White Paper:
Statewide Travel Demand Forecasting

Prepared for:
Meeting Federal Surface Transportation Requirements in Statewide and Metropolitan Transportation Planning: A Conference

Requested by:
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Standing Committee on Planning

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White Paper: Statewide Travel Demand Forecasting

Abstract

This whitepaper reviews recent implementations and innovations in statewide travel demand forecasting within the context of statewide and national transportation planning needs. Recent efforts to upgrade existing models and develop new models were reviewed for major themes. This whitepaper also presents current research initiatives and proposed research topics. This whitepaper concludes that progress in statewide travel demand forecasting is incrementally driven, mainly by practitioners, and that more research and data are needed on long-distance travel.

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Introduction

Statewide travel forecasting models predict all travel in the state, potentially by all modes, for both goods and people. Logically included with statewide models are super-regional models that cover all or parts of multiple states and, possibly, the whole US. The importance of statewide models stems directly from the amount of long-distance and intercity travel in the US. According to the 2001-02 NHTS, just under one-third of all person miles are long-distance (as defined within the NHTS as more than 50 miles), and according to the 2002 Commodity Flow Survey the vast majority of freight ton-miles are long-distance. Statewide models go beyond metropolitan models principally by including larger, if not all, portions of long distance trips and by explicitly including passenger and freight modes for intercity travel.

The field of statewide modeling is still maturing, even though models have been deployed in Michigan and Kentucky for more than 30 years. Almost two-thirds of the states have active modeling efforts, with one or two states completing a new model each year. There have been several important events in the dissemination of information on statewide model development.

- Guidebook on Statewide Travel Forecasting” and Irvine Conference, Transportation Research Circular E-C011, 1999
- Statewide Travel Demand Modeling: Peer Exchange, Transportation Research Circular E-C075, September 2004
- “Statewide Travel Forecasting Models”, NCHRP Synthesis #358, 2006
- TRB Annual Meeting Sessions in 2004, 2006 and 2008
- Meetings of the TRB Subcommittee on Statewide Travel Forecasting Models

The initial motivation for information dissemination was to encourage the development of models in states that did not have them, but a more recent motivation has been to foster research and development to improve models across-the-board. Persistent dominant themes emerged from each of these sessions, conferences and reviews.

- Statewide models have for the most part developed along similar methodological lines to those of traditional metropolitan models; however, there is less certainty as to what should be contained within a statewide model.
- The largest problems in implementing statewide models relate to issues of scale.
- Models from different states vary greatly in complexity, cost and development time.
- Models are most successful when they are able to address statewide priorities as expressed by legislators and other political leaders.
- There are major deficiencies in our data about long-distance passenger travel and rural passenger travel.
- Statewide models are more compatible with secondary freight data sources, such as the Commodity Flow Survey, than are metropolitan models.
- There is keen interest among states (with or without models) in the progress other states have made in deploying models.

The statewide modeler community, centered on the TRB Subcommittee on Statewide Travel Forecasting, is promoting selective research topics to improve the state-of-the-practice. Successes have included multiple NCHRP projects or tasks that have documented the current state-of-the-practice, expanded our knowledge of freight forecasting and outlined a prospective
national travel forecasting model. A recent attempt to include rural and long-distance travel parameters in the scope of the revision to NCHRP Report #365 was, as of this writing, not successful. Proposed research statements are currently pending before NCHRP on improving our knowledge of commercial vehicle travel and statewide model validation standards.

One of the more recent products of this information dissemination is “Statewide Travel Forecasting Models”, NCHRP Synthesis #358. This synthesis is serving as a foundation for further discussions of statewide models, including this white paper. NCHRP Synthesis #358 mainly describes results of a survey done of all 50 states as to their current statewide models and plans for future development of those models. The synthesis gives a snapshot of the state-of-the-practice, and it highlights innovative efforts by a few states in order to give a sense of what the remaining states may want to consider for future enhancements.

The Relationship of Statewide Models to Values

Except for a specific mention of TRANSIMS and for a reference to a research program that could include travel models, the relationship between SAFETEA-LU and travel forecasting is indirect. Models are a means of calculating evaluation criteria, so models are deeply embedded in the middle of the transportation planning process. Models are not essential, and, indeed, many states, large and small, have managed without them. Statewide models have found their niches in many locations by adding specificity to the potential achievement of statewide planning goals. As statewide models are not mandated, nor particularly promoted by the federal government, the life and death of a model is completely governed by how well the outputs of the model address local societal values.

So it is important for model developers to be aware of values for their state transportation plans. It has been stated that there are certain irreducibles which form the basic desires and drives governing our behavior. To these, we assign the term “values”. Whether these values are viewed as inborn and instinctive, or whether they are seen as culturally defined and acquired by people as they grow and learn, values form the basis for perception and behavior (Wachs and Schofer, 1969).

Values can be found in statutes, planning documents, common law, religion, cultural heritage, case law and the US Constitution. Only a small subset of human values pertains to statewide transportation planning. To determine which values are most pertinent it is only necessary to visit a few statewide transportation plans and federal planning guidelines. Table 1 deconstructs goals, guidelines and factors from the US government and four selected states with models.

