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Statewide Travel Demand Modeling

A Peer Exchange

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Statewide Travel Demand Modeling

A Peer Exchange

Longboat Key, Florida
September 23–24, 2004

Assembled by
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For the
Transportation Research Board
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Introduction and Purpose

The Transportation Research Board Committee on Statewide Multimodal Transportation Planning (ADA10) and the Federal Highway Administration sponsored a national Statewide Travel Demand Modeling Peer Exchange in Longboat Key, Florida, September 23–24, 2004. The states represented in the peer exchange had a wide range of experiences with statewide travel demand models (TDMs)—some had never considered a model, some were debating the development of a model, some had attempted to develop a model with limited success, and others were actively using a model in many aspects of state planning and operation. The participants discussed their statewide models (if they had one), the purpose and use of models in their state, problems and limitations of the model, and plans for future improvements.

This document was assembled from responses submitted by the various participants. Most of the responses were received from state departments of transportation and this document focuses on a presentation and comparison of the modeling efforts in these various states. This comparison is not meant to be all inclusive as a number of states with important statewide modeling efforts are not included either due to their own inability to participate or the constraint on the number of participants.

TABLE 1 Participants

Participant	Affiliation
Rob Schiffer	Cambridge Systematics
Wade White	Citilabs
Tim Baker	Colorado DOT
Bob Gorman	FHWA
Nancy McGuckin	FHWA
Supin Yoder	FHWA
Huiwei Shen	Florida DOT
Steve Smith	Indiana DOT
Rob Bostrom	Kentucky DOT
Eric Kalivoda	Louisiana DOT
Bob Frey	Massachusetts DOT
John Miller	Missouri DOT
Subramanian Sharma	New Hampshire DOT
Bob Miller	New Jersey DOT
Greg Giaimo	Ohio DOT
Bill Upton	Oregon DOT
Rick Donnelly	Parsons Brinckerhoff
Alan Horowitz	Horowitz University of Wisconsin–Milwaukee
Michael D. Nichols	Virginia DOT
Charlie Howard	Washington DOT
Donald Uelmen	Wisconsin DOT
Tom Cooney	Wilbur Smith

The report is organized as follows. Section 1 is this introduction. Section 2 summarizes the participants' responses regarding the status of their statewide modeling efforts. The states are listed alphabetically and each follows a standard format beginning with a general description followed by information related to seven topic areas:

1. Data requirements
2. Maintenance/use
3. Implementation
4. Scale/level of detail
5. Statewide/urban model integration
6. Freight/commercial vehicle modeling
7. Long-distance/recreational/tourism travel

Section 3 provides a tabular comparison of various specific features of the statewide models. This comparison was mainly drawn from a set of specific questions that was included with the list of major topic areas above. The responses to those questions are contained in Appendix B. In many cases those responses had to be interpreted or combined with information provided elsewhere to adequately complete the tabulation.

Section 4 contains a summary of the discussion held during the Statewide Model Peer Exchange. Each participant made a brief presentation to further describe the status of statewide modeling and responded to questions from other participants.

Section 5 provides a discussion on the ranking of future research efforts and includes four statements on the four highest ranked research needs identified by the participants.

Finally the report contains two appendices. Appendix A is the agenda for the peer exchange and Appendix B is the detailed questionnaire responses as previously discussed.

Perspectives on Statewide Modeling

As discussed in the introduction, this section presents the various statewide modeling efforts of the peer exchange participants. Before proceeding to the individual states, a few general observations are in order.

In most instances, statewide modeling efforts are a recent phenomenon (last 10 years). Early attempts in a number of areas some 30 years ago were largely unsuccessful. In Ohio's case this seems to have been due to two factors: lack of a strong enough motivating factor for the model and inapplicability of urban model techniques at a statewide level. The current round of model efforts appears to have coincided with the advent of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), providing both motivating factors as well as renewed interest in traffic modeling in general which has begun producing techniques which hold promise at a statewide level. Even so, this field is still largely unexplored and fraught with dangers. Some states such as Colorado have considered statewide models but not embarked upon them due to the uncertainties of a useful payoff and risk of failure. Some models have been developed and abandoned. Others seem in imminent danger, such as in Missouri. Still others seem to be accepted but produce results which are regarded with great skepticism. Finally, others seem to be in a continuous state of development with the big pay off always just around the corner (this category includes almost everyone else).

The various statewide modeling efforts can be categorized based on how (and if) passenger and commercial vehicle travel is handled. The first group is states which have opted not to pursue statewide models as represented by Colorado and Washington among the peer exchange participants. The second group is states which have built traditional four-step style TDMs following the urban paradigm. The passenger travel models of this group have largely been built from scratch (New Hampshire, Massachusetts, Missouri) possibly using zonal data/geography from metropolitan planning organization (MPO) models while that in New Jersey was built entirely from MPO models. These models are characterized by either having no representation of commercial vehicle traffic (New Hampshire, Missouri) or a non-commodity–based approach using quick response techniques (Massachusetts, New Jersey). Special representation of long-distance/tourism travel is not accounted for in this group. These models can be seen to fall squarely in the realm of urban regional modeling and successful applications have only occurred in relatively small states. The third group has attempted to depart from the urban model paradigm in a limited way. These models are usually developed independent from their state's MPO models except Florida whose passenger models use the data and some of the components of the urban models. Some representation of long-distance/tourism travel is superimposed on the tradition urban type trip purposes in these models. In most cases the data for these models comes from the American Travel Survey (ATS) or its successor though in the case of Indiana a statewide household survey included long-distance travel components. Commercial vehicle travel in these models is typically commodity-based using the TRANSEARCH database except in Indiana. These models use traditional techniques to generate and distribute commodities which are then converted to truck loads typically using factors derived from the Vehicle Inventory and Use Survey (VIUS). Since this freight only accounts for a fraction of the actual commercial vehicle travel these models must then account for the remaining travel using either quick response techniques alone (Florida, Wisconsin) or in combination with matrix estimation (Kentucky, Louisiana, Virginia). In Indiana, matrix estimation and growth factor techniques are applied to a truck trip table whose genesis can be traced to a commodity flow table produced by Indiana University. The fourth and final group might be called the O-Models (O stands for omnimodel, but it can also stand for Oregon, Ohio, or "Oh my God, what have I gotten myself into?"). These models attempt to depart in a major way from the traditional paradigm using integrated land use–transport–econometric modeling. An attempt is made in these models to account for all aspects of travel demand at a behavioral level. They are characterized by the use of large amounts of purpose collected data, long development time, and high cost. If successful, these models, or some components thereof, point the way to the future, particularly if some of the data are found to be transferable. While the models being developed for the two states in this group have many similarities (due in no small part to the use of the same consultants), there are important differences with the Oregon effort being a purer application of the principals being developed while the Ohio model takes a more pragmatic approach.

Regardless of type, most of the models developed have been initiated by staff in response to corridor or statewide system analysis needs formerly carried out using consultants or ad hoc techniques. The main exception to this general theme is Massachusetts which developed its model primarily for air quality conformity purposes. The participants have mentioned a number of lessons learned; the main ones follow:

- Consensus–support–interaction with decision makers, experts, users, etc., is needed for success.
- Costs and manpower requirements are easy to underestimate.
- If you don't have good data, you don't have a good model.

On the data side, the participants listed a number of data items that were somewhat lacking. These fell in three main groups:

- Poor external travel data/need for intercept surveys;
- Need for better commercial vehicle data especially on intermodal movements, containerized freight, and non-freight commercial travel; and
- Need for more complete employment data.

An alphabetical state-by-state listing of statewide model efforts follows.

COLORADO

No formal statewide model currently available or being developed. A geographic information system (GIS) network for the state highway system is maintained along with a database including a variety of traffic variables.

Traffic projections (for state highway segments mostly) are currently obtained using by-directional annual average daily traffic (AADT) and 20-year growth factors developed using trend analysis. Growth factors are also used to forecast volume to capacity (V/C) ratios.

Future development of a formal statewide model remains under consideration. The primary impediments to moving to a statewide model include, cost, manpower, accuracy of data and precision of the data.

For data regarding the state highway system roads, segment AADTs are updated every year based on

- Available automatic traffic recorders (ATRs) (less than 3% of the total road segments).
- Short-term volume counts (40% to 50% of the highway segments). Weekly factors obtained from the ATR sites for the different seasonal groups are used along the 24- and 48-h counts to estimate AADTs.
- Trend analysis for segments without a volume count for the current year. Exponential smoothing is done with historical volumes for the last 5 years using a damping factor of 30%.

Twenty-year factors are obtained from available historical segment volumes for the last 34 years as well as available growth projections from MPOs. AADTs are then multiplied by this 20-year factor to estimate volumes for scenarios 20 years into the future and linear interpolation is used to forecast volumes for scenario years other than 20 years. We also include 20-year factor data from the MPOs.

V/C ratios for every road segment are calculated every year as a measure of congestion for a representative design hour. AADTs are multiplied by a design hourly volume factor and a directional distribution factor, and then divided over the hourly directional capacity.

Data collection and maintenance costs for the permanent volume and classification counters are about $150,000 per year and six full-time employees (FTEs).

The cost for short-term volume and classification counts is about $200,000 per year and requires five FTEs.

FLORIDA

Florida has a functional TRANPLAN-based statewide model. It was developed in the late 1980s, but was updated in the late 1990s. The model is based largely on the urban area models, and aggregates urban productions and attractions to statewide travel analysis zones (TAZs). It then adds some trips for rural areas and external travel, and performs a statewide distribution and assignment of vehicles. The statewide model has 540 TAZs. This TRANPLAN-based model was extended to the 4,000 zone systems and a more detailed network. However, the newer TRANPLAN-based model was not fully calibrated and validated.

The Florida Model Task Force adopted TransCAD as the new engine for FSUTMS (Florida Statewide Urban Transportation Modeling System). We are currently working on the calibration and validation of the TransCAD-based statewide passenger model.

Florida also has a functional Statewide Intermodal Highway Freight Model that tracks intercity freight movements. Work is being done to implement this model in TransCAD and to account for all trucks instead of just freight trucks. The Florida Statewide Passenger and Freight Models will be integrated based on the same zonal system and the same network structure.

Like many statewide model, Florida’s models has a lot to be desired in terms of absolute accuracy. However, it has proven to be a useful tool for intercity analysis. The model now is being greatly enhanced, and will function in a TransCAD environment.

Data

Florida has taken the approach to use urbanized area data wherever possible. But there is a distinct lack of comprehensive long-distance travel data. The new passenger model will add a long-distance travel component, based primarily on existing tourist data. Similarly, the model will be coordinated with the commodity flow model to add a truck purpose. The primary source of freight flow data has been Reebie. While there are some deficiencies in Reebie, it is unlikely that another comprehensive data source will be developed in the short-term.

Current efforts with the statewide models are focused on refining the highway network in terms of centroid connectors and compatibility with the TAZ system, and adding a long-distance travel component.

Maintenance/Use

The model is being developed in a series of consultant contracts and university research. It is being used for statewide planning, and planning for the Turnpike District.

Implementation

Currently, the model is being enhanced in an evolutionary process. Some major lessons follow:

- Need to spend more time on TAZ and network development;
- Coordinate networks and TAZs;
- Choose software platform before beginning model development; and
- Assemble long-distance travel data.

Scale/Level of Detail

There are 3,974 TAZs: 3,519 are urban, 395 are rural, and 60 are external. Chosen to conform well to 2000 census geography and MPO TAZ systems, MPO TAZs are aggregated to the statewide system. More TAZs were deemed to cumbersome.

Statewide/Urban Model Integration

- No formal integration other than the model uses the urban area trip generation procedures to estimate urban productions and attractions. TAZs are compatible.
- Results of the statewide model are used in the estimation of external station data for some urban models.

Freight/Commercial Vehicle Modeling

- The model only assigns truck trips but does have a mode choice module.
- The major modes include carload rail, intermodal rail, and truck. These modes are in Reebie and are the major components.
- The model is based on commodity flows.

- The model contains a tons-to-vehicle model that is a function of distance and commodity based on the VIUS.
- Statistical analysis of Reebie.
- Work being done currently involves the quick response method to generate non-freight truck trips.

Long-Distance/Recreational/Tourism Travel

This category is under development using existing data sources.

INDIANA

Indiana DOT (INDOT) has been involved in statewide modeling for several years in support of the I-69 corridor study and for our long-range plan development. The initial use of the model was for economic analysis of major intercity corridor improvements. We are currently receiving a new upgraded model from our consultant team and beginning training in model applications using the new model.

The Indiana statewide model began with the congressionally mandated I-69 study in 1989. The congressional mandate was to study both user and economic development benefits of the highway improvements. The approach INDOT wished to pursue was based upon an Wisconsin corridor study which used a economic simulation model (REMI) to estimate the impacts of vehicle miles traveled (VMT) and vehicle hours traveled (VHT) of future alternatives. This required a travel demand simulation model. The 1990–1991 corridor study used a Cambridge Systematics–developed TRANPLAN model which covered about two-thirds of the state. Also in this same timeframe INDOT was involved in a 1993 State Planning and Research (SPR) project to develop a statewide commodity flow model with the Indiana University Research Center using TransCAD. The statewide modeling approach was successful and led to the development of a full TransCAD-based statewide highway model in a following economic development study: the Major Corridor Investment Benefit Analysis System (MCIBAS) in the 1995 to 1997 period. This model covered the full state of Indiana and consisted of 761 zones and the 12,000-mi state highway network. The model was based on an incremental modeling process which promised to reduce data collection needs by using a synthetic trip table estimation process using origin–destination matrix estimation (ODME) TransCAD procedures and extensive INDOT ground counts. Trucks trips were developed from the Indiana University Commodity Flow model. This model was also used in the environmental study on the I-69 corridor (1998) and provided future travel volumes for a statewide interchange study. The environmental study for I-69 was re-scoped and an enhanced statewide model was developed which added more network and zonal detail in the I-69 corridor area in southeastern Indiana and expanded the model to cover portions of the surrounding states. The number of zones increased from 761 to 842. In addition the modeling process moved from the incremental modeling process to a true four-step model using the four-step trip generation, trip distribution, modal split, and assignment process. This model was further enhanced in the 2003 period by expanding the model detail found in the I-69 corridor to the entire modeling area and improving the trip generation procedures. The number of zones increased from increased from 842 to 4,720.

Data

The initial development of the incremental model was intended to minimize data collection costs via the ODME trip table simulation approach and the development of the future travel demand increment. This process had the drawback of not being linked to the land use/socioeconomic zonal data as a validated model. The lack of external trips and an inventory of through truck trips has been a problem. Indiana is one of the states which cannot stop traffic to conduct roadside interviews. Employment data were also an issue. Due to confidential issues we were not able to obtain ES-202 data during the initial model development and were required to spend $60,000 for Dun and Bradstreet data. This issues has since been resolved and we currently are able to use ES-202 data. It was decided to invest additional resources to develop a four-step model which would be able to be validated. Data continues to be a major issue and we continue to attempt to use innovative approaches to lower costs.

Maintenance/Use

INDOT uses extensive consultant support to for the model development process, to maintain the model, and for modeling applications. The primary application of the INDOT statewide model has been the I-69 environmental study development, corridor/statewide economic analysis studies, and use in the developing the project specific INDOT 25-year long-range plan. The model also provides a data input file into the FHWA Highway Economics Requirements System (HERS/ST) Indiana state model. Currently, the long-range planning section has limited staff resources with the primary mission focusing on the development of long-range plan projects, corridor planning studies, and management of consultant-conducted statewide planning studies (access management, interchange improvements, and new developments). The ability of the in-house staff to use the model for more extensive applications is a challenge due to the continuing modeling enhancements coming out of I-69 corridor work, the lack of sufficient staff time to become proficient with the model, and complexity of modeling procedures.

TABLE 1 Validated Trip Production Rates: Non-Home-Based Trip Purpose (Average Weekday Trips per Household)

Area Type	Household Size	Vehicles Available			
		0	1	2	3+
Urban	1	0.676	1.625	1.625	1.625
	2	1.151	2.335	2.561	2.561
	3	1.828	2.730	2.923	3.633
	4+	2.121	3.803	4.942	5.033
Suburban	1	0.923	2.226	2.226	2.226
	2	1.580	3.190	3.508	3.508
	3	2.503	3.744	4.000	4.964
	4+	2.892	5.200	6.759	6.893
Rural	1	0.656	1.600	1.600	1.600
	2	1.139	2.287	2.523	2.523
	3	1.795	2.687	2.872	3.569
	4+	2.082	3.734	4.852	4.944

Source: Cambridge Systematics, Inc. 2004

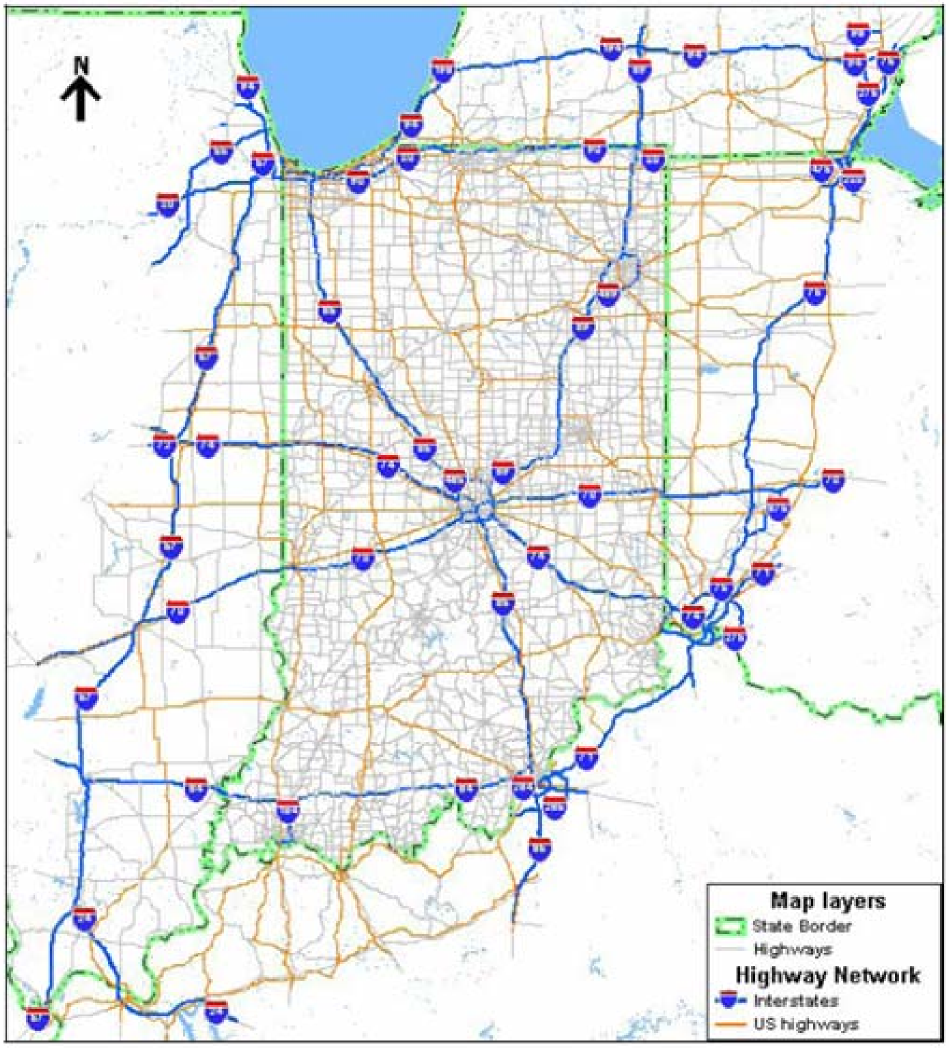

FIGURE 1 ISTDM model area.
(Source: Bernardin, Lochmueller & Associates, Inc., 2004.)

TABLE 2 Validated Trip Production Rates: Long Trip Purpose
(Average Weekday Trips per Household)

Income Category	Vehicles Available			
	0	1	2	3+
$0 to $20k	0.0099	0.3000	0.0579	0.0595
$20k to $40k	0.0199	0.0599	0.1157	0.1188
$40k to $60k	0.0245	0.0737	0.1424	0.1461
$60k+	0.0377	0.1136	0.2195	0.2252

Source: Cambridge Systematics, Inc. 2004

TABLE 3 Regression Models for Trip Attractions by Trip Purpose

Trip Purpose	Variable	Parameter Estimate
Home-Based Work Trips	Intercept	0.000
	Employment in retail, FIRE, education, services, and government sectors	1.400
	Employment in non-retail, construction, manufacturing, agriculture, forestry and fisheries, and transportation sectors	1.120
Home-Based Other Trips	Intercept	0.000
	Employment in retail sector	4.850
	Employment in FIRE, education, services, and retail sectors	3.200
	Employment in education sector	1.750
	Households	1.650
Non-Home–Based Trips	Intercept	0.000
	Employment in retail sector	4.490
	Employment in FIRE, education, services, and government sectors	1.1130
	Employment in non-retail, construction, manufacturing, and transportation sectors	0.380
	Households	0.590
Long Trips	Intercept	0.000
	Total employment	0.023
	Employment in FIRE, education, services, and government sectors	0.090
	Employment in agriculture, forestry and fisheries, mining, construction, manufacturing, non-retail, and FIRE sectors	0.030
	Employment in retail and services sectors	0.020

Source: Cambridge Systematics, Inc. 2004

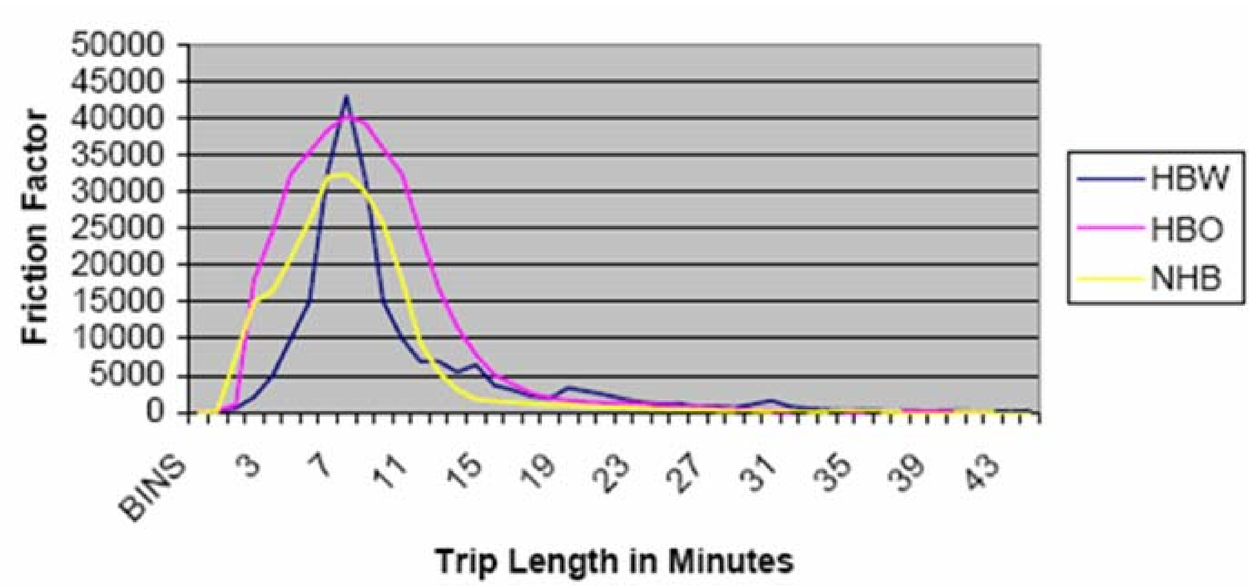

FIGURE 2 Friction factors for HBW, HBO, and NHB trips. (Source: Cambridge Systematics, Inc., 2004.)

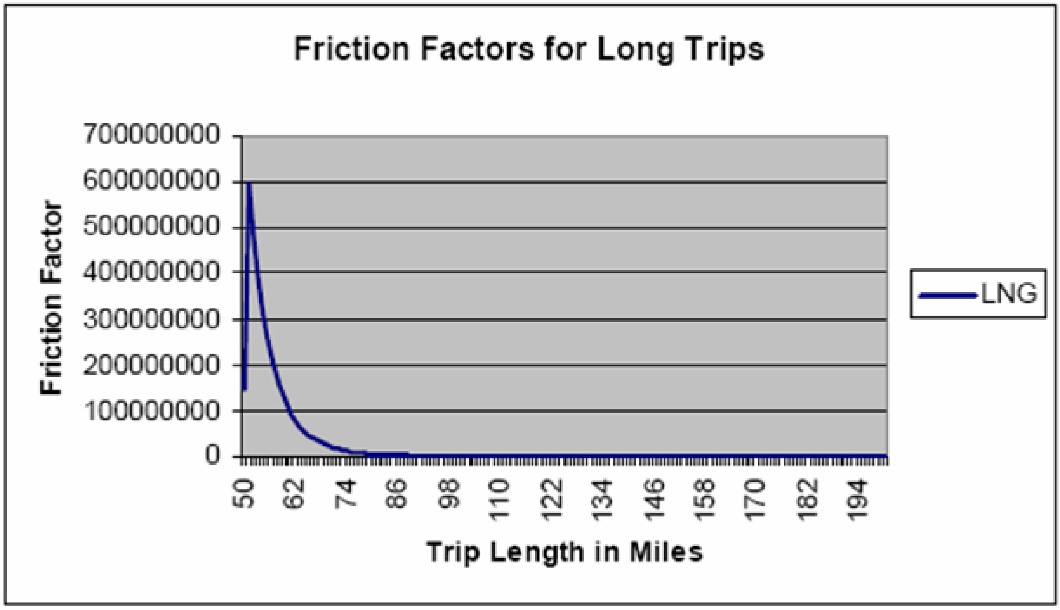

FIGURE 3 Friction factors for long trips.

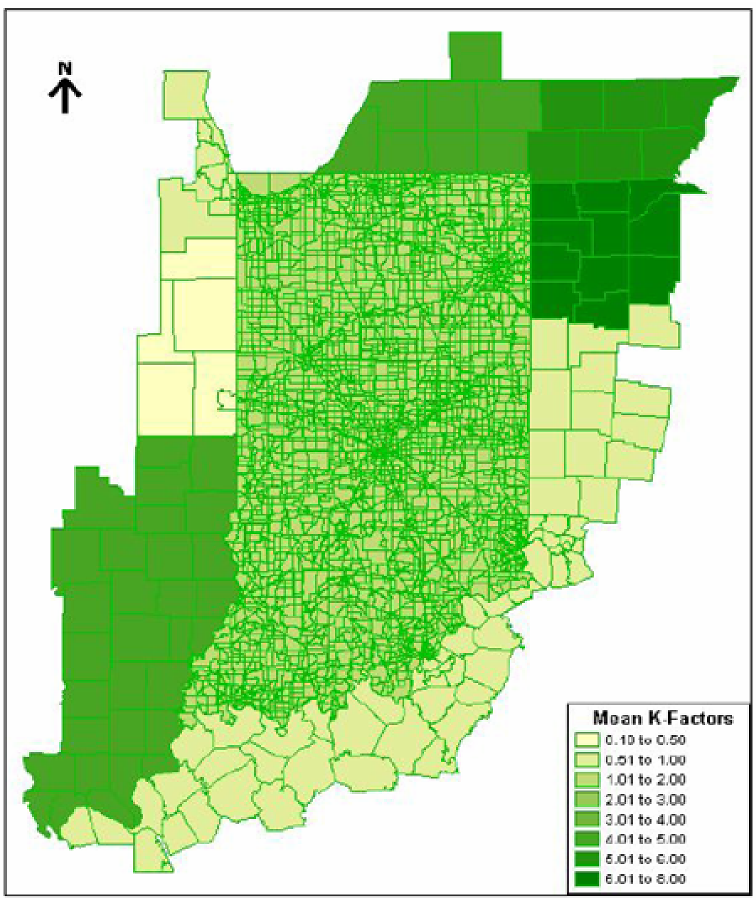

FIGURE 4 Average K-factors by TAZ.
(Source: Bernardin, Lochmueller & Associates, Inc., 2004.)

TABLE 4 Observed Mode Shares by Area Type and Trip Purpose

Trip Purpose	Mode	Urban	Suburban	Rural
HBW	Auto	93.8%	99.7%	98.1%
	Bus	1.4%	0.0%	0.0%
	Walk	1.2%	0.3%	1.9%
	Bike	3.6%	0.0%	0.0%
HBO	Auto	80.3%	80.9%	77.4%
	Bus	1.3%	0.2%	0.0%
	School bus	8.8%	15.7%	16.8%
	Walk	7.4%	2.8%	4.8%
	Bike	2.2%	0.5%	1.0%
NHB	Auto	97.7%	97.4%	97.0%
	Walk	2.2%	2.6%	3.4%
	Bike	0.1%	0.0%	0.1%

Source: Cambridge Systematics, Inc., 2004

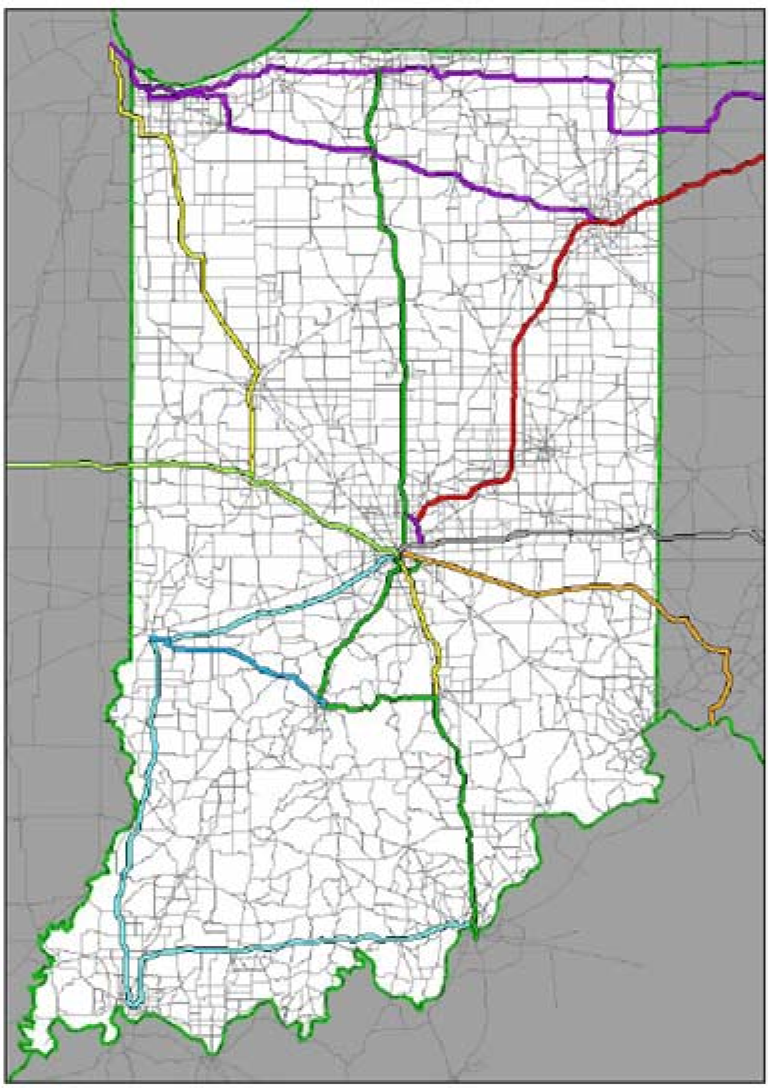

FIGURE 5 Transit routes. (Source: Cambridge Systematics, Inc., 2004.)

