight, transportation and warehousing; SIC 44, water transportation; and SIC 47, transportation services. Excludes firms without paid employees, governmental establishments, and auxiliary establishments.		
Sponsoring Organization: Department of Commerce, Bureau of the Census, Business Division	**Availability**: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)783-3238		
Contact for Additional Information: Dennis Shoemaker Chief DOC/Bureau of the Census, Utilities Census Branch (301)763-2662			

1992 Census of Transportation, Communications and Utilities Geographic Area Series Summary (UC92-A-1)

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state, metropolitan	**USEFULNESS**: Useful	USE WITH MANUAL: Base year statistics
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: 1992 Census of Transportation, Communications and Utilities Geographic Area Series Summary (UC92-A-1); other series also available: Series Establishment and Firm Size (Including Legal Form of Organization) (UC92-S-1) and Miscellaneous Subjects (UC92-S-2) Publication			
Abstract: Presents data for establishments with payroll in transportation, communications, and utilities industries as defined in Division E of the 1987 Standard Industrial Classification (SIC) Manual, except for SIC Major Group 43, U.S. Postal Service. Presents general statistics on number of establishments, revenue, payroll, and employment. Data are also provided on revenue and employees per establishment, and on revenue and payroll per employee. Comparative statistics showing percent changes in revenue and payroll between 1987 and 1992 area also shown for some kind-of-business classifications.			
Source of Data: 1992 Economic Census; 1992 Census of Transportation, Communications, and Utilities {transportation companies).			
Attributes:			
Geographic Coverage of Data: National, Stratified by State, Consolidated Metropolitan Statistical Areas, Primary Metropolitan Statistical Areas, Selected Metropolitan Statistical Areas		**Time span of Data Source**: January 1, 1992-December 31, 1992	
First Developed: In Progress		**Update Frequency**: Every Five Years	
Last update: 1989		**Media**: CD-ROM, Hardcopy	
Significant Features and/or Limitations: Includes all establishments with one or more paid employees engaged in these classifications: SIC 41, local and suburban transit and interurban highway passenger transportation; SIC 42, motor freight transportation and warehousing; SIC 44, water, transportation; SIC 45, transportation by air; SIC 46, pipeline, except natural gas; SIC 47, transportation services; SIC 48, communications; SIC 49, electric, gas, and sanitary services. Also includes SIC 40, railroad transportation reported to the, Association of American Railroads; they were not in the 1992 Census of Transportation, Communications, and Utilities universe. Likewise, data reported to DOT's RSPA/Office of Airline Statistics were included in the tabulations for SIC 45, but were excluded from the universe. Excludes firms without paid employees and governmental organizations. Excludes auxiliaries for all industries except firms in SIC's 46 (pipeline, except natural gas); 481 and 482 (telephone, telegraph and other message			
Sponsoring Organization: Department of Commerce, Bureau of the Census, Business Division		**Availability**: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202) 512-1800. Publication not available until February 1995.	
Contact for Additional Information: Dennis Shoemaker Chief DOC/Bureau of the Census, Utilities Census Branch (301) 457-2786 Fax (301) 457-4576			

Annual Motor Carrier Reports

MODE: Demographics, Flows, etc., highway	**GEOGRAPHY**: National, state	**USEFULNESS**: Useful	USE WITH MANUA L: Establish sampling base for survey
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Annual Motor Carrier Reports			
CONTENT: Employment and leased-employee information for Class I and Class II for hire motor carriers (this group represents a small percent of total for-hire carriers).			
METHODOLOGY: For-hire motor carriers file for interstate operating authority with the ICC. Class I and Class II carriers (annual revenues greater than $3 million) also submit a Motor Carrier Annual Report (Form M). An employment census (including the number of leased owner-operators) is included in Form M.			

Annual Registration Filings

MODE: Highway	**GEOGRAPHY**: National, state	**USEFULNESS**: Useful	USE WITH MANUAL: Establish sampling base for survey
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Annual Registration Filings			
CONTENT: Varies significantly from state to state. The data include: Size of motor carrier Measured by equipment used, employees, and/or estimate revenue.			
Type of operation: Service, for-hire, private, construction, agriculture, off-highway.			
Commodity hauled: Broad classifications usually, no greater detail than 2-digit SIC level.			
Area of operation: Range of operation carrier.			

Annual Survey of Manufactures Publication

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state	**USEFULNESS**: Marginal	USE WITH MANUAL: Base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Annual Survey of Manufactures Publication

Abstract: This survey of manufactures was initiated in 1949 and has been conducted since that time for years not covered by the Census of Manufactures. The survey provides up-to-date statistics on the key measures of manufacturing activity for industry groups and individual industries, and for states by 3-digit industry groups. Approximately 55,000 plants from a total of 350,000 were surveyed. Included in the sample are all large manufacturing plants, that account for more than two-thirds of total employment of all manufacturing establishments in the U.S., and a sample of the more numerous medium- and small-sized establishments. This program is designed to provide estimates of general statistics (employment, payroll, hours worked, value added by manufacture, cost of materials, expenditure for new plant and equipment, value of manufacturers inventory, etc.) for industry groups and industries; general statistics for values of shipments for classes of products; fuels and electric energy data by industry groups, and labor cost.

Source of Data: Questionnaire is completed by manufacturing establishments with one or more paid employees.

Attributes:

Geographic Coverage of Data: National, Stratified by State	**Time span of Data Source**: 1949-1991
First Developed: 1949	**Last update**: 1991
Update Frequency: Annual	**Media**: CD-ROM, Printed Source
Sponsoring Organization: Department of Commerce, Bureau of the Census, Industry Division	**Availability**: Publications: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)512-1800. CD-ROM: DOC/Bureau of the Census, Customer Services, Washington, DC 20233; telephone, (301)457-4100.
Contact for Additional Information: William Visnanski, Data Manager DOC/Bureau of the Census, Industry Division (301) 457-4141 Fax (301) 457-2298	**Contact for Additional Information**: Judy Dodds, Data Manager - Food, Textiles, & Apparel DOC/Bureau of the Census, Manufacturing and Construction Division (301) 457-4651 Fax (301) 458-4503

BEA Regional Projections to 2040; County Projections also available Publication

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state, metropolitan, other	**USEFULNESS**: Very useful	USE WITH MANUAL: Growth factor, base year statistics, forecast statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: BEA Regional Projections to 2040; County Projections also available Publication

Abstract: This document illustrates estimates for 1973, 1979, 1983, 1988, and projections for 1195, 2000, 2005, 2010, 2020, and 2040 for total persons income, population, per capita personal income, and employment and earnings by industry for the U.S., BEA regions, states, metropolitan statistical areas, and BEA economic area. Volume 1 contains data on states, Volume 2 contains data on MSAs, and Volume 3 contains data on BEA Economic Areas.

Source of Data: Department of Commerce/Bureau of Economic Analysis.

Attributes:

Geographic Coverage of Data: U.S., States, MSAs, BEA Economic Areas	**Time span of Data Source**: 1973-2040
First Developed: 1964	**Update Frequency**: Every 5 Years

Sponsoring Organization: Department of Commerce, Bureau of Economic Analysis, Regional Economic Analysis Division

Availability:
Volume 1 - National Technical Information Service, Springfield, VA 22161; telephone, (301)487-4650. Price, $27; order number PB90-264532.
Volumes 2 and 3 - Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20590; telephone,, (202)783-3238. Price, $17/Volume 2 order number 003-010-00211-5; $10/Volume 3, order number 003-010-00212-3.
Disks: DOC/Bureau of Economic Analysis, Regional Economics Analysis Division, Washington, DC 20230; telephone, (202) 523-0959. Prices vary.
County Level: DOC/Bureau of Economic Analysis, Regional Economic Analysis Division, BE-61, Washington, DC 20230; telephone, (202) 523-0959. Price, $260 (13 disks). Data also available for user-selected states at $20/disk.

Contact for Additional Information: Duane Hackman Data Manager DOC/Bureau of Economic Analysis (202)606-9218	**Contact for Additional Information**: George Downey Chief DOC/Bureau of Economic Analysis, Projects Branch (202)606-5341

Commercial Drivers Licenses

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state	**USEFULNESS**: Useful	USE WITH MANUAL: Growth factor
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Commercial Drivers Licenses			
CONTENT: Number of Commercial Drivers Licenses issued. These data are updated continuously.			
METHODOLOGY: A Commercial Drivers License (CDL) is required for all commercial drivers whose vehicle falls into one of the following categories: • gross weight of more than 26,000 pounds, including a towed unit over 10,000 pounds; • designed to haul more than 15 passengers, including the driver; • requires placards under the Hazardous Materials Regulations.			

Commodity Flow Survey: 1993

MODE: Demographics, Flows, etc., Multi-mode	**GEOGRAPHY**: National, state	**USEFULNESS**: Useful	USE WITH MANUAL: Growth factor, base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Commodity Flow Survey: 1993

Abstract: The Commodity Flow Survey (CFS) is designed to provide data on the flow of goods and materials by mode of transport. The CFS is a continuation of statistics collected in the Commodity Transportation Survey from 1963 through 1977, and includes major improvements in methodology, sample size and scope. A sample of 200,000 domestic establishments randomly selected from a universe of about 900,000 establishments engaged in mining, manufacturing, wholesale, auxiliary establishments (warehouses) of multi-establishment companies, and some selected activities in retail and service was used. Each selected establishment will report a sample of approximately 30 outboard shipments for a two week period in each of the four calendar quarters of 1993. This will produce a total sample of about 20 million shipments. For each sampled shipment, zip code of origin and destination, 5-digit Standard Transportation Commodity Classification (STCC) code, weight, value, and modes of transport, will be provided. Check box information on whether the shipment was containerized, a hazardous material, or an export will also be obtained.

Source of Data: A sample of manufacturing wholesale establishments will complete questionnaire.

Attributes:

Geographic Coverage of Data: National, Stratified by State	**Time span of Data Source**: 1993
First Developed: 1993	**Update Frequency**: Every Five Years
Number of Records : ~20 Million (Estimated)	**File Size**: TBD
File Format: TBD	**Media**: 9-track Tape, CD-ROM, Hardcopy

Significant Features and/or Limitations: The 1993 CFS will differ from previous surveys in greatly expanded coverage of intermodalism. Earlier surveys reported only the principal mode. The 1993 survey will report all modes used for the shipment (for-hire truck, private truck, rail, inland water, deep sea water, pipeline, air, parcel delivery or U.S. Postal Service, other mode, unknown). Route distance for each mode for each shipment will be imputed from a Mode-Distance Table developed by Oak Ridge National Laboratory. Distance, in turn, will be, used to compute ton-mileage by mode of transport.

Corresponding Printed Source: Commodity Flow Survey, 1993	**Sponsoring Organization**: Department of Transportation, Bureau of Transportation Statistics, Department of Commerce, Bureau of the Census
Performing Organization: Department of Commerce, Bureau of the Census, Oak Ridge National Laboratory	**Availability**: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202) 783-3238. Data not available until late 1995.

Contact for Additional Information:
John Fowler
DOC/ Bureau of the Census, Business Division
(301)763-6087

County Business Patterns

MODE: Demographics, flows, etc.	**GEOGRAPHY**: National, state, county	**USEFULNESS**: Very useful	USE WITH MANUAL: Growth factor, base year statistics
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: County Business Patterns			
CONTENT: The County Business Patterns (CBP) is an annual series of state and national publications presenting county-level data on number of establishments, total employment, and payroll on an establishment basis, with economic activity classification reflecting the principal activity at each individual locations. The data are derived from a universe of employees covered by Federal Insurance Contributions Act (FICA). Data in the CBP represent the following types of employment covered by FICA: • all covered wage and salary employment of private nonfarm employers and of nonprofit organizations; • all employment of religious organizations covered under the elective provisions of FICA. Data for employees of establishments totally exempt from FICA are excluded. These include the following types of employment: self-employed, government, domestic service, agricultural, foreign, and railroad employment jointly covered by Social Security and railroad retirement programs. For activities such as construction, transportation, electric and gas, establishments are represented by those relatively permanent main or branch offices, terminals, stations, etc. Hence, the individual sites or systems of such dispersed activities (e.g., worksites) are not ordinarily considered to be establishments. Note: Data for industries with less than 100 employees in a given county are not shown in the printed reports, but are included on the CD-ROM and computer tape.			
County Business Patterns Addendum:			
Source of Data: Department of Commerce/Bureau of Economic Analysis		**Attributes**: **Geographic Coverage of Data**: US, states and counties, to zip code level by special request	
Update Frequency: annual		**Sponsoring Organization**: Department of Commerce, Bureau of Economic Analysis	
Availability: Printed reports, tape, diskette, microfiche, CD-ROM		**Entire US**: Superintendent of Documents, PO Box 371954, Pittsburgh, PA 15250-7954, ph. 202-512-1800, fax (202) 512-2250. Price $245, stock number 803-049-00000-9.	
Individual States: (county level) Prices vary from $2.50 to $15.00. Contact above for order information.		**Internet**: To county level by 4-digit SIC code - total employment, not by employment by size. Sample//http://www.census.gov/>	
Special request: Total establishments and establishments by employment size class by 4-digit SIC code by zip code. Minimum charge $300; total US $1000			
Contact for additional information: Carol Comisarow, Statistician DOC - Economics Planning and Coordination Division Phone: 301-457-2580		Also contact: Customer Services Branch Data Users Services Division Bureau of the Census Washington, DC 20233 Phone: 301-457-4100 <http://www.census.gov/>	