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1 Rick Donnelly, PowerPoint presentation at the Statewide Travel Demand Model Peer Exchange, Longboat Key, FL, September 2004, briefly summarized in Giaimo and Schiffer, 2005.
TABLE 1  Planning Values as Expressed in Goals and Other Statements in Most Recent Statewide Planning Documents

<table>
<thead>
<tr>
<th>Entity</th>
<th>SAFETEA-LU</th>
<th>Louisiana</th>
<th>Michigan</th>
<th>Florida</th>
<th>Oregon</th>
</tr>
</thead>
</table>
| Values | - Economic vitality  
         - Global competitiveness  
         - Productivity  
         - Efficiency  
         - Safety  
         - Security  
         - Accessibility  
         - Mobility  
         - Protect/enhance environment  
         - Energy conservation  
         - Quality of life  
         - Planned growth  
         - Economic development  
         - Preservation |
|        | - Mobility  
         - Accessibility  
         - Choice/Flexibility  
         - Safety  
         - Environmental responsibility  
         - Innovation  
         - Equity  
         - Service quality  
         - Economic vitality  
         - Environmental preservation  
         - Land preservation  
         - Aesthetics  
         - Fiscal responsibility  
         - Social responsibility  
         - Energy independence |
|        | - Preserve system investments  
         - Protect environment  
         - Strengthen economy  
         - Safety  
         - Security  
         - Mobility  
         - Accessibility  
         - Efficiency |
|        | - Mobility  
         - Accessibility  
         - Economic Vitality  
         - Quality of Life  
         - Efficiency  
         - Safety  
         - Economic expansion  
         - Environment soundness  
         - Energy efficient  
         - Sustainability  
         - Fairness  
         - Security  
         - Choices |

Only a few states with models are listed in Table 1, because the goals and values tend to be repetitive. The order of the listed values is roughly the same as given by the states.

Although not evident in Table 1, values, as expressed in goals and other statements, do not vary appreciably between states with and without models. States vary considerably in how many values are expressed in a plan, perhaps by trading off emphasis against breadth. Table 1 also includes for comparison an extraction of values from the mandated statewide planning factors from SAFETEA-LU, which should logically be incorporated into statewide plans. These federal values constitute an important subset of all values that are expressed in federal legislation, regulation and executive orders. It seems entirely reasonable that research and development of statewide models should be driven by how well or how poorly our current set of models is responding to stated values. A comparison of the values of Table 1 to the NCHRP Synthesis #358 suggests that at least some states have tried to address almost all important values through statewide travel modeling. Conversely, a textbook model with three or four “steps”, modified for statewide application, is unlikely to address many important values.
Deployment of Statewide Models

A map of the United States illustrating model deployment (similar to Figure 1) was first shown in NCHRP Synthesis #358 for Spring, 2005. The map from the Synthesis has been updated to Summer, 2008, by the participants at this TRB Conference and a series of follow-up queries with state DOTs.

Partial models are most often stand-alone freight components. Major changes since 2005 include newly finished or almost finished models in Alabama, Arizona, New Mexico and Utah, and new truck models in North Carolina and North Dakota. Models in Pennsylvania, Wisconsin and Tennessee are now operational. Even though its status on the map has not changed, the Iowa model has progressed from initial scoping stages to being nearly ready for application. Revisions and extensions of existing models are progressing in many other states. None of the previously operational models has gone dormant. There are a total of 35 states with active modeling efforts (developing, revising, or applying). There have also been a number of spin-off modeling efforts, not reflected on the map, where separate models were created from an original statewide model for a special purpose.

Past Research Priorities for Statewide Models

The Peer Exchange made four principal research recommendations, none of which have been fully acted upon.
• The Quick Response Freight Manual should be updated to include rural commercial trip characteristics.
• The US should develop a national passenger travel model to enable quality forecasts of passenger vehicle flows between states. There was a recently completed NCHRP task (Project 8-36, Task 70) to define the scope of a possible national passenger travel model.
• Accepted validation performance standards for statewide models need to be created.
• The American Travel Survey, now 13 years old, needs to be repeated or the NHTS needs to be upgraded to a comparable level of detail for long distance trip making.

As a result of a comprehensive survey of current state practices, the NCHRP Synthesis #358 on “Statewide Travel Forecasting Models” made several additional research recommendations beyond those of the peer exchange.

• As statewide models evolve to the level of precision of metropolitan models, there is a need for a better representation of travel during peak periods. Because of long rural trips, most current models are incapable of correctly modeling peak periods, so traffic assignments require improved ways of dealing with traffic dynamics.
• Better methods are needed to overcome the lack of precision from coarse zone systems.
• Computation time continues to constrain what can be accomplished in a statewide model; faster algorithms, particularly at the traffic assignment step, are desirable.
• Statewide models still rigidly segregate freight by mode. Research is needed regarding how to best handle intermodal shipments that span multiple modes.
• Improvements are needed in knowledge of mode choice for long-distance freight, particularly in the costs of transporting freight by varying modes.
• There is increased interest in obtaining origin-destination tables from ground counts, but the sizes of statewide networks are daunting. Better methods, suitable for large-scale, highly detailed and multiclass models, are needed.
• Innovative methods are needed for combining existing data sources and economic models for filling-in the gaps in the Commodity Flow Survey. The potential of FHWA’s Freight Analysis Framework (FAF) for providing better commodity flow information should continue to be explored. (An FHWA-sponsored project is working on this subject.)
• There is a need for a National Business Travel Survey, analogous to the NHTS, that can shed light on business logistics practices and provide information that can lead to default commercial trip making characteristics for the QRFM.
• University transportation planning curricula should be upgraded to meet the challenges of integrated transportation/land-use/economic-activity models.

