An Overview of the Piedmont Triad Freight Model
Freight Model Overview

- Why? - Existing Freight Model and its limitations
- What does an advanced freight model do?
- How does it work?
  - Freight model process
  - Integration into overall regional model
- Where does the data come from?
- What can we do with it
Why do an Advanced Freight Model

“Creating better data and models will enable state, regional, and local planners to better predict freight movement trends, and make more informed project investment decisions.” - PART

“Many current freight demand forecasting models and data sources are more appropriate for passenger transportation than for forecasting freight movements and understanding freight travel behavior.” - FHWA
How did PTRM handle freight?

PTRM used a typical trip-based process:

- Trip Generation (based on employment by type)
- Trip Distribution (based on trip length)
- Time-of-Day (trips are split into each time period)
- Trip Assignment (auto, single-unit, multi-unit)

Nearly every model in the US uses a similar methodology
So what is the issue?

1) Truck trips are not strictly based on employment – commodities are important
2) The interaction between distribution centers and businesses is missed
3) Trips aren’t “linked” – Each trip has no memory

The ability to realistically reflect and analyze freight movements is limited
What do advanced freight models do?

• Represent characteristics of firms and shipments
• Represent supply chains – link buyers and suppliers
• Capture trip-chaining - follow truck “tours” throughout the day
• Differentiate freight versus commercial vehicles - shipments versus goods and services
Types of advanced freight models

• **Supply Chain Models**
  • Tend to be national in scope
  • Some State and Regional examples

• **Tour-Based Models**
  • Tend to be Regional in scope
  • Some State and National examples

• **Hybrid Models**
  • Combined supply chain and tour-based models
  • For regional and statewide planning purposes but with a national component
The Piedmont-Triad Freight Model

Main model components:

• Firm Synthesis
• Freight Truck Touring Model
• Commercial Vehicle Touring Model
What is a tour?

A sequence of trips connecting activities that starts and ends at the same location.
PTRM Freight Model Process

- Synthesizes Firms
- Simulates Freight Touring Trips - truck movements within the PART region that deliver and pick up freight shipments at business establishments
- Simulates Commercial Vehicle Touring Trips - the remainder of the travel of light, medium, and heavy trucks that is for commercial purposes, i.e., providing services and goods delivery to households and services to businesses
- “Aggregates” tours to time periods and reformats for assignment in the passenger trip-based model
Both the freight truck and commercial vehicle touring models follow a similar general sequence:

1. Establish demand
   • freight model – shipment pick up and delivery
   • commercial vehicle model – service activity, home deliveries
2. Estimate activity durations at stops
3. Allocate appropriate vehicles types to support the activity
4. Group and sequence stops into tours
5. Establish time of day
6. Add in intermediate stops for breaks, refueling etc.
7. Finalize the trip timing with both scheduled and intermediate stops
Where does the Data come from?

• Four primary types of data used to develop the freight model:
  • Survey data describing travel behavior
  • National data describing business and freight travel behavior
  • Data describing current demand and transport supply in the region
  • Data describing future demand and transport supply in the region and nationally
Where does the Data come from?

• Survey data describing travel behavior
  • How do trucks travel?
  • Dimensions such as how are trips arranged in tours, what time of day, what type of vehicles are used for different activities

• Sources:
  • Ohio Establishment Survey (2003-2004): 24-hour diaries for drivers at 562 establishments
  • Texas Commercial Vehicle Survey (2005-2006): 24-hour diaries for 1,711 commercial vehicles

• Usage:
  • Model estimation, model calibration
Where does the Data come from?

- National data describing business and freight travel behavior
  - Commodity flow data: Freight Analysis Framework v4
  - Input/output data: Bureau of Economic Analysis Input/Output Accounts
  - Average payloads: Vehicle Inventory and Use Survey
  - Correspondences between industrial classification and commodity coding systems: Census Bureau, US BEA, FHWA, TRB NCHRP/NCFRP reports, RSG
Where does the Data come from?

- Data describing current demand and transport supply in the region
  - TAZ level SE data: from the PTRM
  - Business location data: InfoUSA data
  - Freight node data: Phase 1 survey, InfoUSA data
  - Network travel times and distances: from the PTRM
  - Truck traffic counts at external stations and count stations within the region: NCDOT, etc.
Where does the Data come from?

- Data describing future demand and transport supply in the region and nationally
  - TAZ level SE data: from the PTRM interim and future scenario SE data
  - Network travel times and distances: from the PTRM interim and future scenario networks
  - Commodity flow forecasts: Freight Analysis Framework v4 future year forecasts
What does the output look like?

You can look at all the data the previous model could provide:

- Total Truck Trips by Type
- Overall Vehicle-Miles Traveled
- Truck Vehicle-Miles Traveled
- % of Traffic by model link
- Select Link Analysis
- Overall Truck Demand
What does the output look like?

But now additional data is available for analysis:

• Tabular, disaggregate data from the four model components:
  1. Firm synthesis: firm location database matched to TAZ SE data with additional synthesized variables
  2. Freight demand: annual shipment database for shipments to and from all freight shipping and receiving businesses in the region
  3. Freight truck touring: tour and trip roster database for all freight truck movements to, from, and within the region
  4. Commercial vehicle touring: tour and trip roster database for all commercial vehicle movements within the region
Firm synthesis
Output

Firm location database matched to TAZ SE data with additional synthesized variables
Freight Demand Output

Annual shipment database for shipments to and from all freight shipping and receiving businesses in the region.
Touring Model Output

- Freight truck touring: tour and trip roster database for all freight truck movements to, from, and within the region
- Commercial vehicle touring: same for all commercial vehicle movements within the region
How can these outputs be visualized?

Output dashboard, built at end of each scenario run, provides access to summary charts and maps of outputs from each of the four main freight model components.
Tour Length by Vehicle for Freight Trucks
Trip Duration by Vehicle for Commercial Vehicles
What can we do with it?

• Some examples of analysis we can now do that the old model couldn’t:
  • Commodity/shipment movement changes under different SE growth scenarios
  • Analysis of impacts of new freight intensive development
  • Analysis of impacts of new freight node (e.g., distribution center) development
  • Impacts of regional or large scale modal investments that impact freight mode choice to and from the region
Summary

• Completed model development, validation, and sensitivity testing for the phase 2 freight model
• The freight model offers a significant step up for the PTRM’s ability to answer freight planning questions
• The freight model includes new tools to support output visualization and scenario analysis
• The recommendations for phase 2 (to be presented later) include new data collection, model enhancements, and additional training