Current Employment Statistics Publication

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, metropolitan	**USEFULNESS**: Useful, specialized	USE WITH MANUAL: Base year statistics
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Current Employment Statistics Publication			
Abstract This publication provides monthly employment data collected from payroll records of business establishments. Statistics on employment, hours, and earnings are published for industry groups in the transportation sector, with these data classified using the Standard Industrial Classification (SIC). Publication detail includes all 2-digit SIC detail (railroad transportation, local and interurban passenger transit, trucking and warehousing, water transportation, transportation by air, pipelines, transportation services) and selected 3- and 4-digit detail.			
Source of Data: Monthly payroll records from a sample of business establishments. Employment data for Class I Railroads are provided by the ICC. Data collected via mail, computer automated telephone interviewing, and touchtone data entry.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Current Year	
Update Frequency: Monthly		**Sponsoring Organization**: Department of Labor, Bureau of Labor Statistics	
Availability: DOL/Inquiries and Correspondence Branch, Office of Publications, Bureau of Labor Statistics, Washington, DC 20212; telephone, (202)606-5902			
Contact for Additional Information: Lois Plunkert Data Manager BLS/Division of Monthly Industry Employment Statistics (202) 606-6527			

Current Population Survey

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National	**USEFULNESS**: Useful	USE WITH MANUAL: Base year statistics, forecast statistics
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Current Population Survey			
CONTENT: The Bureau of Census conducts the survey each month for the Bureau of Labor Statistics and provides comprehensive data on the employed and unemployed, including such characteristics as age, sex, occupation, hours worked and industry.			
METHODOLOGY: Data based on household interviews are obtained from the Current Population Survey (CPS), a sample survey of the population 16 years of age and over. CPS employment data are estimated from a sample survey of about 60,000 households and 115,000 persons selected to represent the entire civilian noninstitutional population. The CPS estimates are designed to measure overall employment, unemployment, and those not in the labor force. The survey data are weighted to derive national estimates.			

Employment and Earnings

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state	**USEFULNESS**: Marginal	USE WITH MANUAL: Base year statistics
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Employment and Earnings			
CONTENT: The Employment and Earnings database contains information on industry employment, by state, and nationwide occupational employment. This data is published monthly.			
METHODOLOGY: According to the BLS, Employment and Earnings (E&E) statistics are compiled from two places: household interviews and employer results. Data based on household interviews are obtained from the Current Population Survey (CPS), a sample survey of the population 16 years of age and over. The Bureau of Census conducts the survey each month for the BLS and provides comprehensive data on the employed and unemployed, including such characteristics as occupation, hours and industry. Data based on establishment records are compiled each month from questionnaires sent by the Bureau of Labor Statistics, in cooperation with state employment agencies. The Current Employment Statistics (CES) survey provides industry information on non-farm wage and salary employment, hours, and average weekly earnings. State agencies mail the questionnaires, then collect and compile data and make employment estimates at the state level. National employment estimates are then made by the BLS. The Employment and Earnings publication is prepared in the Office of Employment and Unemployment Statistics in collaboration with the Office of Publications and Special Studies.			
AVAILABILITY: Data are available in printed publications and on computer files.			

Employment and Wages

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state	**USEFULNESS**: Marginal	USE WITH MANUAL: Base year statistics
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Employment and Wages			
CONTENT: The Employment and Wages database contains information on employment, wages and establishments, by industry, by state. The data represent the count of employment and wages for workers covered by State unemployment insurance programs (UI) and Federal civilian workers covered by the Unemployment Compensation for Federal Employees (UCFE) program. The BLS aggregates the data to national levels, by State and by industry -- private sector data are shown at the 4-digit SIC level. Employment and Wages data are available quarterly.			
AVAILABILITY: The Office of Employment and Unemployment Statistics at the BLS in Washington, D.C. maintains the database of employment and wages data. The BLS data can be copied onto diskettes using compression software. The BLS may have their employment and wages data available on CD-ROM and also on the **Internet** -- where databases can be downloaded via modem.			

Highway Performance Monitoring System (HPMS) Database

MODE: Highway	**GEOGRAPHY**: National, state, metropolitan, facility- airport, marine port, etc.	**USEFULNESS**: Very useful	USE WITH MANUAL: Network related

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Highway Performance Monitoring System (HPMS) Database

Abstract: This system includes universe data consisting of a small amount of information for all public road mileage in each state. Additional information on physical characteristics, condition, use, and performance for sample roadway sections within the state are included in the sample data. Sample data are statistically valid for each arterial and collect or functional system for rural, small urban, and urbanized areas. Areawide data, consisting of accident data, system length and travel by functional system, and travel activity by vehicle type are also reported in summary form. Accident data contains summary statistics on fatal and non-fatal injury accidents.

Source of Data: State inventory, sampling, and surveys are conducted by State Highway Agencies.

Attributes:

Geographic Coverage of Data: National, Puerto Rico, Limited Data from U.S. Territories	**Time span of Data Source**: 1978, 1980-1992
First Developed: 1978	**Update Frequency**: Annual
Last update: 1992	**Number of Records**: ~3.3 Million Universe/Year including 116,000 Sample Section Records/Year
File Size: ~568MB	**File Format**: ASCII, EBCDIC, LOTUS (areawide)
Media: 9-track Tape, Disk, Hardcopy	Significant Features and/or Limitations: Sample data only for collector through interstate functional systems.
Corresponding Printed Source: Highway Statistics (not inclusive of all data)	**Sponsoring Organization**: Department of Transportation, Federal Highway Administration, Office of Highway Information Management

Availability: DOT/FHWA, Office of Highway Information Management, HPM-20, 400 7th Street, SW, Washington, DC 20590; telephone (202) 366-0175. Price $30-$150 and up for non-government agencies; price varies depending upon amount and coverage desired.

Contact for Additional Information:
Don Kestyn, Transportation Specialist
DOT/FHWA, HPM-20
(202)366-0175

Monthly Traffic Volume Trends

MODE: Highway	**GEOGRAPHY**: National, state	**USEFULNESS**: Useful	USE WITH MANUAL: VMT related
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Monthly Traffic Volume Trends			
Abstract: This data base contains information on vehicle miles of travel (VMT) generated by the Highway Performance Monitoring System. VMT is expanded from the previous year to give a current year estimate based on the change in traffic volumes at approximately 4,500 locations across the nation. The VMT estimates are generated by functional highway system within each state and the aggregate for national totals. A computer data base for the VMT has been created on the DOT central computers beginning with 1970. A new, expanded data base is generated on the current micro computer system beginning with 1991 VM2 (Traffic Volume Trends Report) data.			
Source of Data: State Highway Agencies provide FHWA with traffic counts from automatic traffic data recorders buried in roadway surfaces.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1970-present	
First Developed: 1935		**Update Frequency**: Monthly	
Number of Records : Varies		**File Size**: Varies	
File Format: dBASE		**Media**: Disk, Hardcopy	
Significant Features and/or Limitations: Sample limited by statistic sampling and finances available. A computer data base for the VMT has been created on the DOT central computers beginning with 1970. A new, expanded data base is generated on the current micro computer system beginning with 1991 VM2 data.		**Corresponding Printed Source**: Traffic Volume Trends	
Sponsoring Organization: Department of Transportation, Federal Highway Administration, Office of Highway Information Management		**Availability**: DOT/FHWA, Office of Highway Information Management, HPM-30, 400 7th Street, SW, Washington, DC 20590; telephone (202)366-5055. Price, monthly report is free; annual cost for monthly data base is $240.	
Contact for Additional Information: Kenneth H. Welty, Highway Engineer DOT/FHWA, HPM-30 (202)366-5055			

Motor Carrier Census

MODE: Highway	**GEOGRAPHY**: Other	**USEFULNESS**: Useful	USE WITH MANUAL: Establish sampling base for survey
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Motor Carrier Census			
Abstract: This system includes the name and address, type and size of operation, commodities transported and other characteristics of the operation of approximately 300,000 motor carriers (truck and bus) and shippers subject to the Federal Motor Carrier Safety Regulations or Federal Hazardous Materials Regulations.			
Source of Data: Interstate motor carriers are required to submit an identification form, Form MCS-150, to FHWA which results in the carrier being registered in the data base system and being issued a USDOT number.			
Attributes:			
Geographic Coverage of Data: U.S., Canadian, and Mexican Carriers Operating in U.S.		**Time span of Data Source**: Current	
First Developed: 1979		**Update Frequency**: Continual	
Number of Records : ~300,000		**File Size**: Varies	
File Format: EBCDIC		**Media**: 9-track Tape, 6250 bpi/1600 bpi	
Significant Features and/or Limitations: On-line data base that is directly accessible by all Office of Motor Carrier Headquarters and field personnel. Changes to the data can be made at any time, generally after contact with the motor carrier, i.e., a safety or compliance review, roadside, inspection, etc.		**Sponsoring Organization**: Department of Transportation, Federal Highway Administration, Office of Motor Carriers	
Availability: The Scientex Corporation, OMC Data Dissemination Program, P.O. Box 13028, Arlington, VA 22219. Price, $275/6250 bpi tape; $375/1600 bpi tape.			
Contact for Additional Information: Linda Giles Data Manager DOT/FHWA, HIA-10 (202)366-2971			

Motor Freight Transportation and Warehousing Survey

MODE: Highway	**GEOGRAPHY**: National	**USEFULNESS**: Marginal	USE WITH MANUAL: Establish sampling base for survey
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Motor Freight Transportation and Warehousing Survey			
Abstract This data base reflects information obtained from firms furnishing local and long-distance trucking, and courier services, except by air; public warehousing and storage including farm product warehousing, refrigerated, general, and special warehousing and storage. Excluded are private motor carriers and independent owner-operators. The data items consist of total operating revenue, and total operating expenses that include annual payroll and employee benefits. Information collected from trucking firms also includes commodities carried, end-of-year inventory of revenue generating equipment, and type of carrier.			
Source of Data: Data are collected from employer businesses on a national level.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1984-1991	
First Developed: 1984		**Update Frequency**: Annual	
Last update: 05/93		**Number of Records**: 2,345	
File Size: Not Available		**File Format**: Not Available	
Media: CENDATA, Hardcopy		Corresponding Printed Source: Motor Freight Transportation and Warehousing Survey	
Sponsoring Organization: Department of Commerce, Bureau of the Census, Business Division		**Availability**: DOC/Bureau of the Census, Business Division, Washington, DC 20233; telephone, (301) 763-3990. Price, $2.50.	
Contact for Additional Information: Christine Tucker Project Manager DOC/Bureau of the Census, Business Division (301)763-3990			

National Commodity Flow Netwo rk

MODE: Demographics, Flows, etc., Multi-mode	**GEOGRAPHY**: National, state, metropolitan, facility-airport, marine port, etc.	**USEFULNESS**: Useful	USE WITH MANUAL: Network related
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: National Commodity Flow Network			
Abstract: This data base includes information on highway, railroad, waterway, aviation, and pipeline networks with intermodal connections for use in calculating distances for the Commodity Flow Survey. Emphasis has been placed on topological accuracy rather than planimetric accuracy for use in network analysis such as minimum path calculations.			
Source of Data: Public domain maps, digital line graphs from the U.S. Geological Survey.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1993	
First Developed: 1993		**Update Frequency**: Annual	
Last update: 1993		**Number of Records**: TBD	
File Size: TBD		**File Format**: ASCII	
Media: CD-ROM		Significant Features and/or Limitations: These networks are based on 1:2,000,000 maps and are generally accurate to 1,000 meters.	
Sponsoring Organization: Department of Transportation, Bureau of Transp. Statistics		**Performing Organization**: DOT/Research and Special Programs Administration, Volpe National Transportation Systems Center (RSPA/Volpe Center), Service Assessment Division, Oak Ridge National Laboratory	
Availability: DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone (202)366-3282; fax (202)366-3640			
Contact for Additional Information: Staff, DOT/Bureau of Transportation Statistics (202)366-3282	**Contact for Additional Information**: Bruce Spear DOT/RSPA/Volpe Center, DTS-49 (617)494-2192	**Contact for Additional Information**: Mike Bronzini Oak Ridge National Laboratory (615)574-8267	

National Highway Planning Network (NHPN)