Prior to the peer exchange, TRB’s Subcommittee on Statewide Travel Forecasting generated a list of research priorities, some of which have moved forward. The subcommittee requested these actions:

• Perform an analysis of international traffic not included in current flow surveys (addressed by FAF^2);
• Find better ways to model commodity flow traffic attraction for geographical areas of different sizes (efforts are now ongoing to disaggregate FAF^2 origin-destination flow data);
• Determine some of the missing flows in the Commodity Flow Survey, including trash, waste and the mails (addressed by FAF^2);
- Compile and/or collect origin-destination surveys at all state ports-of-entry, both interstate and international;
- Review the various approaches that have been used or could be used to develop and apply mode choice models for passenger travel and freight traffic and to summarize their advantages, disadvantages, limitation, etc. for long-distance applications (long-distance, time-of-day models have been reviewed, see X. Jin, 2007);
- Create a synthesis on statewide travel forecasting (accomplished);
- Develop a national transportation model (just recently studied by NCHRP);
- Perform a survey of GIS applications in travel demand modeling;
- Identify the existence, characteristics and location of data on freight movements for use in statewide travel forecasting;
- Improve passenger travel demand estimation in multimodal, statewide passenger travel forecasting models for use in the statewide transportation planning process;
- Critically review the analytical tools available to states for estimating and depicting the movement of freight over major transportation facilities; and
- Review both current and potentially novel ways of generating both base year and forecast origin-to-destination, statewide freight movement matrices.

The recent TRB conference on freight demand modeling made about three dozen research and development recommendations, many of which apply to statewide models (Meyer, 2008). Here are the most pertinent:

- Create a national freight flow model, presumably a later generation of FAF2;
- Develop a freight-data architecture, leading toward a coordinated data collection effort;
- Create examples and case studies of how to best use secondary data sources;
- Make available a “microdata” set of freight-related demographic information;
- Update freight databases more frequently;
- Determine best practices in truck origin-destination collection methodologies; and
- Create a safety post-processor.

**Components and Resources**

**Critical Data Sources for Statewide Models**

Statewide models tend to lean heavily on borrowed and secondary data sources because surveys for a whole state can be very expensive. The situation with secondary data is improving slowly of late. The last NHTS contained a separate long distance survey, although it was quite modest when compared to the 1995 American Travel Survey (ATS). At this writing a contract is underway to update NCHRP #365, but the update focuses entirely on urban trip making. The Quick Response Freight Manual II has also retained the urban focus of its predecessor, but it has provided new trip distribution parameters and has given some data on truck trips/employee. The recent upgrade of the Freight Analysis Framework, FAF2, has freight origin-destination tables between 114 US regions, broken out by commodity, mode and year through 2035.
**Freight Components**

NCHRP Report #606 and NCHRP Synthesis #358 reviewed several statewide freight models and found that states are able to incorporate forecasts into their plan through one of four categories of analysis.

- **No model.** Specialized studies work from existing proprietary or public databases or from locally collected data.
- **Truck model.** Truck models are used to account for the congestion effects of freight on highways or to help determine single equivalent axle loads for payment design purposes.
- **Commodity-based four-step-model.** Commodity based models follow the same steps as passenger models, except that trip generation is performed for weight of commodities by groups of commodities.
- **Economic activity model.** Economic activity models trace the flows of commodities between economic sectors and between zones. Economic activity models are often implemented within a framework that also forecasts the locations of employers and residences.

Many variations are possible. To this list Donnelly (2008) adds “tour-based microsimulation”, as practiced in Oregon and “sample enumeration”, as practiced in Ontario.

Finally, FAF² might best be described as a commodity-based two-step model, in which existing secondary source data are used to build and factor commodity-based origin-destination tables that can be assigned to national networks, mode by mode.

At this writing, FHWA is sponsoring a project to artificially disaggregate FAF² commodity origin-destination tables from 2002 to the county level, which would be a product for immediate application in statewide freight models.

**Passenger Components**

There are fewer variations from metropolitan models for a passenger travel, with the four-step paradigm remaining intact in most states. However, passenger components still range greatly in complexity from two-steps (e.g., origin-destination table estimation and assignment) to more than four steps (integrated land-use/transportation models). Passenger components are trending toward the level of detail found in metropolitan models by adopting smaller zones within urban areas and by increasing the number of links.

TRB Special Report #288 recently critiqued the current state of metropolitan models and many of those criticisms can be applied to statewide models, as well.

- Time-of-day procedures are not policy sensitive.
- Models are too aggregated for testing many policies.
- Models omit non-motorized travel.
- Models do not correctly represent traffic dynamics.
- Models are built with insufficient data.
- There is a tendency for models to be optimistic.
- There is insufficient quality control.
- Validation suffers from a lack of independent data.
It is important to temper any criticism about statewide models with the knowledge that many states are in their initial, fledgling efforts. Unreasonably high standards should be avoided. Statewide models, in many locales, have not achieved the level of acceptance of their urban cousins. History has shown that statewide models can evolve in sophistication over time, so that it might be best for the statewide transportation community to lay out a direction for model improvement, rather than to define a specific end product.