TABLE 5 Estimated Changes in Worker Productivity (Indiana Version of REMI Model)

Employment Category	Productivity Factors (2000–2030)
Durables manufacturing	2.92
Non-durables manufacturing	1.79
Mining	2.64
Construction	1.60
Transportation and public utilities	1.96
FIRE	1.91
Retail trade	1.67
Wholesale trade	2.71
Services	1.33
Agriculture, forestry, and fisheries	0.78

Source: Cambridge Systematics, Inc., 2004

TABLE 6 Truck Trip Generation Rates—Quick Response Freight Manual (Average Weekly Truck Trips per Employee)

Employment Category	Four-Tire Vehicles	Single Unit Trucks (6+ Tires)	Combination Trucks	Total
Agriculture, mining, and construction	1.110	0.289	0.174	1.573
Manufacturing, transportation, communications, utilities, and wholesale trade	0.938	0.242	0.104	1.284
Retail trade	0.888	0.253	0.065	1.206
Office and services	0.437	0.068	0.009	0.514
Households	0.251	0.099	0.038	0.388

Source: Cambridge Systematics, Inc., 2004

TABLE 7 Model Performance by Volume Group (All Roads)

Class (AADT)	Count Average	Loading Average	% Error	VMT % Error	% RMSE
1,001 to 2,000	1,468	1,994	35.81	35.70	99.06
2,001 to 3,000	2,497	3,041	21.77	22.72	77.79
3,001 to 4,000	3,546	3,779	6.56	7.63	49.28
4,001 to 5,000	4,483	4,599	2.60	3.16	42.29
5,001 to 6,000	5,485	5,562	1.41	0.22	42.97
6,001 to 8,000	6,985	6,666	–4.58	–2.67	37.52
8,001 to 10,000	8,942	8,347	–6.66	–4.00	35.52
10,001 to 15,000	12,347	11,351	–8.06	–6.99	35.60
15,001 to 20,000	17,367	16,319	–6.04	–4.69	31.33
20,001 to 25,000	22,394	21,788	–2.71	–4.65	29.34
25,001 to 30,000	27,429	26,553	–3.19	–4.53	26.45
30,001 to 40,000	34,067	33,879	–0.55	1.85	21.93
40,001 to 50,000	44,086	44,801	1.62	–1.14	15.74
50,001 to 75,000	58,410	58,321	–0.15	0.79	13.22
75,001 to 100,000	86,069	89,403	3.87	4.23	14.60
>100,001	119,874	115,256	–3.85	–1.77	19.87
All	**10,199**	**10,070**	**–1.26**	**0.45**	**39.45**

Source: Bernardin, Lochmueller & Associates, Inc., 2004

TABLE 8 Statistics Generated by POST_ALT

Statistics Reported on Roadway Segments	Statistics Reported in Aggregate for Functional Classes, Area Types, Counties, and Corridors	Additional Statistics Reported for Corridors when Applicable*
Average daily speed	Vehicle miles traveled (VMT)	Average peak hour flow
Average daily travel time	VMT by autos	Average peak hour flow density
Level of service (LOS) (by v/c ratio)	VMT by non-freight trucks	LOS (by HCM 2000 method)
Daily v/c ratio	Vehicle hours traveled (VHT)	LOS (by v/c ratio)
Peak hour flow rate	VHT by freight trucks	
Peak hour speed	VHT by non-freight trucks	
Peak hour flow density (for freeways and multilane highways)	Average daily speed	
Percent time following (for rural two-lane highways)	Total delay from congestion	
Congestion delay	Percent of travel time due to congestion delay	
Percent of travel time due to congestion delay	Average daily v/c ratio	
	Average peak hour v/c ratio	
	Number of fatal accidents	
	Number of injury accidents	
	Number of PDO accidents	
	Total number of accidents	

* In order for average peak hour flow density, average percent time spent following, and the HCM 2000 method LOS to be calculated and reported for a corridor, the entire corridor must be of the same facility type so that the same criteria can be applied. (Source: Bernardin, Lochmueller & Associates, Inc., 2004)

KENTUCKY

Kentucky Statewide Model History

1971: First model, designed by Alan M. Voorhees & Associates
1991: Model update by Wilbur Smith Associates (WSA)
1997: Model update by WSA
1999: Model update by WSA
2001: I-66 Corridor Calibration by WSA
2002: Combined Zones for Census/TAZ Disaggregation by WSA
2003: Network Update by WSA

Applications

- Corridor studies
- New routes
- System questions

Current Model Specifications from 1999 Model Update

This update basically created a completely new model although the 1991 network and TAZs were used.

- Number of zones = 1,530 (includes 823 Kentucky zones)
- Number of links = 28,282
- Trip purposes: home-based work (HBW), truck, tourist, external, other person [combined non-home–based (NHB)/home-based office (HBO)]
- Software: MINUTP
- Current year: 1999;: future year: 2030
- Assignment methodology: AON
- Calibration: 10 screen lines, final ground adjustment program
- Network development: use existing 1991 Kentucky network plus National Highway Planning Network (NHPN) outside of Kentucky
- Data collection: no new data collected

Recent Updates

2001 I-66 Corridor Calibration

This contract converted Kentucky Statewide Traffic Model (KySTM) link-based external truck trips to trip table format, updated KySTM network and trip matrices to reflect existing plus committed I-66 conditions, and updated networks/matrices to include I-66 network implementation.

2002 Combined Zone

This contract revised existing KySTM TAZs.

2003 Network

This work creates a true GIS network in TransCAD and expands the network to the entire United States.

2003 Major KySTM Update

This includes

- Updated truck travel submodels using the latest TRANSEARCH data.
- Updated long-distance submodels using an ATS-based long-distance person travel model.
- Updated trip generation/trip distribution using new journey to work and Nationwide Personal Transportation Survey (NPTS) data.
- Development of GISDK procedures.

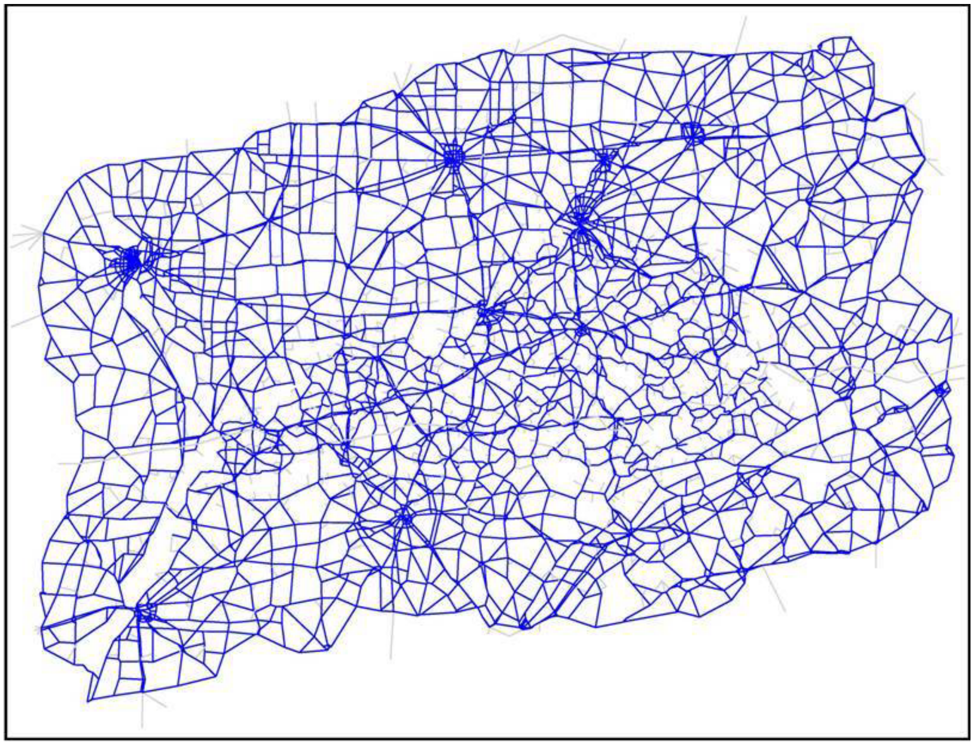

FIGURE 6 1999 Kentucky model network.

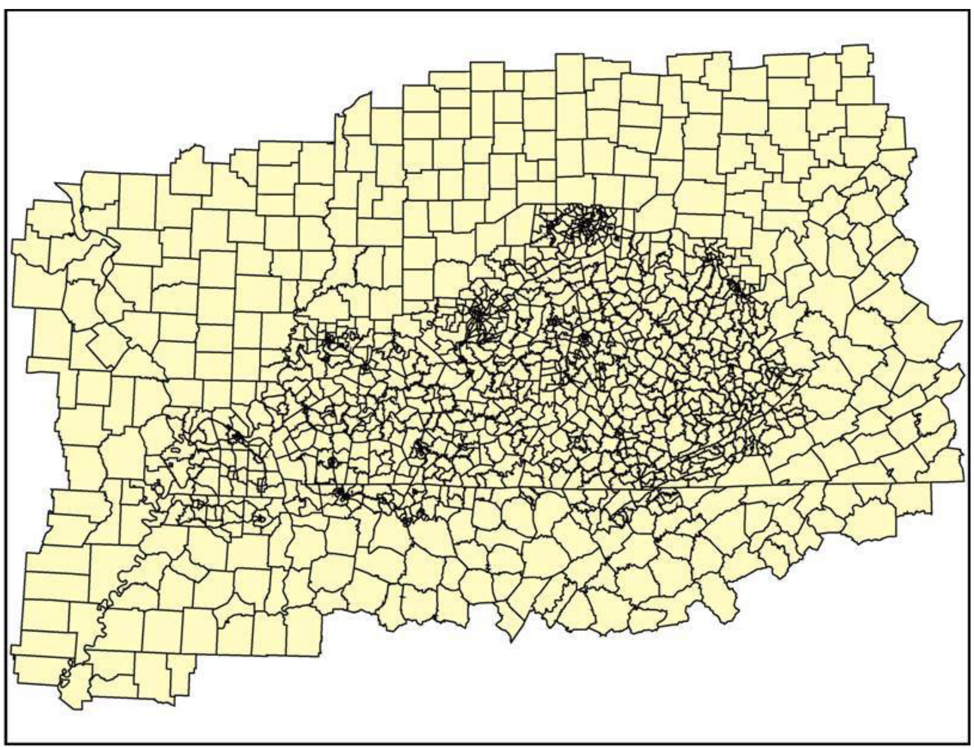

FIGURE 7 1999 Kentucky model TAZ system.

Data

There were no primary data collected for the KySTM. Off the shelf data were used in all cases with the exception that Kentucky participated in the National Household Travel Survey (NHTS) add-on surveys and did purchase some household surveys via that national effort:

- NHPN for roadway geography and characteristics outside Kentucky;
- National Highway Performance Monitoring System (HPMS) for roadway characteristics outside Kentucky;
- Kentucky Transportation Cabinet (KyTC) Highway Information System for roadway geography and characteristics inside Kentucky;
- ATS data for long-distance travel (interstate and intrastate);
- 2000 nationwide TAZ-level census journey to work data;
- TRANSEARCH TAZ-level commodity flow data (including flows to, from, within, and through Kentucky) by four-digit Standard Transportation Commodity Code (STCC) and mode (truck, rail, water, and air);
- NHTS for household trip rates, including Kentucky add-on samples;
- 2000 census demographic data;
- Woods and Poole nationwide Complete Economic and Demographic Data Source (CEDDS) data (historic and forecast county-level socioeconomic data);
- Dun and Bradstreet census block-level 2000 employment data for Kentucky; and
- Claritas census blockgroup-level density classifications for Kentucky.

Maintenance/Use

Corridor studies have been the most common use of the KySTM. Some of the more widely known corridor studies include the I-66 project and the I-69 project. Others include a proposed I-74 extension, I-64 improvements, a proposed I-875 (Kentucky to Tennessee) and many others.

Implementation

- Latest model (1997, updated in 1999 through 2001) was developed by WSA. They are also working on the current update begun in 2003. The original KySTM was done in house but was designed by Alan Voorhees Associates.
- The 1991 model was developed in response to general forecasting needs. The 1997 model was developed in response to the need to study I-66. The current model is being developed due to general consensus that the model is indeed important and useful.

Scale/Level of Detail

- The KySTM focuses on highways, cars, and trucks. Current and forecast TRANSEARCH commodity flow data are available for other modes, but not modeled.
- Within Kentucky the network includes all arterial roads and, outside the modeled MPOs, all collector roads.

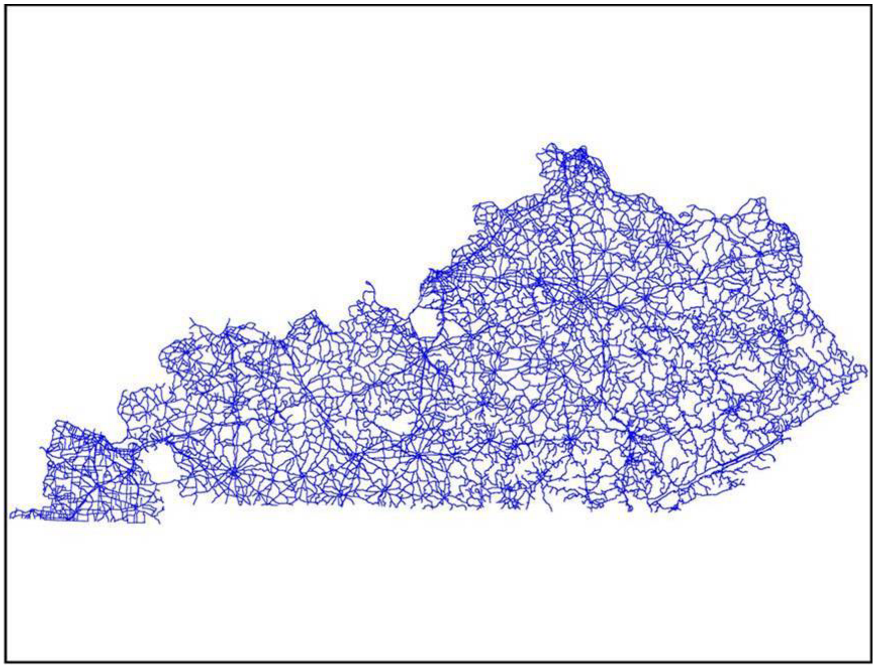

FIGURE 8 Major arterials in Kentucky.

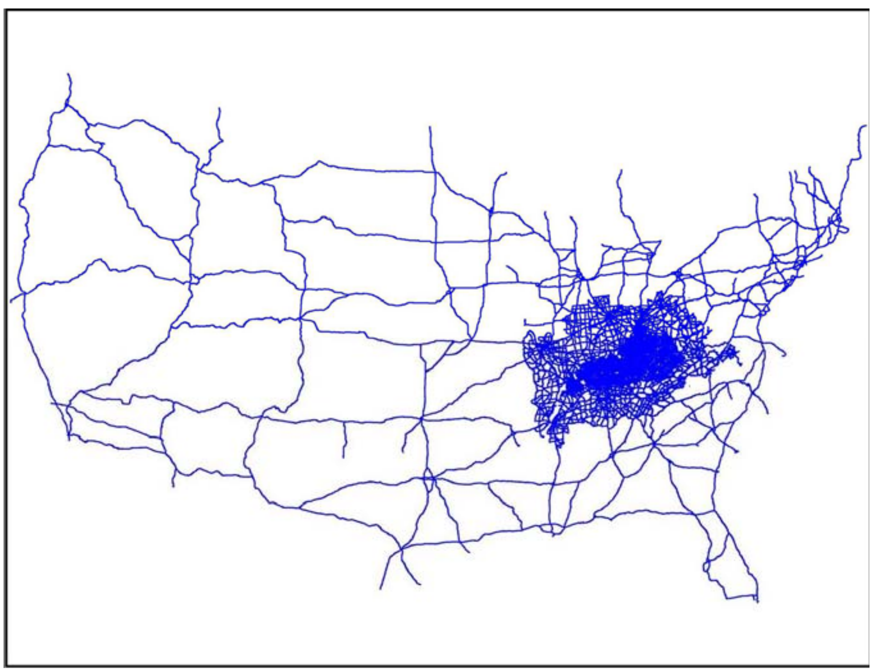

FIGURE 9 Roadways outside Kentucky included in model.

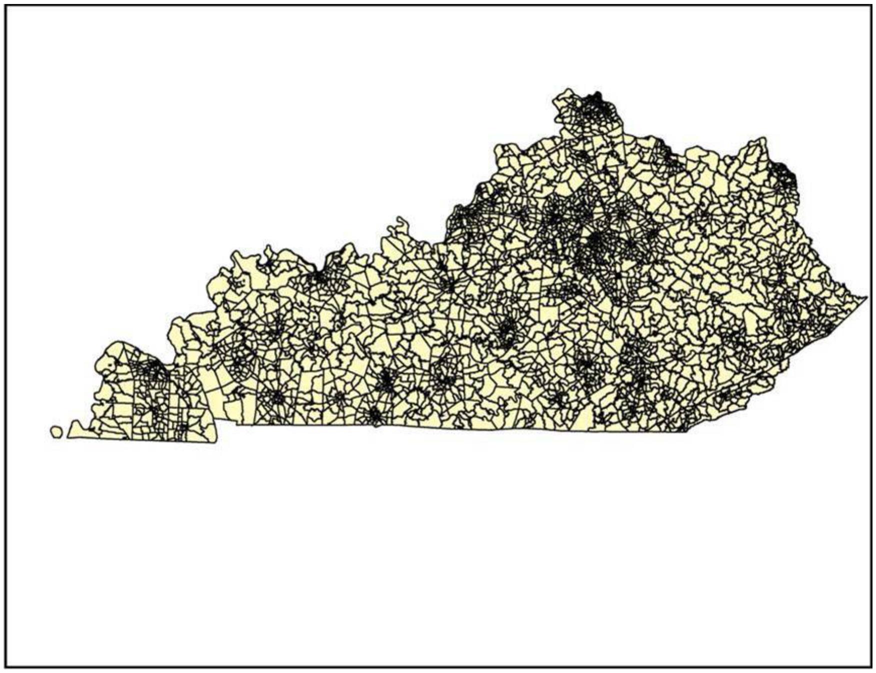

FIGURE 10 TAZs in Kentucky.

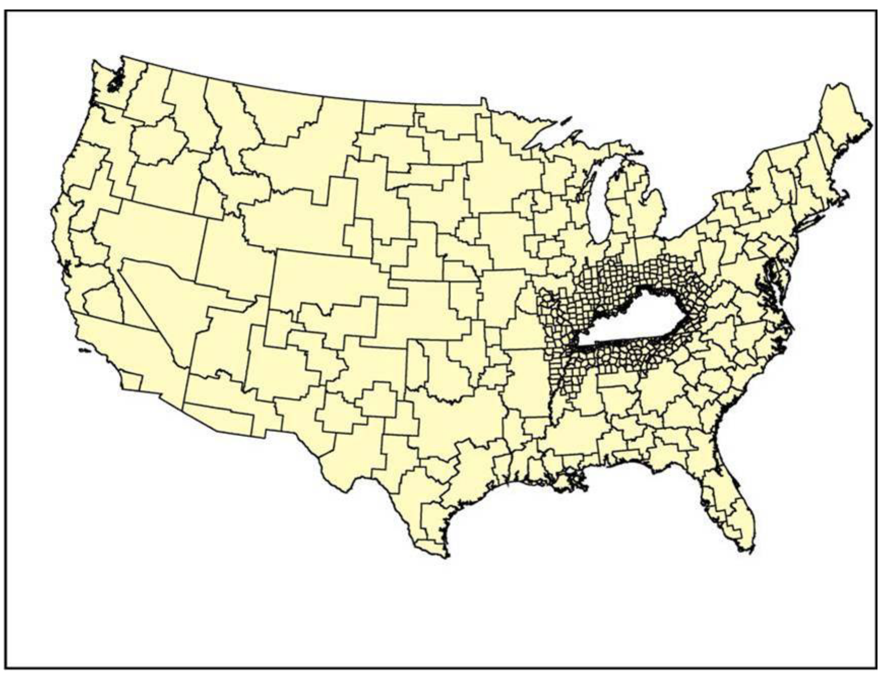

FIGURE 11 TAZs outside Kentucky.

- To capture interstate auto and truck movements, the network also covers the continental United States and includes all major Interstate highways and, for the area surrounding Kentucky, all major arterials.
- The KySTM uses a total of 3,644 TAZs;
- 882 TAZS are inside Kentucky MPO areas; these are defined using aggregations of MPO model TAZs;
- 2,762 are inside Kentucky but outside the MPO areas—these are defined using census block groups and census places;
- 1,109 are outside Kentucky—these are defined using counties and Bureau of Economic Analysis (BEA) zones.

Statewide/Urban Model Integration

The statewide model was explicitly designed to complement, not compete with, the urban models. As such, it provides forecasts for traffic to, from, and thru, but not within urban areas.

Freight/Commercial Vehicle Modeling

The KySTM is designed to forecast heavy truck trips on rural arterials. The KyTC purchased base year (2000) TRANSEARCH commodity flow data. The TRANSEARCH database included commodity flow tonnage by two-digit STCC, mode (truck, rail, air, and water), and origin–destination (O-D) (county-level within Kentucky and larger zones for areas beyond Kentucky). Matrix estimation is used to estimate heavy truck trips not covered by 2000 TRANSEARCH data.

Long-Distance/Recreational/Tourism Travel

The KySTM does forecast long-distance auto-based tourist, business, and other travel, including both interstate and intrastate. The absolute number of trips is relatively small, but the VMT impact on the statewide arterial system is significant. State to state data from the 1995 ATS was used to develop TAZ-level long-distance trip tables. Fratar procedures are used to develop 2000 and forecast year trip tables.

LOUISIANA

To support the most recent update of the Louisiana State Transportation Plan as well as continuing planning and programming activities, the Louisiana Department of Transportation and Development (LDOTD) has developed a statewide TDM. This model is used to forecast auto and truck traffic on rural portions of the state highway system. Like traditional urban models, this model is used to evaluate statewide transportation projects and issues, and to assist in developing and maintaining LDOTD’s Statewide Long-Range Transportation Plan (LRTP).

A number of interesting modeling approaches and techniques were developed and applied for the Louisiana statewide model:

- Travel market segmentation techniques allow better understanding and prediction of travel on the Louisiana highway system. In addition to the traditional HBW, HBO, and NHB trips, the model also forecasts longer distance Interstate and intrastate tourist, business, and other trips.
- The macro–micro modeling framework allows state officials to evaluate impacts of transportation projects that lie within or outside Louisiana. The interrelated nationwide macro model and Louisiana-only micro model have different network coverages, zone structures, calibration techniques, modeling procedures, and calibration and validation data sources.
- An activity-based zone structure allows accurate prediction of intercity auto and truck travel. The macro model zone structure is based on BEA zones and counties. For the micro model, a census place and block group-based zone structure was used to locate population concentrations where the activities occur. Special treatments for the centroid connectors were also applied to reflect the settlement patterns observed in Louisiana.
- Claritas lifestyle cluster trip making information allows development and use of household trip rates based on NPTS data and "contextual density" of human settlements at the census block-group level, resulting in much more accurate trip rates as compared with metropolitan statistical area (MSA)/non-MSA rates, or urban/rural rates.
- Preservation of Linear Reference System and Linkage to LDOTD legacy databases in network design allows for easier updating of network attributes.

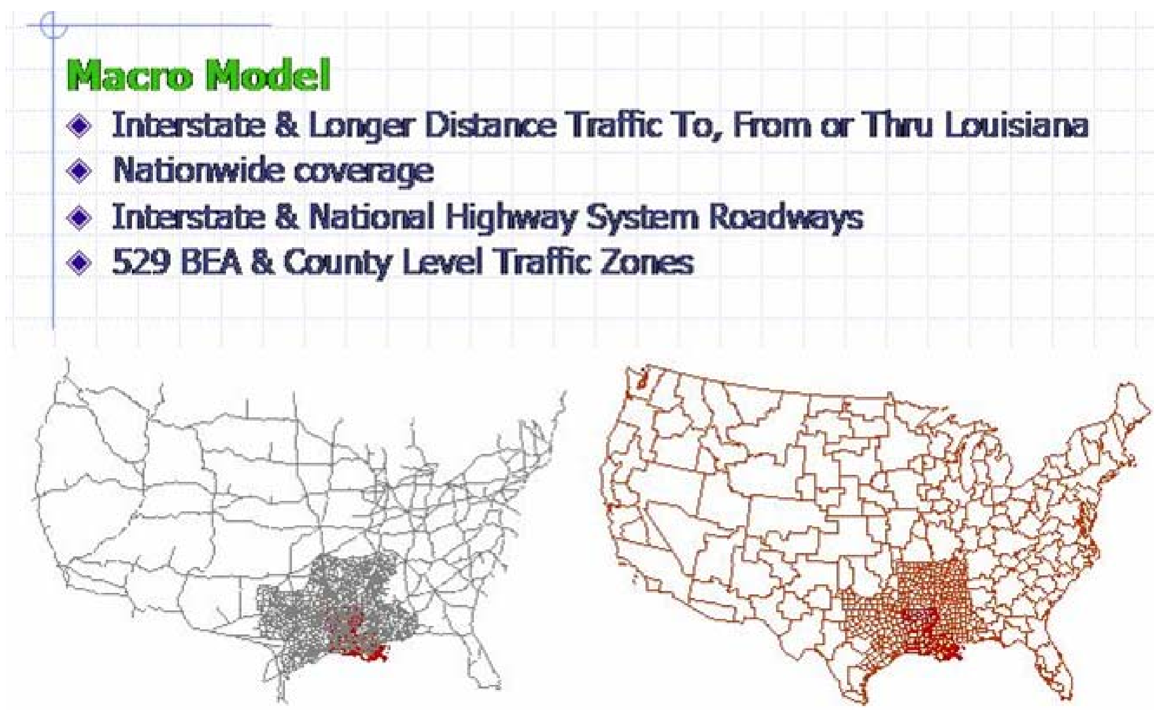

FIGURE 12 Macro–micro modeling approach.

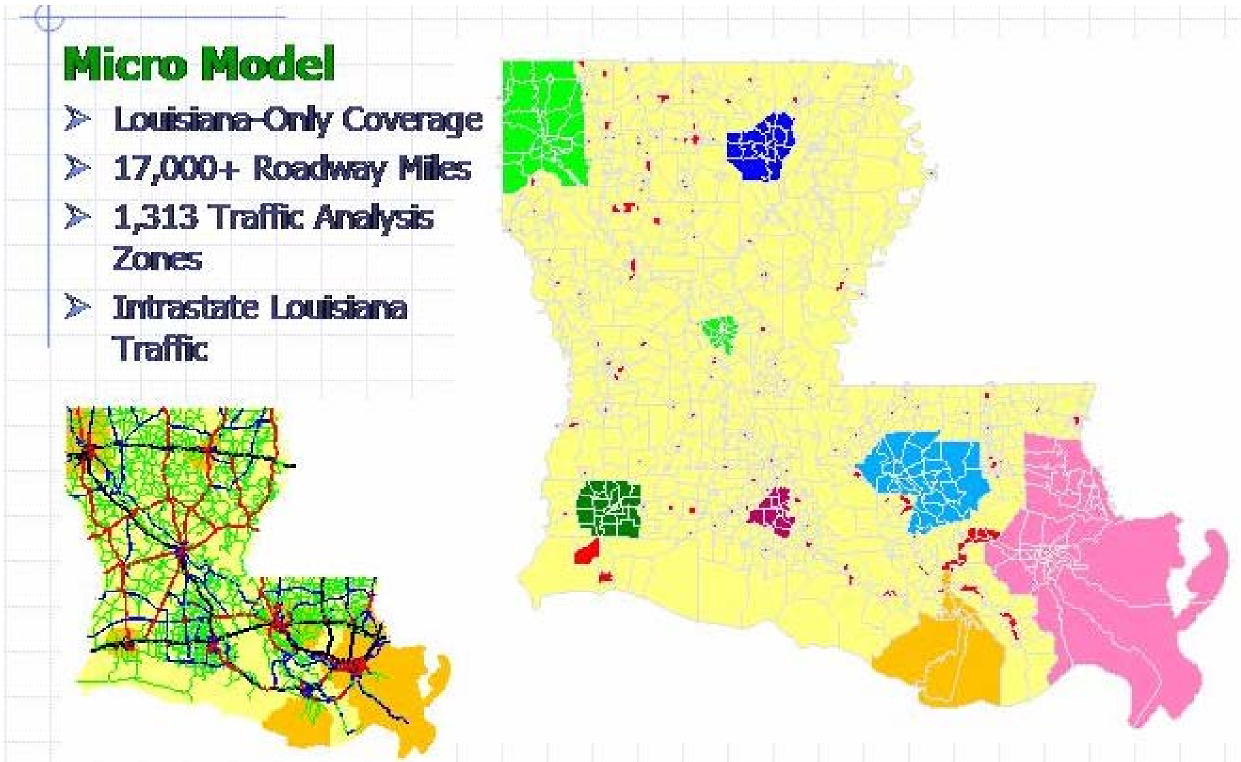

FIGURE 13 Macro–micro modeling approach, Louisiana only.

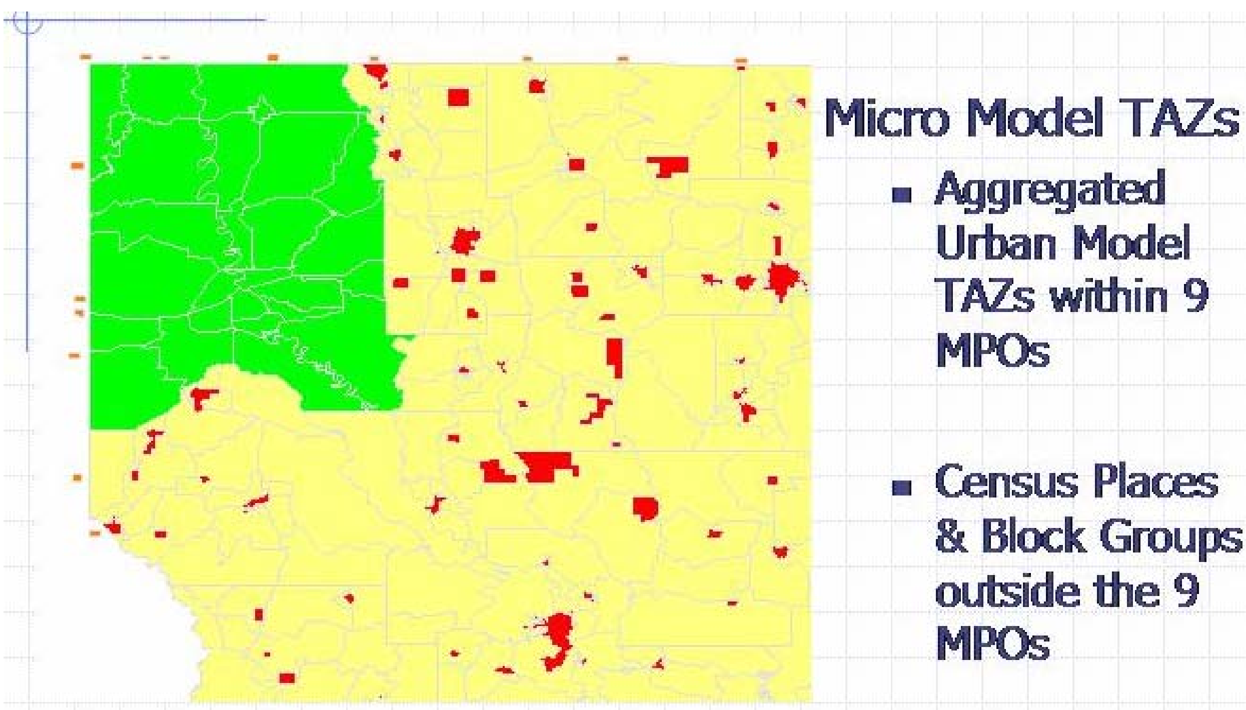

FIGURE 14 Activity-based zone system.