<table>
<tr><td>MODE: Highway</td><td>GEOGRAPHY: National, state, metropolitan, County, Facility-airport, marine port, etc.</td><td>USEFULNESS: Useful</td><td>USE WITH MANUAL: Network related</td></tr>
<tr><td colspan="4">SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES</td></tr>
<tr><td colspan="4">TITLE: National Highway Planning Network (NHPN)</td></tr>
<tr><td colspan="4">Abstract The NHPN is a data base of the major highways in the U.S. It is a foundation for analytic studies of highway performance, vehicle routing and scheduling problems, and mapping purposes. The network is based on the U.S. Geological Survey's 1:2,000,000 digital line graphs (DLG's). The DLG's have been enhanced through addition of transportation attributes such as number of lanes, degree of access control, median type, and FHWA's functional classification codes. Other enhancements include the digitation of some additional links and the correction of topological errors to create a true analytic network.</td></tr>
<tr><td colspan="4">Source of Data: U.S. Geological Survey's digital line graphs and the States.</td></tr>
<tr><td colspan="4">Attributes:</td></tr>
<tr><td colspan="2">Geographic Coverage of Data: National</td><td colspan="2">Time span of Data Source: Real-Time</td></tr>
<tr><td colspan="2">First Developed: 1985</td><td colspan="2">Update Frequency: Continual</td></tr>
<tr><td colspan="2">Number of Records : ~35,000</td><td colspan="2">File Size: ~16 MB</td></tr>
<tr><td colspan="2">File Format: ASCII</td><td colspan="2">Media: Disk, Hardcopy, CD-ROM</td></tr>
<tr><td colspan="2">Significant Features and/or Limitations: 1:2,000,000 accuracy insufficient for some types of analyses. This data base has been expanded upon by the Department of Defense, Military Traffic Management Command, Transportation Engineering Agency. See National Highway Planning Network Strategic, Highway Corridor Network (STRANET) and Connectors located in the MTMC profiles section.</td><td colspan="2">Corresponding Printed Source: Description of the National Highway Planning Network</td></tr>
<tr><td colspan="2">Sponsoring Organization: Department of Transportation, Federal Highway Administration, Highway Needs and Investment Branch</td><td colspan="2">Performing Organization: Oak Ridge National Laboratory</td></tr>
<tr><td colspan="4">Availability:
Disk, Printed Source: DOT/FHWA, Highway Needs and Investment Branch, HPP-22, 400 7th Street, SW, Washington, DC 20590; telephone (202)366-9223. No charge for data, however, six high density floppy disks must be provided by the customer.
CD-ROM: Transportation Data Sampler - DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone, (202)366-3282; fax (202)366-3640</td></tr>
<tr><td colspan="2">Contact for Additional Information:
Stephen M. Lewis, Data Manager
FHWA, HPP-22
(202)366-9223</td><td colspan="2">Contact for Additional Information:
Bruce Patterson, Data Manager
Oakridge National Laboratory
(615)574-4419</td></tr>
</table>

National Transportation Statistics (NTS)

MODE: Highway, Multi-Mode	**GEOGRAPHY**: National, state, metropolitan, County,	**USEFULNESS**: Useful	USE WITH MANUAL: Network related
SOURCE: US DOT BTS			
TITLE: National Transportation Statistics (NTS)			
Abstract The Highway Performance Monitoring System (HPMS) is the source of road mileage data and is considered reliable. The Federal Highway Administration (FHWA) of the U.S. Department of Transportation (USDOT) collects and reviews state-reported HPMS data for completeness, consistency, and adherence to specifications. Some inaccuracy may arise from variations across states in their adherence to federal guidelines in the Traffic Monitoring Guide and the Highway Performance Monitoring System Field Manual for the Continuing Analytical and Statistical Database. Beginning with the 1997 issue of Highway Statistics, FHWA instituted a new method for creating mileage-based tables derived from the HPMS. Previously, adjustments to tables developed from sample data were made using area-wide mileage information provided by states. These adjustments are now being made using universe totals from the HPMS dataset. In addition, FHWA has discontinued the process of spreading rounding and other differences across table cells. Thus, users may note minor differences in table-to-table totals. FHWA considers mileage totals from table HM-20, "Public Road Length, Miles by Functional System" to be the controlling totals should a single value be required			
Source of Data: Bureau of Transportation Statistics, National Transportation Statistics 99			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**:	
First Developed:		**Update Frequency**:	
Number of Records		**File Size**: 2031 KB	
File Format: PDF files		**Media**: Internet	
Significant Features and/or Limitations: Reliability may be diminished for comparisons with pre-1980 data, which were collected via different methods and special national studies. For instance, pre-1980 mileage data included some nonpublic roadways (95,000 miles in 1979) while post-1980 data reports only "public road" mileage (roads or streets governed and maintained by a public authority and open to public travel).		**Corresponding Printed Source**: *The National Transportation Statistics 1999 (NTS)* tables are available in two formats. (HTML or Excel) You may also download all of the tables in a chapter as a single Acrobat PDF file.	
Sponsoring Organization: Department of Transportation		**Performing Organization**: DOT BTS	
Availability:			
Contact for Additional Information: http://www.bts.gov/ntda/nts/NTS99/ch1index.html		**Contact for Additional Information**:	

Nationwide Truck Activity Survey (NTACS)

MODE: Highway	**GEOGRAPHY**: National, state	**USEFULNESS**: Marginal	USE WITH MANUAL: Base year statistics
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Nationwide Truck Activity Survey (NTACS)			
Abstract The NTACS is a follow-on to the 1987 Truck Inventory and Use Survey (TIUS) designed to collect detailed information on travel characteristics of commercial motor vehicles. The survey provides detailed annual and daily activity for a probability sample of trucks responding to the TIUS. The data were collected for days selected at random over a 12-month period ending in October 1990. Among the truck, shipment, and location characteristics, the NTACS identifies shipments carried by the truck that were picked up or delivered to another mode. In addition, the survey provides information on temporal, geographic and other characteristics of truck use that are not collected in the TIUS.			
Source of Data: Survey of a sample of all trucks reported carrying commodities over long distances in the 1987 TIUS, approximately half of the trucks that were reported as carrying commodities locally in the 1987 TIUS and a small portion of the remaining, 1987 TIUS respondents.			
Attributes:			

Geographic Coverage of Data: National, Regional	**Time span of Data Source**: 1989-1990
First Developed: 1990	**Update Frequency**: TBD
Last update: 1990	**Number of Records**: 22,044
File Size: 180 tracks, ASCII, 510 Tracks SAS	**File Format**: ASCII, SAS
Media: 9-track Tape, 6250 bpi; Hardcopy; CD-ROM	Significant Features and/or Limitations: Data limited to trucks 4-years old and older. NTACS suffered from a low response rate and data inconsistency problems. Where possible, the collected data were adjusted to compensate for and to decrease the extent of these problems.
Corresponding Printed Source: 1990 Nationwide Truck Activity and Commodity Survey, Selected Tabulations	**Sponsoring Organization**: Department of Transportation, Federal Highway Administration, Federal Railroad Administration, Office of the Secretary of Transportation
Performing Organization: Department of Commerce, Bureau of Census, Oak Ridge National Laboratory	**Availability**: Tape, Printed Source: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 5500A, MS6366, Oak Ridge, TN 37831-6366; telephone, (615)574-5957; fax, (615)574-3851 CD-ROM: Transportation Data Sampler - DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone, (202)366-3282; fax, (202)366-3640
Contact for Additional Information: Stacy Davis, Data Manager Oak Ridge National Laboratory (615)574-5957	**Contact for Additional Information**: Jim March, Data Manager DOT/FHWA, HPP-12 (202)366-9237

Occupational Compensation Surveys Publication

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state, metropolitan	**USEFULNESS**: Marginal	USE WITH MANUAL: Growth factor
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Occupational Compensation Surveys Publication			
Abstract This publication presents occupational earnings estimates by metropolitan area for selected occupations. Among the occupations studied are four levels of local truck drivers, forklift operators, material handling laborers and warehouse specialists. Surveys combine data for most industries, but data are published separately for the transportation, communication, electric, gas and sanitary services industry division. Several occupational compensation surveys conducted biennially for the Employment Standards Administration of the Department of Labor relate to specific transportation industries: Alaskan Air Transportation, Deep Sea Freighters, and Deep Sea Tankers.			
Source of Data: Large sample survey of business establishments representing all MSAs in the U.S. are conducted via personal interviews every three or four years, with data for interviewing years collected by combination of mail, telephone and personal, visits.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Annual	
Update Frequency: Annual, Biennial		**Sponsoring Organization**: Department of Labor, Bureau of Labor Statistics, Division of Occupational Pay and Benefit Levels	
Availability: DOL/Inquiries and Correspondence Branch, Office of Publications, Bureau of Labor Statistics, Washington, DC 20212; telephone, (202)606-5902			
Contact for Additional Information: Staff, Data Analysis DOL/BLS, Division of Occupational Pay and Benefit Levels, OCSP Information (202) 606-6219 Fax (202) 606-7856			

Occupational Employment Statistics Publication

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state	**USEFULNESS**: Marginal	USE WITH MANUAL: Base year statistics
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Occupational Employment Statistics Publication			
Abstract This publication provides employment statistics by detailed occupation within detailed industries. Statistics on the occupational profile of transportation employment are provided at the 2 and 3-digit SIC level of detail on a three year cycle.			
Source of Data: Annual sample of 250,000 employer units conducted by State employment security agencies in cooperation with the Bureau of Labor Statistics. Sample is conducted using mail surveys, telephone follow-up, and personal interviews.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Current Year	
Update Frequency: Annual		**Sponsoring Organization**: Department of Labor, Bureau of Labor Statistics, Office of Employment and Unemployment Statistics	
Availability: DOL/Inquiries and Correspondence Branch, Office of Publications, Bureau of Labor Statistics, Washington, DC 20212; telephone, (202) 606-5902			
Contact for Additional Information: Mike McElray Data ManagerDOL/BLS/Occupational Employment Statistics (202) 606-6516 Fax (202) 606-6645			

Occupational Employment Statistics

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state, detailed Sub-areas, other	**USEFULNESS**: Marginal	USE WITH MANUAL: Base year statistics
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Occupational Employment Statistics			
CONTENT: The Occupational Employment Statistics (OES) covers wage and salary employment by occupation for establishments in nonagricultural industries. The OES is an annual survey that provides employment by detailed occupation within detailed private industries, plus state and local governments.			
METHODOLOGY: According to the BLS, the OES is a federal-state cooperative program. State employment agencies mail a BLS survey to a sample of about 250,000 employer units, the collect and compile the data. Employment estimates are based upon survey results adjusted to reflect total industry employment. Statistics are derived for employment by occupation and industry for about 750 occupations (which include trucking activity occupations such as truck drivers, dispatchers and truck mechanics) and 400 industries. The states also conduct the SIC coding of establishments, with the occupational data shown separately.			

Occupational Outlook Handbook

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state	**USEFULNESS**: Marginal	USE WITH MANUAL: Growth factor, base year statistics, forecast statistics
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Occupational Outlook Handbook			
CONTENT: Current and projected occupational employment data include employees in private and government sectors, and estimates for self-employed persons (for total employment only and not at the industry level).			
METHODOLOGY: According to the BLS, the employment estimates are derived from the BLS industry-employment matrix, which includes data for more than 500 detailed occupations and 250 detailed industries. The main sources of data used in the matrix are Current Employment Statistics (CES) estimates for total wage and salary jobs by industry, and Occupational Employment Statistics (OES) data for employment by occupation within detailed industries.			

Payroll Reports

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National, state, county	**USEFULNESS**: Marginal	USE WITH MANUAL: Base year statistics, establish sampling base for survey
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Payroll Reports			
CONTENT: Payroll information reported to the states each month depicting employment, hours worked, establishment name, address, and type of business.			
TYPOLOGY MAPPING: The payroll data are very detailed and provide state-and-county-level coverage of payroll data for all business establishments, but only within the SIC structure. As such, only for-hire carriers (SIC 4213) will be reflected as trucking operations in the data. Payroll data for private fleet operations will be represented in the particular company's SIC category.			
AVAILABILITY: Data are available to government agencies only.			