**Economic Impacts from Statewide Models**

**Economic Development in Statewide Models**

States are particularly interested in how improvements in their transportation systems encourage economic development. Until just recently, any assessments of the economic development potential of a statewide plan were almost entirely judgmental, because there were no reliable methods for tying outputs from statewide models to job creation. Two relatively new software products, LEAP as part of TREDIS from Economic Development Research Group, and TranSight from REMI, have attempted to make this linkage to model output. TranSight evolved from the research in NCHRP Report #463 for urban areas, and LEAP evolved from HEAT in Montana (Horowitz, Jin and Zhu, 2007) and studies in New York (Hodge, Weisbrod and Hart, 2003), Indiana (Gkritza, 2006) and the Appalachian region (Cambridge Systematics, Inc., 2008). Briefly, LEAP follows this logic.

- Businesses will gain employment in direct proportion to operational cost savings from transportation system improvements.
- Business cost savings can be tabulated separately by freight mode (e.g., truck, air cargo and railroad), by county and by industrial category (e.g., three-digit NAICS).
- Business cost savings are proportional to positive changes in various accessibility indices that are calculated from network origin-destination travel times.
- Businesses also will increase employment if there are cost savings to customers and suppliers due to transportation system improvements, also indicated by accessibility indices.
- Only a fraction of the cost savings becomes employment gains.
- Employment gains are sensitive to the cost of doing business in a county and by the availability in a county of an appropriately trained labor force.
- Employment gains within an industry can be constrained by the historic rate of growth nationally or regionally and can be constrained to occur only in industries that are underrepresented in the county.

States have performed additional analyses of the LEAP results with either IMPLAN or REMI’s Policy Insight to determine base multiplier effects. LEAP does not deal explicitly with industrial location and is insensitive to existing land use.

Although the intent and philosophy of TranSight are the same as LEAP, they have fundamentally different structures; LEAP is difficult to briefly summarize in words alone because of its complexity and it peculiar mathematical structure. A brief description of TranSight can also be found in the HEAT evaluation by Horowitz, Jin and Zhu (2007). As compared to LEAP, TranSight works more directly with cost savings by industries, rather than depending upon accessibility equations, and relates those costs saving to industrial production.
functions. Each production function has numerous calibrated parameters. Cost savings can come from commuting costs and from delivery of both final products and intermediate goods.

At this writing Ohio is developing its own economic development model for statewide applications that will capture the same effects as LEAP or TranSight.

It should go without saying ... but statewide models can only properly assess economic impact if they are capable of correctly forecasting the differences in origin-destination trip times across projects and alternatives. As a practical matter this implies that models should have:

- a sufficiently dense road network in urban areas so that v/c ratios are correct;
- a sufficiently small zone size so that route choice is reasonable and intrazonal trips are just a small fraction of total trips, even if the economic impact is evaluated at the county level;
- mechanisms that can correctly assess the delay from signalized intersections; and
- mechanisms that can incorporate the fundamental operational differences between two-lane roads and multilane roads.

Of course, these are readily implementable, quick-wins for many existing models, regardless of the need for economic impact analysis.

**Land Use and Economic Redistribution with a State**

Perhaps the most innovative statewide models that deal with economic redistribution are still those from Oregon and Ohio. Models from these states have land-use allocation steps and were described in depth in NCHRP Synthesis #358. Both models’ freight components also were extensively reviewed in NCHRP Report #606. The freight component of the Oregon1 model was also recently described by Hunt and Gregor (2006) in TRB Conference Proceedings #40. Nonetheless, work is continuing on both of these ambitious undertakings.

**Ohio**

The second phase of the Ohio statewide model has retained its land-use aspects, but the land-use allocation step has been scaled back somewhat from earlier ideas. Rather than a microsimulation for land-use allocation, Ohio has now adopted a pair of models that work in concert to achieve the same result. The Simplified Land Use Model (SLUM) resolves competition for land within constraints and the Simple Economic Allocation Model (SEAM) introduces notions of accessibility. Recently the Ohio statewide model added a railroad network with intermodal connections and also added a bus network. Ohio is currently planning its third version of the model.

**Oregon**

The Oregon statewide travel model, called Oregon2, is now well into its second revision. It was essentially finished in 2006 and has not changed structurally since NCHRP Synthesis #358 was published, but it has been undergoing calibration in the 2007-2008 timeframe, and it has been applied to multiple tasks. The dimensions and extent of the model can be gleaned from a description of the model’s categories during a recent conference presentation (Weidner and Hunt, 2008).

- Activities
- 18 household income/size categories
- 20 industrial sectors

**Commodities**
- 42 commodity groups
- 8 occupations
- 15 services
- 19 floor space types

**Modes**
- Auto: drive alone, shared ride
- Urban transit: Portland, Eugene, Medford, Salem, Corvallis
- Intercity passenger: air, AMTRAK, intercity bus
- Non motorized: walk, bicycle
- Freight: 5 truck weight classes, air cargo, railroad, water, pipeline

**Road Network**
- Approximately 40,000 links
- 2950 “alpha” zones

The Oregon2 model allocates activities to land in steps through time with a simulation preferably occurring yearly. Computation-time difficulties have caused the model to be scaled back to a 12-year time horizon, and the full model is not run for each yearly time slice. In addition, the 5 truck classes have been reduced to two in recent applications. Overall, modelers are satisfied with the quality of the calibration and the reasonableness of the model’s sensitivity.