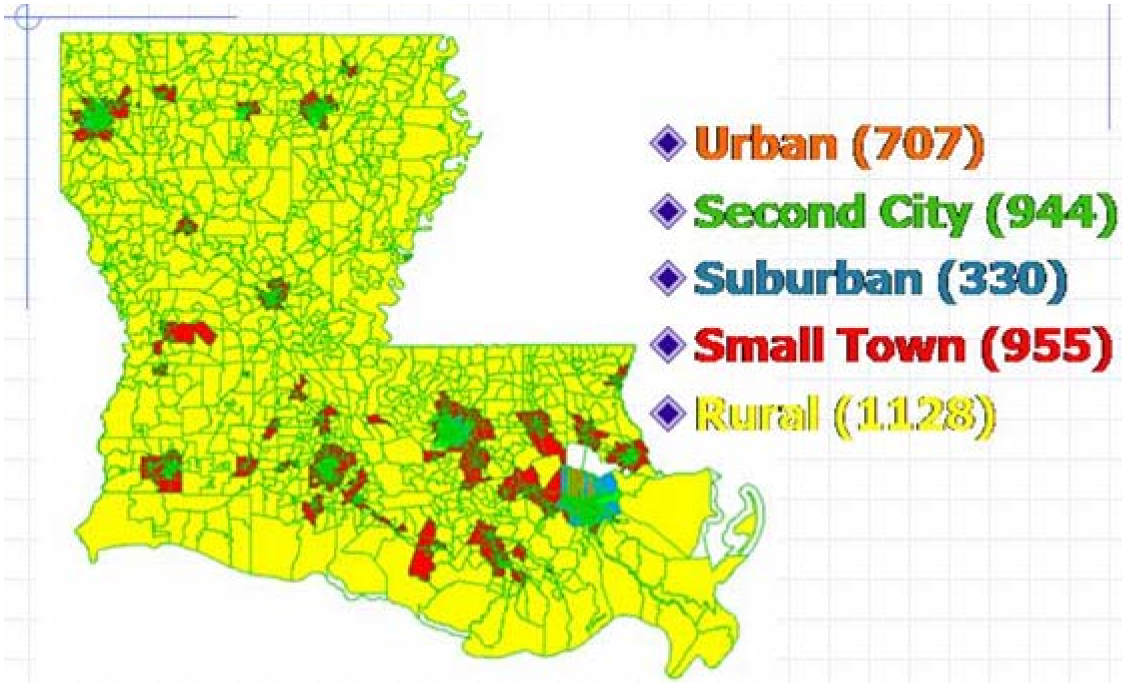

FIGURE 15 Claritas lifestyle cluster classification by block group.

Data

The model development process included no time or money for primary data collection. Consequently the model was specifically designed to take maximum advantage of available data, including state, federal, and commercial sources. These sources included

1. NHPN for roadway geography and characteristics outside Louisiana;
2. HPMS for roadway characteristics outside Louisiana;
3. LDOTD data files for roadway characteristics inside Louisiana;
4. ATS data for long-distance travel (interstate and intrastate);
5. 1990 nationwide tract-level census journey to work data;
6. TRANSEARCH TAZ-level commodity flow data (including flows to, from, within, through, and near Louisiana) by four-digit STCC and mode (truck, rail, water, and air);
7. NPTS for household trip rates;
8. 2000 census demographic data;
9. Woods and Poole nationwide CEDDS data (historic and forecast county-level socioeconomic data);
10. Dun and Bradstreet census block-level 2000 employment data for Louisiana; and
11. Claritas census block group-level density classifications for Louisiana.

Maintenance/Use

The Louisiana statewide model is a tool to assist experienced transportation planners forecast auto and heavy truck traffic on the state's rural arterial roadway system. It was designed to complement, not compete with, the urban models. As such, it provides information on traffic to, from, and through, but not within urban areas. The model was used extensively in the recent statewide plan update to evaluate and prioritize systemwide, corridor, and project-level improvements.

Implementation

A design–build approach was used to develop the Louisiana statewide model. A series of three model design workshops were held to identify model users, uses, and data and other resources. All model stakeholders, including technical and policy-level staff from the LDOTD and all MPOs were involved in the model design process, which resulted in a detailed blueprint for the model.

Scale/Level of Detail

The model was designed to generate reliable auto and heavy truck forecasts on arterial facilities outside the modeled urban areas. The model is divided into two major components:

1. A macro model that
   a. Focuses on longer distance Interstate travel,
   b. Covers the entire United States, and
   c. Includes National Highway System (NHS) routes within and near Louisiana, and Interstate routes within the remainder of the United States; and

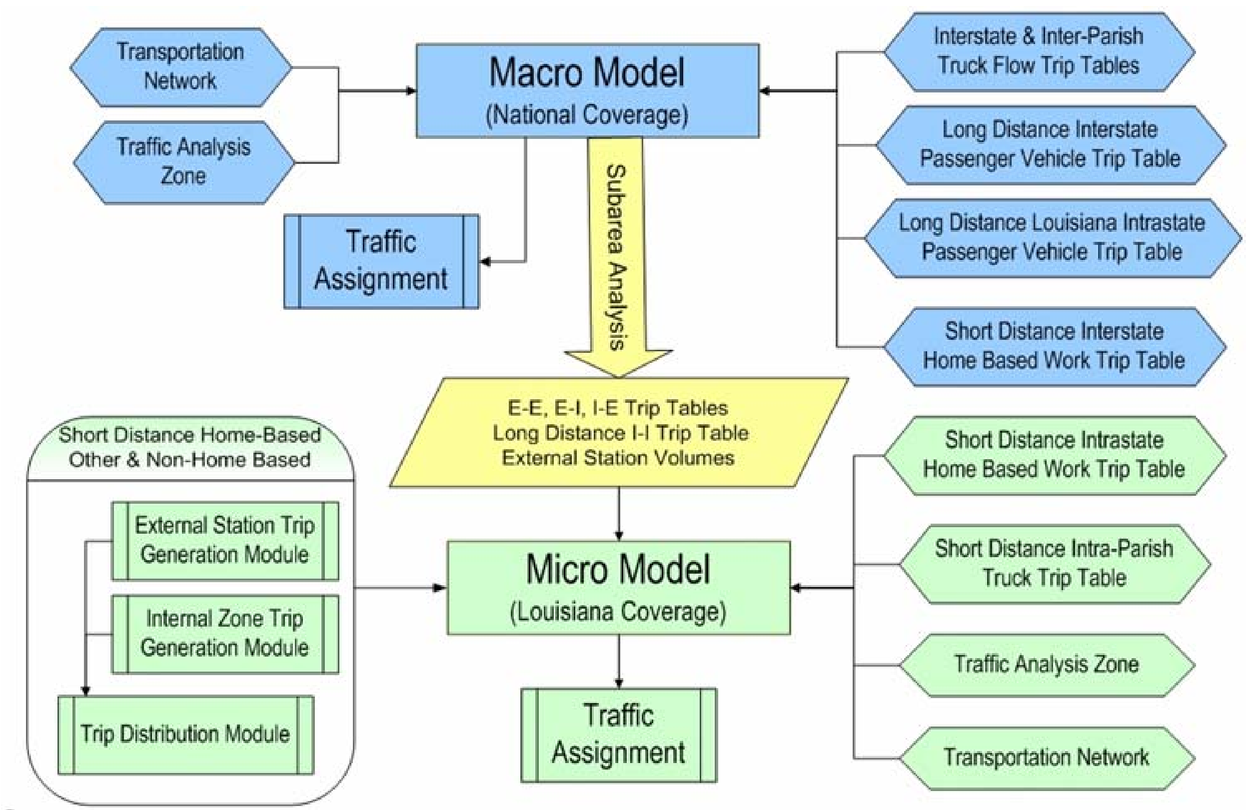

FIGURE 16 Macro–micro framework: Louisiana statewide model.

2. A micro model that
   a. Focuses on short-distance intrastate travel,
   b. Covers only Louisiana, and
   c. Includes all arterials and collectors outside the modeled urban areas.

Statewide/Urban Model Integration

The statewide model was explicitly designed to complement, not compete with, the urban models. As such, it provides forecasts for traffic to, from and through, but not within urban areas.

Freight/Commercial Vehicle Modeling

The Louisiana statewide model is designed to forecast heavy truck trips on rural arterials.

The LDOTD purchased base year (2000) and future year (2030) TRANSEARCH commodity flow data. The TRANSEARCH database included commodity flow tonnage by four-digit STCC, mode (truck, rail, air, and water), and O-D (county-level within Louisiana and the contiguous BEA zones, and BEA zones beyond that). The forecast data were generated by DRI/WEFA.

In addition to tonnages, the purchase also included truckloads and empty trucks. Matrix estimation was used to estimate heavy truck trips not covered by 2000 TRANSEARCH data. A fratar procedure is used to forecast heavy truck trips not covered by forecast TRANSEARCH data.

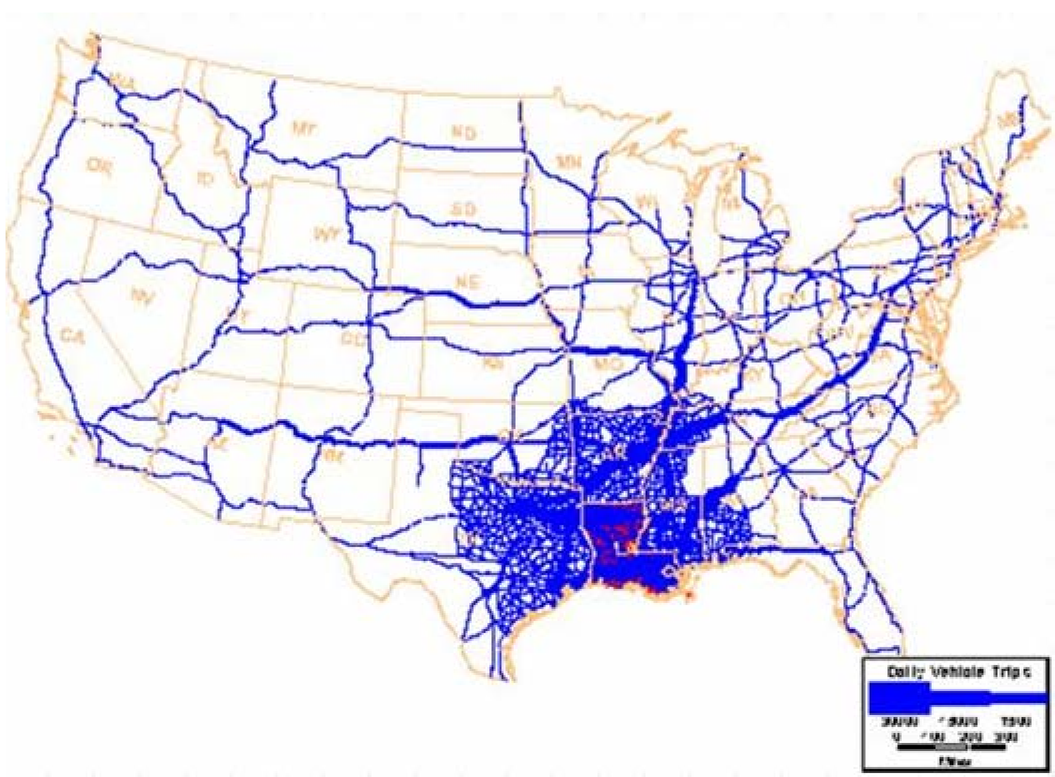

FIGURE 17 Reebie TRANSEARCH data: year 2000 truck flows.

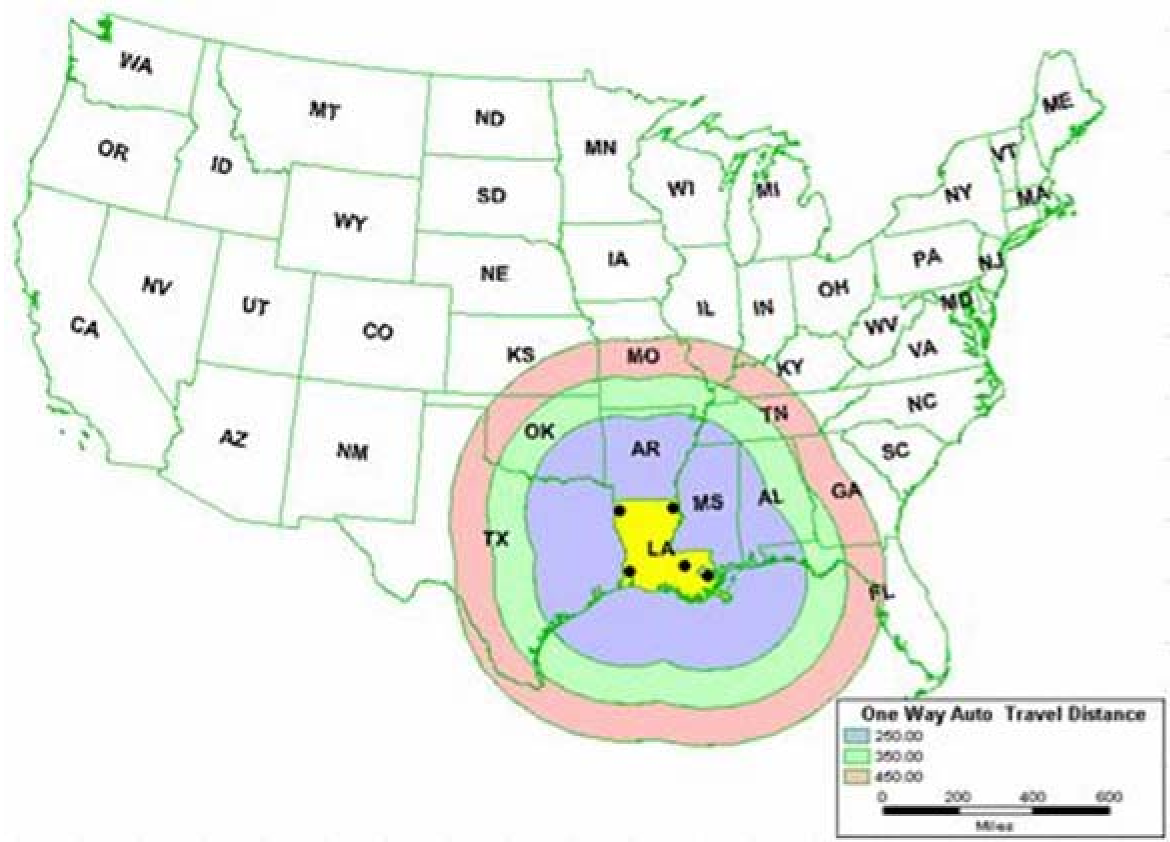

FIGURE 18 American Travel Survey—auto trip lengths to, from, and through Louisiana: 66% < 250 mi; 82% < 350 mi; and 90% < 500 mi.

Long-Distance/Recreational/Tourism Travel

The Louisiana statewide model does forecast long-distance auto-based tourist, business, and other travel, including both Interstate and intrastate. The absolute number of trips is relatively small, but the VMT impact on the rural arterial system is significant. State to state data from the 1995 ATS was used to develop TAZ-level long-distance trip tables. Fratar procedures are used to develop 2000 and forecast year trip tables.

MASSACHUSETTS

Massachusetts started developing a statewide model in 2000 through a consultant contract. The first version of the model that was used in an application was in 2002 for emissions budget development for the state implementation plan (SIP). This working draft version was further refined and finalized in 2003, and was used for air quality conformity determinations. In 2004, all the detailed documentation is being completed and we are just starting to familiarize ourselves with the details of the model and evaluate its usefulness for other applications. A general overview follows:

The Massachusetts Statewide TDM was developed to help MassHighway staff improve their ability to

1. Obtain independent traffic forecasts, including project level analyses;
2. Provide MPOs with regional model inputs, particularly forecasts of external traffic volumes and through trips;
3. Provide additional tools to perform regional and corridor analyses; and
4. Perform air quality emissions analyses required by environmental agencies.

Massachusetts' statewide model is similar to many other integrated travel demand forecasting model systems in structure. It is applied in TransCAD software with a customized graphical user interface. The model is based on the common four-step process, and uses many state-of-the-practice methods. For trip generation, the model predicts the number of trip productions for each zone by purpose using household level cross-classification models estimated from the 1995 NPTS (Massachusetts oversample). Trip attraction models were formulated as zone-level multiple regression models. They were estimated with the NPTS data and year 2000 zone level employment data. Trip productions and attractions were balanced to total productions for the whole model. For trip distribution, the model utilizes a group of purpose-specific gravity models. The gravity models were calibrated using the NPTS data and initial estimates of daily congested travel times based on free flow travel times from a single feedback loop using Bureau of Public Roads volume delay functions. For mode choice, person trip estimates are converted to vehicle trip estimates using a combination of tools. For transit trips, the statewide model links to standard output tables from the Boston MPO model (the statewide model does not include its own transit network at this time). For trips with trip ends outside the Boston region, vehicle trip/passenger trip ratios from the NPTS dataset were applied. There are four time-of-day periods that are also based on the NPTS dataset. Traffic assignment employs an equilibrium assignment routine.

The main source of data for TAZs was the census for the base year model (2000), and MassHighway/MPO socioeconomic forecasts provided data for the future years of 2007, 2015, and 2025 (see responses to other questions for more details). MassHighway's road inventory database served as the initial geographic basis and highway attribute database for the base year and future year highway networks. The road inventory work represented a significant portion of overall model development, including identifying and correcting connectivity problems; identifying and accounting for grade separation in the highway network; improving the representation of highway ramps; and developing speed-capacity tables. Based on current and future project information, the statewide model uses a unified highway network database that includes all current and future network links, coded by their year of implementation.

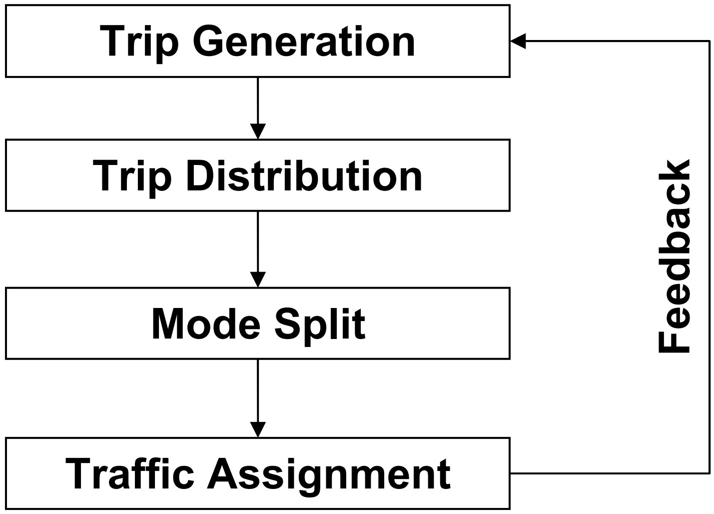

FIGURE 19 Massachusetts statewide travel demand model: basic elements—"Four-Step Process."

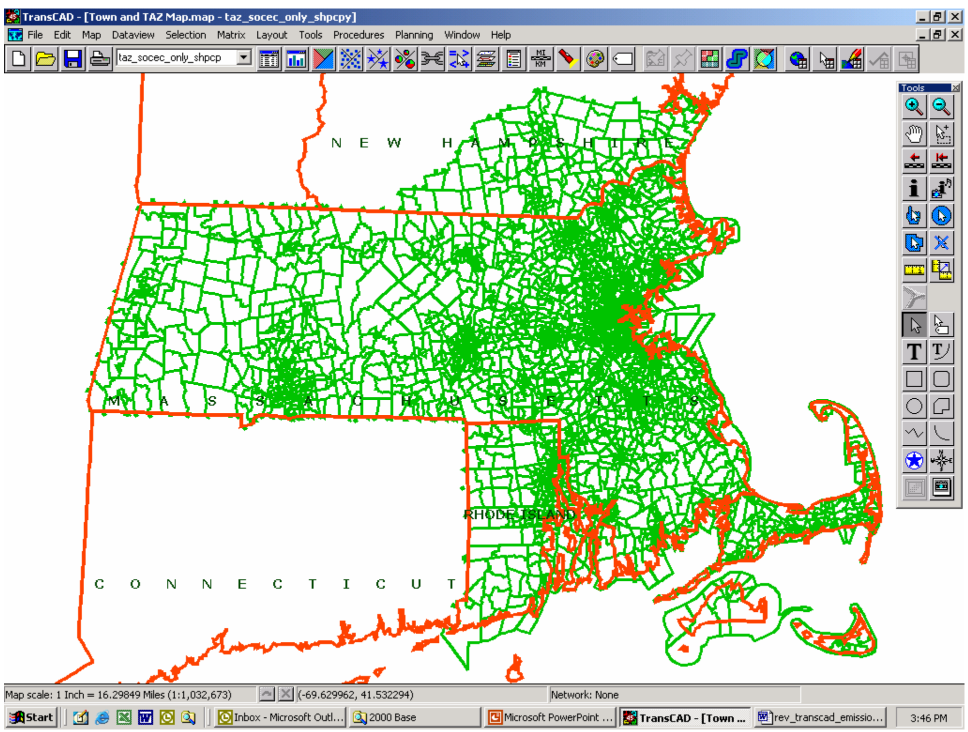

FIGURE 20 Town and TAZ map, Massachusetts.

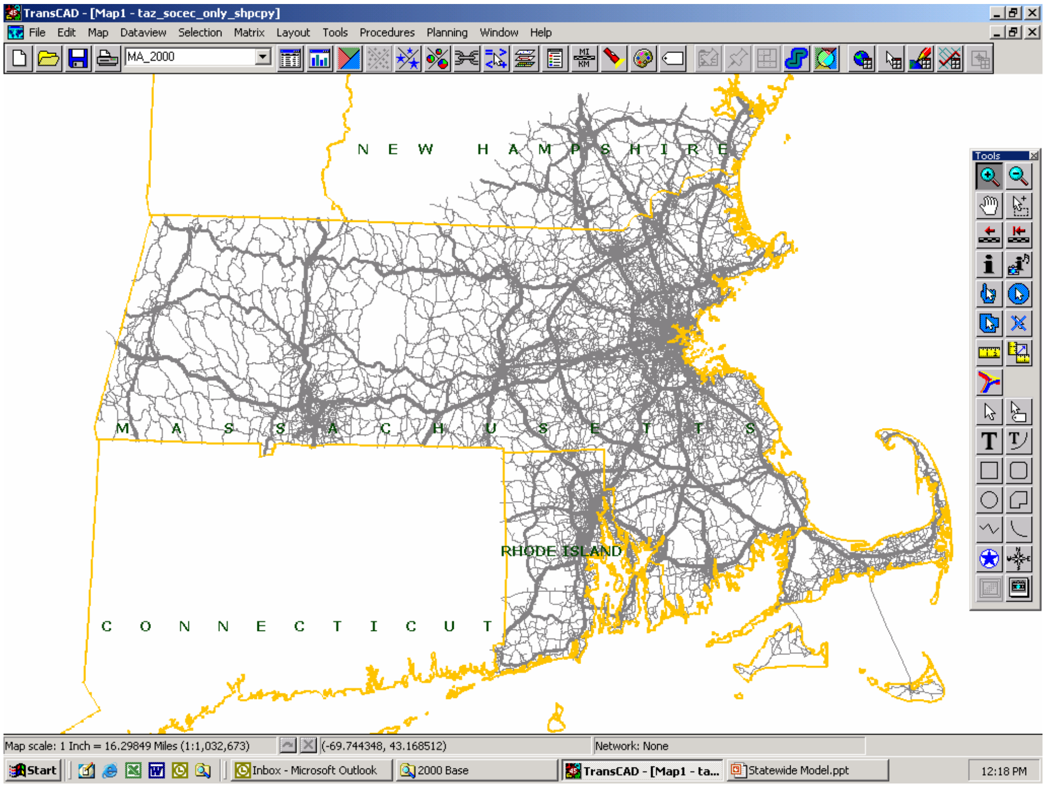

FIGURE 21 TAZ-only map, Massachusetts.

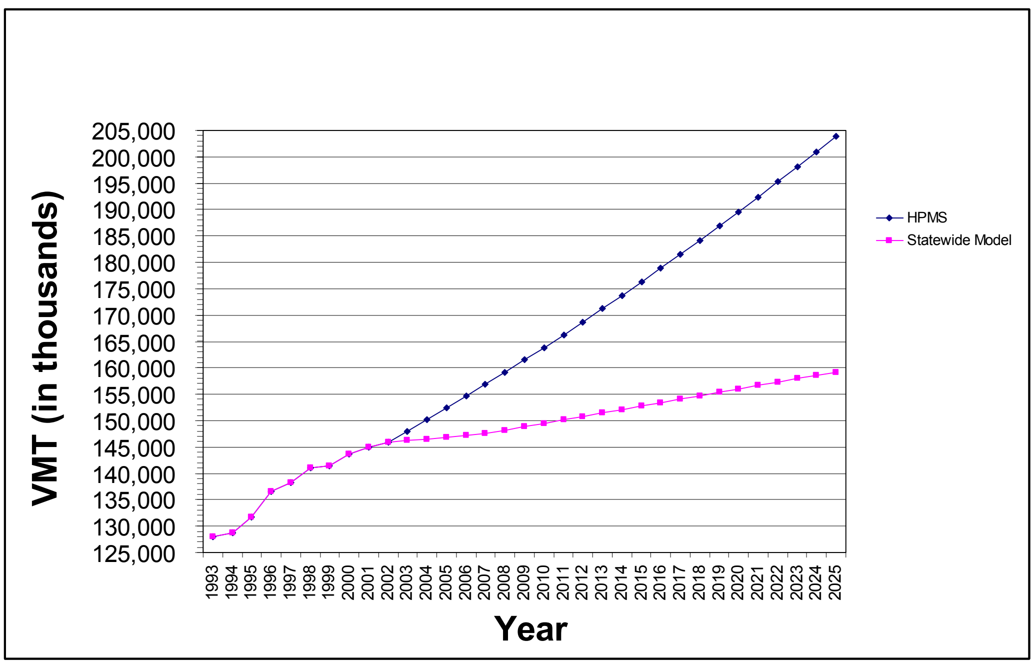

FIGURE 22 Massachusetts DVMT (HPMS straight line forecast compared to statewide model data).

Data

Network data were obtained from MassHighway's road inventory database, which provided all the necessary link information. TAZ inputs were developed mainly from census data, with miscellaneous other sources as supplements (see answers below for more detail). Forecast data for the TAZs were derived from a series of socioeconomic projections developed by MassHighway and MPO staff (future network changes were similarly identified by DOT and MPO staff). Due to commuting patterns and the interaction of activities across state boundaries, the statewide model needed to extend into two other states, and existing model data from these other states was used.

One of the biggest data issues we faced was getting geographically accurate employment data. The ES-202 data we received from the Division of Employment and Training (DET) was riddled with location errors and lacked needed specificity because of the aggregation of employees (all at a corporate headquarters as opposed to individual business locations, for example). We ended up using what data we could, and made use of other sources to refine the information. We are trying to get DET to improve their database for future updates.

Maintenance/Use

Maintenance is not underway yet—so far the model is primarily used for air quality conformity purposes.

Implementation

The Massachusetts statewide model was developed in roughly three phases. The first phase (2000–2002) involved data collection and systems integration by the consultant team. Preliminary base year (2000) and forecast year (2007) models were developed in time to meet air quality conformity deadlines. The second phase (2003) involved refining the base year model (consultant), and developing detailed socioeconomic forecasts for the TAZs (MassHighway and the MPOs). For the current (2004) phase, the model is being documented in detail, and will be tested for various applications (and undergo minor improvements if needed). In retrospect, the timeframe for the consultant contract was too long; it allowed activities to get too strung out on both the consultant and the DOT sides. There were some delays that were inevitable, but we should have taken more steps to resolve them sooner. Another lesson learned related to the delays in waiting to resolve certain developmental elements like road inventory data and ES-202 employment data. The lesson was to move on and go with the next best approach rather than setting the project back too far.

Scale/Level of Detail

The Massachusetts statewide model has 3,754 zones covering all of Massachusetts, all of Rhode Island, and parts of southern New Hampshire. The distribution is as follows: 3,500 TAZs (3,069 in Massachusetts, 272 in Rhode Island, and 159 in New Hampshire), 99 external stations, and 155 "park-n-ride" centroids (which connect to transit, specifically commuter rail stations and high-volume subway stations). At the time of model development, this was considered a workable zone structure in terms of consistency with census geography and computer resources.

The network covers all functionally classified roads (collectors and higher), and was initially developed from MassHighway's road inventory database and linework. There are no local roads in the model. All network roads are spatially accurate within a GIS environment, and therefore can be overlaid with aerial photos and other standard GIS coverages.

Statewide/Urban Model Integration

Partially integrated. The statewide model and most MPO models share common socioeconomic base year and forecast data for TAZs, although the level of aggregation is different. Work is underway to match TAZ data even more closely with remaining MPOs. Also, the statewide model and most all of the MPO models use the same software (TransCAD), which can offer opportunities for future integration.

Freight/Commercial Vehicle Modeling

The statewide model forecasts commercial vehicles using a traditional three-step process (no mode split): Trip generation for trucks is based on rates obtained from FHWA's *Quick Response Freight Manual*. Zone to zone exchanges are distributed by the gravity model. Truck traffic is assigned to the network with an equilibrium method. Quick response techniques were also used for time-of-day factoring.

Long-Distance/Recreational/Tourism Travel

Three long-distance trip purposes are used, plus a regular home-based recreation trip purpose as well. 1995 NPTS data were used to develop these trip rates. See answers below for more details.

MISSOURI

Individuals at Missouri DOT (MoDOT) have done modeling in limited capacity for urban development in the mid-1990s and a statewide traffic model was developed to do traffic projections in 1998. The statewide model was developed to do corridor analysis on I-70 in addition to limiting numerous models being developed on a project by project basis, which ultimately would be a waste of funding. The model seemed to be fairly good when evaluating larger corridors (20 mi or more in length). An internal staff member used the model for several projects to get traffic projections, but this employee moved to another area of MoDOT, resulting in remaining projects being done by an on-call consultant. I must add we have struggled with the model for the last 3 years and ultimately decided to update the model last year to include the latest census information. Also, we decided to convert the model from TRANPLAN to TransCAD.

The model was used heavily for an I-70 corridor study and will most likely be used for an I-44 corridor study. With the I-70 corridor study, an east–west route to the north (US36) and an east–west route to the south (US50) were used to determine traffic patterns and options if I-70 were expanded to three lanes per direction.

The model basically involved 26 tasks that started with data collection and concluded with training. Below are the two phases of the model and the identified tasks:

- Phase 1—Develop I-70 Corridor Model
  - Task 1: Collect data
  - Task 2: Confirm model software (TRANPLAN)
  - Task 3: Develop model structure
  - Task 4: Establish TAZs
  - Task 5: Establish external stations
  - Task 6: Prepare a base year network (1998)
  - Task 7: Generate base year productions and attractions
  - Task 8: Establish mode share
  - Task 9: Distribute base year trips
  - Task 10: Assign base year trips
  - Task 11: Calibrate/validate phase 1 model
  - Task 12: Prepare phase 1 forecasts (2020)
  - Task 13: Update network to 2020
  - Task 14: Prepare and process 2020 phase 1 model
- Phase 2—Develop statewide model
  - Task 15: Upgrade TAZs
  - Task 16: Upgrade base year network
  - Task 17: Generate base year productions and attractions
  - Task 18: Perform mode split
  - Task 19: Distribute base year trips
  - Task 20: Assign base year trips
  - Task 21: Calibrate/validate phase 2 model
  - Task 22: Prepare 2020 forecasts
  - Task 23: Update network to 2020
  - Task 24: Prepare and process 2020 phase 2 model
  - Task 25: Document and process models
  - Task 26: Staff training workshops

Data

The model was developed in two phases. Phase 1 involved the I-70 corridor and Phase 2 involved further refinement of the model to be used for statewide purposes.

I believe a major issue we have is lack of a complete network of roadways in addition to a lack of traffic volumes for non-state routes. Because we have no volume data for many city streets or county roads that intersect a corridor, we have found the traffic projections are not always dependable and this has caused a confidence issue. We hope the update to the model will boost our confidence in the projection and also allow internal staff to modify more easily when necessary.

I also need to indicate the lack of good O-D information may have been a problem. Obviously it is costly to obtain good O-D information and this has limited our efforts. We have found that good O-D data is critical in making the best transportation decision.

Maintenance/Use

The model has been maintained by a consultant to date. We have updated the model about every 2 years with our traffic count information. The model has been used for corridor analysis and bypass type projects.

Implementation

The model was initially developed in two phases that involved over 26 tasks as described earlier. The model was developed for many individuals to use within MoDOT, but this did not materialize due to issues that surfaced. The goal of developing the model was very good (limit the number of models being developed on a project by project basis—saves money), but due to staffing issues this did not prove to be a realized benefit. All 10 districts were made aware of the model and its intent, but other models were still being developed due to lack of qualified individuals within our work unit and lack of confidence with the model results (past experience).