Regional Economic Information System (REIS)

MODE: Demographics, Flows, etc., Multi-mode	**GEOGRAPHY**: National, state, metropolitan, county	**USEFULNESS**: Very useful	USE WITH MANUAL: Growth factor, base year statistics, forecast statistics
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Regional Economic Information System (REIS)			
Abstract: The REIS contains estimates of annual personal income by major source, per capita personal income, earnings by two-digit SIC industry, full- and part-time employment by one-digit SIC industry, regional economic profiles, transfer payments by major program, and farm income and expenses for states, metropolitan areas and counties. In addition, other information includes BEA estimates of quarterly personal income by state (1969-1992); Census Bureau data on intercounty flows for 1960, 1970 and 1980; BEA's latest gross state product estimates for 1977-1989; its projections to 2040 of income and employment for states and metropolitan areas; and total commuter's income flows, 1969-1991.			
Source of Data: Department of Commerce/Bureau of Economic Analysis.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1969-1991	
First Developed: 1991		**Update Frequency**: Annual	
Number of Records : Not Available		**File Size**: 450MB	
File Format: ASCII		**Media**: CD-ROM	
Sponsoring Organization: Department of Commerce, Bureau of Economic Analysis, Regional Economic Measurement System		**Availability**: DOC/Bureau of Economic Analysis, Regional Economic Measurement Division, BE-55, Washington, DC 20230; telephone, (202) 523-5360. Price, $35.	
Contact for Additional Information: REIS Staff, DOC/Bureau of Economic Analysis (202) 606-5360			

Truck Inventory and Use Survey

MODE: Highway	**GEOGRAPHY**: National, state	**USEFULNESS**: Marginal	USE WITH MANUAL: Base year statistics, growth factor
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Truck Inventory and Use Survey			
Abstract: This data base provides detailed information collected from a 152,000 truck sample producing state universe estimates for the United States, including a national summary of the nation's truck population. Data include year of truck model, average weight, state of registration, major use, principal products carried, annual and lifetime miles, vehicle body type and size, axle arrangement, maintenance, area of operation, size class, leasing arrangements, miles per gallon, and hazardous materials carried.			
Source of Data: Owners of private and commercial trucks registered in each state complete a mail survey.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1987 (Results of the state reports from the 1992 TIUS are expected to be released in Fall 1993 through Summer 1994. The U.S. summary report and microdata tape are expected to be released in Fall 1994.	
First Developed: 1990		**Update Frequency**: Every Five Years	
Last update: 1985		**Number of Records**: 104,600 Logical Records; 424 Character Logical Record Length	
File Size: ~44MB		**File Format**: Not Available	
Media: Microdata File, Hardcopy		**Sponsoring Organization**: Department of Commerce, Bureau of the Census	
Significant Features and/or Limitations: Only source of comprehensive data collected for trucks that are classified by their physical and operational characteristics and that also provide microdata analysis from a public-use tape to data users of the transportation community. The records on, the microdata tape are modified to avoid disclosure of a sampled vehicle or operating company.		**Availability**: Data File - DOC/Bureau of the Census, Customer Services, Washington, DC 20233; telephone, (301) 763-4100. Printed Source - Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202) 783-3238., Price, $1.50/Individual State Report; $9.50/U.S. Summary Report; $175/Microdata File. Data available for 1963, 1967, 1972, 1977, 1982, and 1987 surveys.	
Contact for Additional Information: Bill Bostic, Project Manager DOC/Bureau of the Census (301) 763-2735			

Truck Weight Study Data Database

MODE: Highway	**GEOGRAPHY**: National, state	**USEFULNESS**: Useful	USE WITH MANUAL: Growth factor
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Truck Weight Study Data Database			
Abstract This data base contains weigh-in-motion data from the states submitted in accordance with the Traffic Monitoring Guide. Summary files are produced for generating weight reports.			
Source of Data: State Departments of Transportation submit data to FHWA in accordance with the Traffic Monitoring Guide.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1986-present	
First Developed: 1989 (supersedes data base dating to 1930)		**Update Frequency**: Annual	
Last update: 1993		**Number of Records**: 40,000,000	
File Size: 3GB		**File Format**: ASCII	
Media: Read/Write Optical Disk		**Significant Features and/or Limitations**: Amount of data varies tremendously by state because some states submit data from continuously operating weigh-in-motion sites whereas others submit the minimum 48 hours of data from each weigh-in-motion site. Some states have not submitted weigh-in-, motion data because of various problems with the equipment, etc.	
Sponsoring Organization: Department of Transportation, Federal Highway Administration, Office of Highway Information Management		**Availability**: DOT/FHWA, Office of Highway Information Management, HPM-30, 400 7th Street, SW, Washington, DC 20590; telephone, (202) 366-0175. No cost to customer if magnetic or optical disks are supplied.	
Contact for Additional Information: Ralph Gillmann, Data Managers DOT/FHWA, HPM-30 (202)366-0175		**Contact for Additional Information**: Perry Kent, Data Manager DOT/FHWA, HPM-30 (202)366-0175	

Vehicle Classification and Vehicle Miles Travelled (VCVMT) Database

MODE: Highway	**GEOGRAPHY**: National, state	**USEF ULNESS**: Marginal	USE WITH MANUAL: VMT related
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Vehicle Classification and Vehicle Miles Travelled (VCVMT) Database			
Abstract: This data base is a compilation of vehicle classification type by highway functional classification by state. Depicts the vehicle type in each functional classification as a percentage of annual vehicle miles travelled (AVMT). One table is developed each year that contains data for all the states.			
Source of Data: Data collected by each state.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1985-present	
First Developed: 1985		**Update Frequency**: Annual	
Last update: 1991		**Number of Records**: 612	
File Size: 471KB		**File Format**: LOTUS	
Media: Disk, Hardcopy		Corresponding Printed Source: Highway Statistics	
Sponsoring Organization: Department of Transportation, Federal Highway Administration, Office of Highway Information Management		**Availability**: DOT/FHWA, Office of Highway Information Management, HPM-30, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-5052.	
Contact for Additional Information: William Grush Data Manager DOT/FHWA, HPM-30 (202)366-5052			

SUBPART

a: AIR

Airport Activity Statistics of Certificated Route Air Carriers Publication

<table>
<tr><td>MODE: Air</td><td>GEOGRAPHY: Facility- airport, marine port, etc.</td><td>USEFULNESS: Useful</td><td>USE WITH MANUAL: Growth factor/Base year statistics/Forecast statistics</td></tr>
<tr><td colspan="4">SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES</td></tr>
<tr><td colspan="4">TITLE: Airport Activity Statistics of Certificated Route Air Carriers Publication</td></tr>
<tr><td colspan="4">Abstract This report presents detailed data on the volume of revenue passengers, freight express, and mail traffic carried by U.S. certificated route air carriers for each airport and individual airline; and total departures by airport, airline, and aircraft model operated. Scheduled/nonscheduled service shown by airport and carrier are included.</td></tr>
<tr><td colspan="4">Source of Data: Data are derived from RSPA Form Schedules T-100 and T-3.</td></tr>
<tr><td colspan="4">Attributes:</td></tr>
<tr><td colspan="2">Geographic Coverage of Data: National</td><td colspan="2">Time span of Data Source: 1993</td></tr>
<tr><td colspan="2">First Developed: 1962</td><td colspan="2">Update Frequency: Annual</td></tr>
<tr><td colspan="2">Last update: 06/93</td><td colspan="2">Sponsoring Organization: Department of Transportation, Federal Aviation Administration, Statistics and Forecast Branch and Research and Special Programs Administration, Office of Airline Statistics</td></tr>
<tr><td colspan="4">Availability: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202)512-1800 or National Technical Information Service, Springfield, VA 22161; telephone, (703)487-4650</td></tr>
<tr><td colspan="2">Contact for Additional Information:
Patricia Beardsley, Data Manager
DOT/FAA, APO-110
(202)267-8032
fax (202)267-9636</td><td colspan="2">Contact for Additional Information:
Paul Gravel, Data Manager
DOT/RSPA/DAI-1
(202)366-9059
fax (202)366-3383</td></tr>
</table>

Aviation Data and Analysis System (ADAS)

MODE: Air	**GEOGRAPHY**: Facility- airport, marine port, etc.	**USEFULNESS**: Specialized	USE WITH MANUAL: Growth factor
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Aviation Data and Analysis System (ADAS)			
Abstract: This system provides access to official agency activity forecasts and approved benefit/cost methodologies for any airport or group of airports reported by the system. ADA also provides all the tools necessary to study the effects on the benefit/cost ratio of changes in costs, aviation activities, or airport specifics such as runway utilization, existing minima, or weather data.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1993	
First Developed: 1993		**Update Frequency**: Not Available	
Last update: Unknown		**Number of Records**: ~4,000	
File Size: Not Available		**File Format**: Not Available	
Media: Not Available		**Significant Features and/or Limitations**: Descriptive historical and forecasted data are stored for approximately 4,000 airports nationwide.	
Sponsoring Organization: Department of Transportation, Federal Aviation Administration, Information Systems Branch		**Availability**: DOT/FAA, Information Systems Branch, APO-130, 800 Independence Ave., SW, Washington, DC 20591; telephone, (202) 267-3550; fax (202)267-5800.	
Contact for Additional Information: Staff, DOT/FAA, APO-130 (202)267-3550			

FAA Statistical Handbook of Aviation Publication

MODE: Air	**GEOGRAPHY**: National	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: FAA Statistical Handbook of Aviation Publication			
Abstract: This report covers statistical data from the Federal Aviation Administration, National Airspace System, airports, airport activity, U.S. air carrier fleet, U.S. civil air carrier operating data, airmen, general aviation aircraft, aircraft accidents, aeronautical production, and imports/exports.			
Source of Data: Federal Aviation Administration.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1991	
First Developed: 1945		**Update Frequency**: Annual	
Sponsoring Organization: Department of Transportation, Federal Aviation Administration, Statistics and Forecast Branch		**Availability**: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202)512-1800 or National Technical Information Service, Springfield, VA 22161; telephone (703)487-4650	
Contact for Additional Information: Patricia Beardsley Statistician DOT/FAA, APO-110 (202)267-8032			

Terminal Area Forecast

MODE: Air	**GEOGRAPHY**: Facility- airport, marine port, etc.	**USEFULNESS**: Marginal	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES	
TITLE: Terminal Area Forecast	
Abstract Twelve-year forecast of aviation activity at selected airports in the U.S., encompassing at least those airports with towers and/or receiving commercial service. For each airport, detailed forecasts are made for the four major user groups of the air traffic control system: air carrier, air taxi/commuter, general aviation, and military. Summary tables contain national, FAA regional, and state aviation data and other airport specific highlights. Forecasts are prepared to meet the budget and planning needs of the FAA and to provide airport specific information that can be used by state and local aviation authorities, by the aviation industry, and by the general public.	
Source of Data: FAA-developed.	
Attributes:	
Geographic Coverage of Data: National	**Time span of Data Source**: Twelve Years
First Developed: 1993	**Update Frequency**: Annual
Last update: 1992	**Number of Records** : Not Available
File Size: Not Available	**File Format**: Not Available
Media: Hardcopy	**Corresponding Printed Source**: Terminal Area Forecast
Sponsoring Organization: Department of Transportation, Federal Aviation Administration, Statistics and Forecast Branch	**Availability**: Printed Source: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202)512-1800 or National Technical Information Service, Springfield, VA 22161; telephone (703)487-4650
Contact for Additional Information: Staff, DOT/FAA, APO-110 (202)267-3355	

SUBPART

b: PIPELINE

Capacity and Service on the Interstate Natural Gas Pipeline System Publication

MODE: Pipeline	**GEOGRAPHY**: National, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Capacity and Service on the Interstate Natural Gas Pipeline System Publication			
Abstract: This report identifies and quantifies the capability of the national natural gas pipeline infrastructure to transport natural gas to the natural gas markets of the country. The report examines the capabilities of the pipelines that make up this network to move gas across regional and state borders and compares these to 1990 levels of natural gas flow to and within regional markets. In addition, envisioned and currently approved plans to construct major new pipelines and expand existing systems are presented and assessed relative to the needs of the current and near-term marketplace.			
Source of Data: A variety of government (federal, state, and regional) publications and industry documents, data bases, interviews, and industry analytical reports.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1990	
First Developed: 1990		**Update Frequency**: One-Time Special Report	
Last update: 06/92		**Sponsoring Organization**: Department of Energy, Energy Information Administration, National Energy Information Center	
Availability: National Technical Information Service, Springfield, VA 22161; telephone (703)487-4650			
Contact for Additional Information: Staff, DOE/EIA/National Energy Information Center (202)586-8800 Fax (202)586-0727			

Statistics of Interstate Natural Gas Pipeline Companies

MODE: Pipeline	**GEOGRAPHY**: National, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Statistics of Interstate Natural Gas Pipeline Companies			
Abstract: This data base contains financial and operational data on major interstate natural gas pipeline companies as defined by the Federal Energy Regulatory Commission (FERC).			
Source of Data: Data are collected on FERC Form 2, Annual Report of Major Natural Gas Companies, from interstate natural gas companies subject to the accounting and reporting requirements of the FERC.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Current year	
First Developed: 1976		**Update Frequency**: Annual	
Last update: 04/92		**Number of Records** : 240/year	
File Size: 2.5-3.0MB		**File Format**: EBCDIC	
Media: 9-Track Tape, 1600/6250 bpi; Hardcopy		Significant Features and/or Limitations: Data are company specific to the reporting company.	
Corresponding Printed Source: Statistics of Interstate Natural Gas Pipeline Companies 1990		**Sponsoring Organization**: Department of Energy, Energy Information Administration	
Availability: National Technical Information Service, Springfield, VA 22161; telephone (703)487-4650. Requests for tape conversion to disk can be made through NTIS.			
Contact for Additional Information: Juanita Mack Data Manager EIA/National Energy Information Center (202)586-6169			