**Recent Research on Intercity Travel Demand and Long-Distance Trip Making**

Intercity demand modeling, both for passengers and freight, remains an active, but low-key, research area that emphasizes applications or modest extensions of existing methodologies. Issues of mode choice dominate research on intercity travel, although recent studies have touched on destination choice, route choice and time-of-day choice.

**Passenger Models**

“Toward Time-of-Day Modeling for Long Distance Trips”, Xia Jin, 2007. In her doctoral dissertation Jin analyzed data sets from the NHTS and California to gain a better understanding of departure time choice for long-distance travel. The calibration of a logit model of departure time choice revealed that trip duration, activity duration, travel day type, whether traveling with other persons and the presence of young children, were significant.

“Growth Forecasting of Vehicle Miles of Travel at County and Statewide Levels”, Feng Liu, Robert G. Kaiser, Michail Zekkos and Christopher Allison, 2006. In a Pennsylvania study, Liu, et al. tested a variety of linear statistical models to forecast VMT for counties and statewide. Their recommended model included, as independent variables, the forecast year and logarithms of number of households, mean household income and lane-miles per capita.

“Modeling Route Choice Behavior in Multi-Modal Transport Networks”, Piet H. L. Bovy and Sacha Hoogendoorn-Lanser, 2005. Hierarchical nested logit models were estimated from revealed choice data on the choice of route for intercity train trips in the Rotterdam-Dordrecht
region of the Netherlands. Choices were intermodal and covered the whole trip from origin to destination. The nesting structure reflected the differences between access and line-haul modes.

“Stated Preference Analysis of New Microjet On-Demand Air Service”, Srinivas Peeta, Alexander Paz and Dan DeLaurentis, 2007. This paper describes application of the model developed by Peeta et al, 2008 (see next listing).

“Stated Preference Analysis of a New Very Light Jet Based On-Demand Air Service”, Srinivas Peeta, Alexander Paz and Dan DeLaurentis, 2008. This study estimated the probability that air travelers would switch from their current mode to on-demand air service (ODAS) for trips up to 960 km. The study found that travel distance, service fare and level of accessibility were important factors in the success of ODAS.

“Development of Intercity Model Choice Models for New Aviation Technologies: ”, Senanu Ashiabor, Antonio A. Trani, Hojong Baik and Nicolas Karlsson Hinze, 2007a. In a study similar to Peeta, et al. (2008) Ashiabor, et al., applied nested logit models to the 1995 ATS and to their own stated preference surveys to forecast passengers for on-demand air service. They found the main explanatory variables to be travel time and travel cost, stratified by income category.

“Logit Model for Forecasting Nationwide Intercity Travel Demand in the United States”, Senanu Ashiabor, Hojong Baik and Antonio A. Trani, 2007b. This is another paper from the same group (see Ashiabor, 2007a) that discusses the nationwide application of their intercity travel demand model.

“Intercity Route Choice Stated-Preference Model to Investigate Driver Response to Road Pricing”, Dilum Dissayake and Sofia Kouli, 2007. This study used a stated-preference survey to estimate demand for a toll road in Greece. The binary choice between the free road and the toll road had the explanatory variables of travel time, travel cost and road type.

“An Empirical Analysis of the Impact of Security Perception on Intercity Mode Choice: A Panel Rank-Ordered Mixed Logit Model”, Sivaramakrishnan Srinivasan, Chandra R. Bhat and Jose Holguin-Veras, 2006. A stated-preference survey was analyzed to determine the tradeoffs between travel time and feelings of security when choosing intercity travel modes. The study found that feelings of security increased air travelers’ utility, but long inspections times reduced air travelers’ utility.

“The Safety Perceptions of Road, Rail and Air and Their Implication on Travel Choices”, R. R. Liu and G. Li, 2005. This study added perceptions of safety and reliability to a traditional intercity model choice model, as ascertained from a stated-preference survey of travelers between Washington DC and New York City.

“A Study of an Integrated Intercity Travel Demand Model”, E. Yao and T. Morikawa, 2005. These authors used a nested framework to model the combined choice of mode, destination and route. Both revealed and stated preference data were used in estimating coefficients. The model contained the ability to estimate induced demand. The model was applied to high speed rail service in Japan.

“Modeling Side Stop Purpose During Long-Distance Travel Using 1995 American Travel Survey”, Jeffrey James LaModia and Chandra Bhat, 2007. The choice of a side stop was modeled by these authors using a mixed multinomial logit framework. Side stop choice was found to be sensitive to the purpose of the main trip and whether the trip was a planned vacation.
“Choice of Mode of Transport for Long-Distance Trips: Solving the Problem of Sparse Data”, Andres Monzon and Alvaro Rodriguez-Dapena, 2006. This paper demonstrated how it would be possible to employ a choice-based sampling scheme to obtain data for calibrating an intercity mode split model. The scheme needed to correct for biases that can occur because of the lack of coverage of many origin-destination pairs. The methodology was tested on the Madrid to Barcelona corridor.