One of the lessons learned involves the data collection phase of development. The more complete and accurate work done in this stage pays dividends in the long run. The term “garbage-in, garbage-out” is definitely a real issue we have dealt with. Ultimately, confidence in the results suffers when the output seems flawed. This has resulted in some of the districts developing a project specific model.

Another lesson learned is the issue of consultant dependence. This relates to both the maintenance and use of the model. Having internal qualified staff in place would allow our confidence to grow. Can this be done by a couple of individuals on a limited basis? This question will hopefully be answered soon.

Scale/Level of Detail

The statewide model has a network of roadways in place and will generally have all roadways functionally classified as arterial and higher and does have many collector routes and a few of the local roadways. However, the traffic count information appears to be limited for many collector routes and lower functional class (no one has counted these routes). The model has worked relatively well for larger scale projects (corridor analysis like I-70), but has provided mixed results in many cases for a smaller scale project (shorter project length involved—10 mi or less). The smaller scale project more than likely has been a problem due to the lack of quality data (traffic counts) due to a more focused tighter network.

Statewide/Urban Model Integration

The statewide model is not integrated with urban TDMs. The MPO urban models were used to assist in the development of the statewide model.

NEW HAMPSHIRE

New Hampshire began its statewide model development in the year 1994. In 1994 the New Hampshire Department of Transportation (NHDOT) began an important statewide study to carry the department's transportation planning into the 21st century. The overall goal of the statewide planning study is to "provide recommendations for developing a coordinated transportation system that will facilitate the movement of persons and goods in a safe, cost effective, efficient, and environmentally conscious manner." Recommendations from this study were to be directed to all transportation modes in the state of New Hampshire, including highways, public transportation, and freight movement.

This study reflected the emerging direction of transportation planning. It also reflected the department's desire to lead in this direction, as NHDOT strives to meet the goals of transportation-related legislation, such as the federal ISTEA, and the Clean Air Act of 1990. Among other things these laws call for increasing the availability of transportation options to reduce the reliance on single-occupant vehicles, and for greater public participation in transportation planning and decision making.

NHDOT also recognized that better study decisions can be made through an open public participatory process. With this in mind, a comprehensive public participation program was developed to accompany the statewide planning study. Elements include: a legislative advisory committee, technical steering committee, periodic newsletters, public workshops, and a travel demand management brochure and video.

Other study objectives included: developing methodologies to assess the impacts of transportation projects; coordinating local and regional travel demand planning and management; helping to implement recommendations of the department's Transportation in the 21st Century January 1993 report; and demonstrating on specific corridors (I-93 and Route 16) the analytical tools developed through this study.

The New Hampshire Statewide Travel Demand Model System (NHSTMS) was developed as part of this study to help predict travel behavior (i.e., how people travel—by car, bus, etc.) and travel demand (i.e., how many people want to travel on a certain road or by a certain mode). The model is based on statewide data collected on highway, bus, rail, and airport systems; and land use, social, and economic characteristics. Household travel, roadside motorist, and transit rider surveys were conducted as part of the data collection effort. The department and its consultants plan to use the model to identify potential new or improved transportation services and strategies, designed to improve overall transportation services, reduce congestion, and improve air quality.

The NHSTMS was developed to address the needs of the department in the following areas:

a. Project/subarea analysis—The model will be used as a tool to analyze the impacts of major highway projects such as new corridors and widening of existing alignments.

b. Policy alternative analysis—The model has the capability to look at impacts of policy decisions such as increases in tolls and transit fare increase.

c. Air quality analysis—The model is designed to generate, for peak and off-peak periods of a summer average weekday, VMT estimates, which can be used as input to air quality analyses.

d. Inputs to regional models—The statewide model is expected to provide the external cordon line volumes for other regional models (such as the models developed by the metropolitan planning commission).

e. Management systems—The model will serve as a tool to develop congestion management, public transportation, and intermodal management system.

f. Statewide planning study analysis—The model will be used to identify potential new or improved transportation services (such as bus or rail) and strategies, designed to improve overall transportation services and reduce reliance on single occupant vehicles, reduce congestion, and improve air quality.

Data

A variety of data sources were used in the development of the NHSTMS. These include the following.

The primary data source for the estimation of the travel behavior models was the New Hampshire Activities and Travel Survey, which was conducted for the statewide planning study by the firm of Market Opinion Research. A total of 2,844 households in New Hampshire provided data on the activities and travel undertaken by household members over a 24-h period. Households were recruited for the survey by phone, were sent a diary form for travel and activity data, and were called back to retrieve the diary data. The survey was conducted between August 1994 and June 1995.

A series of transit on board surveys was conducted in summer/fall 1994 to supplement the household survey data on transit trips. Surveys were conducted of riders of bus service from New Hampshire on C&J, Concord Trailways, Coach, and Vermont Transit. Riders were handed survey forms on the buses or at the stops, which were mailed back for tabulation. This provided a trip file similar to the household survey trip file. This file was used to supplement the trip file from the household survey, which, not surprisingly, had relatively few transit trips.

Data were also obtained from a 1994 survey of riders on the Massachusetts Bay Transportation Authority (MBTA) commuter rail service. A total of 210 of the records from this survey represented trips by New Hampshire residents boarding on the Fitchburg, Lowell, Haverhill, and Ipswich lines. These records were important because there were only a handful of actual commuter rail riders in the household survey. They were added to the trip file from the transit onboard survey.

A series of vehicle intercept surveys was conducted in summer 1994 by Holden Engineering to obtain data on external trips. In this context, external trips refer to trips made by New Hampshire residents to locations outside the state and trips made by non-New Hampshire residents to or through New Hampshire. Drivers were surveyed at 24 locations at or near major New Hampshire border crossings using one of three methods:

Drivers were stopped and asked the questions at the survey sites. Responses were tabulated on hand held computers. Drivers were handed survey forms and asked to mail them back. License plates were recorded and matched against records from motor vehicle departments in New Hampshire and Massachusetts (this procedure was used only at sites on the Massachusetts border). This survey provided a trip file similar to the household survey trip file. This file was used to model trips by non-New Hampshire residents.

A stated-preference survey is conducted to obtain information about behavior, which is rare or nonexistent and therefore cannot be easily obtained from travel behavior surveys. Market

Opinion Research conducted a stated-preference survey, on a subset of the respondents to the Activities and Travel Survey. Respondents were asked to make hypothetical choices given the availability of new transit service, increased auto costs, or other potential changes to the transportation system. This resulted in another supplemental trip file, which contained a richer sampling of transit choices.

The main source for information about the highway system in New Hampshire was the database maintained by NHDOT using the Graphics Design System (GDS). The GDS database contained information on all roads in New Hampshire.

The NHSTMS has a transit network, which is used for developing travel time and cost information for the mode choice and transit assignment processes. This network focuses on longer intercity routes such as the intercity service provided by C&J, Concord Trailways, Coach, and Vermont Transit, and commuter rail service provided by the MBTA. The following data on these transit services were required for model development and/or application:

- Fare structures;
- Headways/frequencies;
- Travel times; and
- Ridership.

This information was obtained directly from transit operators or from published information (e.g., schedules).

- Socioeconomic data:
  - U.S. census (households by municipality, tract, and block group by income level, number of persons, number of workers, and number of vehicles available);
  - New Hampshire Department of Employment Security figures on employment by category for each municipality;
  - U.S. census Public Use Microdata Sample (PUMS) for New Hampshire;
  - Dun and Bradstreet employment database for New Hampshire; and
  - New Hampshire Office of Planning Population and household forecasts by community, and
  - Employment forecasts by county.
- Geographic boundary information: U.S. census TIGER files.

Maintenance/Use

Since its implementation in 1998 the model has not been updated with socioeconomic or network changes.

The model was calibrated for base year 1990. Future networks were established for 1997, 2007, 2017, and 2020 based on major highway projects expected to be complete by these years. Future year 2020 socioeconomic data were generated using the projections from New Hampshire Employment Security and Office of State Planning. Model runs were done for future years 1997, 2007, and 2017 by extrapolating the socioeconomic data. The outputs from these model runs are occasionally checked to develop growth rates for traffic in different regions. These growth rates are used to estimate future traffic for highway design projects.

The model was used to estimate transit rider-ship and high occupancy vehicle (HOV) lane use for the I-93 corridor from Manchester, New Hampshire, to Massachusetts state line (a major widening project now under study). However, the results were not well received.

The model was also used to analyze the impact of adding additional transit service along the State Route 16 corridor from Portsmouth to Berlin, New Hampshire, as part of the Corridor Preservation program. Again the model results were inconclusive.

Implementation

The model implementation was completed in 1998. NHDOT staff received some training in the use of the model. Also, three NHDOT staff attended a training session hosted by Inro Consultants, developer of the EMME/2 model.

EMME/2 model, though very powerful, is difficult to work with. Also, in the model development process NHDOT staff did not have much oversight and the department depended on the expertise of the consulting firm in model development and calibration. Once the model was implemented, NHDOT staff could not make efficient use of the model since NHDOT staff were not familiar with the programs that were written by the consultant to compile the data as input into the model. We had to rely on the consultant to fix any errors that resulted in the model runs to crash. Also, the model used several EMME/2 macros and in the initial stages we had difficulty running these macros.

Model development needs department staff to be trained and involved in the process. We cannot expect a consultant to develop a model with the hope that a technician can run the model with few instructions and develop the outputs.

Scale/Level of Detail

The New Hampshire Statewide Travel Model has a total of 500 zones and about 10,000 links. The model includes zones in Maine, Vermont, and Massachusetts.

The model area is the area, which includes the O-D of most trips, which are made wholly or partially in New Hampshire. This area includes the entire state of New Hampshire and locations in neighboring states which represent destinations for significant numbers of New Hampshire residents, or whose residents make significant numbers of trips to New Hampshire.

The highway network included freeways, expressways, arterials, collectors, and local roads.

Statewide/Urban Model Integration

No, but the model update will include integration of MPO models. Information from the MPO models was used to create networks and zones in those areas.

Freight/Commercial Vehicle Modeling

No.

Long-Distance/Recreational/Tourism Travel

No. As part of the model update we will develop procedures to estimate tourist trips.

NEW JERSEY

All of New Jersey and most of the adjacent boundary areas are covered by MPO/regional TDMs. In the early 1990s, the development of a statewide model began. The goal was to produce an analysis tool, large enough in scope, that could address growing questions about statewide truck and highway travel. The model was developed over many years but mostly in two phases. The model structure could be considered a hybrid with the auto component derived from MPO models and the truck component using a more traditional four-step model process. Phase 1 included core model development activities and validation of the base year conditions. Phase 2 was initiated in late 1990s as a major update to the truck trip generation component and the development of a future year. During and since that time, the model has been used extensively for truck/freight projects and highway projects that are not covered by regional MPO models. In recent years, updates to the model have been consisted of improvements as a result of specific applications.

Data

The revised version of the New Jersey statewide model requires employment by type and household data for the truck trip generation process. Bridge weight restriction data were obtained and coded into the network. Specific data needs for external stations are 24-h AADT, E-E %, Total Truck %, and Medium Truck %.

Specific Port Newark/Elizabeth data were used for validation purposes. Various other counts were also obtained for validation of the model.

Maintenance/Use

The New Jersey statewide model is updated on an as-needed basis. It is usually updated and revalidated when it is needed for a certain project. The model is used primarily to determine the volume and movement of trucks on the statewide network. Examples of this include analyzing the impacts of the completion of I-287 and I-295. This model has also been used for to determine auto volume and movement for various projects that span the boundaries of our individual regional models. Examples of this include the Central Jersey Study.

Implementation

The creation of this model is an ongoing process. The first phase was to define the study area and create the actual model. Several existing regional models split the study area so it was decided to merge the networks and zonal systems instead of creating them from scratch. It was agreed that our MPO models accurately portray auto volumes and movement in the state. The existing auto trip tables were “weaved” to create a unified auto trip table. A commodity-based truck trip generation method was decided upon to simulate truck travel. In the second phase the truck trip generation method was revised because distribution related truck trips were not represented with the commodity-based results. A more traditional trip generation method was adopted which used employment, household, special generator data along with FHWA truck trip generation algorithms. The network and zonal system were also revised. A future year network/zonal system was also created. In our third phase we will be looking to add additional detail to the network and zonal system and provide feedback to our other models.

Scale/Level of Detail

The statewide model contains over 2,800 zones, 44,000 links, and 17,000 nodes. At the time, this model pushed the limits of most transportation planning models. The scale of this model is primarily a function of the size of the three MPO models that cover New Jersey. A tool was needed to determine longer intra- and interstate movements of trucks and autos.

Statewide/Urban Model Integration

This model is a stand-alone tool but as stated previously, it is an aggregation of other New Jersey regional models. The network and zonal system was created by merging five regional models together. The models were combined and an analysis was done to determine and remove all overlapping zones and links. A second analysis was performed to determine if all remaining zones and links were necessary. Some detail from the out-of-state portions of the Delaware DOT and Delaware Valley Regional Planning Commission models were removed. All links and zones inside of New Jersey remained in the model.

While the truck trip table is simulated, the auto trip table was created by "weaving" the trip tables from the five individual regional models. Trips are then assigned to the network using a standard gravity model.

Freight/Commercial Vehicle Modeling

The updated model estimates truck trips using traditional modeling techniques. The truck trip generation process requires employment by type and household data. The model uses the trip generation rates referenced in from the 1996 *Quick Response Freight Manual*. The trip generation approach provides a mechanism to independently simulate major truck trip generators that would be poorly represented by employment-based trip generation equations. Zones that were coded as including special generators were assigned different rates based on the type of generator.

The truck productions and attractions are then balanced and distributed to the highway network.

OHIO

Ohio began its statewide model development in the mid-1990s. The first phase of development was a study of user needs and model capabilities which resulted in a model specification and data collection program. This specification was for a leading edge advance land use/travel demand/econometric model that would take at least five years to develop. Therefore, an interim model capability was specified as well. The interim model consists of car and truck trip tables developed from counts, roadside surveys, and MPO trip tables. It uses the same highway network as the advanced model. It has been operational for 2 years and has been used extensively. Some examples of its use include analysis in support of Ohio's statewide long-range plan update (Access Ohio), a corridor study of the Ohio Turnpike, analysis of the user benefits of the Governor's Jobs and Progress Plan (a major capital improvement program that is basically the first 10 years of the long-range plan), numerous project level forecasts, and VMT estimates for air quality conformity analysis in counties not covered by urban models. The advanced model is just entering development this year following about 4 years of data collection. It is scheduled for completion next year. Two supporting documents are included in the attached zip file. One is the most recent model specification outline for the advanced model. The second is a Power Point presentation that was given at the 2004 Annual Meeting which shows various schematics and sample outputs.

Data

The data needs of the advanced model are immense. However, it was decided from the start that the in-house resources available to maintain this model would be two people, so the specification has been tailored with that in mind from the beginning. Network data is primarily obtained from Ohio DOT's (ODOT's) centerline roadway information database. However, there was also a need to build networks outside Ohio and for other modes. This was obtained from federal sources as well as some MPOs. Socioeconomic data for the standard types was needed as well and were obtained from census and ES-202. Considerable effort was applied to cleaning/geocoding ES-202 since this data would be used to reconcile other data sets. Land use and land value data were obtained from the Ohio Department of Natural Resources and County Auditors. However, the coverage of both of these data were intermittent and models of detailed land use/land value with respect to courser levels and employment had to be used. A variety of other existing data sources were tapped as well such as IMPLAN data used for the aggregate econometric modeling. The demand models themselves are driven by a series of three surveys. A traditional 1-day household survey was conducted. This survey served the dual purpose of updating small/medium MPO models and was combined with similar surveys conducted in the largest three urban areas of Ohio to produce a combined survey dataset of about 25,000 households. A small subset of these households were also equipped with Global Positioning System (GPS) -based survey equipment to help determine survey under-reporting which was found to be significant. The second survey was a 2-week survey of long-distance travel (over 50 mi) as these types of tours will be separately modeled due to their importance at a statewide level. About 2,000 households were included in this survey. Lastly, an establishment survey of about 800 establishments was conducted. This survey was geared towards supplementing information available in the TRANSEARCH database. The intention is to do aggregate commodity flow modeling for those commodities well represented in TRANSEARCH. The survey therefore focused on obtaining business travel not directly related to commodity flow except for industry sectors not well represented in TRANSEARCH. There were several primary issues regarding the data. The network data based on our own roadway information database has been difficult because those databases are in a state of gradual change which has made standardizing network building difficult. Data obtained from other state agencies (ES-202, Land Use) has suffered from the relative lack of funding those agencies receive and the commensurate lack of effort put into maintaining their data. Finally, the lack of standards and Federal data for commercial vehicles and the high degree of variance in that data means the reliability of those models won't be of the same order of magnitude as the personal travel models.

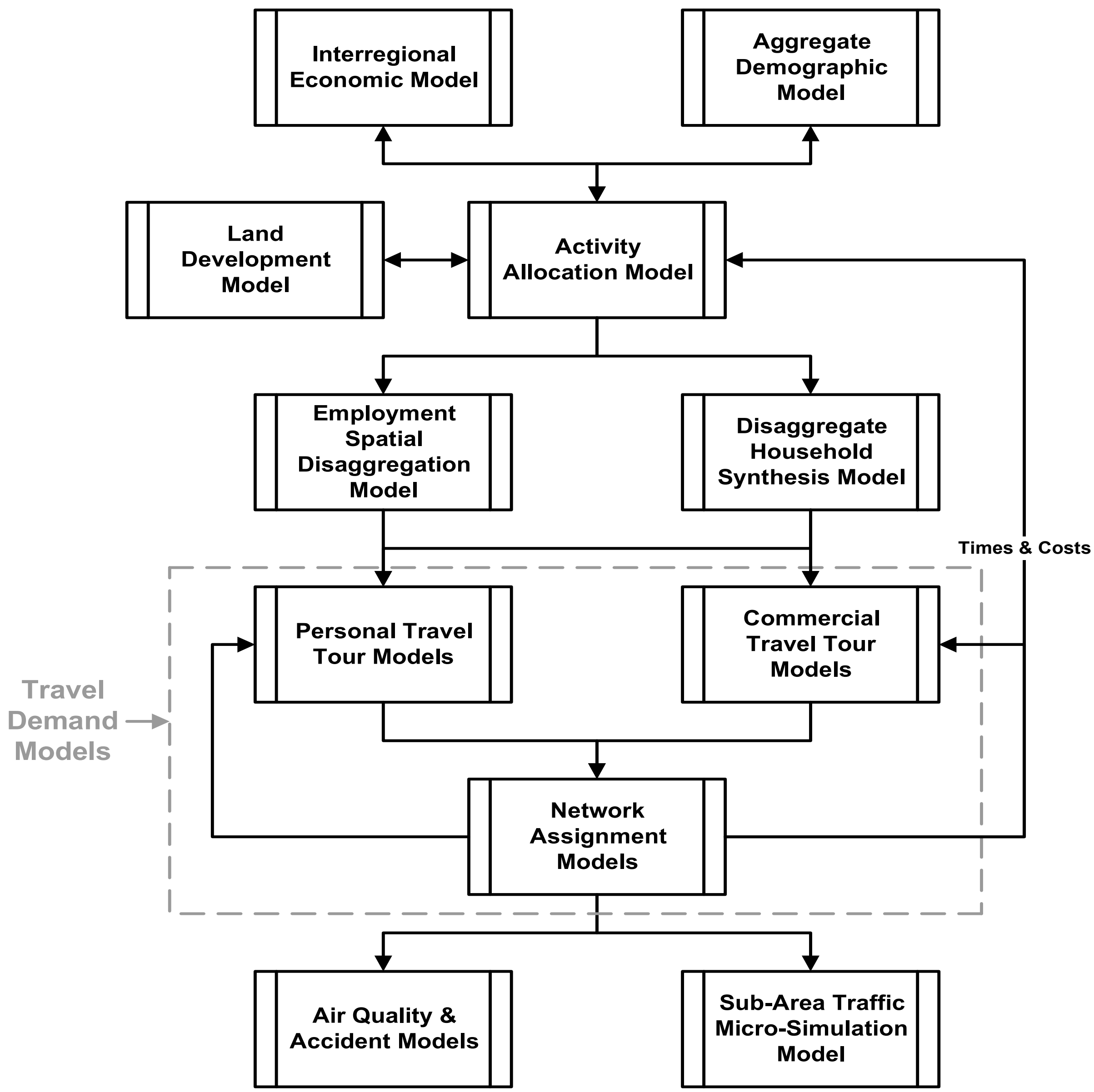

FIGURE 23 Model components.

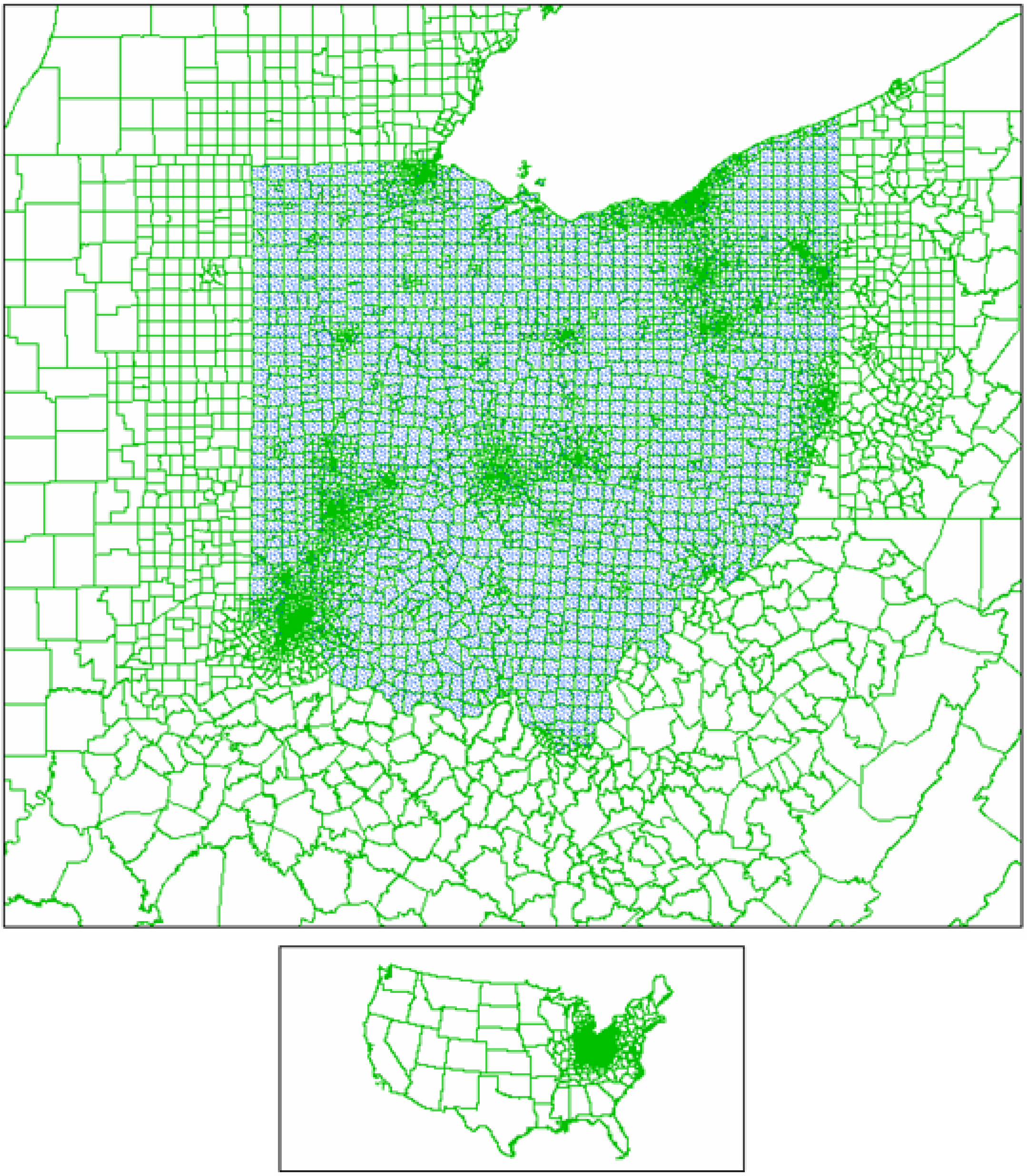

FIGURE 24 Statewide traffic analysis zones.

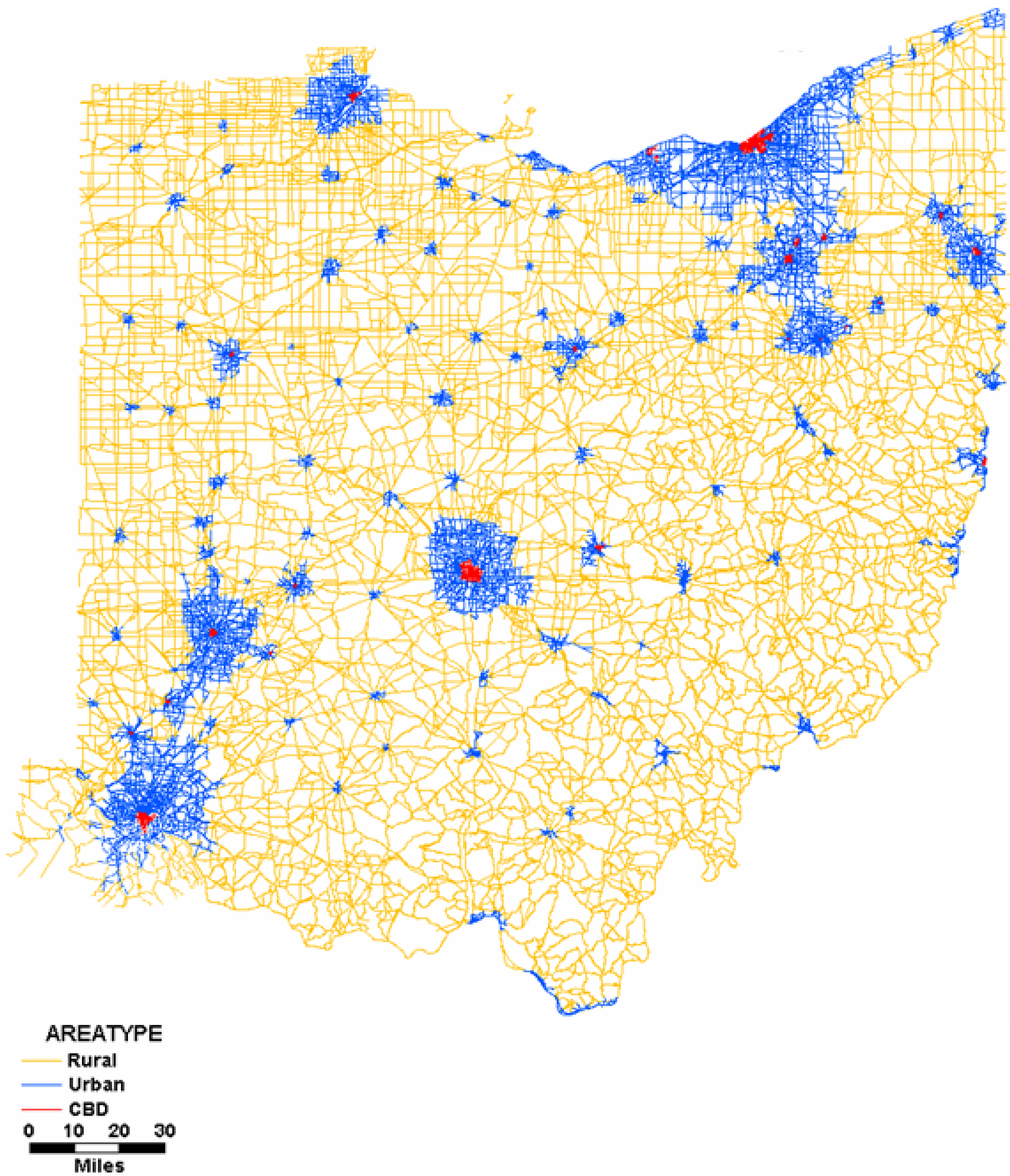

FIGURE 25 Statewide network area types.

Maintenance/Use

The interim model is maintained by updating the employment and network data annually. In addition, for each major project the model is evaluated and adjustments are often made. For example when the requirement to produce VMT estimates for the SIP update process came up, adjustments for matching county-level VMT estimates were made since the original validation was statewide only. The model is used for corridor studies, long-range plan support, project planning, and soon will be used to support conformity/SIP development. More detail on some of these activities follows. For project planning, a standardized set of assignments is maintained with are referenced when design traffic in non-MPO areas is determined. The model results in this case are merely consulted and manually adjusted or disregarded as the analyst sees fit since no specific adjustments are made to the model for these purposes (which is impossible since our section handles many of these requests daily). A study of the turnpike corridor was conducted in which the network and zone system in that corridor where disaggregated and various toll strategies applied to see how the system responded. The primary purpose was to identify roughly which parallel facilities were sensitive to toll changes on the turnpike. While the interim model does not have detailed toll models allowing one to actually set toll policy from the results, it was able to indicate that certain parallel routes were too far away to be measurably impacted by toll policy and therefore could proceed with capital improvements without regard to Turnpike tolls. In support of long-range planning, there have been two major efforts. The first was to analyze Ohio's "Macro Corridor" system. The Macro Corridors are basically highway routes on which ODOT supports major capital improvements. Such routes receive bonus points when distributing funding so the designation is important. The model was used to identify routes for addition to this system based on latent demand for freeway type facilities on current two-lane alignments. The second effort was to analyzed the Governor's Jobs and Progress plan for user benefits. This plan uses the new gas tax increase for a series of major capital investments over the next 10 years (about $500 million per year). The user benefit due to the congestion reduction alone was calculated using the model and ODOT's congestion management system post-processor. For bypass studies, detailed O-D surveys are conducted to determine diversion of traffic currently entering the study city while the model is used to determine the amount of traffic that would divert into the study area due to the bypass.

Implementation

The model could be viewed as being developed in three phases. In Phase 1 a user needs study was conducted and a model specification/data collection program was developed. In Phase 2, data were collected for the advanced model concurrently with the interim model being developed from existing data. Phase 3 which is just beginning then involves development, validation, and testing of the advanced model. This seemed to be a good way to do it. I think the biggest mistakes we made were allowing a couple of the subconsultants to go off and develop procedures without enough oversight with the result that those procedures didn't do what we needed (these were related to highway network and ES-202 processing). Because of staff limitations, we had a fairly large budget for the prime consultant to manage the project, however, I don't think the same sense of urgency or vested interest in the outcome results from that technique. It would be better to manage the project in house if possible.

Scale/Level of Detail

The interim model has about 1,200 zones covering all of Ohio and small amounts of Indiana, Kentucky, and Michigan where the Toledo and Cincinnati MPO models extend out of state. The network covers all functional class collector and better with some local roads. It is intended to give reasonable results on the high type facilities only (freeways, major U.S. routes) as well as decent overall VMTs by functional class for collectors and up. The advanced model will have over 5,000 zones and extends 50 mi outside Ohio as well as a less detailed coverage of the rest of the United States. It will model more of the local system as well as including other modes (mainly rail). This zone system will be the basic level at which O-D matrices will be assigned, however, two other zone systems exist as well. A subzone system of some 20,000 zones is used to maintain the population and employment data. These subzones allow for automated disaggregation of the model in are near a specific project or study areas. The networks also contain this extra high level of detail which can be brought in to a focus area automatically. There is also a set of about 700 activity model zones at which the higher level econometric models operate.

Statewide/Urban Model Integration

No. Some information from MPO models was used for networks and the seed trip table used in the interim model. Also the same Census and ES202 data is used for socioeconomic data. Also, statewide model uses TransCAD and MPO models use Cube or QRSII.

Freight/Commercial Vehicle Modeling

The interim model simply has a truck trip table based on roadside surveys and counts. The advanced model will attempt to cover all aspects of the economy and thus model all forms of commercial vehicles and business travel in addition to freight. Categories of commodity movement covered in TRANSEARCH will be model as O-D flows of commodity which will be translated to trucks. Other forms of commercial vehicle/business travel will use disaggregate models (logits) similar to modern personal travel models.