SUBPART

c: RAIL

Carload Waybill Sample

MODE: Rail	**GEOGRAPHY**: National, state, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Carload Waybill Sample			
Abstract: This data base contains rail shipment data such as origin and destination points, type of commodity, number of cars, tons, revenue, length of haul, participating railroads, and interchange locations. The waybill sample contains confidential information and is used primarily by Federal and state agencies. The public-use version of the sample, however, contains aggregated nonconfidential data. Movements are aggregated to the BEA-to-BEA level at the 5-digit STCC level. For a particular commodity, the origin or destination BEA is not included unless there are at least three freight stations in the BEA and there are at least two more freight stations than railroads in the BEA.			
Source of Data: Annual stratified sample of waybills for railroads which terminate over 4,500 cars per year.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1991	
First Developed: Unknown		**Update Frequency**: Annual	
Last update: 1993		**Number of Records**: >350,000	
File Size: Not Available		**File Format**: ASCII	
Media: 9-track Tape, 6250 bpi, CD-ROM		**Significant Features and/or Limitations**: The waybill sample contains confidential information and is used primarily by Federal and state agencies. There is, however, a public-use version that contains aggregate nonconfidential data.	
Corresponding Printed Source: Carload Waybill Statistics: Territorial Distribution, Traffic and Revenue by Commodity Class		**Sponsoring Organization**: Interstate Commerce Commission	
Performing Organization: Department of Transportation, Federal Railroad Administration, Office of Policy Systems		**Availability**: CD-ROM: DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone, (202) 366-3282; fax, (202) 366-3640. Tape: Mr. James Nash, ICC, Office of Economics, 12th and Constitution, Washington, DC 20423; telephone, (202) 927-5740; fax, (202) 927-6225. Printed Source: National Technical Information System, Springfield, VA 22161; telephone, (703) 487-4650	
Contact for Additional Information: James Nash, Data Manager ICC, Office of Economics (202) 927-5740			

FRA National Planning Network

MODE: Rail	**GEOGRAPHY**: National, state, metropolitan, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: FRA National Planning Network			
Abstract This database presents a digital representation of the major continental U.S. railway systems, covering some 186,000 miles of track. Link attributes include owning railroads, trackage rights railroads, state, previous owning railroads, subsidiary railroads, FAA region, passenger service, U.S. Geological Survey (USGS) region, and significance in civil rail lines important to national defense. All links in original USGS data are retained. Links subsequently abandoned are so identified. Node attributes include name, state (where there is a name), standard point location code, and junction code, if any.			
Source of Data: USGS 1:2,000,000 digital line graph.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Current	
First Developed: 1990		**Update Frequency**: As Required	
Number of Records : 11,010/Nodes; 15,800/Links		**File Size**: 13MB	
File Format: ASCII		**Media**: Disk	
Significant Features and/or Limitations: Locational accuracy of the network is approximately +/- 1,200 meters for those links carrying shape point data.		**Sponsoring Organization**: Department of Transportation, Federal Railroad Administration, Office of Policy Systems	
Availability: DOT/FRA, Office of Policy Systems, RRP-20, 400 7th Street, SW, Washington, DC 20590: telephone (202)366-2920; Fax (202)366-7688.			
Contact for Additional Information: Raphael Kedar Director, DOT/FRA, RRP-20 (202)366-2920			

Grade Crossing Inventory System (GCIS)

MODE: Rail, highway	**GEOGRAPHY**: National, state, other	**USEFULNESS**: Specialized, useful	USE WITH MANUAL: Network related
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Grade Crossing Inventory System (GCIS)			
Abstract: This system contains a record of every public and private crossing in the U.S. along with the accident history of each crossing. Information includes the identification number, railroad, railroad division, subdivision, milepost and branch, state, county, city or nearest city, street or highway, and crossing type. In addition, public grade crossing information such as number of daily train movements, train speeds, type and number of tracks, details of crossing protection both active and passive, crossing angle, number of traffic lanes, daily highway traffic volume, pavement markings, advance warning signs, crossing surface, highway system, and percentage of trucks is available.			
Source of Data: Information is supplied by the railroads and states on an optional basis.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Current Year	
First Developed: 1973		**Update Frequency**: Continual	
Number of Records: ~600,000		**File Size**: ~200MB	
File Format: Sequential		**Media**: 9-track Tape, Disk, Hardcopy	
Corresponding Printed Source: Railroad-Highway Crossing Accidents		**Sponsoring Organization**: Department of Transportation, Federal Railroad Administration, Data Analysis Branch	
Availability: DOT/FRA, Data Analysis Branch, RRS-22.1, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-2760. Price, $35/tape, non-government agencies. No charge to government agencies, railroad, or railroad labor requestors.			
Contact for Additional Information: Robert Finkelstein, Chief DOT/FRA, RRS-22 (202)366-2760 Fax (202)366-7592			

SUBPART

d: WATER

American Intermodal Equipment Inventory

MODE: Waterway	**GEOGRAPHY**: National	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: American Intermodal Equipment Inventory			
Abstract This system records all intermodal equipment of U.S.-flag intermodal marine carriers and major container leasing companies operating in the U.S. It includes for each company the type and number, dimensions of containers and trailers. Chassis are shown by types, number of units and containers carried. The size and number of slots available on container vessels and barges is recorded. Forty foot equivalent units of trailers along with automobile capacity are also included for Ro/Ro ships and barges.			
Source of Data: Survey of U.S.-flag carriers and major leasing companies operating in the U.S.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1991-present	
First Developed: 1991		**Update Frequency**: Annual	
Number of Records : 1,000		**File Size**: 250K	
File Format: ASCII, dBASE		**Media**: Disk	
Significant Features and/or Limitations: Only source of aggregated data on American-owned containers, chassis, trailers and vessels, that are essential for planning most efficient use of U.S. intermodal equipment.		**Corresponding Printed Source**: Inventory of American Intermodal Equipment	
Sponsoring Organization: Department of Transportation, Maritime Administration, Office of Port and Intermodal Development		**Availability**: DOT/MARAD, Office of Port and Intermodal Development, MAR-831, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-4357. Data available in second half of year following close of period.	
Contact for Additional Information: Doris Bautch Data Manger DOT/MARAD, MAR-831 (202)366-4357			

Analysis of Ports for National Defense

MODE: Waterway	**GEOGRAPHY**: National, facility-airport, marine port, etc.	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Analysis of Ports for National Defense			
Abstract This system includes data on specific evaluations of the commercial ports capabilities to support early deployment of DoD military units during a contingency. Port areas analyzed include Baltimore, Boston, Charleston, Hampton Roads, Jacksonville, Morehead City, Narraganset Bay, New York and New Jersey, Philadelphia, Savannah, Wilmington (NC), Beaumont, Houston, New Orleans, Gulfport, Port Arthur, Pascagoula, Lake Charles, Port Hueneme, Los Angeles, Long Beach, and San Diego. Military Ocean Terminals in New Jersey and Oakland are also evaluated. Data include number and characteristics of berths, ship mixes, staging areas, inloading/outloading positions, cargo handling apparatus, rail and highway access, and general information on port facilities. Also included is a theoretical cargo throughput capability for each port.			
Source of Data: MTMC conducts this study through site visits and questionnaires.			
Attributes:			
Geographic Coverage of Data: Continental United States and military ocean terminals in New Jersey and Oakland	**Time span of Data Source**: 1977-present		
Update Frequency: Every Three Years	**Last update**: 1994		
Sponsoring Organization: Department of Defense, Department of Army, Military Traffic Management Command, Transportation Engineering Agency	**Availability**: Department of Army, Military Traffic Management Command, Transportation Engineering Agency, 720 Thimble Shoals Blvd., S130, Newport News, VA 23606-2475; telephone (804)599-1186; fax (804)599-1563.		
Contact for Additional Information: Ralph Compton, Data Manager MTMCTEA (804)599-1186			

Estimated Waterborne Commerce Statistics Publication

MODE: Multi-mode, waterway	**GEOGRAPHY**: National, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Estimated Waterborne Commerce Statistics Publication			
Abstract: The estimated Waterborne Commerce Statistics report provides tonnage estimates of the national waterborne commerce and selected waterways by major commodity groupings for the most recent calendar year. It also shows actual annual tonnage by commodity for nine years prior to the year being estimated.			
Source of Data: Vessel operating companies file vessel operation reports and lock performance monitoring systems reports.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: 1989-1992	
First Developed: 1989		**Update Frequency**: Annual	
Last update: 1992		**Significant Features and/or Limitations**: Timely estimates and 10-year trends.	
Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office		**Availability**: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280, telephone, (504)862-1424; fax (504)862-1423	
Contact for Additional Information: Thomas Mire, Data Manager COE/Waterborne Commerce Statistics Center (504)862-1424 Fax (504)862-1423		**Contact for Additional Information**: Roy Walsh, Data Manager COE/Waterborne Commerce Statistics Center (504)862-1424 Fax (504)862-1423	

Exposure Data Base (EDB)

MODE: Waterway	**GEOGRAPHY**: National, demographics, Flows, etc.	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Exposure Data Base (EDB)			
Abstract: This system was developed to provide accurate program Measures of Effectiveness (MOE) and effective resource allocation using operational data concerning vessel inventories on specific waterways by gross tonnage and vessel type. System generates matrices of commercial vessel transits and cargo data in a port area, region or district, and nationwide in domestic and foreign trade during a time frame. These transits would become an indicator or predictor of the amount of the industry's exposure to particular hazards, being compared to the number of incidents (pollution, casualties, deaths) occurring within the same time frame.			
Source of Data: U.S. Army Corps of Engineers, domestic traffic; Bureau of Census, foreign trade.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Current Year	
First Developed: Unknown		**Update Frequency**: Annual	
Number of Records: Not Available		**File Size**: Not Available	
File Format: Write One Read Many		**Media**: 9-track Tape, CD-ROM	
Significant Features and/or Limitations: System will generate a measure of effectiveness that is independent of current data gathering practices in the Marine Safety program, and provides vessel and cargo activity reports unavailable from any other system. The EBD can be used in conjunction, with other data bases such as the casualty and pollution data bases. It can also be used independently to provide throughput data for risk analysis projects.			
Sponsoring Organization: Department of Transportation, United States Coast Guard, Marine Safety Evaluation Branch		**Availability**: DOT/USCG, Marine Safety Evaluation Branch, G-MMI-3, 2100 2nd Street, Washington, DC 20593; telephone (202)267-1430, fax (202)267-1416	
Contact for Additional Information: CDR Thomas Tansey, Data Manager DOT/USCG, G-MMI-3 (202)267-1430			

Maritime Statistical Information System

MODE: Waterway	**GEOGRAPHY**: National, other	**USEFULNESS**: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES
TITLE: Maritime Statistical Information System
Abstract: This system contains detailed information on U.S. oceanborne foreign trade statistics by commodity, vessel, port, weight and value; vessel data on all merchant vessels over 1,000 gross tons and worldwide itineraries for the same vessels.
Source of Data: Bureau of Census for foreign trade data; Lloyd's Maritime Information Services primarily for vessel data and exclusively for itinerary data/
Attributes:

Geographic Coverage of Data: National/Oceanborne Foreign; Worldwide/Merchant Fleet and Itinerary	**Time span of Data Source**: 1989-present
First Developed: 1991	**Update Frequency**: Monthly/Foreign Trade; Quarterly/Vessel and Itinerary
Last update: 07/93	**Number of Records**: 6 Million/Year - Foreign Trade; 40,000 - Vessel Characteristics; 1 million/Year - Itinerary
File Size: ~1GB/Year	**File Format**: ASCII, dBASE
Media: Disk	Significant Features and/or Limitations: Foreign Trade data available at the individual vessel level, linked to vessel characteristics and movements. Data base contains proprietary and copyright information and can only be released in summary form.
Corresponding Printed Source: United States Oceanborne Foreign Trade Routes, Merchant Fleets of the World, Vessel Inventory Report	**Sponsoring Organization**: Department of Transportation, Maritime Administration, Office of Trade Analysis and Insurance

Availability: DOT/MARAD, Office of Trade Analysis and Insurance, MAR-570, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-2277. Publications are free; price for special requests depends upon data requested.
Contact for Additional Information: Robert Brown, Chief DOT/MARAD, MAR-570 (202)366-2277

Origin and Destination of Waterborne Commerce of the United States, Public Domain Data

MODE: Multi-mode, waterway	**GEOGRAPHY**: National, state, other	**USEFULNESS**: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES	
TITLE: Origin and Destination of Waterborne Commerce of the United States, Public Domain Data	
Abstract This database contains aggregated information that depicts waterborne commodity movements between 26 geographical regions or between individual states of the U.S. This database protects the confidentiality of the data provided by the individual companies and provides the origin/destination commodity flows.	
Source of Data: Vessel operating companies file vessel operations reports.	
Attributes:	
Geographic Coverage of Data: National, U.S. Territories	**Time span of Data Source**: 1985-1992
First Developed: 1985	**Update Frequency**: Annual
Last update: 1992	**Number of Records** : 400
File Size: 10,000 Bytes	**File Format**: ASCII
Media: Disk, Hardcopy	Significant Features and/or Limitations: All companies moving commerce by water are required by law to report.
Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office	**Availability**: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280, telephone, (504)862-1424; fax (504)862-1423. Price, $5, data file; $15, printed source.
Contact for Additional Information: Thomas Mire, Data Manager COE/Waterborne Commerce Statistics Office (504)862-1424	**Contact for Additional Information**: Roy Walsh, Data Manager COE/Waterborne Commerce Statistics Office (504)862-1424