“Temporal Transferability of Long-Distance Trip Rates”, Jeffrey Henderson and Antonio A. Trani, 2008. This study compared long-distance trip rates, for both business and non-business travel, estimated from 1977 to those from 2001. The estimation of rates included income and education. The authors concluded that the rates could not be transferred because of changes in service quality and destination attractiveness.

**Freight Models**

“Analysis of Route Choice Decisions by Long-Haul Truck Drivers”, John H. Knorring, Rong He and Alain L. Kornhauser, 2005. This study looked at how truck drivers trade off time and distance while choosing routes. A logit model was created from revealed preference data to predict the likelihood of a driver taking an alternate intercity route. The model was applied to estimating the traffic on a bypass given the perceive speed of travel through a downtown area.

“Logistics Costs Based Estimation of Freight Transportation Demand”, Michael Gorman and Daniel G. Conway, 2005. This study estimated the potential demand for full truckload and for intermodal service for the western US. Potential demand was determined from the minimum logistics cost for a mode between a given origin and destination.

“Evaluation of Practice Today” in Freight Demand Modeling: Tools for Public-Sector Decision Making, Huiwei Shen and Rick Donnelly, 2008. These authors wrote separate short articles that were organized together under the same title. Shen reported on the Florida statewide freight model. Donnelly commented on the range of statewide freight models, as well as metropolitan models.

“State of the Practice in Freight Modeling at State Departments of Transportation” in Freight Demand Modeling: Tools for Public-Sector Decision Making, Greg Giaimo, 2008. This article is a brief review of the range of statewide freight models.

**Recent Research on the Deployment and Use of Statewide Travel Forecasting Models**

Research on statewide models, as a whole, is dominated by practitioners. Since most practitioners do not have a strong incentive to publish their findings, it is likely that many valuable innovations are not finding their way into the archived literature.

“A Tiered Approach to Validating the Integrated Florida Statewide Model”, Robert Gregory Schiffer, Huiwei Shen, Yongqiang Wu, Konald Kenneth Kaltenbach and Thomas Rossi, 2007. This study divided validation into three phases: system-wide, district-wide (for each of FDOT’s seven districts) and corridor-level. Comparisons were made to the outputs of district models, as well as performing traditional checks of network and zonal outputs for corridors.

“Validation of Pennsylvania Statewide Travel Demand Model”, Mark Radovic and Larry M. King, 2007. This paper describes the Pennsylvania model, which includes toll diversion, and
describes how a volume refining technique from NCHRP #255 was incorporated directly into the model sequence. The model was validated at 8500 counting stations, with statistics presented in the paper.

“Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study”, Cambridge Systemics, Inc., et al., 2007. This study created separate but integrated interregional and intraregional models. The interregional model had components for the choice of trip frequency, mode and destination. Frequency and destination were multinomial logit frameworks. Mode was divided into line-haul choice and access mode choice. Both of these mode choice frameworks were nested logit.

“Developing a Statewide Travel Demand Model from a Person-Based Time Series Household Survey”, Scott Thompson-Graves, Mike DuRoss, Edward C. Ratledge and David P. Racca, 2006. This paper describes the use of a cost-effective household survey technique in Delaware. The survey has been conducted yearly since 1995, but it asks for full trip diary information from only one household member. Adjustments are required to use this data for model calibration.

“Developing a Toll Demand Model for DelDOT’s Statewide Travel Demand Model”, Scott Thompson-Graves, Michael DuRoss and Li Li, 2008. This study extends an existing nested logit framework to incorporate the choice between “no toll” and “cash/E-ZPass” for both SOV and HOV highway users. An E-ZPass ownership model was also developed.

“Wisconsin Passenger and Freight Statewide Model: Case Study in Statewide Validation”, Kimon Proussaloglou, Vasasvi Popuri, Daniel Tempesta, Krishnan Kasturirangan and David Cipra, 2007. This paper describes the Wisconsin model in some detail and gives validation statistics.

“Univariate Sensitivity and Uncertainty Analysis of Statewide Travel Demand and Land Use Models for Indiana”, Li Jin and Jon D. Fricker, 2008. This paper shows how an integrated model responds to variations in input data and parameters that might be caused by random events or other uncertainties. The principal technique is sensitivity analysis.

“Developing Statewide Weekend Travel Demand Forecast and Mode Choice Models for New Jersey”, Rongfang Liu and Yi Deng, 2008. This paper discusses the need for an enhanced model that includes weekend travel.

“Florida’s Turnpike State Model: Development and Validation of an Integrated Land Use and Travel Forecasting Model”, Thomas Jay Adler, Youssef Dehghani, Michael Doherty and William Olsen, 2007. This paper describes the development and validation of a second Florida statewide model, specifically designed for evaluating toll highways. A prominent feature of this model is its reliance on secondary data sources.

“Enhancing MPO Travel Models with Statewide Model Inputs: Application from Wisconsin”, Kimon Proussaloglou, David Cipra, Bruce Aunet, Dan Tempesta, Derek Hungness and Jerry Shadwald, January 2006. The paper reports on how statewide and metropolitan models are linked in Wisconsin. It shows how statewide models can be enhanced by using metropolitan-level network data, and how metropolitan models can be enhanced by taking origin-destination tables from the statewide model.