Long-Distance/Recreational/Tourism Travel

A separate long-distance household travel survey was conducted for trips over 50 mi and this travel is modeled separately. Tourism/visitors will probably be handled in a more abstract, aggregate way. There is a specific visitor trip model and some information on visitors was obtained in the household surveys.

OREGON

Recognizing that modeling is only one component of an integrated analysis effort to support policy decision making, Oregon DOT (ODOT) embarked upon its comprehensive Oregon Modeling Improvement Program (OMIP) in 1994. The Oregon program developed with a five-track approach to make the modeling program useful and accessible to decision makers, stakeholders, and practitioners see attached flow diagram. The five OMIP tracks include: Resources, Outreach, Development, Implementation, and Data. The following is a brief description of the five tracks:

Track 1—Resources

Establishing and maintaining adequate funding is critical to the overall success of the program. ODOT and all Oregon MPOs maintain a joint partnership work program to enhance working relationships, to facilitate providing modeling services to customers, and for resource leveling between agencies. OMIP is also working to create career ladders within the agencies for modelers and to bring about comparable pay between agencies to create an attractive environment for recruiting and retaining employees.

Track 2—Outreach

Collaboration and cooperation among everyone involved in program development and application has been an important component of OMIP. Several cooperative forums meet regularly to provide direction and discussion on OMIP:

- The Oregon Modeling Steering Committee (OMSC) is a consortium of federal, state, and local agencies that provides oversight to the Oregon modeling program. The OMSC regularly provides peer review for a variety of models and model applications.
- A statewide modeling users group meets regularly to exchange information, solve problems, and provide training. This group includes technical staff from local jurisdictions and state agencies, consultants, and others involved in the day-to-day application of the tools. The program is managed by an assigned ODOT staff person.
- An internationally prominent peer review panel meets regularly to review progress on the Transportation and Land Use Model Integration Project (TLUMIP) and to recommend improvements or modifications.

To provide overall coordination for the OMIP, the 5-year SIP incorporates modeling-related work program elements of all OMSC members. This plan is a living document and is updated regularly. The plan provides program direction for annual coordination of the Oregon MPOs and ODOT to coordinate modeling efforts for their respective Unified Planning Work Programs. An OMSC report of accomplishments is prepared annually.

Training and outreach are important activities to develop and implement the OMIP. Training opportunities are identified through the OMSC and it stresses the multidimensional nature and connections between land use, transportation, economics, and the environment when developing community solutions to transportation issues. Thinking in an integrated manner using integrated tools requires a new level of technical and policy competency. Outreach is important to share program information and to engage decision makers and staff to define needs and opportunities. Portland State University is a member of the OMSC and is coordinating activities to provide the necessary skills to fully implement the OMIP initiatives and to assist the evolution of simulation and modeling into public policy analysis.

Track 3—Development

Development includes research, model development, and documentation.

Research

The OMSC annually identifies research projects that benefit the OMIP and OMSC member agencies and jurisdictions. Projects to develop policy performance measures (PMs) and for freight surveys are currently funded through joint programs.

Model Development

In 1996, ODOT embarked upon the TLUMIP. TLUMIP is intended to develop and refine an interactive statewide economic, land use, and transport model for use in planning and policy analyses at varying scales of geography. The model simulates the economic, land use, and travel behavior relying on a variety of data, from exports by the business sector to transportation operator characteristics. This statewide model is a valuable complement to MPO models which are regionally focused. The complexity of the interactions and the interdependence of economics, land use, and transportation are represented in the following figure. Policy parameters can be introduced at any point in the modeling process.

The first generation TLUMIP model (Gen1) is in use and demonstrates the overall validity of the concept. Analyses are used to consider a variety of policy issues, including how alternative land use and transportation policies affect land use patterns and state highway congestion. The second generation model is being developed, incorporating information from applications of the first generation model. TLUMIP is expanding capabilities of transportation modeling throughout Oregon by more thoroughly simulating travel and land use behavior and reflecting the economic impacts of that behavior. The models use the strength of GIS to analyze land use and transportation data and to display information in easily understood maps and graphics. Models developed at the statewide and urban levels are being integrated to allow analysis of the entire state transportation system in a multimodal, coordinated, and standardized process.

Oregon is currently building a transitional model as a stepping stone from the Gen1 model set outlined above and the specified ultimate goal for the TLUMIP model set. The transitional model incorporates information gained from use of the Gen1 model and is a significant improvement over the Gen1 models.

The transitional model represents the behavior of the land use, economy, and transport system in the state of Oregon using a set of seven connected modules that cover different components of the full system. An eighth module, the application orchestrator, integrates the modules and executes a model run. Modules and flows in the transitional model are shown in the following figure.

FIGURE 26 Schematic representation of the statewide model.

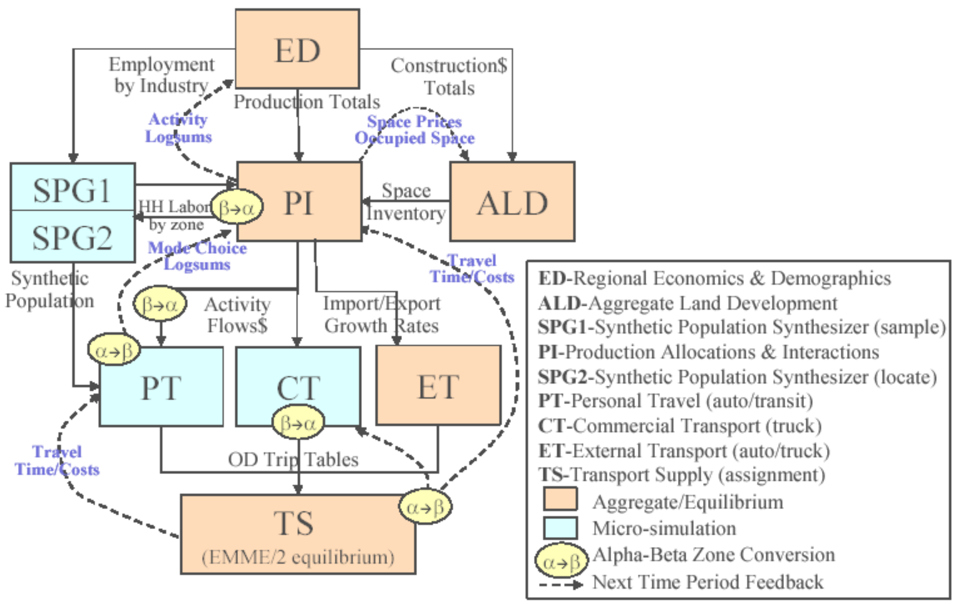

FIGURE 27 Sequence of modules in transitional models.

Each module is run in turn, starting at the top (ED) and working down through the figure, once for each year of simulation. As a dynamic sequence of models, the transitional model differs from the traditional equilibrium hierarchy, as decisions in individual modules influence each other over time through dynamic feedback. A summary of each module's function is listed below:

- ED—The Economics and Demographics module determines model wide production activity level, employment, and imports/exports.
- SPG—The Synthetic Population Generator module samples household and person demographic attributes (SPG1) and assigns a household a-zone (SPG2).

- ALD—The Aggregate Land Development module allocates model wide land development decisions among study area a-zones considering floor space prices and vacancy rates.
- PI—The Production Allocations and Interactions module determines commodity (goods, services, floor space, labor) quantity and price in all exchange zones to clear markets, including the location of business and households by b-zone.
- PT—The Person Travel module generates activity-based person trip tours for each study area person in the synthetic population, during a typical weekday.
- CT—The Commercial Transport module generates mode split for goods movement flows, and generates an activity-based truck trip list, combining shipments, for a typical weekday.
- ET—The External Transport module updates a series of input O-D trip matrices representing import, export and through trips based on PI and external station growth rates.
- TS—The Transport Supply module assigns vehicle, truck, and transit trips (separately) to paths on the congested transport network for a 24-h period, generating time and distance skims for a.m. and off-peak periods.

Most input and output files are ASCII comma separated value format (no tabs). Some files, notably travel skims, are saved in a compressed zipMatrix format.

Efforts are also underway to improve Oregon small city and urban models. The Urban Joint Estimation Model in the analytical program R (JEM-in-R) is an estimated TDM using combined data for all Oregon MPOs. The urban JEM-in-R has been calibrated and is available for use in the MPO areas. Similarly, an Oregon Small Urban Model for the non-MPO areas in Oregon uses data from eight rural counties to do estimation and calibration. Local social and demographic data is used in the JEM-in-R structures for both urban and rural areas to create local validated models.

Track 4—Implementation

The OMSC serves as the technical clearinghouse for modeling issues and applications. Modeling practices at the MPO and local levels continue to be upgraded and standardized throughout the state. Several documents guide model development and application in Oregon, including

- TDM Development and Applications Guidelines,
- Strategic Plan for Development of new Modeling Tools,
- Modeling Protocol, and
- Model Documentation Guidelines.

Applications are used to test methodologies and technical capabilities of models. They provide a public forum to discuss policy issues and how modeling tools can help decision makers address complex issues. White papers, reports, OMSC minutes, and other documentation on the Oregon program and development of the TLUMIP statewide model are available at www.odot.state.or.us/tddtpau/modeling.html. Case studies were developed for the following applications of the statewide model:

- UrbanSim: Eugene–Springfield Area. The prototype TLUMIP model was applied to a case study in Eugene–Springfield, Oregon. The case study was designed to test the model for performance (longitudinal calibration) and to assess how it works over time and conducted a simulation from 1980 through 1994. The results of the case study provided useful insights into the behavior of the model over the historical period of the calibration.
- Willamette Valley Livability Forum. With direction from the governor, the forum initiated a comprehensive regional visioning process for the future of land use and transportation in Oregon's populous Willamette Valley. The first generation of the TLUMIP model was used to model eight scenarios that varied by land use, road and public transit networks, and mileage tax. Results of modeling various combinations of land use, economic, and transportation policy options allowed decision makers to see effects of each policy and how it will shape the future of the Willamette Valley.
- House Bill 3090: Eastern/Central Oregon Freeway. The 1999 Oregon Legislature directed ODOT to analyze whether a freeway in eastern/central Oregon would off-load increasing traffic in the Willamette Valley. The TLUMIP model was used to evaluate the effectiveness of three alternative alignments to meet this objective. The study looked at designating a north–south freeway in central or eastern Oregon, from the Washington to California borders. Overall, the project did not meet the objectives of transferring growth from the Willamette Valley to central or eastern Oregon and the project was not pursued.
- Newberg–Dundee Bypass Induced Demand. An environmental impact statement (EIS) is being prepared for a proposed highway bypass of two small communities between Portland and McMinnville. The TLUMIP model was used to evaluate induced demand potential in rural Yamhill County, Oregon, as a result of the new bypass highway. Although better access provided by the bypass contributes to the economic growth of McMinnville, the analysis shows minimal effects in Newberg, Dundee, and other small communities in the county.
- Economic and Bridge Options Report. The TLUMIP model was used to examine the impacts of weight limits for vehicles using deteriorating bridges throughout Oregon. The model limited truck weights to reduce bridge loads and assessed the effect on state and regional economic production and jobs, transportation costs, and changes in travel and land use patterns. Modeling analysis estimates that weight limits on Oregon's bridges could cost the state as much as $123 billion in lost production and 88,000 lost jobs over the next 25 years if action is not taken to address deteriorating bridges. The modeling analysis also showed that regional impacts of different weight restriction scenarios are significant and vary considerably across the state. This analysis was the basis for a discussion with the 2003 legislature and resulted in a $4.5 billion investment in Oregon's transportation infrastructure. This is the largest investment in Oregon transportation infrastructure since World War II. The model will be used for the next phase of the program, which will include corridor and project prioritization, and reporting back to ODOT management and the Oregon Legislature on how the program has achieved intended economic/job results.
- Oregon Transportation Plan Update. The ODOT strategic policy document for transportation is undergoing its first update since it was adopted in 1992. The statewide model is being used to help define a reference case and different transportation service and investment scenarios.

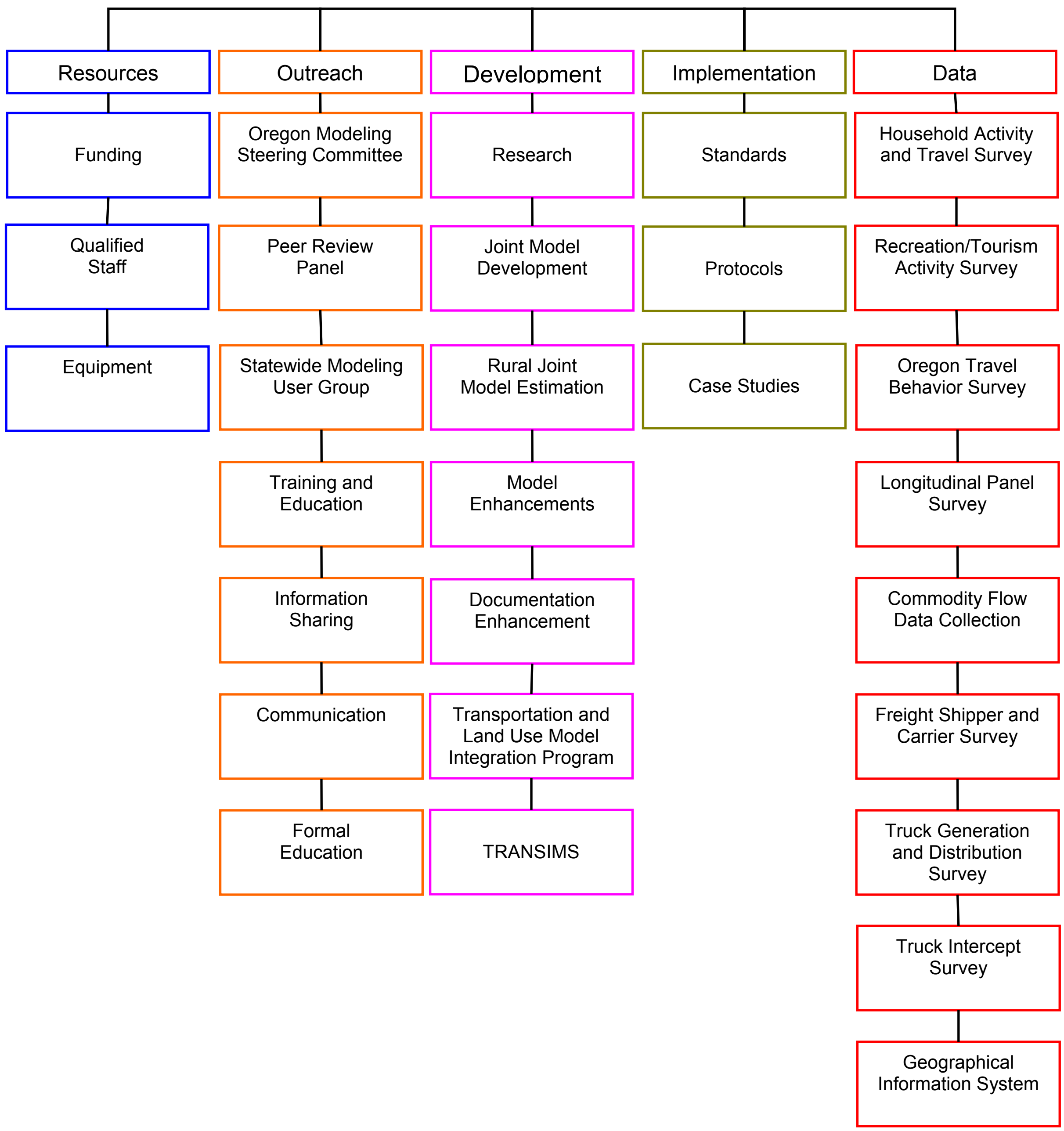

FIGURE 28 Oregon modeling improvement program: strategic elements.

TABLE 9 Capabilities to Address Policy Issues

Analysis Issue	Applicable Scale			Required Data	Modeled Response(s)[1]
	Statewide	Substate	Local		
Effect of land supply on land use and location decisions	ν	ν	ν	Zonal area, employment and housing by type, network travel times by mode, exogenous constraints on growth (non-movable businesses, urban growth boundaries).	Changes in residential and commercial land prices, changes in land consumption by category of use, migration of employment.[2]
Effect of congestion on land use and location decisions	□	ν	ν		Changes in zonal accessibility and its indirect effect on residential and business location choice.
Cumulative effects of retail location choice		□	ν		Current and lagged changes in land prices and land use in the target and adjacent zones, increased infrastructure cost as a function of increased travel demand, changes in zonal accessibility and destination choice.
Effect of large commercial development on periphery of the growth boundaries	□	ν	ν	Employment and household supply by zone, network travel times and cost by mode, estimates of the elasticity of trip generation by trip purpose	Changes in trip generation as a function of zonal accessibility and congestion[3], changes in destination choice as a function of changes in residential and business location choice.
Effect of land supply on travel behavior	ν	ν	ν		Changes in trip generation and destination choice by trip purpose, changes in corridor and systemic network measures[5], changes in travel disutility by trip purpose and area (county, zone group, etc.).
Effect of highway capacity increases on travel behavior[4]	ν	ν	ν		Changes in trip generation and destination choice as a function of zonal accessibility, changes in network measures for the study area.
Effect of network connectivity on travel behavior		□	ν		
Effect of parking supply on travel behavior		□	ν	Total travel time and cost by mode, employment and household supply by zone, exogenous forecast of parking cost and supply by zone.	Changes in mode choice as a function of parking cost at the destination lagged residential and business location choices as a function of decreased accessibility and changes in land prices.
Effect of urban form on mode choice		□	ν	Zonal area and density, parking cost and supply by zone, travel cost and time by mode.	Changes in mode choice as a function of destination parking costs and differential travel times and costs, lagged changes in residential and business location choice and attendant changes in trip generation and destination choice.

Continued on next page

TABLE 9 Capabilities to Address Policy Issues (continued)

Analysis Issue	Applicable Scale			Required Data	Modeled Response(s)[1]
	Statewide	Substate	Local		
Effect of rail investment on highway use	ν	□		Rail service and network attributes, rail passenger and freight origin-destination data by mode of access and trip purpose (persons) or commodity family (freight), zonal accessibility.	Truck-rail diversion by commodity group as a function of current and lagged cost and travel time differentials, changes in unit transport cost by mode, passenger mode choice as a function of travel time and cost differential and changes in consumer surplus.[7]
Effect of changes in the demographic composition of Oregon	ν	ν	□	Changes in household composition by time period, estimates of trip generation elasticity by household type.	Changes in trip generation by area and household type[8], changes in the demand for employment by businesses, inducement

[1] Some measures of effectiveness will be applicable for all analyses, such as changes in consumer surplus (for persons) or aggregate changes in transport cost (for freight).
[2] Zonal accessibility is a derived output of the travel model which is fed back into the land use model until user-defined equilibrium occurs; it is primarily a function of zonal density and the level of congestion on the network serving it.
[3] These changes can be measured both in terms of changes for a single zone or group of zones, or systemwide using measures such as changes in vehicle miles and house of travel by area, corridor, trip purpose, mode of transport, etc.
[4] These effects are still not well understood; see TRB Special Report 245.
[5] Includes but not limited to changes in vehicle miles and houses of travel by mode and trip purpose (under congested conditions and total) for the corridor under study, a buffer zone around it, and for the state or substate area as a whole.
[6] Some measures of effectiveness will be applicable for all analyses, such as changes in consumer surplus (for persons) or aggregate changes in transport cost (for freight).
[7] Estimation of passenger patronage will not be possible using the Phase 2 model. Exogenous estimates of modal shifts can be accommodated but not explicitly modeled in the statewide model.
[8] Three household classifications based on income (low, medium and high) have been specified for the statewide model, based upon data availability.

Data

The data required to develop the statewide and substate models are shown in the following table. The transportation supply and demand data are comparable to those required to develop traditional travel demand forecasting models. The same is true for the land use–transportation interface data, except that factors must be developed to translate flows in dollars to equivalent person and freight movements. The widespread deployment of GIS has collected large data sets and the tools needed to manipulate and render them. The data required to develop and apply integrated land use–transportation models is not difficult to acquire, but it is unfamiliar to most transportation planners.

Robust land price and supply data proved the hardest to obtain. Residential land sale transaction data is readily available, but non-residential sales are not plentiful even over a 5-year period. Eventually, a Delphi panel of commercial realtors convened to help derive current and historical trends in non-residential land prices for the three metropolitan areas in the Willamette Valley (Salem, Eugene, and the Portland/Vancouver area). The use of Delphi panels to collect certain types of land data is likely to play a larger role in future model development. Historically, data has been collected independently by different jurisdictions and agencies, using different methodologies for data collection and recording. This has made it difficult to compare or transfer data from one jurisdiction or one model to another. The OMSC

TABLE 10 Statewide Model Data Requirements

Land Use and Socioeconomic Data	**Land Use–Transportation Interface Data**
• Base year socioeconomic data (input-output accounts, induced production, etc.) • Exports by sector • Imports by sector • Restrictions on internal production by zone and sector • Location utility function parameters • Demand function parameters • Demand substitutions • Attractors of exogenous demand • Attractors for induced production • Global increments of exogenous production and consumption • Increments of exogenous demand, production, and external zone exports and imports • Increments of endogenous location attractors, production restrictions, and value added to production	• Time and volume conversion factors, directionality of flows • Intrazonal costs • Exogenously defined trips **Transport Supply and Demand Data** • Network (link endpoints, length, capacity, etc.) • Transit lines • Trip purpose characteristics (available modes, value of travel and waiting time, etc.) • Trip purpose characteristics (available modes, value of travel and waiting time, etc.) • Trip generation and mode split parameters (elasticity, dispersion, and scaling factors) • Energy and operating costs • Vehicle operating characteristics • User charges (fares and tariffs) • Speed-flow curve parameters (for network assignment)

has undertaken several collaborative data collection efforts to ensure consistent collection methodologies and model applications.

Maintenance/Use

Since the model is fairly new, little maintenance has been needed. The model has been used for a number of statewide and regional transportation studies (see sample case studies in previous questions) and incremental improvements have been made to the model in conjunction with these studies. The most notable improvements include splitting trucks into several different classes, improving the traffic assignment procedure, and incorporating feedback between the overall statewide economic growth and the cost of state exports. Other maintenance/ improvement activities include the development of programs to automate the running of the model and the reporting of model outputs.

Implementation

The prototype TLUMIP (Gen1) model was applied to a case study in Eugene–Springfield, Oregon in 1999. The results of this case study provided useful insights into the behavior of the model over the historical period of the calibration. The simulated 1994 values of key variables of population and employment achieved fairly high correlation and goodness-of-fit measures. On the other hand, the results showed considerably lower ability of the model to reproduce the observed changes from 1980 to 1994. The corresponding correlation and goodness-of-fit measures were quite low. Considerable sensitivity testing of the model was carried out to learn more about the behavior of the model. Simulated annealing techniques (smoothing results to compensate for variability in raw data) were used to search for coefficient and parameter values capable of matching the calibration targets.

With completion of the Gen1 Model, it was applied to a broad regional planning effort to evaluate transportation futures for the Oregon Willamette Valley. The scenarios were chosen to test the responsiveness of land use and transportation patterns to various public policies. The scenarios do not represent proposals but were chosen to represent a range of possible policy types. The objective was to identify scenarios with clear differences and variance from the reference scenario in only one respect to facilitate the evaluation. After evaluating the five scenarios, the project steering committee defined two additional scenarios that blended elements of the five policies to assess their aggregate effects. An eighth scenario, part of a separate project, blended policies in a third hybrid combination. To focus the statewide model outputs, the steering committee identified the following evaluation measures:

- Distribution of growth in households within the Willamette Valley and surrounding regions,
- Distribution of growth in jobs within the Willamette Valley and surrounding regions,
- Changes in per capita passenger and VMT in the Willamette Valley,
- Changes in per capita passenger and VHT in the Willamette Valley,
- Changes in passenger and vehicle travel times in the Willamette Valley,
- Changes in auto and truck speeds on urban and rural freeways and arterials in the Valley,
- Changes in auto travel times between selected Willamette Valley cities,

- Emissions from vehicles in motion in the Willamette Valley, and
- Changes in residential and industrial/commercial land prices in the Willamette Valley.

Comments received from the steering committee and the general public were useful to help focus on the most practical application of the integrated modeling and analysis tools to be of most value to decision-makers. When the statewide model was first developed, it focused on land use and transportation interactions. It became clear from the Willamette Valley project that economic ramifications of transportation policies were of most interest to decision makers. This was made abundantly clear for the Economic and Bridge Options Report, where the growth/loss of jobs and statewide/localized economies was the model output relied upon by legislators and ODOT management to define a significant transportation funding package in 2003.

Lessons Learned

New Tools Take Time to be Accepted in a Large Agency For the bridge analysis, because the initial modeling results did not fit with preconceived conclusions on the nature of the problem and therefore the best solution, it was not automatically embraced by ODOT management. In-depth discussions on the model results and how they could help frame the discussions and recommendations were necessary to use the model most effectively on the project.

It is Important to Build and Maintain Relationships Between Technical Staff and Management Well-established relationships between modeling staff and senior management make management more willing to take a chance on a process that does not support their initial preconceived ideas. The structure of the OMSC helps facilitate these discussions, with a policy and a technical representative from each member agency/MPO. Because of the relationships and perceived unbiased expertise of staff, questions on the Willamette Valley study and the bridge analysis applications primarily related to how to use the modeling tools effectively. There was little challenge to the technical accuracy or credibility of the model, staff interpretations or analysis results, even when analysis provided results that were counter-intuitive or that did not support preconceived perceptions of results.

Interest and Support of Modeling from "Outsiders" Is Helpful The Gen1 model has been used to address several large-scale policy questions in Oregon. Those who used the modeling tools in the past support and advocate for its use on new projects. It is helpful to have advocacy from others external to the process that are perceived as nonbiased and those that may better understand non-traditional model outputs (e.g., economic measures).

The Credibility of the Model and Modeling Results Is Critical Recognized modeling and economic experts participate on OMSC subcommittees to make recommendations on model input and to review reasonableness of model results and analysis. This peer review gives the results credibility within ODOT, with other state agencies and with stakeholder groups.

Good Interpretation and Visualization of Model Results Is Critical A significant amount of data is generated from the many model runs. In order to focus the discussion, it is important to identify and effectively present the data deemed most useful to the decision-making process. Although transportation metrics are now well understood, identifying effective economic PMs is more challenging. If the user of the information cannot understand it, the information is of little value. In the bridge analysis, the same information was presented in a variety of ways—maps, graphs, histograms, tables, text—to be responsive to the many different ways people comprehend complex information. This is especially important given the limited time to produce and present the information and the variety of audiences that will make opinions and decisions based on the information. This continues to be a difficult and important challenge.

Models Are Best Used to Help Define the Problem and Develop Options Instead of Reinforcing Preconceived Solutions The value of the models is that they allow consideration of economic, transportation and land use issues in an integrated manner. The Gen1 model can be used to develop "What If?" scenarios and to look at how different actions affect one another, immediately and in the long-term. In fact, the model is best used iteratively. Most decision makers are accustomed to asking linear questions of a model—"If I invest in these bridges, what happens?" However, the question should evolve just as much as the solution. As technical analysis proceeds, the results should identify whether additional or different questions should be asked (e.g., "How do we provide accessibility to remote regions that rely economically on heavy goods transport?" or "How do we use the bridge program as an opportunity for economic development in depressed regions of the state?"). In the bridge analysis, an iterative process helped decision makers understand the complexity of the bridge issue and what truly constituted a crisis.

It Is Challenging to Balance the Time Required to Run the Model and Interpret Results with Needs of Decision-Makers for Fast Turnaround To maintain integrity in the process, education is necessary about the time and resources required to set up and validate the Gen1 model for numerous runs, and the length of time required to run the model and digest and analyze the results. It is clear that there will always be a gap between decision makers' need for immediate feedback and the technical desire for additional time for analysis. It is important to have this discussion at the outset of the project so that schedules can be negotiated as much as possible.

The Model Is One of Many Inputs to the Decision-Making Process For complex issues, it is not appropriate to rely on model results alone any more than only cost should define the solutions. The bridge analysis was valuable because it considered the economic and transportation results from the Gen1 model, along with bridge repair/replacement costs, Motor carrier information on suitable detour routes, information on city/county bridges and needs, trucking industry needs, and other anecdotal information

Scale/Level of Detail

The Gen1 statewide model uses an established integrated land use–transportation modeling framework, and runs programs in a linked fashion to simulate changes in activities and travel distribution over time. It uses the TRANUS modeling package with some functions carried out in Excel spreadsheets and R. The statewide model has two primary elements—a location model and a transportation model. The location model allocates growth among zones and simultaneously determines the amount of trade occurring between zones by economic sector. The transportation model converts the trade flows into trips, apportions them among modes, and assigns them to the road and transit networks.

The second generation statewide model is a modular, component-based modeling system. These models will be developed in an open source environment, enabling others to use and contribute to the development of the software.

Statewide/Urban Model Integration

Integrating the statewide model with urban models is a very important issue for Oregon. The Gen1 model has been integrated with HERS, and integration of the statewide model with urban models is expected to be completed next year.

Freight/Commercial Vehicle Modeling

The economic and location portion of the model establishes the economic flows between sectors and parts of the state. For the Gen1 model, the economic flows by sector are converted into tons of products to be moved. This produces an O-D flow matrix in tons of product that are then assigned to vehicles. These are split into loads that typically move in heavy trucks (>80,000 pounds) and loads typically carried in lighter trucks. The model includes several truck-type operators, each with different payload, operating cost and other parameters. The assignment procedures assign trips to combinations of operators and routes based on a multinomial logit model where the utility is cost. The transitional model has a more sophisticated approach involving the allocation of freight flows among freight modes and the use of a "traveling salesman" approach for determining truck routing.

Long-Distance/Recreational/Tourism Travel

Recreational travel is one of the trip purposes. Trips are generated as with other trip purposes based on the economic exchange between various economic sectors associated with recreational travel.

VIRGINIA

The state of Virginia's first statewide model effort is presently underway and is scheduled to wrap up this year. The statewide model was initially undertaken in a two-phase approach. The "fast rack model" was slated for a rapid deployment and focused on highways, autos, and trucks. The second "full featured model" phase was to consider multimodal and intermodal persons and freight movements. Due to various delays and difficulties the final model combined the two-phase approach into a single phase with some of the intended features scaled back somewhat.

The final "full featured model" estimates passenger travel for both autos and rail (the air mode was ultimately removed due to the small amount of in-state travel) and freight travel for trucks only. Although not explicitly modeled, freight flows for other modes (water, air, rail) are forecasted and can be used to address various policy questions such as the effect on truck movements due to shifts to/from other modes. Another feature of the model is a GIS/database management system for ease in updating the model network.

The intent of the model is to estimate inter-city/inter-MPO travel in the rural areas of the state. Other anticipated model applications are to derive VMT estimates for jurisdictions not covered by a TDM and the prioritization of highway projects for the statewide planning process. In addition the statewide model will provide external travel flows for input to the MPO models.

The model originally used a macro and micro scale of geography for both the TAZ and network, later combined for ease of maintenance and simplicity of operation. However, the model retains the two-level approach in the model structure. The macro model estimates auto and truck travel external to the state as well as trips >100 min within the state and serves to provide inputs to the micro model for trips originating or destined outside of Virginia. The micro model estimates travel within the state and serves as the primary travel-forecasting tool for all modeled modes of travel (see presentation for a more detailed explanation of the model structure).

Although not yet complete several pieces of the statewide model have been utilized in various projects around the state. The land use data has been used to crosscheck data for developing MPO models around the state. The ongoing I-81 study has utilized various data from the statewide model including TAZ and network data as well as the development of time and distance matrices from the highway network for the estimation of truck travel affecting the I-81 corridor. In addition, the draft base (2000) model was employed to verify various travel data for the Route 460 corridor study such as through-trip percentages as well as the O-D of trips in the corridor.

Data

The original intent of the fast track model was to utilize existing data sources rather than rely on new data collection. As a great deal of data is readily obtained or purchased it was determined to utilize these existing data sources as much as possible.