Port Facilities Inventory

MODE: Waterway	**GEOGRAPHY**: National, facility- airport, marine port, etc.	**USEFULNESS**: Specialized, useful	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Port Facilities Inventory			
Abstract: This system contains detailed information on more than 4,000 major ocean and river port facilities, including location, physical characteristics, cargo handling equipment and capacities.			
Source of Data: Data are purchased from the U.S. Army Corps of Engineers which systematically surveys all U.S. ports; additional data supplied periodically port authorities.			
Attributes:			
Geographic Coverage of Data: Major U.S. ocean and river port facilities		**Time span of Data Source**: 1988-1994	
First Developed: 1976		**Update Frequency**: As Information is Available	
Number of Records : 4,000		**File Size**: 8MB	
File Format: ASCII, dBASE		**Media**: Disk	
Significant Features and/or Limitations: Extensive detail on major U.S. port facilities, both ocean and river; does not include all U.S. port facilities.		**Sponsoring Organization**: Department of Transportation, Maritime Administration, Office of Port and Intermodal Development	
Availability: DOT/MARAD, Office of Port and Intermodal Development, MAR-832, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-5477; fax (202)366-6988.			
Contact for Additional Information: William Dean, Data Manager DOT/MARAD, MAR-832 (202)366-5477 fax (202)366-6988			

Port Series, 1921-Present

MODE: Waterway	**GEOGRAPHY**: National, facility-airport, marine port, etc.	**USEFULNESS**: Specialized, useful	USE WITH MANUAL: Growth factor
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Port Series, 1921-Present			
Abstract: The fifty-seven reports in the port series include information on commercial facilities at the principal U.S. Coastal, Great Lakes and Inland Ports. Each report consists of complete listings of a port area's waterfront facilities, including information on berthing, cranes, transit sheds, grain elevators, marine repair plants, fleeting areas, and docking and storage facilities. Aerial maps show the locations of the described facilities.			
Source of Data: Facility operators, port organizations, transportation companies conduct on-site investigations.			
Attributes:			
Geographic Coverage of Data: U.S. Coastal, Inland Ports, and Waterways		**Time span of Data Source**: Varies 1-10 Years	
First Developed: 1987/Data File; 1921/Printed Source		**Update Frequency**: Every 8-12 Years	
Number of Records : ~10,000		**File Size**: 56MB	
File Format: ASCII		**Media**: Tape, CD-ROM, Diskettes, Hardcopy	
Significant Features and/or Limitations: Contains complete physical data on each facility limited by knowledge of on-site informants.		**Corresponding Printed Source**: Port Series 1921-Present	
Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, CEWRC, Navigation Data Center		**Availability**: U.S. Army Corps of Engineers, CEWRC, Navigation Data Center, Ports and Waterways Division, Casey Building, Ft. Belvoir, VA 22060-5586; telephone, (703)355-3315; fax (703)355-0047. Price, $6-$26 depending on size.	
Contact for Additional Information: John Vetter, Data Manager COE/CEWRC, Navigation Data Center (703)355-3315	**Contact for Additional Information**: Bob Ray, Data Manager COE/CEWRC, Navigation Data Center (703)355-3315	**Contact for Additional Information**: Jim Feagans, Data Manager COE/CEWRC, Navigation Data Center (703)355-3315	**Contact for Additional Information**: Sid Formal, Data Manager COE/CEWRC, Navigation Data Center (703)355-3315

Tonnage for Selected United States Ports

MODE: Waterway	**GEOGRAPHY**: National, facility-airport, marine port, etc.	**USEFULNESS**: Specialized, useful	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES	
TITLE: Tonnage for Selected United States Ports	
Abstract: This data base provides listings of tons handled at U.S. Ports for a given calendar year. The ports are sorted by total, domestic, and foreign tonnage and alphabetically.	
Source of Data: Vessel operating companies file vessel operation reports.	
Attributes:	
Geographic Coverage of Data: National, U.S. Territories	**Time span of Data Source**: 1992
First Developed: 1986	**Update Frequency**: Annual
Last update: 1992	**Number of Records** : 600
File Size: 50,000 Bytes	**File Format**: ASCII
Media: Disk, Hardcopy	Corresponding Printed Source: Tonnage for Selected United States Ports
Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office	**Availability**: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280, telephone (504)862-1424; fax (504)862-1423
Contact for Additional Information: Thomas Mire, Data Manager COE/Waterborne Commerce Statistics Center (504)862-1424	**Contact for Additional Information**: Roy Walsh, Data Manager COE/Waterborne Commerce Statistics Center (504)862-1424

U.S. Waterborne Exports and Outbound Intransit Shipments (TM-780)

MODE: Waterway	**GEOGRAPHY**: National, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: U.S. Waterborne Exports and Outbound Intransit Shipments (TM-780)			
Abstract: This data base provides information on the shipping weight and value by type of vessel service by Customs district and port of lading by foreign port or country/area of unlading by SITC Rev. 3 and by country of destination. The report presents percentage of containerized cargo. In-transit tables present data on country of origin and destination. An annual version (TA-780) is also available.			
Source of Data: U.S. Customs Service.			
Attributes:			
Geographic Coverage of Data: National, U.S. Customs Districts and Ports of Lading, Foreign Ports of Countries of Unlading, Countries of Origin/Destination		**Time span of Data Source**: 1989-present	
First Developed: 1989		**Update Frequency**: Monthly	
Number of Records : ~200,000/Month		**File Size**: 20-25MB	
File Format: Flat ASCII		**Media**: Disk, Tape	
Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division		**Availability**: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)457-1237.	
Contact for Additional Information: Norman Teague Data Manager DOC/Bureau of the Census, Foreign Trade Division (301)763-5140			

U.S. Waterborne General Imports and Inbound Intransit Shipments (TM-380)

MODE: Waterway	**GEOGRAPHY**: National, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: U.S. Waterborne General Imports and Inbound Intransit Shipments (TM-380)			
Abstract: This data base presents type of vessel services by U.S. Customs port by foreign port by SITC commodity by country of origin. Data provided include shipping weight, customs value, import charges, and percentage of containerized and containerized and noncontainerized cargo. Inbound intransit shipments are also included. An annual version (TA-380) is also available.			
Source of Data: U.S. Customs Service.			
Attributes:			
Geographic Coverage of Data: National, U.S Customs Districts and Ports of Unlading, Foreign Ports of Lading, Countries of Origin/Destination		**Time span of Data Source**: 1989-present	
First Developed: 1989		**Update Frequency**: Monthly	
Number of Records : ~200,000/Month		**File Size**: 20MB	
File Format: Flat ASCII		**Media**: Tape	
Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division		**Availability**: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)457-2317; Fax, (301)457-1237.	
Contact for Additional Information: Norman Teague, Data Manager DOC/Bureau of the Census, Foreign Trade Division (301)457-2317			

Waterborne Commerce of the United States, Parts 1 thru 5 Publication

<table>
<tr><td>MODE: Multi-mode, waterway</td><td>GEOGRAPHY: National, other</td><td>USEFULNESS: Specialized</td><td>USE WITH MANUAL:</td></tr>
<tr><td colspan="4">SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES</td></tr>
<tr><td colspan="4">TITLE: Waterborne Commerce of the United States, Parts 1 thru 5 Publication</td></tr>
<tr><td colspan="4">Abstract: The statistics of waterborne commerce have been published in five parts by the regional offices of the Corps of Engineers since 1953. Prior to 1953, the statistics were published annually as Part 2 of the annual report of the Chief of Engineers. Tables give tonnage and ton-miles of freight traffic by commodities; comparative statement of traffic, trips, and drafts of vessels. Parts include: Part 1-Atlantic Coast Area; Part 2-Gulf Coast, Mississippi River System and Antilles (Puerto Rico and Virgin Islands); Part 3--Great Lakes Area; Part 4-Pacific Coast, Alaska, and Pacific Islands area; and Part 5--National Summaries.</td></tr>
<tr><td colspan="4">Source of Data: Vessel operating companies file vessel operating reports.</td></tr>
<tr><td colspan="4">Attributes:</td></tr>
<tr><td colspan="2">Geographic Coverage of Data: National, U.S. Territories</td><td colspan="2">Time span of Data Source: 1953-present</td></tr>
<tr><td colspan="2">First Developed: 1953</td><td colspan="2">Update Frequency: Annual</td></tr>
<tr><td colspan="2">Significant Features and/or Limitations: All companies moving commerce by water are required by law to report. Hardcopy dates back to 1920.</td><td colspan="2">Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office</td></tr>
<tr><td colspan="4">Availability: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280, telephone (504)862-1424; fax (504)862-1423. Price, $17.50.</td></tr>
<tr><td colspan="2">Contact for Additional Information:
Thomas Mire, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424</td><td colspan="2">Contact for Additional Information:
Roy Walsh, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424</td></tr>
</table>

Waterborne Transportation Lines of the United States

MODE: Waterway	**GEOGRAPHY**: National, facility-airport, marine port, etc.	**USEFULNESS**: Specialized, useful	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Waterborne Transportation Lines of the United States			
Abstract This system contains information on vessel operators, characteristics and description of operations for all domestic vessel operations. Major data content include alphabetical listing of operators, description of vessels (net registered tons, length, breadth, draft loaded, horse power, capacity, highest point above waterline, cargo handling equipment, year built, home base), description of operations (principal commodities carried and areas served). General ferries, floating equipment used in construction work such as dredges, pile drivers, fishing vessels, and recreational craft are not included.			
Source of Data: Vessel operating companies complete annual questionnaire.			
Attributes:			

Geographic Coverage of Data: National, U.S. Territories	**Time span of Data Source**: 1940-1992
First Developed: 1940	**Update Frequency**: Annual
Last update: 1992	**Number of Records**: 40,000, Vessels
File Size: 9MB; Owners/Operators, 3,200	**File Format**: ASCII
Media: Tape, Disk, Hardcopy	**Corresponding Printed Source**: Waterborne Transportation Lines of the United States
Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office	**Availability**: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280; telephone (504)862-1424; fax (504)862-1423. Price, $50/data file; $10/printed source.
Contact for Additional Information: Thomas Mire, Data Manager COE/Waterborne Commerce Statistics Center (504)862-1424	**Contact for Additional Information**: Roy Walsh, Data Manager COE/Waterborne Commerce Statistics Center (504)862-1424

SUBPART

e: MULTIMODAL AND OTHER

A compendium of selected regional transportation, and demographic statistics (NYMTC)

MODE: Highway, Multi-Mode	**GEOGRAPHY**: State, metropolitan,	**USEFULNESS**: Useful	USE WITH MANUAL: Network related
SOURCE: NYMTC			
TITLE: 1997 Regional Transportation Statistical Report			
Abstract: A compendium of selected regional transportation, and demographic statistics			
Source of Data:			
Attributes:			
Geographic Coverage of Data:		**Time span of Data Source**: 1986-1997	
First Developed:		**Update Frequency**: Annual data for selected transportation characteristics	
Number of Records:		**File Size**:	
File Format: Transport-Truck trips		**Media**:	
Significant Features and/or Limitations: NYMTC - A Report Card for the Region, Includes transit information.		**Corresponding Printed Source**:	
Sponsoring Organization: NYMTC - Monitoring & Analysis Unit		**Performing Organization**: NYMTC	
Availability:			
Contact for Additional Information: Written by Leokadia Glogowski		**Contact for Additional Information**: www.nymtc.org	

Census of Population and Housing, 1990: Census Transportation Planning Package (CTPP)

MODE: Demographics, Flows, etc., multi-mode	**GEOGRAPHY**: National, state, county, metropolitan, Detailed sub-areas	**USEFULNESS**: Very useful	USE WITH MANUAL: Growth factor, base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Census of Population and Housing, 1990: Census Transportation Planning Package (CTPP)

Abstract The CTPP is a set of cost reimbursable special tabulations, produced for the Department of Transportation in each state. The detailed cross-tabulations have been designed to meet the needs of state and local transportation planners, and are provided for counties, places of 2,500 or more inhabitants and custom-defined traffic analysis zones (TAZs). The CTPP is a continuation of the 1970 and 1980 Urban Transportation Planning Package programs.

Geographic Coverage: The CTPP statewide tabulations will provide data for persons who live or work in the state. Data will be tabulated for the state, each county, county subdivision (only available for 9 states for workplace data), and place of 2,500 or more persons. Totals for state parts of MSAs, CMSAs, and PMSAs will also be provided, as will urbanized area totals (place of residence data only). The statewide tabulations will consist of six parts: Part A, tabulations by place of residence; Part B, tabulations by place of work; Part C tabulations by place of residence by place of work; Part D, tabulations by place of residence for areas of 75,000 or more persons; Part E, tabulations by place of work for areas of 75,000 or more persons; Part F, tabulations of place of residence by place of work for areas of 75,000 or more persons. Urban tabulations produced for the metropolitan planning organizations (MPO) in each area where the Census TIGER/Line files contain address ranges. Data will be tabulated for either standard census **GEOGRAPHY** like census tracts of block groups, or for locally-defined, custom geographic areas like traffic analysis zones. Subtotals for study area, CTPP Region, MSA, CMSA, PMSA, and urbanized area (place of residence data only) will also be provided. The urban tabulation will consist or seven parts: Part 1, tabulations by small area of residence; Part 2 tabulations by small area of work; Part 3, tabulations of small area of residence by small area of work; Part 4, tabulations of large area of residence; Part 6 tabulations of super district of residence by super district of work for regions with 1 million of more persons; Part 7, tabulations by census tract of work; and Part 8, tabulations of small area of residence by small area of work for regions with one million or more persons. There is no Part 5 in the urban element 1990 CTPP.