“Applying the Texas Statewide Analysis Model: Cross-border Commercial Vehicle Model for El Paso, TX”, William Smithson and Joseph Savage, 2006. This presentation described the
combined use of statewide and metropolitan models to forecast truck traffic between El Paso and Juarez. The procedure extracted El Paso truck origin-destination flows from the statewide model and disaggregated them (using vehicle classification counts and employment) so they could be integrated into the metropolitan model.

“Using a Statewide Model to Analyze Truck Traffic for the I-81 Corridor Study in Virginia”, Paul Agnello, 2006. This presentation was a description of the model and an application. Truck origin-destination flows were obtained from a commercial data source and then massaged to match traffic counts in order to properly account for empties.

Continuing and Fledgling Efforts

The presentations at this conference by people now involved in initial statewide model development indicate that a great deal of thought is being put into the effective use of existing resources and into keeping the modeling efforts within practical budget and time constraints. Conference participants heard about model developments in North Carolina, Georgia, Maryland, New Mexico, Iowa, Utah, North Dakota, Ohio, Appalachia, Wisconsin, Delaware, California, Tennessee, Texas and Kentucky. These presentations showed a very diverse set of approaches to statewide models. However, there were several cross-cutting themes.

- States have been appreciative of the information dissemination activities of other statewide modelers, particularly mentioning NCHRP Synthesis #358.
- States reaffirmed the need for stakeholder outreach to help determine the correct structure and level of detail for their models. MPOs were considered to be important stakeholders.
- While the impact of TRB Special Report #288 is still being keenly felt by those doing urban models, experts who are familiar with this report have had a difficult time assessing its direct impact on statewide models.
- Modeling software platforms have been selected largely as a matter of convenience to be consistent with the majority of MPO models in the state or to be able to gain quick access to a particular data source.
- States are well aware of the impact of budget limitations on the scope of their modeling activities, with some states even opting for synthetic origin-destination table estimation to keep their models at the lowest cost. States that adopted such low-cost strategies are also well aware of their models’ lack of sensitivity to certain policies.
- Most of the new and upgraded models still have three or four steps, generally consistent with urban models. The gravity model remains in use for trip distribution. Some models are segregating trips into purposes according to whether trips are long-distance or short-distance.
- Many states are using FAF$^2$ commodity flow tables and networks, even though the zone structure for those tables is coarse. States have found ways of disaggregating the commodity flow tables down to smaller spatial units in order to match their own traffic analysis zones.
- The idea of a “master” network, one that contains all alternatives that can be switched on or off, is gaining popularity among statewide modelers.
- A small number of states have simplified their models to improve computation times or to achieve better compatibility with existing data sources. Kentucky has aggressively streamlined its model particularly to improve the process of its calibration to traffic counts.
• A prevalent strategy of model building is to stitch together MPO models, perhaps with aggregated zones, and filling-in rural areas with state- or national-source networks. A “stitch” strategy can result in very large networks and may not be appropriate for every state.

• A popular method of dealing with external travel is a zone system that consists of dense pattern of internal zones, a moderately dense halo just outside the state, and a coarse set of zones (built up from states or BEA regions) for the rest of the continental US or all of North America. External stations are not used in such a framework.

• Although intended for urban applications, parameters from NCHRP Report #365 have been occasionally used as defaults for statewide models, either directly or for seeding synthetic origin-destination tables.

• States are inconsistent with each other in their applications of the mode split step. Mode split steps range from complex nested-logit formulations to no mode split step at all.

• Base year economic data and economic forecasts have been purchased from private vendors, even though economic forecasts are readily available from the BEA. Forecasts differ considerably depending upon the vendor.

• Statewide models are not yet competitive with urban models for local planning purposes, although statewide models have been used for addressing local problems when the study area was not adequately covered by an MPO’s model. The Wisconsin model was deliberately reduced in detail so as to not compete with the model maintained by the Southeastern Wisconsin Regional Planning Commission.

• A national model, should one be developed, would assist states in dealing with external areas, would facilitate quick construction of multistate corridor models and would allow for analysis of issues that span many states, such as greenhouse gas emissions and evacuations.

• Newly developed models have placed the greatest emphasis on obtaining fundamental outputs, such as traffic volumes. Less emphasis has been placed on post-processors for socio-economic and environmental impact. HERS-ST was mentioned as a possible post-processor in the context of the Georgia model.

Given the fairly sizeable number of states giving presentations, the absence of substantial discussion of certain topics is noteworthy. Some topics might have been omitted because they are considered old-hat or a side issue or an uninteresting detail; other potentially worthy topics might have been omitted because there was very little to report.

• There was no mention of certain innovative or cutting-edge methods of travel forecasting as identified in TRB Special Report #288, such as activity-based models, better congestion relationships and traffic dynamics. Road pricing and freight, two common deficiencies in urban models brought up by TRB Special Report #288, have been incorporated into many statewide models.

• There was little mention of validation standards and no mention of sensitivity analysis or peer reviews.

• There was no mention of traffic microsimulation, although Ohio uses microsimulation techniques in its demand-related steps.

Finally, none of the newly develop models have scopes that are as comprehensive and as far-reaching as those in Oregon and Ohio.
Other Roles of Statewide Models

The possible roles of a statewide model are directly tied statewide to plan values. Economic and land-use impacts have been dealt with earlier. Other critical roles relate to estimating the impacts on mobility, accessibility, the environment, security and safety.