Zonal Geography

Obtained from readily available sources such as census, BEA, etc. The macro model utilizes county level zones within the state of Virginia, which are aggregated to the BEA regions outside the state and combined at further distances to aggregates of BEA zones. Even further out states and aggregates of states are utilized for the zonal structure. The micro model, which covers the Virginia portion of the model, utilizes aggregates of MPO zones inside the urban areas and census tracts and places outside of the urban regions.

Networks

The highway network was derived from the NHPN and the FHWA HPMS data supplemented by the statewide roadway coverage from the Virginia DOT’s (VDOT) Highway Traffic Records Information System (HTRIS) for the portion inside of Virginia. The HTRIS database provides detailed information about traffic flows, lanes, and speeds on state roadways. The rail network was obtained from inspection of existing maps and readily available line coverages.

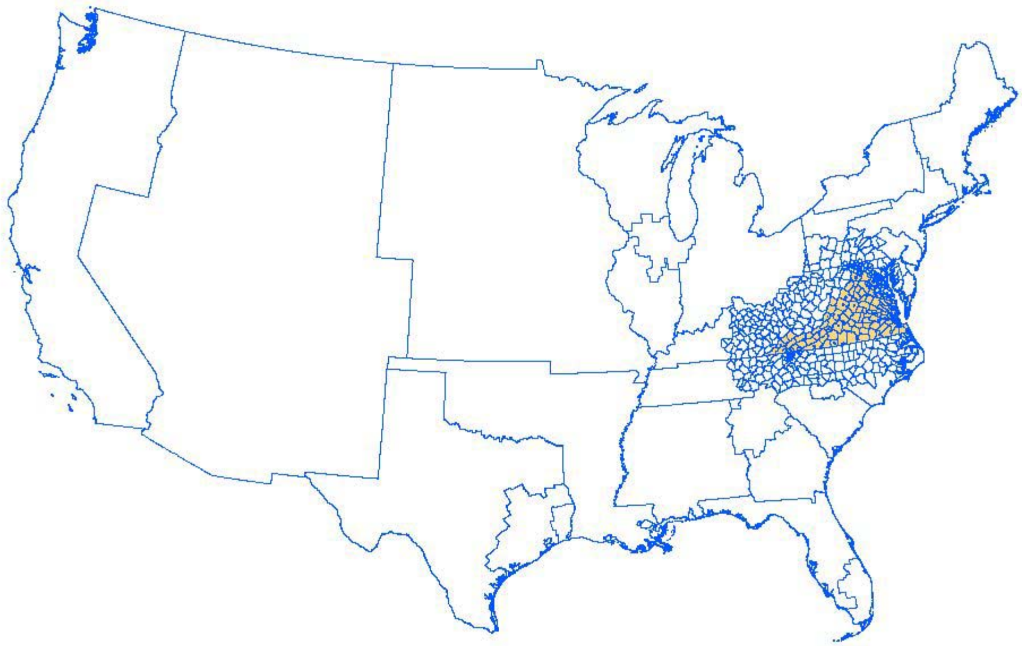

FIGURE 29 Overall zone geography.

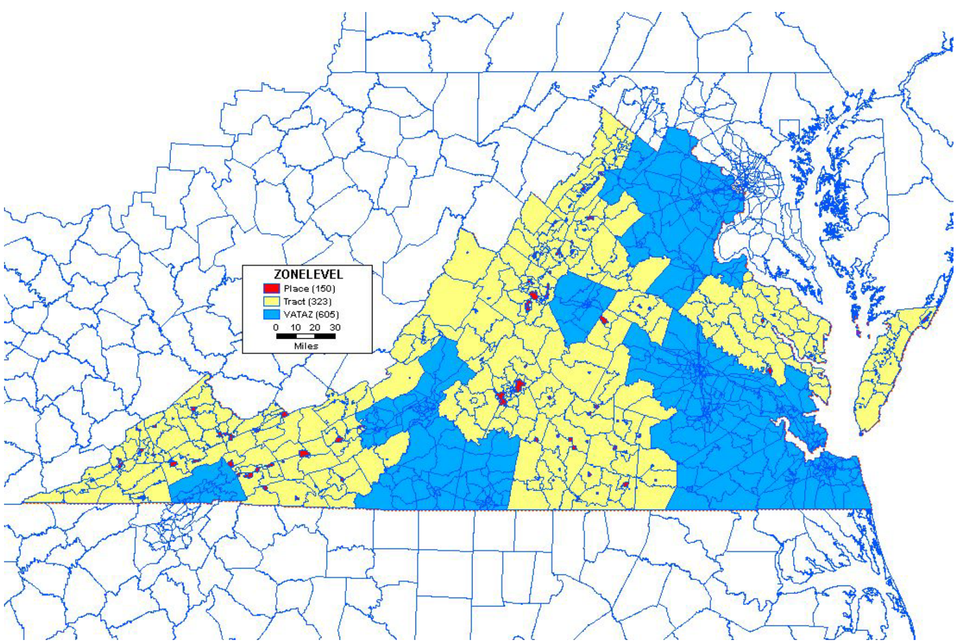

FIGURE 30 Virginia zone geography.

Demographics

The Census 2000 data were utilized for population and household data. PUMS data were employed to develop household size and income data for use in the micro model trip estimation. Employment data were obtained through the Virginia Department of Labor supplemented with data purchases from Woods and Poole as well as Dun and Bradstreet

Trip Generation

The 1995 ATS was utilized to develop an interstate passenger trip table. The 2000 Census Transportation Planning Package (CTPP) was used to derive the intrastate work trip table. Intrastate trip production rates were developed from the 2001 NHTS and attractions from *NCHRP Report 365: Quick-Response Urban Travel Estimation Techniques and Transferable Parameters*. Intrastate trips were distributed using friction factors from NCHRP Report 365. Data for special generators was developed from various available sources either by direct contact of the respective location or by estimation through other information.

FIGURE 31 Links to Virginia.

Freight Data

Developed from the 1998/2001 Reebie TRANSEARCH database previously produced for VDOT by Reebie Associates, Inc.

Mode Choice

Passenger rail ridership was obtained from available Amtrak and Virginia Rail Express data. Passenger air travel information was obtained from FAA 10% sample ticket data.

The most significant data issue was related to development of the highway network. Resolving various errors in the NHPN network as well as reconciling the national network with the (local) in-state Virginia HTRIS and SHIPS data as well as developing the data linkages proved to be significant hurdles. Another issue was the lack of forecasts for freight data, as this was not purchased from Reebie. Therefore freight forecasts were derived based on other sources. Another issue with the Reebie data were that the data as purchased did not include intermodal or international freight movements as well as data/estimates on empty truck movements, which affected some of the assumptions in the model.

Maintenance/Use

As the model is still under development the maintenance has not been formally established and will depend on various factors. However, it is intended to utilize similar, established resources from which the model was originally developed in order to maintain and update the model. The in-state highway network will be updated utilizing the linkage to our HTRIS database that maintains current roadway information. The non-Virginia portion will be updated as per the NHPN. It is anticipated that VDOT will continue to purchase the Reebie data on a regular basis as a part of its freight activities. An established VDOT database of completed (and planned) projects will be utilized for developing future year network(s). An initial list has already been developed.

The intent of the model is to estimate intercity/inter-MPO travel in the rural areas of the state. Other anticipated model applications are to derive VMT estimates for jurisdictions not covered by a TDM and the prioritization of transportation projects for the statewide planning process based on passenger and freight movements forecasted by the model. In addition the statewide model will provide external travel flows for input to the MPO models.

Implementation

The statewide model was initially undertaken in a two-phase approach. The fast rack model was slated for a rapid deployment and focused on highways, autos and trucks. The second full featured model phase was to consider multimodal and intermodal persons and freight movements. Due to various delays and difficulties the final model combined the two-phase approach into a single phase with some of the intended features scaled back somewhat.

One of the most important lessons learned is not to underestimate the staff resources—both time and skill—necessary to properly manage and assist the model development. Although this project was consulted out, there were various data issues that required staff time and skill to properly address. In addition the time required to properly review and evaluate project deliverable was underestimated. Another lesson was the need to phase the project as was originally intended. That is, to separate the multimodal portion from the vehicle model.

Scale/Level of Detail

The model originally used a macro and micro scale of geography for both the TAZ and network, later combined for ease of maintenance and simplicity of operation. However, the model retains the two-level approach in the model structure. The macro zone system (522 zones) covers the contiguous 48 states in order to properly model freight (truck) and passenger travel external to the state. The micro zone system (1,059 zones) covers the state as well as portions of surrounding states including Maryland, West Virginia, the District of Columbia, and Tennessee. The original scale of the macro zone system proved to be too coarse therefore additional zones were added in order to provide better trip assignments.

Statewide/Urban Model Integration

The zonal system is comprised of aggregations of the MPO model zones in order to possibly utilize data collected at the MPO level for use in the stateside model. Otherwise there is no other relationship between the models.

Freight/Commercial Vehicle Modeling

Reebie data were utilized to develop point-to-point freight movements within the state. For the truck portion, matrix estimation based upon truck count data were used to produce the final truck trip table. However, it was necessary to supplement the Reebie data (which underestimated the truck counts by about 30%) with an estimate of local (in-state) truck trip generation, developed based upon relative zonal population and employment totals.

Commercial trips are not included in this version of the model.

Long-Distance/Recreational/Tourism Travel

The 1995 ATS was utilized to develop passenger trip tables for interstate travel and trip rates for intrastate longer distance trips (which include recreational travel), which were disaggregated to the micro zones based upon population. Also destinations were limited to those falling within the trip length.

WASHINGTON

Currently Washington State does not have a statewide model. A few attempts were made in the last few years on developing a statewide model. In 1997, Washington State DOT (WSDOT) retained KJS Associates to develop a conceptual design report entitled “Washington State Interregional Travel Forecasting Model.” This was a survey effort that compared other statewide models to determine likely requirements for a statewide model in Washington State. For Washington, a two-tiered approach was recommended for the TAZ system: an initial county-level analysis of socioeconomic and trip data, followed by a subcounty allocation to TAZs. The consultant recommended TransCAD as the software best suited for the Washington statewide model development. In 2001, WSDOT retained consultants in an attempt to develop a partial statewide model as part of the Cross-Cascades Corridor planning study effort. The corridor strides the state east–west between Seattle and Spokane. An integrated land use-transport model was chosen in order to address both the transport and economic/land use-related questions frequently asked of WSDOT by the Washington Legislature. Due to lack of funding, the model was never competed. In 2002, funding the initial phase of developing a statewide model was included in a statewide referendum, but the voter rejected referendum.

Data

In the absence of a statewide model, travel forecasts for state highways in MPO areas have relied on respective MPO's regional travel demand forecast models. The WSDOT has 176 permanent counting locations throughout the state that collect traffic data 24/7. In areas that are not in an area covered by a regional traffic model a trend analysis using the historical count information from appropriate permanent traffic counting sites is performed to estimate the growth rate for traffic forecasts.

Maintenance/Use

For the various tasks listed below, we use respective MPO's regional travel demand forecast models if available. In most cases, we contract these tasks to consultants.

For the mobility program, the Highway System Plan (HSP) includes a mix of strategies that address congestion. Congestion is typically defined by when, how often, and for how long a driver is delayed or stopped. With the varying geographic conditions of the state, defining congestion on a statewide basis is a difficult task, as is the problem of identifying highway segments for the purpose of qualifying for congestion relief investment. In the past, WSDOT compared each highway's peak-hour V/C ratio. This method demonstrated congestion levels only during the peak hour but many segments of highways experience congestion outside of the "peak hour," something the V/C method does not measure.

A more refined deficiency analysis tool was developed and used in the 2003–2022 HSP. This tool is a post processor utilizing outputs such as growth rates, volumes, etc., from regional travel demand forecasting models in urban areas, and trend line forecasts based on hourly traffic counts and historic data where travel demand forecasting models were not available.

Currently,

- There is an agreement at WSDOT that macro-level models do not analyze systems in enough detail to evaluate impacts on congestion patterns and conditions from specific operational or capital investments.
- The problem of congestion must be addressed both through new construction and operational improvements in existing facilities. Measurements are needed that can capture the effectiveness of these strategies.
- Congestion measures must distinguish between congestion caused by incidents ("non-recurrent" congestion) and congestion caused by inadequate capacity ("recurrent" congestion).
- Existing intelligent transportation system (ITS) data collection can be leveraged to provide a resource for a variety of applications, including performance monitoring.

- Real-time traffic flow data has the potential to provide very accurate measurements of average speeds and both recurring and nonrecurring delays, which can then be used to directly measure congestion.

WSDOT's Congestion Measurement Approach

In December 2001 WSDOT implemented new congestion measurement principles. These principles are the following:

- Use real-time measurements (rather than computer models) whenever possible.
- Measure congestion due to incidents as distinct from congestion due to inadequate capacity.
- Show how reducing congestion caused by incidents improves travel time reliability.
- Demonstrate both long-term trends and short-to-intermediate term results.
- Communicate possible congestion fixes using an "apples-to-apples" comparison with the current situation (for example, if the trip takes 20 min today, how many minutes shorter will it be if we add a freeway lane or improve the interchanges?)
- Use plain English to describe measurements.

WSDOT's approach focuses on measuring system efficiency and travel time reliability, and communicating progress that the public can see and experience in the short and intermediate term. The point is to report the effectiveness of all the congestion management and relief programs the agency is undertaking. Operational data is the only data source with the level of real-time detail required for developing measurements and assessing investments.

More detailed information describing the above congestion measurement principles is attached to this questionnaire. This paper also identifies limitation, continuing research, and data analysis related to these new congestion measurement principles.

Washington State law requires that an evaluation process be followed to differentiate among projects in order to select those that will produce maximum "value"[1] and provide a rationale for investment tradeoffs between programs under budget constraints. WSDOT has developed a methodology for evaluating mobility projects, that utilizes the results of a regional four-step model (developed by the MPO) or a speed–volume curve based on hourly traffic counts.

A project's value cannot be totally expressed in monetary terms. Values, which can be expressed, include travel delay reduction, accident reduction, vehicle efficiency, and elimination of environmental impacts created by past highway projects which created blockages to the movement of fish, pollution caused by storm water runoff, and excess noise levels adjacent to neighborhoods. Other project values, which WSDOT considers, include ease of moving freight, direct economic benefit, pedestrian and transit linkages and partnership opportunities with local and federal transportation agencies.

The department encourages their regions to use the following methodology to evaluate different design alternatives as part of their process to select the preferred design alternative.

The prioritization methodology consists of two primary components:

[1] The term "value," as used here, is meant to encompass all the benefits of transportation improvements, including those that are not typically assigned a dollar value.

1. Screening criteria—The systems plan functions as the first screening criterion. Project requests not contained in the systems plan are ineligible for further prioritization. Because the state highway systems plan must guarantee conformity to air quality requirements, any proposal that would worsen air quality in a non-attainment area would also fail the initial screening.
2. Benefit/cost (B/C) ratio or cost efficiency—The cost efficiency of a project includes the present value of the project's benefits, which can be measured, divided by the project costs. In this category, projects with higher scores are more favorable. The basic equation for the B/C ratio is:

$$B/C = \frac{PV_B}{PV_C}$$

where

B/C = benefit/cost ratio,
PV_B = present value of the project's benefits, and
PV_C = present value of the project's cost.

Costs include right-of-way (ROW), engineering, construction, and operation and maintenance. ROW and construction costs only include the depreciation for 20 years in order to be consistent with the benefits. To expedite the time required to evaluate projects, WSDOT developed a software package called the Mobility Project Prioritization Process Benefit/Cost Tool to estimate a project's cost efficiency.

Benefit highlights of values that can be quantified and what data is necessary to make the calculation are discussed below.

Travel delay benefits consider the reduction in delay for individuals and trucks for 24 h per day, Monday through Friday. Data necessary to calculate the savings include

- AADT count distribution by hour,
- Truck percentage,
- Vehicle occupancy rate,
- Number of existing lanes in each direction,
- Number of proposed lanes in each direction,
- Type of proposed lane(s) if applicable (HOV, general purpose, two-left turn), and
- Type of other improvement such as park-and-ride lot, access control, synchronized signals or other ITS measure

Accident reduction considers the number of accidents for the last 2 or 3 years and estimates the number of accidents and accident severities that would be reduced by the improvement. Data needed to estimate the reduction in accidents and severity include

- Number of accidents during the last 2 years,
- Severity of the accidents during the last 2 years, and
- Accident reduction factor based on local experience.

Vehicle operating efficiency (cars, buses, and trucks) includes the improvement in operating costs due to the reduction in travel delay. No additional data is necessary as it is calculated as a function of travel delay.

Environmental impacts considers the elimination or reduction in environmental impacts that currently exist due to previous constructed transportation projects. The data needed to estimate the reduction in environmental impacts include

- Number and cost of barrier removal to the passage of fish,
- Area of impervious surface and the cost to retrofit with a best management practice, and
- Number of noise receptors and the cost to retrofit the noise level below the acceptable level.

WSDOT has developed the following additional set of criteria to evaluate the value of factors, which are difficult to quantify.

Criteria for Benefit Evaluation System

Safety Benefit

The projects must solve one or more of the identified needs within the department's HSP such as

- High accident location,
- High accident corridor,
- Pedestrian accident corridor,
- Runoff the roadway, and
- At-grade intersections on high-speed, multilane, and accessed-controlled NHS routes.

Measurable Congestion Relief Benefits

A minimum of 100 h of delay per day now (year 1).

Freight Benefit

The highway facility is located on a T-1 freight route (more than 10 million tons per year) or a T-2 freight route (4 to 10 million tons per year). Also a T-3, T-4, or T-5 route if it connects a port or industrial site to a T-1 or T-2 route.

Direct Economic Development Benefit

A company has committed to bring new jobs into the community if this highway improvement occurs.

Transit/Pedestrian Benefit

The project includes a HOV lane, direct transit access to the freeway, a bicycle path, significant network of sidewalks or a series of bus pullouts, and pedestrian refuges.

Water/Habitat Fix

The project solves an existing fish barrier blockage identified by Washington State Fish and Wildlife and in the HSP, an existing noise deficiency identified in the HSP, an existing storm-water retention deficiency identified in the HSP, an animal migration corridor with a large number of collisions with animals as identified by the Environmental Affairs Office (EAO), and an identified flood problem as identified by EAO.

Partner Funding

The project includes a contribution from a local agency or a developer. This category does not include normal federal highway funding or special federal demonstration funds (see next category).

Special Federal Program

The project includes federal funding as a result of a separate federal appropriation bill. These funds are in addition to the normal federal funding which the department receives as part of the federal apportionment act.

Projects, which meet the criteria in the categories above, receive a check mark. WSDOT combines the cost-efficiency value and check marks in order to develop a prioritized list of projects.

WISCONSIN

Wisconsin DOT (WisDOT) is currently under contract with Cambridge Systematics, Inc. and HNTB Corporation to jointly develop a comprehensive, multimodal statewide transportation model. The software platform being utilized is TP+. This will be the third generation of statewide models for WisDOT. Why is WisDOT developing a new statewide model? The application goals and objectives are as follows:

1. Having the capability to analyze modal diversion impacts along our major backbone and connecting corridors.
2. Having the capability to analyze route diversion impacts once corridor-level improvements are made like adding lanes and changing design from expressway to freeway thus increasing the operating speed and lowering the travel time.
3. Analyzing the capacity [level of service (LOS)] and safety impacts associated with increased truck travel on key Wisconsin Interstates due to the introduction of major new intermodal facilities like Rochelle in north-central Illinois and with the ever-expanding regional commercial distribution centers like Wal-Mart and Lowe's.

4. Developing a planning and modeling process that integrates the ongoing development of 14 MPO models and 2 urban area models with our statewide model.
5. The statewide model has two components: a passenger model and a freight model. To conduct air quality (AQ) regional emissions and conformity analysis for rural, isolated counties that do not have a MPO LRTP and transportation improvement plan (TIP).

Data

TAZ structure: Internally the state of Wisconsin is subdivided into 1,642 TAZs with each city, village, and town having their own unique TAZ. In MPO areas, TAZs submitted as part of TAZ-UP to the census are being used and aggregated along political jurisdictions, key connecting highways, and similar land use/area types—MPO central business district (CBD) TAZs were aggregated to develop one statewide TAZ. For adjacent states the TAZ system is setup along county lines and major metropolitan areas like the Chicago and the Twin Cities. The freight component our TAZs are developed nationwide to account for major freight flows into and out of Wisconsin.

Network

For the rural highway system, all facilities functionally classified as major collector status and higher are coded within the model. For the urban systems, all facilities functionally classified as collector status and higher are coded in the model. All network attribute data is obtained from our Wisconsin Information System for Local Roads (WISLR), WisDOT's local roads inventory database. WisDOT's State Trunk Network (STN) inventory is used for state trunk facility attribute and travel data. The world of GIS tools are being used to develop the line layers, network layers for our defined modeled highway system.

NHTS

WisDOT participated in this survey effort and requested that 16,000 add-on surveys be collected as well. NHTS data is key to providing the trip rates for the trip generation phase, the trip length frequency distribution curves by trip purpose, and the mode choice shares for estimating a mode choice model. The trip generation phase will now employ cross-class analysis for the trip productions and use updated trip rates with all new statistically significant variables for the regression-based trip attraction equations. Key trip generation production-side variables being used are number of persons per household, number of workers per household, number of children per household, and autos per household. On the attraction side, key variables used are total households, total employment, retail employment, service employment, educational employment, and arts, entertainment, recreational, accommodations, and food service employment. For the trip distribution phase, the following trip purposes will be used: HBW, shopping, social/recreation, other, and HBSC and NHB and truck. The E-E, EI/IE trip tables will be generated using actual O-D travel surveys conducted at all major gateways that enter/exit Wisconsin. The model choice element will be a nested logit model accounting for autos, trucks, intercity bus, and high-speed rail.

Maintenance/Use

Maintenance

Screen lines and cutlines monitored annually based on AADT collection efforts to check if the key corridors statewide are tracking within tolerance or not. Also, annual statewide and county-level VMT estimates will be compared to model results to see if county level travel is tracking reasonably well based on network coded.

Primary Applications/Uses

1. Long-range plan development
2. AQ conformity analysis
3. Corridor planning for capacity investment, programming, and design
4. Modal investments, e.g., introduction of new intercity bus service
5. Traffic forecasting for project design
6. Travel Industry Association of America analysis
7. Traffic diversion impacts
8. Modal diversion impacts
9. Congestion mitigation planning—WisDOT ITS “blue route” corridor planning efforts
10. Detour simulation analysis
11. Crash rate “hot spot” analysis
12. Construction zone analysis
13. Bypass feasibility studies
14. EIS traffic data input

Implementation

The implementation process involves the formation of a Technical Oversight Committee (TOC) to guide all aspects of the model development process from theory to application and is the decision making body for all modeling decisions.

- Connections2030: WisDOT’s LRTP will be the implementation tool for all systemwide and corridor-level projects for programming and investment.
- Meta-Manager Model: WisDOT’s primary tool used for prioritizing which funding programs will be used for all types of project-level and policy-level investment decisions.
- Traffic Analysis Forecasting Information System: WisDOT project-level forecasting and analysis tool that leads to project-level investment decisions for all highway and bridge projects statewide and is incorporated into the final design process.
- MPO LRTPs.
- Corridors 2030 Plan for major/key corridors.

Scale/Level of Detail

- TAZ System: the state of Wisconsin is subdivided into 1,642 TAZs. In rural Wisconsin, each city, village, and town of under 50,000 population has its own defined place-level TAZ. In MPOs the TAZ system/structure submitted to the census as part of TAZ-UP was used but not at the MPO level of detail. MPO TAZs aggregation criteria used were jurisdictional/corporate boundaries, land use/generalized area type, and key connecting highways. For example, the CBD of each MPO was delineated as a TAZ for the statewide model. Outside Wisconsin, adjoining states have TAZs developed for a three-tier deep system of counties so that major metropolitan areas like Chicago and Twin Cities are adequately covered. For both the freight and passenger elements of the model, TAZs are nationwide and are quite coarse and are based on major regional freight flows from major ports and terminals. This TAZ system was chosen because of the ease of collecting base-year demographic and economic data that drive the trip generation phase as well as the ease of obtaining forecasted demographic and economic data.
- Network: Outside the MPOs (rural Wisconsin by model definition), all functionally classified facilities of major collectors and higher were coded. Within MPOs all collectors and up were coded for modeling purposes. Outside Wisconsin the arterial system is primarily used to make sure that all external cordon line stations have connecting links.
- Network Attribute Data: the standard variables are used plus some special coded variables so that WisDOT can take advantage of the flexible reporting scripts in TP+. For example, besides a functional class/facility type variable we will have a jurisdictional variable so as to summarize VMT by highway jurisdiction (state, county, local).

Statewide/Urban Model Integration

The MPO models will be integrated into the statewide model. Timing is an issue since the statewide model should be completed by January 1, 2005, while our MPO models will not be completed until April 1, 2005. To avoid a credibility problem of having two sets of assignments and forecasts potentially available for all types of users, the statewide model will provide modal and route diversion traffic impacts, in terms of reduction percentages or absolute volume changes only for key state backbone routes like the Interstate system and other principal arterials. With the greater level of model detail, accounting for adopted local/regional land use “smart-growth” plans and mode choice availability, MPO models will override the statewide model assignments and facility forecasts as the definitive source for all facility forecasts within their planning area boundary. The key integration concept for the statewide model and MPO models will be at the external cordon line where AADTs will be validated/replicated for the base year and calibrated for the horizon design year of 2030.

Freight/Commercial Vehicle Modeling

The statewide model does include a freight element. Modes modeled are truck and rail. A truck and rail trip table will be created from the TRANSEARCH 2001 O-D database at the BEA regional level that converts from tons of freight flows to railcars and trucks and then is assigned to the highway and rail modeled networks. TAZ system is comprised of detailed county-level zones (72) within Wisconsin and North American zones and special generator zones like ports and airports.

Long-Distance/Recreational/Tourism Travel

From the NHTS, the statewide model will create a special social/recreational trip purpose for modeling purposes. On the production side for this trip purpose, household size was found to be the most statistically significant variable. On the attraction side, the home based-social/recreation trip purpose is modeled using households and arts, entertainment, recreation, accommodation and food service employment which is represented by standard industrial classification code 7. The employment data is obtained from our Department of Workforce Development datasets, while forecasted data is obtained through Woods and Poole.

PARSONS BRINCKERHOFF RESPONSE RELATED TO MICHIGAN, NEW MEXICO, AND UNITED KINGDOM

Since the development of models in Oregon and Ohio are being described by others in this workshop, I'll focus on models I've worked with in states that are not represented. These are listed in roughly chronological order.

- New Mexico developed and deployed a statewide model in 1989–1991. It was developed primarily to study freight issues, particularly involving trans-continental truck flows moving east and west through the state on I-10 and I-40. Extensive O-D data were collected from trucks at the state ports of entry, which were factored to match control totals from truck counts and partial information available from the aborted 1983 Commodity Transportation Survey. A synthetic matrix estimation process was used to replicate observed auto flows. The state had very limited person O-D data available to seed the model. A Delphi panel was used to help develop forecasts of regional and state growth, as well as likely changes in national flows flowing through the state. Very much a sketch planning model, it was implemented with EMME/2 and ArcInfo. As might be expected, the truck side of the model validated well and provided sensible forecasts, while the auto side of the model performed marginally. As far as I know the model has not been used since 1991, when it was used to study options for a new U.S.–Mexico border crossing west of El Paso, Texas.
- Michigan has arguably been doing statewide modeling for longer than any other state, with published reports from early work dating back to the very early 1960s. The early models were used heavily during the Interstate highway construction era, as well as well as for what was to become the first of scores of studies examining the feasibility of high-speed rail connecting Chicago, Detroit, and Toronto. The model was only infrequently used during the late 1970s and 1980s. During the early 1990s Michigan DOT (MDOT) embarked upon an ambitious update of the model, and became one of the first agencies to implement their travel models in TransCAD. This work was completed in the mid-1990s, and involved the development of a four-step sequential modeling platform that included a high degree of detail within the state (2,300 zones) and progressively coarser geographical detail outside of Michigan. The model included both an interim mode split model as well as a logit-based mode choice model. The modeling system also included a freight model, the truck trips from which were modeled using a three-step sequential modeling

process. It was based on a fusion of data from the 1993 Commodity Flow Survey (CFS) and economic input-output data. MDOT staff has continued to improve the model in the intervening years since the consulting team finished their work. They are currently in the middle of a three-phase program of updating their model. The first phase focused on the design and specification of consistent tour-based travel models at both the urban and statewide level and supporting data collection programs. The second phase, currently underway, involves a 14,300 household travel survey. The third phase, expected to begin next year, will conclude with the development of the new models based upon the new data.

- The Department for Transport, Local Government and the Regions in the United Kingdom is working on several levels towards the implementation of a nested set of transport models at the urban, regional, and national levels. This work has been ongoing for the last several years. The work initially began as two separate efforts, one at the national level and other one in London. Work in the latter had been initiated by department for London, who were interested in building a better freight model for looking at truck flows within and through London. A detailed design was begun in 1990, which influenced the design of the 1991 London Area Travel Surveys. Work is currently underway to build an integrated economic–land use-transportation model for the country as a whole, which will include linkages to trade flows with the European Union. It will provide the context for regional and local models of person and freight flows.

Data

Almost all of the models that I've been involved with have been motivated by freight concerns, particularly truck flows. Data on these movements, especially at the level of spatial detail required for statewide modeling, are very difficult to come by. In almost all instances the only option has been to conduct expensive and time-consuming truck intercept surveys, with mixed success. The analyses of these data have in turn highlighted the growing importance of trans-shipment and distribution centers, about which there is also very little known. Data for other modes are generally more accessible, especially for rail movements (which tend to be second mode of concern for most states). Freight flows are the reflection of economic flows, about which there is generally much better data. However, most transport planners are not familiar with them, and many of those who are do not understand their strengths and limitations. Moreover, planners in transport agencies lack the mandate and resources necessary to develop and maintain the economic models that feed the transport models. Sadly, success stories involving effective partnerships between economic development and transportation departments are surprisingly rare.

While there is an extensive body of literature and data on person flows in urban areas, comparable data on intercity travel are neither plentiful nor robust. The ATS is evolving into a useful data source for model estimation, but its coverage is still too sparse. Many states, such as Michigan, Oregon, and Ohio, have fielded their own data collection programs in order to obtain consistent data on both intraurban and long-distance travel. However, data on visitor travel within these states are non-existent.

Several models are under development that explicitly model economic and land use trends as part of the statewide modeling process. The fusion of land use, employment, and development (generally square footage of built structures) has proven problematic in most states. These three streams of data have proven much more inconsistent (i.e., employees in zones with no floor space to accommodate them, while a nearby zone has significant floor space but no employment or households associated with it) than expected.

Maintenance/Use

Rather than attempt to answer each question below, I will try to generalize over all of the models that I've been involved with. In general, the applications of the models that I've been involved in boil down to three principal applications:

1. Evaluation of freight flows within and through the state. The specific issues vary from state to state. Most state legislatures and DOTs seem to be very interested in the question of the potential for diversion of truck traffic onto rail, which unfortunately most statewide models have no prayer of addressing in a robust manner (if at all). They are also interested in knowing the characteristics of freight moving in specific corridors, which the models tend to be much more capable of informing.
2. Evaluation of high-capacity intercity corridors. The models are often used to identify and study priority corridors, especially those entangled in the North American Free Trade Agreement and subsequent lobbying for trade corridors. They are also often used to examine large projects involving more than one metropolitan area, and are used to examine the feasibility of high-speed rail.
3. Revenue forecasting. Some models are used to help assess future user fee revenue streams. Many policy makers seem interested in knowing about the effects of pricing schemes, but in most cases they are just too politically charged to be seriously considered.

I've learned that in every state where models are maintained and actively used in the planning process that there is an evangelist and visionary that drives the program. This person, by force of personality or position, is the key driver behind the success of the model. If this person retires or moves on to other things the modeling program often dies. Thus, maintenance of the model is often more a reflection of the priorities and capabilities of the evangelist more than a systematic or carefully considered process.