Source of Data: 1990 Census of Population and Housing. Approximately 17.7 million housing units were sampled nationwide.

Attributes:

Geographic Coverage of Data: National. (See **Abstract** for more detail.)	**Time span of Data Source**: 1990
Update Frequency: Every Ten Years	**File Format**: ASCII, EBCDIC
Media: 9-track Tape, 6250/1600 bpi, Tape Cartridge, IBM 3480 Compatible	**Significant Features and/or Limitations**: 1990 Census data are based on a sample, and subject to sampling and nonsampling errors.
Sponsoring Organization: Department of Commerce, Bureau of the Census, Journey-to-Work and Migration Statistics Branch	**Availability**: Summer 1993, continuing into 1994. Contact the state transportation agency or local metropolitan planning organization.
Contact for Additional Information: Ernest Wilson (Hotline) Subject-Matter Specialists DOC/Bureau of the Census, Journey-to-Work and Migration Statistics Branch (301)763-2201	**Contact for Additional Information**: Phillip A. Salopek Subject-Matter Specialists DOC/Bureau of the Census, Journey-to-Work and Migration Statistics Branch (301)763-3850

SUMMARY OF ADDITIONAL SOURCES WHICH MAY BE OF INTEREST:
U.S. Waterborne Exports and General Imports (Source-U.S. Customs Service and Canadian Customs; Sponsoring

Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division); Great Lakes State Overseas Trade Report (Source-Journal of Commerce P.I.E.R.S. subscription; bills of lading and vessel manifests; Sponsoring Organization-Department of Transportation, Saint Lawrence Seaway Development Corporation); St. Lawrence Seaway Annual Traffic Report (Source- Vessel Transit Declarations filed by vessel representatives using Seaway lock facilities; Sponsoring Organization -Department of Transportation, Saint Lawrence Seaway Development Corporation, St. Lawrence Seaway Authority (Canadian))

Coal Distribution Data

MODE: Multi-mode	**GEOGRAPHY**: State	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Coal Distribution Data			
Abstract This database contains information on coal distribution by origin, destination (state, Canada, and overseas), consumer category, and method of transportation. Coal production/purchases, stocks and distribution by secondary methods of transportation are also reported.			
Source of Data: Data are collected on Form EIA-6, "Coal Distribution Report" from U.S. companies that owned or purchased coal and distributed in excess of 50,000 tons during a year. These companies include mining companies, wholesale coal dealers, and, retail coal dealers.			
Attributes:			
Geographic Coverage of Data: Worldwide		**Time span of Data Source**: Current Quarter	
First Developed: 1977		**Update Frequency**: Quarterly	
Last update : 09/30		**Number of Records** : Varies 2,500-8,500	
File Size: Varies		**File Format**: ASCII	
Media: Disk; Hardcopy		**Significant Features and/or Limitations**: Data not company specific.	
Corresponding Printed Source: Coal Distribution was discontinued with the fourth quarter publication, 1991. Selected distribution tables have been incorporated into the Quarterly Coal Report and the Coal Industry Annual.		**Sponsoring Organization**: Department of Energy, Energy Information Administration, Survey Management Division	
Availability: Diskette: Survey Management Division, Energy Information Administration, EI-52, Washington, DC 20585; telephone, (202)254-5400. Printed Source: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)512-1800.			
Contact for Additional Information: Thomas S. Murphy Survey Manager DOE/EIA, EI-522 (202)254-5561 Fax (202)254-8503			

Coal Supply and Transportation Model (CSTM) Model

MODE: Waterway, rail	**GEOGRAPHY**: National, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Coal Supply and Transportation Model (CSTM) Model; may also be interested in National Coal Model (NCM) from same source			
Abstract This model projects distribution patterns of coal supply and intermodal movements of coal. Both rail and water movements are represented, covering all major U.S. rail lines and barges by collier routes. Rail shipments are differentiated by sector and various adjustments are possible for coal cleaning, use of compliance coal, etc. A complete set of reports is produced that show detailed shipments, production, and transportation routes. Information on steam and metallurgical coal exports is also included.			
Source of Data: DOE-developed.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Current	
First Developed: 1991		**Media**: 9-track tape, 1600/6250 bpi	
Significant Features and/or Limitations: Written in Fortran IV. The program requires a VS FORTRAN compiler on an IBM 3084 computer under a MVS/XA operating system.		**Sponsoring Organization**: Department of Energy, Energy Information Administration	
Availability: National Technical Information Service, Springfield, VA; 22161; Telephone: (703)487-4650			
Contact for Additional Information: Coal Supply and Transportation Model: Richard Newcombe Data Manager EIA/National Energy Information Center (202)586-2415		**Contact for Additional Information**: National Coal Model Robert Manicke Data Manager EIA/National Energy Information Center (202)586-2157	

Data Bank: U.S. Exports of Domestic and Foreign Merchandise (EM-545)

MODE: Demographics, Flows, etc., Multi-mode / **GEOGRAPHY**: Metropolitan	**USEFULNESS**: Specialized / USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES	
TITLE: Data Bank: U.S. Exports of Domestic and Foreign Merchandise (EM-545)	
Abstract This data base presents current month and cumulative data on the net quantity, value, and shipping weight for 10-digit Schedule B by number, by country of destination, by Custom district of export, and by method of transportation. An annual tape (EA-645) is also available.	
Source of Data: U.S. Customs Serv ice and Canadian Customs.	
Attributes:	
Geographic Coverage of Data: National, U.S. Customs Districts of Exportations, Countries of Destination	**Time span of Data Source**: 1989-present
First Developed: 1989	**Update Frequency**: Monthly
Number of Records : 840,000	**File Size**: 230MB
File Format: ASCII	**Media**: Tape
Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division	**Availability**: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)763-5140. Price, $2400.
Contact for Additional Information: Yvonne Tayler DOC/Bureau of the Census, Foreign Trade Division (301)763-5140	**Contact for Additional Information**: Gerline Roundtree DOC/Bureau of the Census, Foreign Trade Division (301)763-5140

Data Bank: U.S. General Imports and Imports for Consumption (IM-145)

MODE: Demographics, Flows, etc., Multi-mode	**GEOGRAPHY**: National, other	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Data Bank: U.S. General Imports and Imports for Consumption (IM-145)			
Abstract This data base contains data on the net quantity and value of imports for consumption and general imports by 10-digit HTSUSA commodity code by country of origin by Customs districts of entry and unlading. Method of transportation is included. An annual tape (IA-245) is also available.			
Source of Data: U.S. Customs Service.			
Attributes:			
Geographic Coverage of Data: National, U.S. Customs Districts of Entry and Unlading, Country of Origin		**Time span of Data Source**: 1989-present	
First Developed: 1989		**Update Frequency**: Monthly	
Number of Records : 1,000,000		**File Size**: 570MB	
File Format: ASCII		**Media**: Tape	
Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division		**Availability**: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)763-5140. Price, $2400.	
Contact for Additional Information: Yvonne Taylor DOC/Bureau of the Census, Foreign Trade Division (301)763-5140		**Contact for Additional Information**: Gerline Roundtree DOC/Bureau of the Census, Foreign Trade Division (301)763-5140	

Economic Censuses

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Economic Censuses			
CONTENT: The censuses present complete, detailed statistics of specific economic sectors. Information covered includes employment by industry, establishments and payroll. The Economic Censuses provide statistics about business establishments once every five years, for the years ending in 2 and 7. The censuses do not cover the Post Office, railroad transportation, and large certified passenger air carriers.			

Employee Occupational Database

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Employee Occupational Database			
CONTENT: Occupational employment information is available from a database of employee records.			
METHODOLOGY: Occupational counts are based on a search of job titles -- there is a code for each title.			
AVAILABILITY: The occupational employment information is not available in publication. A computer program would have to be written to pull the data.			
RELATED DATA SOURCES: The Postal Service database is a specialized segment. The Occupational Employment in Federal Government database does not include the Postal Service and Employment and Wages provides total Postal Service employment, but not by occupation.			

Fresh Fruit & Vegetable Shipments

MODE: Demographics, Flows, etc., multi-mode	**GEOGRAPHY**: National, state, metropolitan	**USEFULNESS**: Specialized, useful	USE WITH MANUAL:
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Fresh Fruit & Vegetable Shipments			
CONTENT: For each mode of transport, data are collected from regulatory agencies, shippers, and transportation firms. The data include type of fresh fruit or vegetable, origination, destination, mode, tonnage, and rate ranges. The data are reported for major cities and for states. Exports are also reported.			
METHODOLOGY: Several sources are used to report the data. The agencies, federal and state, that inspect and report movements by commodity are the major sources of information. Shippers and transportation firms are also utilized but are not sampled with any statistical procedure. Data are compiled without the ability to cross-check redundant reporting throughout.			
AVAILABILITY: Data are published weekly and annually.			

Hazardous Materials Registration Program Database

MODE: Multi-mode	**GEOGRAPHY**: Other	**USEFULNESS**: Marginal	USE WITH MANUAL: Establish sampling base for survey

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES
TITLE: Hazardous Materials Registration Program Database
Abstract: This system contains information supplied by certain offerors and transporters of hazardous materials on an annual registration statement required by amendments to the Hazardous Materials Transportation Act of 1974, Public Law 93-633. System contains information on the name and principal place of business of each registrant, and on the activities in which the registrant engaged during the previous year that required registration. Fees collected as part of this program fund grants that support emergency response planning and training programs of state and Indian tribal governments.
Source of Data: Hazardous materials offerors and transporters; Form DOT F5800.2.
Attributes:

Geographic Coverage of Data: National	**Time span of Data Source**: 1992-Present
First Developed: 1992	**Update Frequency**: Daily
Number of Records: 75,000	**File Size**: 2 Files - 10MB, 40MB
File Format: System 1032 (VAX)	**Media**: 9-track Tape, Disk, Printout
Significant Features and/or Limitations: Only offerors and transporters meeting certain criteria must register.	**Sponsoring Organization**: Department of Transportation, Research and Special Programs Administration, Office of Hazardous Materials Planning and Analysis

Availability: Government: DOT/RSPA, Office of Hazardous Materials Planning and Analysis, DHM-60, 400 7th Street, SW, Washington, DC 20590; telephone (202)366-4109; fax (202)366-7435
Contact for Additional Information: David W. Donaldson Program Manager DOT/RSPA, DHM-60 (202)366-4109

Industry Productivity and Technology Studies Publication

MODE: Demographics, Flows, etc., Multi-mode	**GEOGRAPHY**: National	**USEFULNESS**: Specialized	USE WITH MANUAL: Growth factor
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Industry Productivity and Technology Studies Publication			
Abstract: This program develops indexes of productivity for individual industries. Statistics on industry labor productivity are published for railroad transportation, bus carriers, intercity trucking, air transportation, and petroleum pipelines. Also, statistics for multifactor productivity are published for railroad transportation.			
Source of Data: Synthesis of other statistics from output/input data from various government sources and trade associations.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Current Year	
Update Frequency: Annual		**Sponsoring Organization**: Department of Labor, Bureau of Labor Statistics, Division of Industry Productivity Studies	
Availability: DOL/Inquiries and Correspondence Branch, Office of Publications, Bureau of Labor Statistics, Washington, DC 20212; telephone (202)606-5902			
Contact for Additional Information: Kent Kunze Chief DOL/BLS/Division of Productivity Studies (202)606-5618 Fax, (202)606-5664			

Nationwide Personal Transportation Survey (NPTS) and the American Travel Survey (ATS)

MODE: Demographic, Multi-Mode	**GEOGRAPHY**: National, state, metropolitan, County,	**USEFULNESS**: Useful	USE WITH MANUAL: Network related
SOURCE: US DOT BTS			
TITLE: Nationwide Personal Transportation Survey (NPTS) and the American Travel Survey (ATS)			
Abstract The 1995 American Travel Survey (ATS) was conducted by the Bureau of Transportation Statistics to obtain information about the long-distance travel of persons living in the United States. The survey collected quarterly information related to the characteristics of persons, households, and tirps for approximately 80,000 American households. The Nationwide Personal Transportation Survey (NPTS) and the American Travel Survey (ATS) are household-based travel surveys conducted every five years by the U.S. Department of Transportation. Survey data are collected from a sample of U.S. households and expanded to provide national estimates of trips and miles by travel mode, purpose, and a host of other characteristics. The emphasis of the NPTS is on daily, local trips while the emphasis of the ATS is on long-distance travel in the United States. These two surveys are being coordinated in 2000. See a PDF of the NPTS/ATS 2000 brochure.			
Source of Data: The NPTS/ATS 2000 is a ONEDOT effort of the Bureau of Transportation Statistics and the Federal Highway Administration.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**:	
First Developed: 1994		**Update Frequency**:	
Number of Records		**File Size**:	
File Format:		**Media**: Internet	
Significant Features and/or Limitations: Pretest Field Materials, NPTS Diary, ATS Calendar, Sample map from the ATS Survey (450 K), Household Interview (MS Word or PDF), Travel Day Questionnaire (MS Word or PDF), Long Trip Questionnaire (MS Word or PDF)		**Corresponding Printed Source**:	
Sponsoring Organization: Department of Transportation, Federal Highway Administration, Highway Needs and Investment Branch		**Performing Organization**:	
Availability:			
Contact for Additional Information: http://www.bts.gov/ats/		**Contact for Additional Information**:	

Occupational Employment Database

MODE: Demographics, flows, etc.	**GEOGRAPHY**: National	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Occupational Employment Database			
CONTENT: Occupational information and company business activities are collected annually by the IRS from tax forms.			
METHODOLOGY: The IRS maintains and updates administrative records on companies and individuals. The occupational information comes from two sources: 1) Form 1040, where individuals fill in a box, and 2) Schedule C (for self-employed persons and sole proprietorships) where individuals fill in a code box for the business activity.			
Example: For the Schedule C, business activity code 6338 is defined as "Trucking, local and long-distance, including trash collection without dump." According to the IRS, 1991 data shows there were 349,327 forms coded 6338 -- a conservative estimate of self-employed independents.			