A World View of Statewide Models

Statewide models would logically fit within a framework that also contains world, national, super-regional and statewide models. According to Schiffer (2008, personal correspondence) there currently are super-regional models for the I-10 corridor, the I-95 corridor and the Appalachian Development Highway System. A national freight model, albeit limited in functionality, already exists in FAF². A national passenger model is under consideration by NCHRP.

There are three generally accepted methods of interfacing models for different geometric scales:

- An integrated halo of dense zones and links surrounding the internal area of the model;
- An integrated skeletal network of large zones and long links that extends considerable distances from the internal area of the model; and
- An interface at external stations, where a larger-scale model supplies an E-E trip table to a smaller scale model (see Proussaloglou, et al., 2006 for an example).

None of these methods require especially unusual technology, although the third interface method (external-external trip table) usually requires excellent cooperation between agencies and typically is not automatic. The interface between statewide and metropolitan models must overcome expected differences in network topology and time periods of analysis (e.g., 24-hours v. peak hour). Ideally, the use of statewide model results in metropolitan models would require a reasonable degree of compatibility in trip purposes, vehicle classes, analysis periods, forecast time horizons and network density. Since more detail is associated with smaller geographies, this means that the statewide model should match the needs of the metropolitan model and not vice versa. A similar argument extends to the interface between a national model and a statewide model.

A world travel model has not received much discussion, but the mere mention of “global competitiveness” in SAFETEA-LU suggests that developers of statewide models will need to routinely think beyond our national borders. Not only are there many well-publicized local concerns about traffic and land-use around and between ports-of-entry, but there are concerns of redistribution of freight traffic within the US due to shifts in international trade. An international trade model, such as GTAP (Global Trade Analysis Project), could provide important insights.

Effect of Fuel Prices on Travel

We have not had enough experience with high fuel prices in the US to fully understand the long-term impact on travel, although the short-term impacts in 2008 have been quite dramatic. The oil shocks of the 1970’s were too short-lived to provide any meaningful lessons. Prevailing theories of urban travel suggest that people will accommodate high fuel prices in numerous ways, including buying smaller automobiles, increasing ridesharing, increasing use of public transit, making more efficient trip tours, selecting closer destinations, foregoing discretionary travel and relocating housing closer to desired activity sites. However, since many of these
mitigating effects do not apply to long-distance and intercity travel, statewide modelers have a special challenge, beyond urban modelers, to account for increased fuel prices in statewide transportation plans. It is fair to say that if high fuel prices persist, many of our existing forecasts of long-distance travel will be obsolete.

Other Planning Needs beyond Economics, Mobility and Accessibility

All statewide travel forecasting models are capable of forecasting passenger car volumes on network links for a 24-hour time period. At the time of the writing of the NCHRP Synthesis #358, only nine states calculated air pollution emissions, just two states calculated greenhouse gas emissions and two states calculated crash reduction. The list of values found on Table 1 would suggest that there are unmet needs in many states for good outputs related to greenhouse gas emissions, ozone-forming pollutants, energy consumption, security (including evacuations) and safety. Fortunately, experience with urban models suggests that many of these impacts do not require much more capabilities than our current set of models already have. Postprocessors for chemical emissions of various types work primarily with volumes and speeds, either at the origin-destination-level or at the link-level.

Visualization of planning data is another recent federal requirement. Fortunately, statewide models are generally well integrated into GISs, so visualization capabilities are close at hand. A recent presentation in Ohio (Ohio Statewide Traffic Forecasting Model: Available Inputs/Outputs and Analyses, March 2007) illustrates the effectiveness and variety of model visualization techniques. Some of the displays include statewide maps showing:

- Modal networks, including intermodal terminals and signal inventory;
- Demographic densities;
- Environmental and infrastructure constraints on land development;
- Attractiveness variables for development;
- Interaction of the state’s economy with the rest of the US;
- Changes in commodity production;
- Current land use;
- High volume roads;
- Flows on major roads;
- Change in traffic flow over time;
- Demographics within buffers around priority corridors;
- Before and after comparisons;
- Travel time isochrones; and
- Locations of household travel surveys.

Visualization with GISs ties in nicely with the need to meet environmental justice requirements. Statewide models can offer a broader perspective to environmental justice that can be achieved by metropolitan analysis, only.

Conclusions

Measurable progress has been made in advancing the state-of-practice in statewide travel demand models over the last 3 years. Part of this progress can be attributed to the community of modelers who have sent a unified message to those doing and funding research. Progress, thus far, has been incremental rather than revolutionary. Methodological advances in passenger
demand forecasting are still being adopted primarily from metropolitan models. However, statewide freight demand models are largely ahead of metropolitan freight models.

The best of the statewide models are well positioned to aid decision making about new or upgraded facilities and policies. Models are also well positioned to provide information on impacts of statewide plans, such as economic development potential, air pollution impacts, energy impacts, greenhouse gas emissions and equity. Statewide models are important tools for achieving statewide planning goals and federal planning requirements.

The current level of research on long distance travel is modest, at best. The lack of recent data on long-distance and rural passenger travel remains a stumbling block.

States are trying to be cost-effective with their statewide model development. The aggressive modeling approaches seen in Oregon and Ohio have not been copied by states who have built new models since the publication of NCHRP Synthesis #358. States are being appropriately cautious in introducing innovative methods, adopting a wait-and-see attitude.

References


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