Implementation

For all of the grief endured during their development, the integration of statewide models into the mainstream of planning practice at the state DOT are a far bigger hurdle. I'd like to say that I've figured out why is this is the case, but have little to offer in this regard. However, from my limited personal experience and from reading about the work of others, I've discovered that models fail for one of several reasons:

1. Vague or poorly defined goals and objectives.
2. Developed with single purpose in mind.
3. Higher than expected maintenance and application costs. This includes the need for more highly skilled staff, the magnitude of data required (both in scale and scope), and inter-agency friction.
4. Lack of management support (read: the models do not provide information useful to decision makers in the metrics and timeframes they need).
5. The models are cumbersome and inaccurate. The models are no better than the quality and quantity of the data used to develop them. Poor models are the only possible outcome from building them with poor or scarce data.

6. Failure to build linkages to economic models. Most state legislatures tend to look at transportation problems as economic problems. Models that simply address traffic flows do not provide the information on key linkages (and benefits) between the economy and transportation. In some instances I've seen state legislators discount modeled outcomes because they are at odds with, insensitive to, or seem uninformed by economic and market trends.

Scale/Level of Detail

The issue of scale is a challenging one, as it is often defined based on the resolution and fidelity desired for analyses, and not upon the data available to develop models at that level. Moreover, the size variable is often very significant in model estimation, rendering the calibration suspect if the size or structure of the zones are changed. This frustrates efforts to develop portions of the statewide model in greater detail in order to study specific projects or corridor studies.

Most of the models I've dealt with have hierarchical zone systems that operate at the subcounty level within the state of interest, and become more geographically abstract as distance from their borders increase. I have only worked with two models whose boundaries were the state border, and was not happy with the performance of either one. In most instances the census tracts in rural areas tend to be very large, and are often used to define subcounty zones. In some cases the TAZs from urban models are embedded in the statewide model, but that seems to be more of a recent trend. The transportation network data used in these models have come from a variety of sources, ranging from the National Transportation Atlas to GIS databases maintained by the state DOT. The latter tend to be more accurate than the former, although their coverage stops at the state borders. Flows on links outside of the state are routed on coarse regional or national networks (Interstate highways, U.S. and major state highways, and links necessary to ensure proper connectivity) or directed graph representation of metropolitan area connections.

The conflict between the scale of analyses and travel data can hopefully be overcome by the use of microsimulation techniques. There are several encouraging projects (Oregon in the United States, and Albatross and others in Europe) that seem to indicate the feasibility of doing so within a statewide modeling context, although further work is required before it can be widely adopted.

Statewide/Urban Model Integration

In almost all instances urban-statewide integration is limited to the exchange of data at their common boundaries. External flows by purpose are sent from the statewide to urban models, and the more accurate intraurban link travel times and transport costs and disutilities are fed up to the statewide model. This exchange of information is done on an ad hoc basis, although Oregon is working to develop a partially automated system. In most cases we now try to embed the urban model's zone system directly within the statewide model rather than trying to abstract it to fit the scale of the extraurban zones in the statewide model. In Michigan we are exploring ways to specify a spatially consistent set of tour-based models at the urban and statewide levels, so that analyses can we carried out at different levels without worrying about the effect of obtaining different estimates based upon the geographic scale and extent of the models. However, a great deal of work still needs to be done in that realm.

Freight/Commercial Vehicle Modeling

As noted earlier, many (most?) of the statewide models I've worked with have been developed at least in part to address freight issues. Thus, they tend to be a much more important part of statewide transportation models than in urban applications. In most instances we've modeled freight at both the commodity and vehicle level, using a sequential modeling process similar to that for person flows. This is carried out in Michigan in several steps:

- Generation of freight demand: This is carried out using trip generation rates developed from the CFS (total tons as a function of employment). Employment is matched to commodity type using technical coefficients from input-output accounts. This is carried out at the county level, the smallest geographical level that the required employment data are available for. The commodities are broken down by two-digit STCC codes, although even at this level there tends to be considerable variation in the underlying trip generation data.
- Estimation of attractors: The CFS only tracks shipment origins, so estimating their consumption at the destination end is a shot in the dark. We use the use coefficients from the input-accounts to weight employment by sector in each zone, and then scale the attractors so that their sum equals the sum of the generation step.
- Destination choice: Another shot in the dark, seeded with prototypical impedance functions from the *Quick Response Freight Manual* and (for truck flows) distributions obtained from truck intercept surveys and Reebie TRANSEARCH data.
- Conversion to truckload equivalents: Modeling to this point has been done in tons, which are converted to truckload equivalents for further analyses (flows from other modes are not modeled past the destination choice stage). Observed payload weight distributions from truck intercept surveys are used to make these conversions.
- Allocation to TAZs: A synthetic process is used to allocate the county-level flows to TAZs within them as a function of each TAZs share of county employment in the appropriate employment categories.
- Network assignment: A multiclass assignment process is used to simultaneously assign autos and trucks to the network.

A number of details have obviously been omitted. It is important to note that employment is only used as a conveniently measured surrogate for industrial output. Employment cannot be used directly in forecasting, as changes in labor productivity, automation, and technology have allowed many industries to maintain or raise output with progressively fewer employees. A Delphi panel is used to help guide the development of growth factors by industry for these models.

Long-Distance/Recreational/Tourism Travel

Most of the models treat recreation and tourism as separate trip purposes, which have been included in all models except for the New Mexico model. A formal distinction is often made between recreation (activities that take place at or near the home) and tourism (travel to destinations outside of one's home state), although the definitions leave a lot to be desired. Michigan's model treats local and long-distance trips differently, using separate submodels for calculating their incidence.

Model Comparisons

Refer to Appendix B for more detail on particular elements.

I. Data Sources		FL	IN	KY	LA	MA	MO	NJ	NH	OH	OR	VA	WI
Networks	State Road Inventory	x	x	x	x	x	x		x	x	?	x	x
	National Hwy Planning Net			x	x					x		x	
	Census (& related products)	x		x									
	HPMS				x		x					x	
	MPO Networks	x						x					
Zones	MPO TAZs	x						x		x		x	x
	Census Geography				x	x	x		x	x		x	x
	BEA											x	
Demographics	Census Data		x	x	x	x	x		x	x	?	x	
	PUMS					x	x		x	x	?	x	
	State/Local Forecasts					x			x	x			
	Claritas Density Classes			x	x								
	MPO Data	x					x	x					
Employment	ES-202		x			x	?		x	x	?	x	x
	Dun & Bradstreet		x	x	x				x			x	
	Woods & Poole		x	x	x							x	x
	MPO Data	x						x					
Land Use	State/Local Tax Assessor									x	x		
	State/Local Land Use Data									x	x		
Demand Data	Transearch	x		x	x					x		x	x
	REMI		x										
	Intercept O-D Surveys	x							x	x	x		x
	Establishment Surveys		x							x	x		
	HHTS (NPTS, ATS)	x	x	x	x	x	x					x	x
	NHTS Add Ons					x							x
	Household Surveys	x	x				x		x	x	x		
	Census Journey to Work			x	x	x	x					x	x
	Other State/Local Data	Tourism						Port Data	Transit & SP svys	LD svy	Tourism	Spc gen	
	QRM or Other Borrowed Rates						x					x	
	Oth Modes (Amtrak, FAA, FRA etc)									x		x	
	Counts	x	x	x	x	x	x	x	x	x	x	x	x
Data Cost		$0+	$160K	$220K	$100K	$200K	$20K	$0	$500K	$5/13M	$2.4M	$2000+	$3.5M
Network Update Cycle		MPO	2-3 Yrs	?	*4-5 Yrs*	*Annual*	2 Yrs	MPO	?	*Annual*	*Annual*	?	Annual

(continued)

Model Comparisons (*continued*)

Data Wish List	
FL	Better data on: external trips, long-distance travel, special generators, trucks, and freight
IN	External Trips
KY	Intercept O-D data on state line, updated ATS data
LA	Intercept O-D data on state line/MPO boundaries
MA	Statewide household survey; more detailed/reliable employment data
MO	Better network data, good O-D information
NJ	Carrier specific freight data
NH	Freight data
OH	More complete/detailed commercial vehicle data including non-commodity related travel
OR	Contents of containerized freight
VA	Data on intermodal movements
WI	O-D Data for internal trucks, particularly non-commodity trucks

II. Mantenance/Use	CO	FL	IN	KY	LA	MA	MO	NH
Who Maintains	No Model	Both	Consultant	Consultant	Consultant	Staff	Consultant	None
Number of Staff	0	1	0.5	0.5	1.5	1.5	0	0
Added Staff	0	0	0	0	0	0	0	0
MOEs	V %Trk, V/C, DHV, DD, VMT	Unknown for new model	VMT, VHT, LOS	?	V, VMT, VHT, LOS	VMT, SPD, VHT, Delay	V	?
System Planning	No	Will Be	Yes, State LRP, Econ anal	No	Yes, State LRP	May Be	No	Yes
Regional Planning	No , MPO	Yes, Turnpike	No	Yes	No	May Be	Yes, Bypass Studies	Yes, Regional Growth Anal
Corridor Planning	No, consultant	Yes, Turnpike	Yes, IR69 etc	Yes, IR66, IR 69 etc	Can Be	Will Be	Yes, IR70	Yes, IR 93, SR 16
Project Prioritizing	No, consultant	Will Be	Yes, in conj. w/ HERS/ST	May Be	Can Be	No	No	No
Project-Level Forecasts	No, consultant	Yes, Turnpike	No	Yes, IR64	Can Be	Yes	No	No
Operational Studies	No, consultant	No	No	No	No	No, Corsim, Syncro, HCS	No, Syncro, Freesim	No, Syncro
Economic Development	No, consultant	No	Yes	No	Can Be	May Be Indirectly	No, DOD	May Be
Freight Planning	No, consultant	May Be	Yes	No	Can Be	May Be	No	No
Planning Other Modes	No	May Be	No	No	Can Be	May Be	No	No
Air Quality	No , MPO	No, MPO	Yes, Non-MPO areas only	Yes, indirectly	No	Yes, Main Use	No, MPO	No, MPO
Safety Studies	No	No	Yes, systemwide	No	No	No	No	No
Toll Studies	No, consultant	Yes	No	May Be	Can Be, prelim only	No	Yes, w/ mods	Can Be
Traffic Impact Studies	No, consultant	No	No	No	Can Be	No, Corsim, Syncro, HCS	No, HCS, Syncro	No

(*continued*)

Model Comparisons (*continued*)

II. Maintenance/Use	NJ	OH	OR	VA	WI	WA
System Planning	Yes, IR Completion Study	Yes, State LRP, SIP	Yes, New Fwy, Bridge Study	Will Be	Yes	No
Regional Planning	Yes, Central Jersey Study	Yes, Bypass Studies	Yes, Willamette Valley Study	Will Be	Yes, Bypass, Toll, AQ	No, MPO
Corridor Planning	Yes	Yes, Turnpike etc.	Yes, Bypass Study	Will Be	Yes, SR 26, US 8	No, MPO
Project Prioritizing	No	Yes	Yes	Will Be	Indirectly	No
Project-Level Forecasts	No, MPO	Yes	No	Will Be (rural only)	Yes	No, MPO
Operational Studies	No	No, Syncro, HCS, VISIM, CORSIM	No, HCM, Microsimulation	No, HCS, simulation	No	No
Economic Development	No	May Be	Yes	May Be	Yes, Traffic Impact Studies	No
Freight Planning	Yes	Will Be	Will Be	Will Be	Yes	No
Planning Other Modes	No	May Be	No	May Be	Will Be	No
Air Quality	No, MPO	Yes, SIP Dev. VMT's	May Be	Will Be	Yes, SIP, Non-MF	No, MPO
Safety Studies	No	No	No	May Be	May Be	No
Toll Studies	Yes	Yes, prelim anal only	Can Be	May Be	Yes	No
Traffic Impact Studies	No	No, Syncro, HCS, ITE	May Be, Indirectly	May Be, Else ITE etc.	Yes	No

III. Implementation	FL	IN	KY	LA	MA	MO
Who Developed	Corradino et al	BLA et al	Wilbur Smith	Wilbur Smith	Cambridge Sys	Louis Berger
How Long	On Going	On Going since 95	Latest Update: 18 M	3 Yrs	5 Yrs	2 Yrs
Cost	$1.5M	$2.7M	Latest Update: $350	$500K	$800K	$1M
Institutional Hurdles	No	?	Getting Funding	No	Emp Data, Hardware	Lack of qualified staff
Impetus for Model		IR69 Study	Staff	Staff	Staff	IR70 Study
Primary Use	System, Turnpike, Intermodal Planning	Corridor Studies, Economic Analysis	Major Corridor Planning	Statewide Planning & Prioritization	Air Quality	Corridor Studies, Traffic Projections
Validated	Yes	?	Yes	Yes	Yes	Yes
	NH	NJ	OH	OR	VA	WI
Who Developed	Cambridge Sys	URS et al	PB Consult et al	PB Consult et al	Wilbur Smith et al	Cambridge Sys
How Long	4 Yrs	3 Yrs	Ongoing since 97	On Going since 96	4 Yrs	2 Yrs
Cost	$1.5M excl data	$500K	$2.5M	$1.1M/yr all modeli	$1.5M	$850K
Institutional Hurdles	No	Trucking Cos.	Emp Data, Hardware	Mgt Acceptance	No	Admin Change, MPO Resistance
Impetus for Model	Plning Steering C	Staff	Staff	Regulatory Mandat	Staff	Staff
Primary Use	Analyze major projects and other modes for SOV reduction	Truck Mvts.	Identify/measure congestion, economic growth, analyze truck flow	Systems planning dealing with 11 criteria related to the interaction of transport supply	Rural Hwy Foreca	Systemwide modal and route diversion particularly wrt. trucks
Validated	Yes	Yes	Yes	Yes	Yes	Yes

(continued)

Model Comparisons (*continued*)

IV. Scale	FL	IN	KY	LA	MA	MO
Modes Modeled	HWY	HWY, BUS	HWY	HWY	HWY	HWY
Geographic Resolution	(MPO aggregates) 395 rural zones (census) 60 externals	4720 zones (150 mi halo)	(MPO zns/Census) ROUS: 1109 zones (BEA)	Macro: 539 zones Micro: 1300 zones	MA: 3069 zones NH, RI, Ext: 685 zns Net: collector & up	Zones, Net is FC Art & some Col
Purposes	Passenger and truck	Typical passenger purposes plus long distance and heavy truck	Short and long distance pass. and heavy trucks, LD uses tourist business & other purposes	Short and long distance pass. and heavy trucks, LD uses tourist business & other purposes	Std passenger purps plus LD work, pers. bus. & vacation, Boston MPO transit trip table incorporated, Freight Trucks	Passenger Travel Some limited commercial and recreation is considered
Special Generators	No	No	Yes, Military, Tourism	Yes	None direct but airport trips in Boston data	

	NH	NJ	OH	OR	VA	WI
Modes Modeled	HWY, RR, BUS	HWY	Net based: HWY, RR Not: H2O, AIR	HWY, BUS, RR, TRK	Passenger: HWY, RR	HWY, RR, BUS
Geographic Resolution	500 zones 10000 links NH plus some of ME, VT, MA	2800 zones 44000 links	Econometrics: 700+ OD:5000+ SE/LU: 20000+	Internal: 122 zones external: 25 zones	Macro: 522 zones Micro: 1059 zones Assignment: 9425 zns	WI: 1642 zones ROUS: coarser zones Freight:132 zones
Purposes	Traditional passenger trip purposes only	Typical auto purposes from MPO models plus freight trucks	Typical tour types plus long distance Commercial: Freight plus non-freight modes	Typical passenger purposes	Passenger: Short and long distance purposes Commercial: Freight Trucks	Passenger: Short and long distance purposes Freight: HWY/RR
Special Generators	Yes, Manchester airport	Yes, intermodal, trk terminals, wharehouses, pipelines	Probably	No	Yes: Univ, Military, Tourism	Yes: distribution & intermodal centers

V. Urban Model Relationship	FL	IN	KY	LA	MA	MO
Shared System	Aggregate zones	Aggregate zones and zone data	Aggregate zones	Aggregate zones	Aggregate zones and zone data being matched up	Some data usedto build net/zones
External Forecasts	No	May Be	Can Be	Will Be	Will Be	No
Urban Incorporated	Same trip gen procedure used	No	No	No	Boston Transit Trip	No
Independent Forecasts	Not recommended if MPO model up to date	Yes	No	No	Yes MPO precedence	Yes
	NH	NJ	OH	OR	VA	WI
Shared System	Aggregate zones	Combination of 5 regional models, trks then overlaid	Aggregate zones	Will be intergrated	Zones	Aggregate zones MPO vols over-ride state
External Forecasts	Can Be	No	Will Be	Will Be	Will Be	Yes
Urban Incorporated	No	Yes, now independent	No	Will Be	No	Yes, over-rides
Independent Forecasts	Yes MPO precedence	Yes, Use statewide near MPO borders and for trucks	Yes MPO precedence	No MPO precedence	No	No

(*continued*)

Model Comparisons (*continued*)

VI. Freight/ Commercial	FL	IN	KY	LA	MA	MO
Modes Included	HWY (net based), RR, Intermodal	HWY (commercial & heavy trk)	HWY	HWY	HWY	None
Modes Excluded	All others excluded because no sig. impact and difficult to estimate	Model built in response to needs which were hwy based	All others by design	All others due to budget & focus of project	Data & project focus	No
Commodity Based	Yes	No (but see below)	Yes	Yes	No	No
Matrix Estimation	New model may	Yes, original seed based on commodity flow	Yes, to estimate trucks not covered by Transearch	Yes, to estimate trucks not covered by Transearch	No	No
Traditional Methods	QRM for non-freight trucks	Fratar/QRM for forecasts	No	For portion not covered by Transearch	Yes, QRM methods	No
Transearch/CFS	Yes/Transearch	No	Yes/Transearch	Yes/Transearch	No	No
	NH	NJ	OH	OR	VA	WI
Modes Included	None	HWY	HWY, RR, H2O, AIR emphases is trucks	Gen1:HWY Gen2: Multimodal	HWY	HWY, RR, H2O, AIR
Modes Excluded	No		Pipeline	Gen1 for time/cost	explicitly model due to budget but forecasts from Transearch are made	Pipeline
Commodity Based	No	No	Yes	Yes	Yes	Yes
Matrix Estimation	No	No	Interim model only	No	Yes, for portion not covered by Transearch	No
Traditional Methods	No	QRM Techniques	Interim model only	No	Yes, estimates of non-freight components not included in Transearch are made	techniques used at commodity level, VIUS and AADT factors used
Transearch/CFS	No	No	Yes/Transearch	Yes/CFS	Yes/Transearch	Yes/Transearch

VII. LD/Rec/Tourism	FL	IN	KY	LA	MA	MO
Included	Not Yet	Yes	Yes	Yes	Yes	No
Special Techniques	Will add as a sep. trip purp	Distribution by distance not time	purposes fratar	purposes fratar	purposes std techniques	No
Special Data	Tourist data/NHTS	Included 2 week LD retrospecitve w/ traditional HIS	ATS	ATS	NPTS	No
Special Time of Year	Peak tourist season which varies by area of state	No	No	No	No	No
	NH	NJ	OH	OR	VA	WI
Included	No	Rec purp frm MPC	Yes	Rec Trip purp	Yes	Soc/Rec trip purp
Special Techniques	No	No	Separate purposes	LD trips in particular	Separate purposes	LD trips in particular
Special Data	No	None beyond MPO needs	Special LD survey w/ 2 week rpt period	Rec/Tourism activity survey	ATS	NHTS, seasonal ATR data
Special Time of Year	No	No	No	No	No	Normal AADT output factored to summer using ATR data

Peer Exchange Summary

The Statewide Model Peer Exchange, sponsored by the National Academies and the Transportation Research Board, was held at Longboat Key, Florida, on September 23–24, 2004. The meeting agenda is included in Appendix C of this report.

The primary purposes of this session were to exchange information on the development, implementation, and application of statewide travel demand forecasting models, and to recommend topics for additional research. This section provides a summary of discussions from the peer exchange while the next section describes the recommendation of topics for additional research.

Alan J. Horowitz, University of Wisconsin–Milwaukee

The keynote speaker was Alan J. Horowitz of the University of Wisconsin–Milwaukee. His presentation, "The Challenges of Statewide Travel Forecasting," helped set the tone for the session by describing what makes the development of statewide models unique from the development of urban and regional TDMs. According to Dr. Horowitz, statewide models tend to struggle while urban and regional models move forward. This makes the leading edge harder to define with statewide models. In developing statewide models, the question must be asked "what do we want from our models?" The answers to these questions help in the design of statewide models.

The movement has been towards greater complexity in TDMs such as microsimulation. Traffic microsimulation is easier to address than behavioral microsimulation. Urban scale is becoming a consideration with statewide models. At the same time, O-D matrix estimation (ODME) is becoming very common with statewide models due to a lack of detailed statewide survey data. ODME does require a wealth of traffic count data for statistical validity to be achieved. Faster computers will continue to impact the development of all TDMs.

The modeling of freight movements has become a major focus of statewide models. The complexity of statewide freight models varies widely from simple truck only models to those that make use of economic activity and railroad operations data. The greatest weaknesses in freight forecasting are data on shipment costs and the supply chain.

The presentation ended with recommendations on what to do and not to do in statewide modeling. It was recommended to avoid reinvention, not letting budgets drive imagination and innovation, and to avoid software development if "shrink wrapped" software will do the job. Recommendations for statewide model development include innovation and communication, working with software developers and stakeholders, build on the experience of others, and adhere to standards of validity.

Robert G. Schiffer, Cambridge Systematics, Inc.

Robert Schiffer of Cambridge Systematics, Inc. made a brief presentation on the four-step modeling process and variations on the sources and procedures used for each step of the statewide modeling process. Variability in approach is largely based on data availability and the intended application of the model. Numerous applications for statewide models were presented as these differ in many ways from urban and regional model applications.

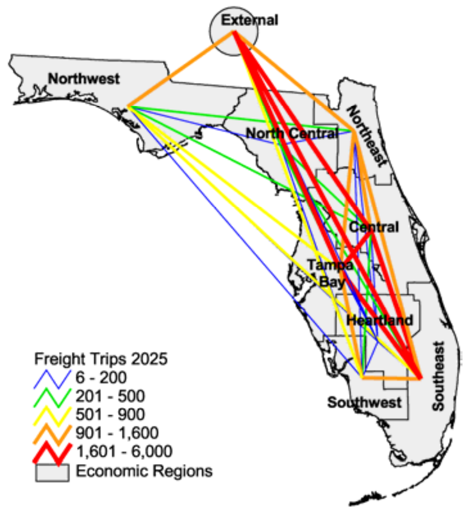

FIGURE 1 Freight trips in Florida.

Tim Baker, Colorado Department of Transportation

Tim Baker used focus groups and literature review to identify statewide data needs and availability. Sketch planning and link-based count extrapolation was used in lieu of traditional four step modeling methods. The Pueblo to Wyoming corridor already has several urban models to use in forecasting so a "why build a statewide model" argument was posited. No single group was championing the concept of a statewide model in Colorado. It was tough to find resources, will, etc., for such an effort. Management saw the need for better policy but the price tag ($1 million) was too high. Resources were needed for a 20-year factor model. CDOT had to work out relationships with MPOs to incorporate MPO forecasts into a statewide factor approach and data repository.

CDOT is serving as a warehouse for data development and taking the lead in a statewide model users group to provide a forum on model issues in the state. CDOT needs to justify the leap into a model or modeling approach. Demand of PMs, asset management, and this sort will cause a long-term shift. The goal is to establish common data and requirements to establish a modeling framework while also trying to manage scarce resources.

Bob Gorman and Nancy McGuckin, Federal Highway Administration

FHWA sponsored the TRB Irvine Conference which defined research topics on freight forecasting tools. FHWA has been working on urban forecasting for more than 40 years, with relatively little time and funding on statewide forecasting. Research needs to be done over coming years to support such an effort. FHWA has developed the Freight Analysis Framework (FAF), which is currently undergoing review with substantial changes possible. FAF still does not cover all the various freight movements including international movements and it does not deal with local trucking or service vehicles. Some efforts are underway to come up with a major Financial Management Improvement Project styled on Travel Model Improvement Program for freight.

FHWA is looking at a major conference in 2006 dealing with freight forecasting issues. The last conference of this type was done in 1971 for urban models (Williams conference).

A course on freight forecasting is under development with a pilot in Colorado. A second course will be in Nashville, Tennessee, in November 2004. Not a lot of staff among the states have a deep understanding of modeling. Nevertheless there is a need for expertise at the state DOT level. A course is under development dealing with "how to use freight data" that should get underway early 2005. FHWA would like to know if we want to do freight forecasting in isolation or integrated with passenger modeling.

The NHTS was discussed along with an upcoming conference in November. The NHTS is a great potential source for statewide model parameters. Sample size is best at aggregate levels.

Huiwei Shen, Florida Department of Transportation

A large focus of the Florida statewide models is on the state's Strategic Intermodal System (SIS) which emphasizes the role that transportation plays in the economy of Florida. Hence, the models currently under development should answer multimodal performance questions and include all SIS intermodal hubs, connectors, and corridors. Work should be completed by the end of the year 2004 on revised base-year statewide passenger and freight models. These models are significantly more detailed than Florida's first generation of statewide models, in going from a 500-zone system to a 4,000-zone system. Better integration with GIS and urban and regional models is also a key.

A related project with the Oak Ridge National Laboratories is underway for multimodal networks and connections to ArcIMS. Other recent innovations include the addition of local trucks to the statewide freight model, isolating a tourist trip purpose, integrating passengers and freight into a seamless model stream, and adding a multiclass assignment with preloading of trucks.

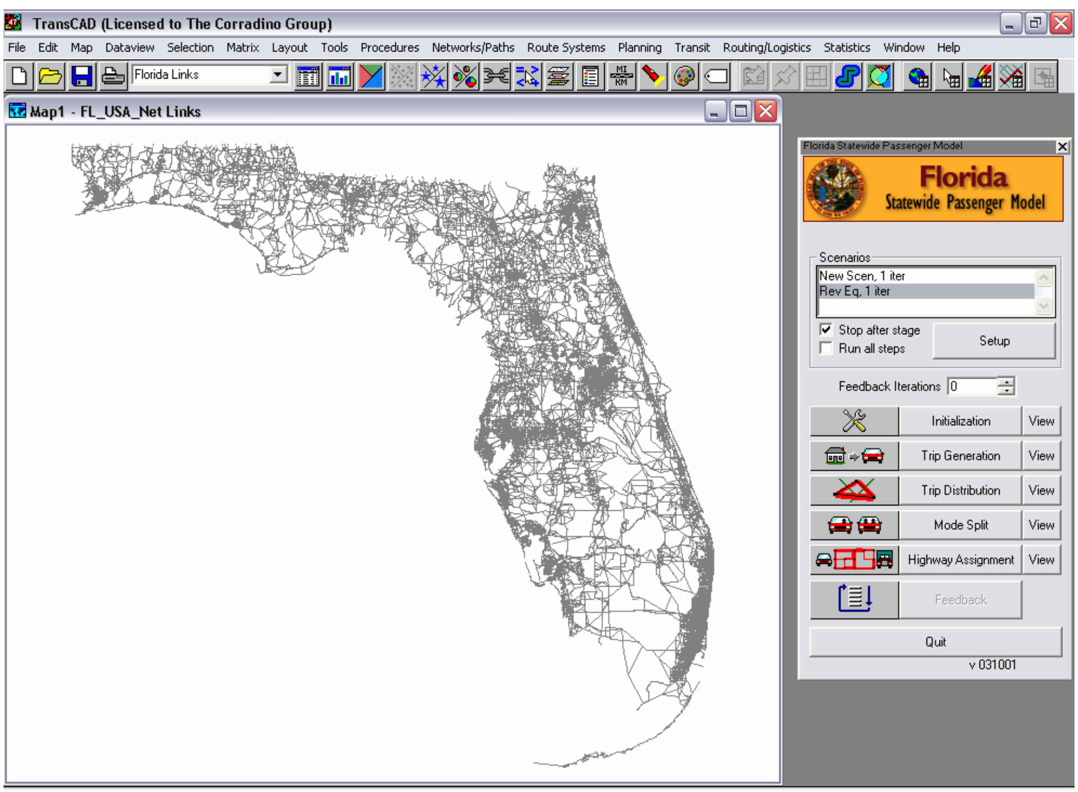

FIGURE 2 Florida network links.

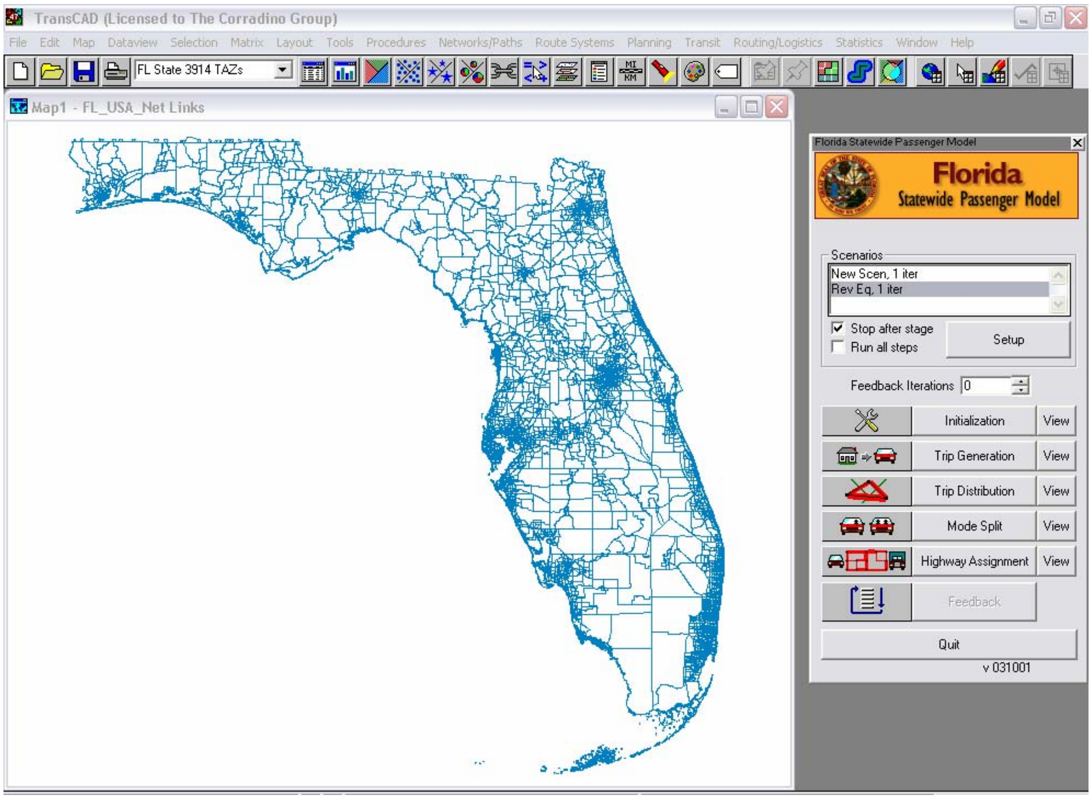

FIGURE 3 Florida TAZs.

Steve Smith, Indiana Department of Transportation

The Indiana statewide model started out as a basic freight four-step model with about 100 zones with some multimodal (freight/truck) capabilities. InDOT's next model was developed in 1995 with 667 zones, 14,700 links, and an incremental modeling approach for trip table. For the I-69 project, the model was expanded to 703 zones, 141 other state zones, and 48 external stations, and 18,200 links. This model moved into a four-step model for non-freight trips.

Now, the model has expanded to 4,700 zones with 25,000 links and has been used for six corridor studies up to 140 mi in length. Five of the studies included economic development impact analyses. MCIBAS was developed for Indiana that converts to a full economic impact assessment via REMI.

The model accounts for productivity increases and compares with FAF findings. REMI was used both in the front end and back end of the process. About $3 million has been spent on the Indiana statewide model over the past 10 years with about 50% of the funding from FHWA for I-69 planning. Other applications of the model have included major corridor studies, INDOT's 25-year LRTP, and AQ conformity for rural counties. Traffic signals and delay are being added to the model as an additional enhancement.