Occupational Employment in Federal Government

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Occupational Employment in Federal Government			
CONTENT: The Office of Personnel Management (OPM) maintains and publishes a statistical series on Federal employment and payrolls with information by agency, type of position and appointment, and characteristics of employees.			

Operating Permits

MODE: Highway, demographics, flows, etc.	**GEOGRAPHY**: National, state	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Operating Permits			
CONTENT: Registration for operating authority varies from state to state. In general, the data collected include carrier's base of operations, headquarters location, some measure of financial viability, proof of insurance, principal commodity hauled, type of equipment to be used, safety record, and carrier personnel.			
TYPOLOGY MAPPING: For-hire carriers seeking operating authority within states must file varying kinds of reports with state agencies. The required information can provide detail on fleet size, employment, commodity, etc. Government and private fleets are not required to file reports.			

Quarterly & Annual Financial Reports

MODE: Highway	**GEOGRAPHY**: National, state, metropolitan	**USEFULNESS**: Marginal	USE WITH MANUAL:
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Quarterly & Annual Financial Reports			
CONTENT: Balance sheet and income statements with accompanying descriptions of publicly-traded carrier operations as related to financial performance.			
TYPOLOGY MAPPING: Only carriers whose equity shares are traded publicly will be required to file financial reports with the SEC. This includes a few for-hire carriers, and a few private fleets whose trucking subsidiaries are reported as distinct operating divisions.			

Quarterly Financial & Operating Reports

MODE: Highway	**GEOGRAPHY**: National, state, metropolitan	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY			
TITLE: Quarterly Financial & Operating Reports			
CONTENT: Balance sheet, income statement, and operating statistics of motor carriers required to file. Revisions are being made to the structure and definition of the accounts to be reported.			
TYPOLOGY MAPPING: Only Class I & II for-hire carriers which report to the ICC are represented in this detailed database. Class I carriers are defined as having $10 million or more in annual operating revenue. Class II carriers are defined as having at least $3 million but less than $10 million in annual operating revenue.			
AVAILABILITY: Data are available to the public and are compiled by secondary sources. Reports in their raw form are available as recorded by the Interstate Commerce Commission.			

Seven NY Metropolitan agencies truck toll data

<table>
<tr><td colspan="2">MODE: Highway, Multi-Mode</td><td colspan="2">GEOGRAPHY: State, metropolitan,</td><td>USEFULNESS: Useful</td><td>USE WITH MANUAL: Network related</td></tr>
<tr><td colspan="6">SOURCE: NYMTC</td></tr>
<tr><td colspan="6">TITLE: Truck Toll Volumes</td></tr>
<tr><td colspan="6">Abstract: Seven NY Metropolitan agencies truck toll data</td></tr>
<tr><td colspan="6">Source of Data:</td></tr>
<tr><td colspan="6">Attributes:</td></tr>
<tr><td colspan="4">Geographic Coverage of Data:</td><td colspan="2">Time span of Data Source:</td></tr>
<tr><td colspan="4">First Developed:</td><td colspan="2">Update Frequency: Annual and quarterly volume by crossing facility</td></tr>
<tr><td colspan="4">Number of Records: 1979-1997</td><td colspan="2">File Size:</td></tr>
<tr><td colspan="4">File Format: Transport-Truck trips</td><td colspan="2">Media:</td></tr>
<tr><td colspan="4">Significant Features and/or Limitations: Includes the Annual commercial vehicle registration</td><td colspan="2">Corresponding Printed Source:</td></tr>
<tr><td colspan="4">Sponsoring Organization: NYMTC - Monitoring & Analysis Unit</td><td colspan="2">Performing Organization:</td></tr>
<tr><td colspan="6">Availability:</td></tr>
<tr><td colspan="4">Contact for Additional Information: www.nymtc.org</td><td colspan="2">Contact for Additional Information: www.nymtc.org</td></tr>
</table>

Surface Transborder Commodity Data

MODE: Demographics, Flows, etc., Multi-mode	**GEOGRAPHY**: National, state	**USEFULNESS**: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES
TITLE: Surface Transborder Commodity Data
Abstract: The Bureau of Census provides the Bureau of Transportation Statistics with unpublished freight flow data by commodity type of mode of transportation (rail, truck or pipeline) for U.S. exports and imports to and from Canada and Mexico. The purpose of this program is to provide information needed to monitor increased traffic associated with the North American Free Trade Agreement and provide border communities better data to plan transportation improvements.
Source of Data: Bureau of the Census, Foreign Trade Division
Attributes:

Geographic Coverage of Data: U.S., Canada, Mexico	**Time span of Data Source**: 04/93-03/94
First Developed: 1993	**Update Frequency**: Monthly
Last update: 06/93	**Number of Records**: ~1 Million/Month (3/4 Million/Canada; 1/4 Million/Mexico)
File Size: 1.87MB (3 Months of Data, 04/93-06/93)	**File Format**: dBASE
Media: Disk	Significant Features and/or Limitations: Files are organized by commodity detail or by geographic detail to satisfy Census confidentiality regulations.
Sponsoring Organization: Department of Transportation, Bureau of Transportation Statistics	Performing Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division

Availability: DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone (202)366-3282; fax (202)366-3640
Contact for Additional Information: Joel Palley Industry Economist DOT/Federal Railroad Administration, RRP-31 (202)366-0348

Transportation Energy Data Book, Edition 14 Publication

MODE: Demographics, Flows, etc., Multi-mode	**GEOGRAPHY**: National	**USEFULNESS**: Useful, specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Transportation Energy Data Book, Edition 14 Publication			
Abstract: This publication is a statistical compendium containing over 200 pages of tables and figures. It is designed for use as a desk-top reference. The data book represents an assembly and display of statistics and information that characterize transportation activity, and presents data on other factors that influence transportation energy use.			
Source of Data: Collected from various published and unpublished sources.			
Attributes:			
Geographic Coverage of Data: National, Some International		**Time span of Data Source**: 1970-present	
First Developed: 1976		**Update Frequency**: Annual	
Last update: 1994		**Sponsoring Organization**: Department of Energy, Office of Transportation Technologies	
Performing Organization: Oak Ridge National Laboratory		**Availability**: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 5500A, MS 6366, Oak Ridge, TN 37831-6366; telephone (615) 574-5957; fax (615)574-3851	
Contact for Additional Information: Stacy Davis Data Manager Oak Ridge National Laboratory (615)574-5957			

Truck Toll Volumes (NY Metropolitan)

MODE: Highway, Multi-Mode	**GEOGRAPHY**: State, metropolitan,	**USEFULNESS**: Useful	USE WITH MANUAL: Network related
SOURCE: NYMTC			
TITLE: Truck Toll Volumes			
Abstract: Seven NY Metropolitan agencies truck toll data			
Source of Data:			
Attributes:			
Geographic Coverage of Data:		**Time span of Data Source**:	
First Developed:		**Update Frequency**: Annual and quarterly volume by crossing facility	
Number of Records: 1979-1997		**File Size**:	
File Format: Transport -Truck trips		**Media**:	
Significant Features and/or Limitations: Includes the Annual commercial vehicle registration		**Corresponding Printed Source**:	
Sponsoring Organization: NYMTC - Monitoring & Analysis Unit		**Performing Organization**:	
Availability:			
Contact for Additional Information: www.nymtc.org		**Contact for Additional Information**: www.nymtc.org	

U.S. Trade with Puerto Rico and U.S. Possessions (FT-985) Publication

<table>
<tr><td>MODE:
Demographics, Flows, etc., Multi-mode</td><td>GEOGRAPHY:
National, other</td><td>USEFULNESS: Specialized</td><td>USE WITH MANUAL:</td></tr>
<tr><td colspan="4">SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES</td></tr>
<tr><td colspan="4">TITLE: U.S. Trade with Puerto Rico and U.S. Possessions (FT-985) Publication</td></tr>
<tr><td colspan="4">Abstract This publication presents data on shipments to and from, and from and to the United States and Puerto Rico and U.S. possessions. The report shows for each territory by commodity, net quantity, value, vessel value, shipping weight, and air value and shipping weight information.</td></tr>
<tr><td colspan="4">Source of Data: U.S. Customs Service</td></tr>
<tr><td colspan="4">Attributes:</td></tr>
<tr><td colspan="2">Geographic Coverage of Data: U.S., Puerto Rico, American Samoa, Guam, and U.S. Virgin Islands</td><td colspan="2">Time span of Data Source: 1990-1992</td></tr>
<tr><td colspan="2">First Developed: 1990</td><td colspan="2">Update Frequency: Annual</td></tr>
<tr><td colspan="2">Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division</td><td colspan="2">Availability: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)763-5140. Price, $10.</td></tr>
<tr><td colspan="2">Contact for Additional Information:
Yvonne Taylor
Data Manager
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140</td><td colspan="2">Contact for Additional Information:
Gerline Roundtree
Data Manager
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140</td></tr>
</table>

Worldwide Household Goods Information System for Transportation (WHIST)

MODE: Demographics, Flows, etc.	**GEOGRAPHY**: National	**USEFULNESS**: Specialized	USE WITH MANUAL:
SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES			
TITLE: Worldwide Household Goods Information System for Transportation (WHIST)			
Abstract: The WHIST data base provides MTMC with an automated means of acquiring, processing, storing and reporting personal property rate and shipment information. It is a centralized data base of personal property data with the decision support tools necessary to easily retrieve and display this information in a variety of formats. The system is responsible for the acquisition of data from a number of outside sources, assuring validity of the data and formatting and displaying the data on appropriate WHIST hardware components both for use by internal MTMC users and for redistribution to external organizations. This system works in conjunction with the Transportation Operational Personal Property System (TOPS).			
Source of Data: Service finance centers process data.			
Attributes:			
Geographic Coverage of Data: National		**Time span of Data Source**: Latest 4 years	
First Developed: 1988		**Update Frequency**: Monthly	
Number of Records : 6,235,289		**File Size**: 13GB	
File Format: Flat File		**Media**: Tape	
Corresponding Printed Source: MSR-Q Progress Report		**Sponsoring Organization**: Department of Defense, Department of Army, Headquarters, Military Traffic Management Command, Headquarters	
Availability: HQMTMC, 5611 Columbia Pike, Falls Church, VA 22041-5050. Data previously provided under TSC OMNI Contract DTRS-57-89-D-0034 by PRC Corporation.			
Contact for Additional Information: William Jackson, Functional MTMC-IM-D (703)756-1192 Fax (703)756-2871	**Contact for Additional Information**: Robert Dyer, Programmer MTMC-IM-D (703)756-1192 Fax (703)756-2871	**Contact for Additional Information**: Betsy Cunningham, Functional MTMC-OP-CM-O (703)756-1192 Fax (703)756-2871	**Contact for Additional Information**: Irene Stegall, Data Manager MTMC-OP-CM-D (703)756-1192 Fax (703)756-2871

Freight Transportation Data Sources

The key at the top of each page of this appendix categorizes the data in terms of perceived usefulness to the quick response freight modeling process. This is not meant to imply that data items categorized as "marginal" or "specialized" do not have very useful applications in other areas.
Appendix K is divided into four main parts related to their most appropriate application in the quick response freight modeling process:

- Part 1 -- Baselines, forecasts, and growth factors
- Part 2 -- Vehicle miles traveled (VMT) and networks
- Part 3 -- Survey development and other
- Part 4 -- Specialized data sources, organized as air, pipeline, rail, water, and multimodal and others.