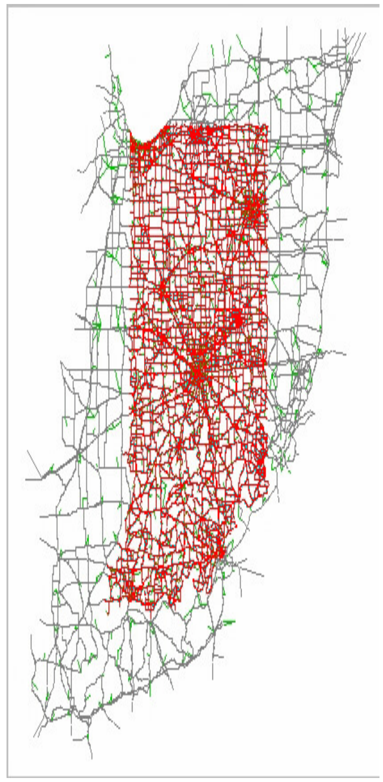

FIGURE 4 Initial Indiana statewide model.

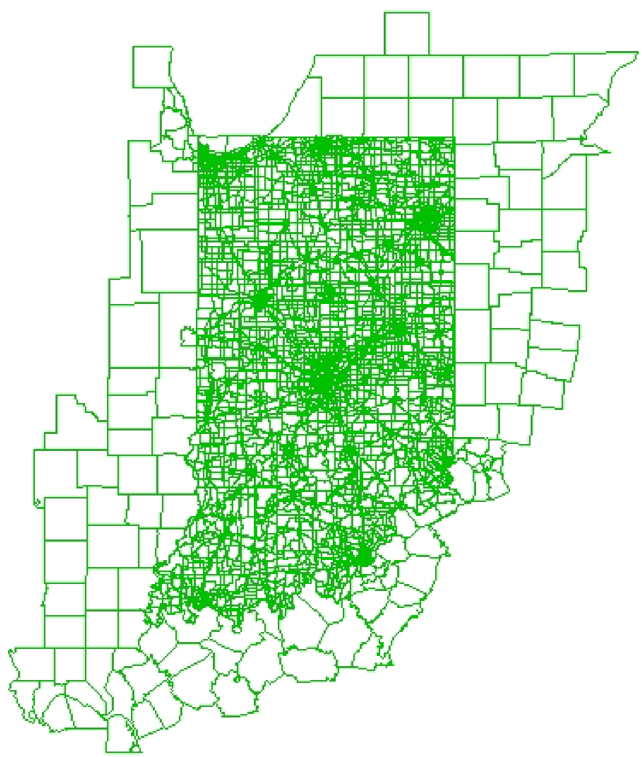

FIGURE 5 Expanded Indiana model.

Rob Bostrom, Kentucky Transportation Cabinet

Kentucky's first statewide model was completed in 1971. In 1991, a low budget update was completed. In 1997, a major update was started for the I-66 study which covered a nine-state study area and included a truck model. A base year of 1999 was recalibrated with a 2030 design year. A 2003 base year current update is ongoing. As an example, the 1997 model had 1,530 zones, 823 in Kentucky and the rest outside with 28,282 one-way links. Their experience has shown that network preparation is often underestimated. TRANSEARCH data were purchased for the current model. Econometric-based changes in commodity flows are being simulated. Kentucky wants to integrate with HERS and Microsim, and would like the model to differentiate among passenger long-distance, business, and tourist travel. Recent model applications include corridor studies, urban external trip estimates, growth rates for rural constrained corridors, and weigh station optimization.

The model is in the process of being expanded to 3,644 in-state and 1,109 out-of-state TAZs. Over time, the staff commitment to the model has been about 0.5 person with updates occurring about every 5 years. About $176,000 was committed to fund an NHTS survey add-on for Kentucky. Trip purposes for the new model will include HBW, HBO, NHB, long-distance tourist/business, and heavy trucks. Special generators, such as military installations, are now being incorporated. It is hoped that additional roadside O-D data can be obtained in the future and that the model can take on a more economic orientation.

Eric Kalivoda, Louisiana Department of Transportation and Development

Economic development was the primary impetus for their statewide modeling effort. True economic development (net increases and income for the state) and real estate development (shifts in pop/comm) are primary issues. The state is attempting to stimulate growth (reverse economic decline and poverty). An advisory council and other stakeholder input has been used to help identify projects and their relative importance. A policy committee was formed to accept or reject advisory findings. The statewide model was used to evaluate $16 billion worth of 50 different "mega projects."

Bob Frey, Massachusetts Highway Department

The statewide model was primarily developed to simulate AQ emissions. It was important to try and maintain compatibility with neighboring states. A roadway characteristics inventory was used as a basis for the network and then refinements were made to maintain the relationship to MPO networks. The project was largely driven by AQ conformity deadlines. Socioeconomic data were based on the census and DET data. Forecast data includes all "regionally significant" projects. The mode choice model for the greater Boston area was incorporated into the statewide model.

The statewide model consists of 3,754 zones. Of these, 272 are in Rhode Island and 159 are in New Hampshire. All TAZs nest within towns. The network includes 65,000 links (55,000 in Massachusetts) and functional classes one through nine. A total of 6,454 centroid connectors and 155 transit connector links are included. Commuter rail freight lines and ferry services are modeled. The model is primarily used for conformity, traffic, planning studies, and policy testing. AQ modeling is a combination of model output, databases, and mobile output for network calculations. The model includes 10 trip purposes, 4 time-of-day periods, and incorporates an NHTS add-on survey.

John Miller, Missouri Department of Transportation

A dynamic statewide model structure has been employed in Missouri. The model was originally conceived for conducting an I-70 corridor study. It is a four-step model with seven categories of employment and four trip purposes (HBW, HBO, NHB, and trucks). The state is trying to develop a system for corridor development, testing policies, and systems planning analysis. 2000 is the model base year with 2025 and 2035 as forecast years. Non-MPO household surveys were conducted of 600 households in rural areas. There are 865,000 line segments in the network, 4,540 block groups, 1,320 census tracts, and 115 counties.

Subramanian Sharma, New Hampshire Department of Transportation

The state's goal to provide a coordinated transportation system as part of their 1994 statewide plan. This was the impetus for developing a statewide model including all modes of transportation. Public outreach, including working closely with Regional Planning Councils, was used to encourage participation in O-D surveys. The state was looking for integration with management systems, projects, AQ, policies, and systems planning. The resulting model is an activity-based, tour-oriented model with time-of-day components (a.m., p.m., md and night), and several modes (single occupant vehicle, HOV2, HOV3, bus, rail, and nonmotorized). TAZs are based on a combination of municipal boundaries, regional boundaries, and census boundaries. All network data are stored in a master network database.

The model has been used as a check of growth rate methods and for an I-93 corridor study. Some of the policies tested with the model include rail, bus, HOV, tolls, and congestion management system (CMS). Since tour-based modeling is more complex than four-step modeling, additional training, and documentation is required.

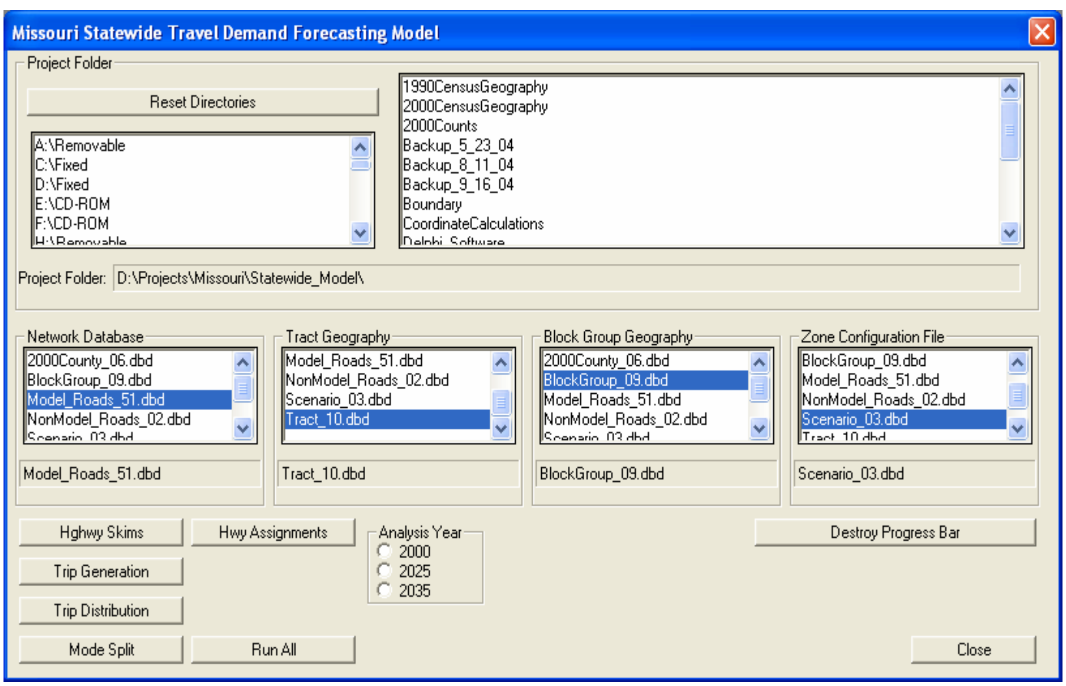

FIGURE 6 Missouri statewide travel demand forecasting.

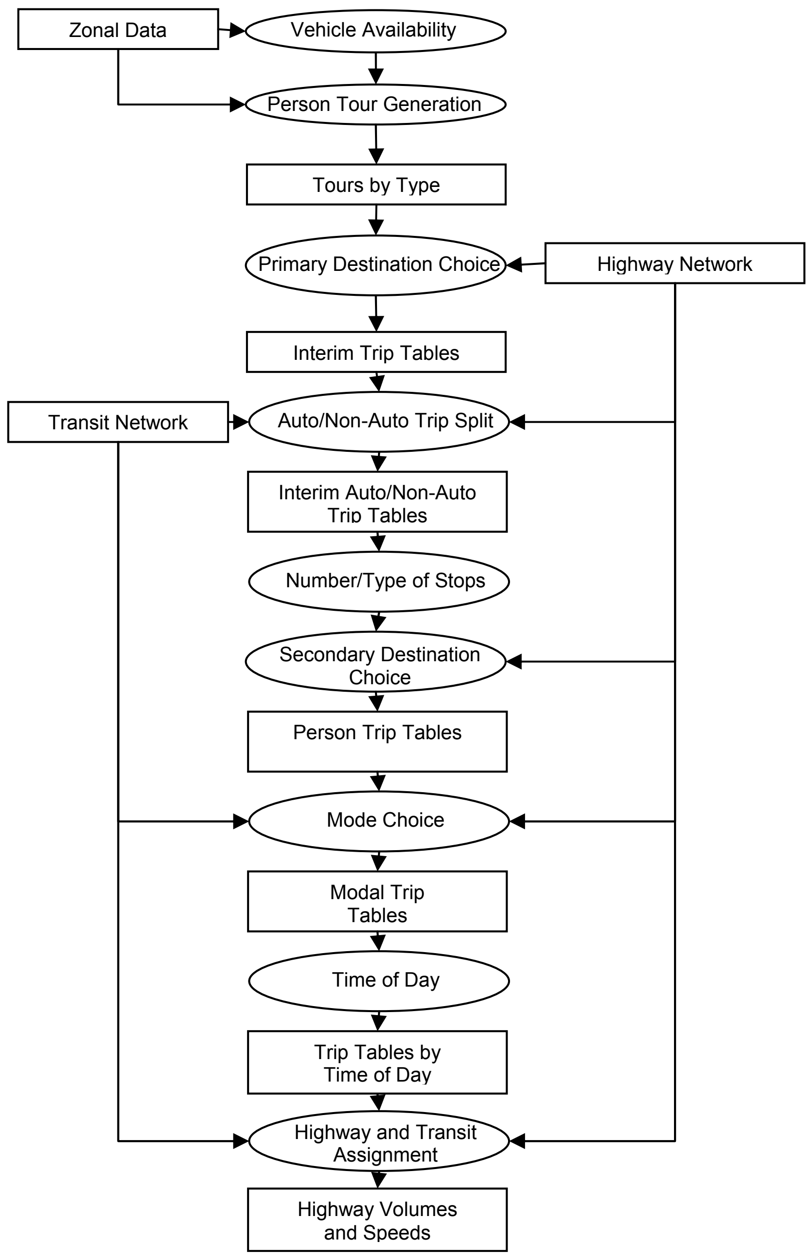

FIGURE 7 Tour-based travel model system: New Hampshire statewide travel model system.

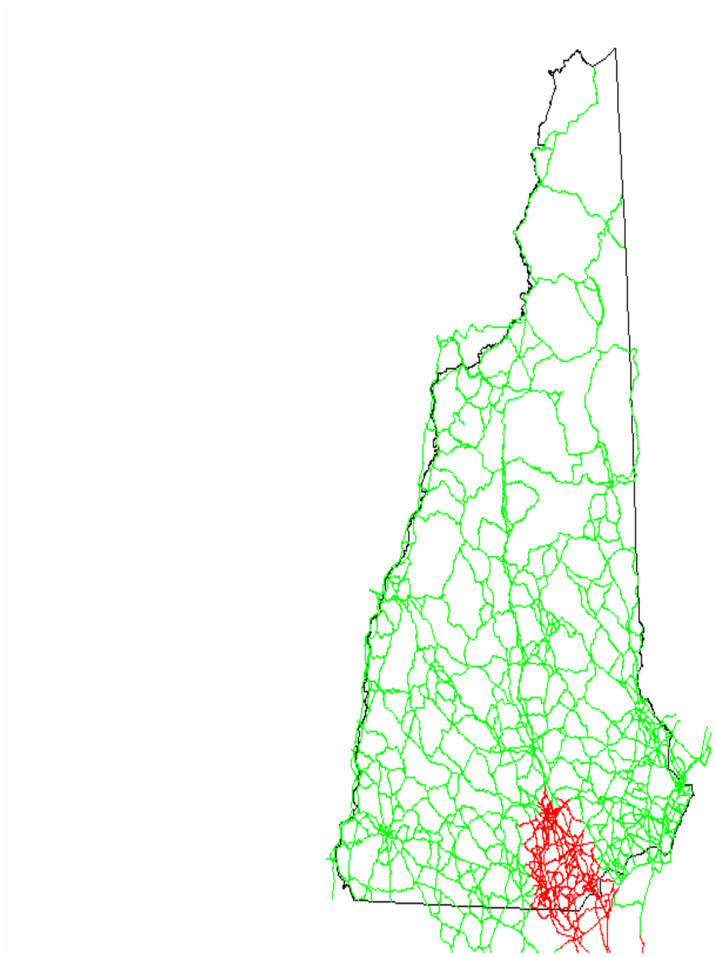

FIGURE 8 New Jersey statewide model.

Bob Miller, New Jersey Department of Transportation

New Jersey's model has primarily been used to test policies, freeways, missing connectors, new interchanges, truck bans, ports, and freight movements. The goal is to provide an analysis tool for statewide truck and highway travel.

The guiding principals include minimizing cost, making management friendly, resisting career modeling project, (i.e., there is never enough data and "perfect is the enemy of good"). Phase 1 was conducted in 1994 using combined auto models and developing commodity flows. Phase 2 was conducted in 1998 and included refinements to truck trip generation, future year analyses, and a revised network and zone system. These two phases cost about $500,000 to complete.

The statewide model was developed largely by combining model networks from five MPO models. The model includes 2,800 zones, 44,000 links, and 17,000 nodes. The model covers eight counties in New York, and five counties in Pennsylvania and Delaware. A "weaving process" was used to merge trip tables from various MPOs. The model includes a number of special generators, survey based travel patterns, truck restrictions, and two class truck tolling.

Medium trucks are classified as 2 axle/6 tire (<28,000 lbs.) while heavy trucks are greater than 28,000 lbs. The model includes three trip tables (auto, medium truck, heavy truck). Recent applications have included I-287, Trenton complex, turnpike tolls, turnpike interchanges, route 92 toll road, port way, and Port brownfields.

Greg Giaimo, Ohio Department of Transportation

Development of the Ohio statewide model began in mid-1990s with a focus on freight and trucks. Twelve hundred zones were in the interim model. Network extended outside of state for diversion analysis at external cordons. Analyses also includes looking at latent demand by adding freeways along new corridors. Toll diversion was applied along the Ohio Turnpike.

The most recent effort has been development of an advanced model, similar to Oregon's (top-level econometric down to travel models). Seven hundred zones are used for economic modeling, 5,000 to 6,000 zones for O-D matrices, and a subzone level of 20,000 at which employment and population data are maintained. All roads other than subdivision streets are found in the network database. Dependent on the project being analyzed, the user can bring that fine level in or network aggregation can be used. The budget for the model started with $2 million and ended up with $8 million over 7 years. Analysis of household survey data continues to determine tour structure. A separate long-distance survey of about 2,500 households was conducted. Crash rate probability analysis module has been discussed.

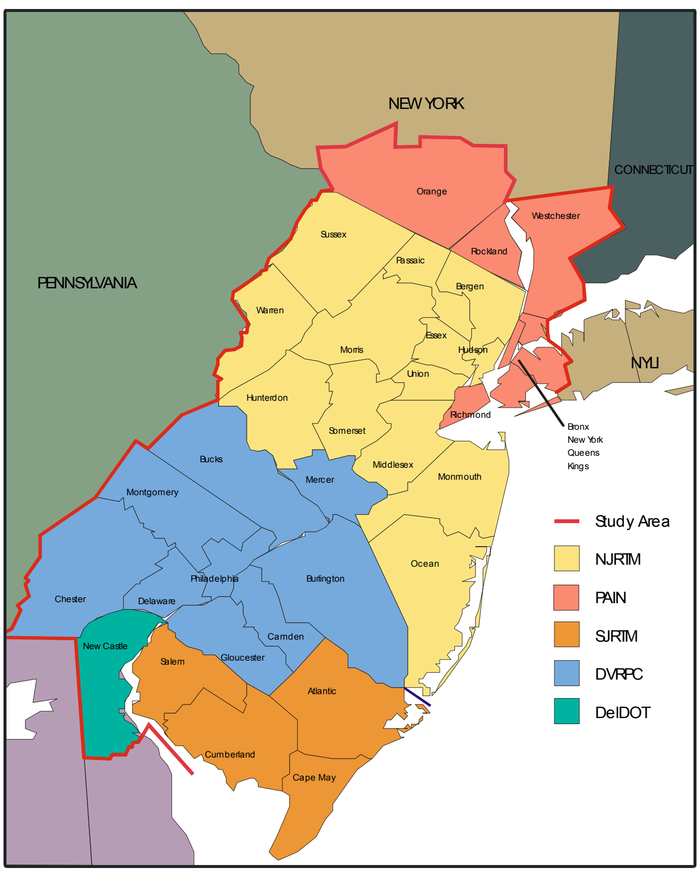

FIGURE 9 Counties included in New Jersey model.

Rick Donnelly, Parsons Brinckerhoff, Oregon Statewide Model

Land use sustainability is the big issue for all, including decision makers. This led to the state's Transportation–Land Use Model Improvement Program. Oregon's statewide model includes an economic model, location model and transport model. Initially, it was based on TRANUS with about 150 zones in Oregon and a "halo" into surrounding states. Microsimulation model capability was desired. Economic and demographic model works with entire state and neighbors (it includes an input/output model). Nested zone systems were established with different systems for different analyses. About 700 zones are used for the microsimulated development model. The model loads on link faces, not centroid connectors. Three thousand zones are used for the land use model (alpha).

A Linux cluster of 10 dual processors run one analysis year at a time for the land use component, which takes about 5 h to complete. The statewide model has been used for new alignment review, bypasses, and how to replace bridges with an economic bend to sell it as a $4.9 billion investment for bridges. Peer review is absolutely essential with a state-of-the-art approach such as this. A real challenge is to develop and retain expertise. Three million dollars has been expended, of which $1.8 million has been spent on data. To set up the first generation model, $350,000 was required. IMPLAN process is like REMI but includes INPUT/OUTPUT methods.

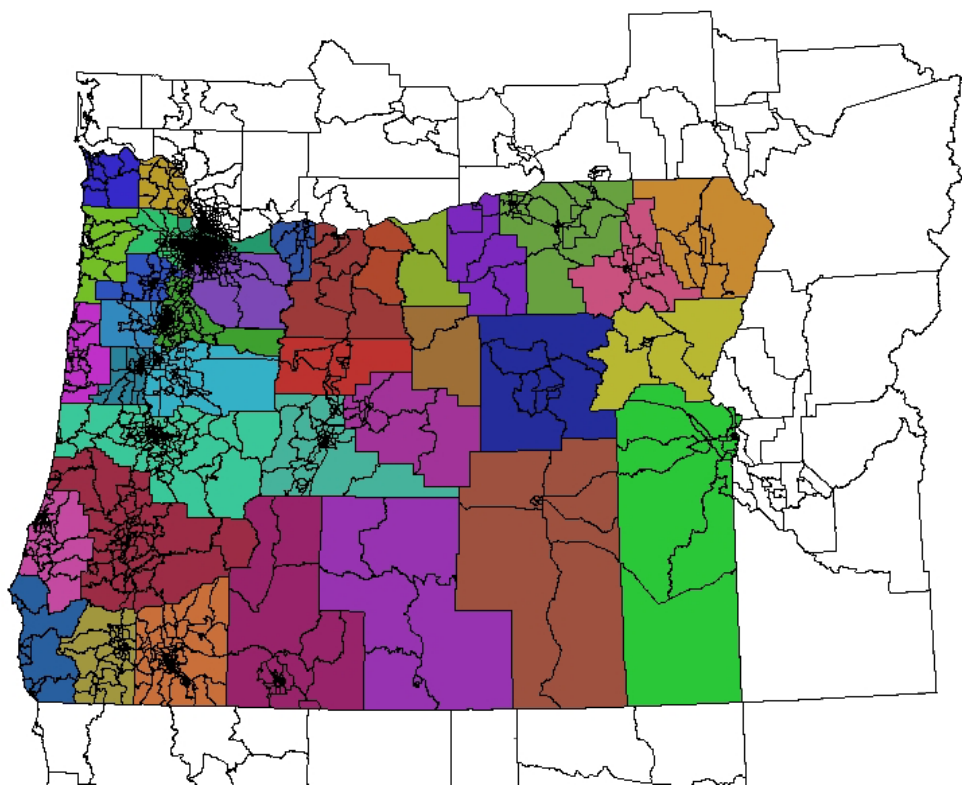

FIGURE 10 Area included in Oregon statewide model.

Rick Donnelly, Parsons Brinckerhoff, General Presentation

Models can be differentiated as megascopic, macroscopic, mesoscopic, and microscopic. Various reasons for statewide models at these different levels. Current conclusions are that data is aged, and synthetic and national data are not sufficient. Models should use a REMI model at the top along with a commodity flow model. A strong interface between urban and statewide networks should exist. A strong desire should exist to improve model accuracy.

The Michigan statewide model is tour based, with a personal travel focus, and inclusion of freight. A 14,000-household survey, visitor surveys, onboard surveys, O-D surveys, and traffic counts were required. After testing, the model was reduced to about 60 tour types with four time periods. Productivity adjustment over time was based on delphi and other approaches. The United Kingdom is working on a national model using a tactical and strategic approach. Tactical approaches emphasize understanding while strategic emphasizes guiding. States sometimes abandon statewide models because of high maintenance and singular purpose.

Mike Nichols, Virginia Department of Transportation

Goals for the Virginia statewide model were to look at intercity travel, freight studies, freight diversion, and tolls (trucks and cars). Estimation of freight and the I-81 study were the impetus for the model. The model will also be used for VMT estimates, to prioritize state highway projects, and estimate external flows to MPO models. The statewide model will not replace urban models but rather is only validated for non-urban sections. The only link between urban and statewide models is a compatible zonal structure. Micro- and macro-level approaches are employed. Macro-level provides external travel times for the micro-level models. Micro models are used to simulate intrastate travel. A $1.5 million budget was allocated for the statewide model.

Trips are divided into components based on trip lengths. Special generators are only in the areas outside MPO models with 500+ trips. Modes include highway, autos, trucks, and passenger rail. Trucks are assigned but other freight modes are not assigned. The model uses REEBIE and some proprietary employment data. The highway network was derived from the national highway planning network, FHWA national HPMS data, and state inventories. A 15,000-subzone system is used for assignment. The model could use a multimodal freight component and additional staff resources.

Charlie Howard, Washington Department of Transportation

Washington doesn't have a statewide model at this point. MPO models are used in metro areas. The state used to do modeling for small MPOs but back in late 1980s dropped that function due to lack of ability to keep up with expertise. The approach includes applying growth factors to volumes and estimating a delay methodology associated over a 24-h period. The state is spending energy to refine congestion management. Peak period measures are becoming increasingly irrelevant in urban areas. Benefits are shown in off-peak and shoulders and needs to be shown/quantified. ITS data are being used to look at patterns of congestion (recurring and non-recurring delay). Washington is trying to differentiate between the two types of delay by two times the average number as non-recurring delay. The state found out that delay is more complex than that. Many more factors than accidents.

The state did have several years ago an economic activity model to look at movement across Cascades but stopped supporting this model due to lack of funding and expertise in house.

Don Uelmen, Wisconsin Department of Transportation

Wisconsin is developing its third generation of a statewide model, and recently received first set of assignments. TAZs inside Wisconsin number 1,642 with 226 outside the state for a total of 1,868 zones. MPO equivalencies were used for statewide zonal data. Intrazonal trips in south Wisconsin model; 60,337 network miles with all major collectors on up in Wisconsin; urban system of the model is 5,200 mi. WISLR is a GIS/web-based system for all roads. For STN, this database provided attributes for state and Interstate roads. A wealth of O-D data were collected for gateways and MPO access points by purpose and mode. NHTS used for model estimation procedures along with census, ES-202, Reebie, and CTPP.

An $850,000 budget was provided along with a 24-month schedule. In addition, $2.3 million was spent on 2001 NHTS add-on surveys (16,000 samples). Concern over MPO/statewide model conflicting forecasts. Focus on "no black box" and need for good staff understanding of how things work. Main impetus to look at diversions to justify needs. Doing 2030 plan and validation will focus on 26 screen lines with focus on ATR information or reliability, using AADT, targets root-mean-square error (RMSE), and GEH approach method for checking change in volumes by class.

Modes modeled include auto, truck, rail and intercity bus. Network attributes include 24-h capacity, AADT 1999–2001, free-flow speed based on design, geometric deficiencies, and assumed posted speeds for non-state highways. Special generators include distribution centers, ports, trucking terminals, and airports using a threshold of 500 trips/day. Trip purposes include work, shop, social–recreational, HBO, HBSC, NHB, truck, and external trips. A destination choice approach is used with nested logit. Assignment uses equilibrium, and the state is debating incremental load or stochastic multipath. Freight uses Reebie at BEA for 140 TAZs nationwide. The model is being validated to a 2000 base, with an intermediate year of 2015 and a design year of 2030.

A model inputs standards guide has been developed. Coordination with MPOs will provide information at their borders regarding possible diversion traffic impacts including percent change and absolute change. Traffic Analysis Forecasting Information System has complete forecast inventory which ties to META model for CMS to help identify needs and priority. Truck, rail, air, and waterborne will be modeled with 25 commodity groups, Reebie, rail/truck mode split, payload conversion factors, and an annual to average daily conversion factor by mode. Truck and rail trips will be assigned to their respective networks. Long-distance trips (50 mi+) data are readily available from local surveys and NHTS. Formation of a TOC helped maintain performance and accountability, including monthly meetings either face to face or via teleconference. It is recommended to establish a reasonable timeframe and to define concise expectations.

Tom Cooney, Wilbur Smith and Associates, General

Must look beyond urban modeling methods in developing statewide models. Staffing and model maintenance will always be a challenge. Available data include NHPN, national HPMS, census, Woods and Poole, Dun and Bradstreet, a GIS for the model, Linear referencing for maintenance, Reebie, ATS, NHTS, CTPP, local survey data collection, and auto and truck traffic counts (although GIS-based networks can cause headaches for modeling). The approach should include model design workshops and maximum stakeholder involvement to set common and realistic expectations. Workshops can cover goals, users, inputs/outputs, software, etc.

Statewide model market segmentation includes urban type business, tourist, and other long-distance, heavy truck long-distance, and local trips. Data and model management, network zone and other data management, post-processing for output data management, and procedures for updating network attributes are important. It is recommended to incorporate a linear referencing dystem or route/milepost to import data directly to merge with other attributes. This requires time, knowledge, and periodic updates to run and maintain statewide models. The model should be a core to DOT missions and provide a consistent methodology for reliable and timely forecasts.

Dr. Black (Indiana University) set up a relationship between employment and productivity improvements (sometimes a factor of three on productivity increases makes trucks increase 2.5 times the rate of passenger travel). Through travel in the mid-United States would be better estimated with a national model to get commodity O-D flows. Data gaps exist in service/delivery, long-distance travel, business and tourism travel, and other.

The role of the statewide model in planning for operations should be identified. Issues of relationships between MPO and statewide models should be identified.

Research Problem Statements

After presentations were concluded by each of the attendees, the peer exchange focused on developing research problem statements. The table below lists all research problem topics suggested by peer exchange attendees.

After conducting paper voting by attendees, the top four topics were rural area trip-making characteristics and parameters, development of a national model, statewide model validation performance standards, and long-distance travel data collection. The following research statements were written for each topic.

Rural Area Trip-Making Characteristics

Statewide travel demand forecasting models are unique in the broad range of area types covered, ranging from large urbanized regions to rural and undeveloped areas. While considerable information is available on the travel behavior within large metropolitan regions (and to a lesser degree smaller urbanized areas), relatively little is known about the travel characteristics of rural residents. Thus many statewide TDMs either use trip rates and other parameters from urban and

TABLE 1 Statewide Travel Demand Model Peer Exchange Topics

	Topics	Total	Rank	Priority
1	Best practices at MPO/STM interface	1		low
2	Chain of assumptions in freight movements	1		low
3	Congestion impacts of long-distance travel	3		medium
4	Economic impacts of transportation investments	1		low
5	FAF productivity factors	0		low
6	Improved freight data	4		medium
7	Intermodal linkages	0		low
8	Long-distance tourism flows	0		low
9	Long-distance travel data collection	6	4	high
10	National model	7	2	high
11	O-D matrix estimation	0		low
12	Rail movement modeling Class I vs. short-line/diversion	3		medium
13	Roles for STMs in operations planning	2		medium
14	Rural area trip-making characteristics/parameters	9	1	high
15	Staffing for STMs	4		medium
16	Statewide model MOEs	1		low
17	Suitability of STMs for applications	1		low
18	Training support for STMs by FHWA	0		low
19	TRANSEARCH parametric review	1		low
20	Truck route choice	0		low
21	Validation performance standards	7	2	high
22	Visualization and display of travel forecasts	0		low
		51	Total votes	
		17	Voters	

regional models in the same state or generalized parameters are borrowed from national research studies such as NCHRP 365. The result of applying urban model parameters to rural areas is the introduction of errors in the number of trips, trip purposes, average trip lengths, and auto occupancies, among other characteristics.

The focus of this research will be to identify a set of transferable rural area model parameters that can be applied to rural TAZs within statewide and regional planning models. An attempt will be made to develop parameters for different types of rural areas such as agricultural areas, rural resort areas, and rural areas transitioning into urbanized areas. A literature search will be conducted to identify potential available sources for rural model parameters from state DOTs, regional planning agencies, and federal research projects. Based on the findings of this literature search, potential survey datasets will be identified where rural residents can be isolated from urban residents. Rural area model parameters will then be derived from these survey databases. On another front, the NHTS will also be evaluated to identify potential rural model parameters. It is expected that the NHTS, due to its national focus, should contain a satisfactory statistical sample of rural households to enable calculation of rural area model parameters. The final product from this study will be a set of transferable model parameters for application to rural TAZs in statewide, regional, and rural travel demand forecasting models.

Development of a National Travel Model

Since ISTEA was passed in 1991, almost one-half of the states have either developed statewide travel models or they are actively considering developing them. One of the problems states face when they develop these models is how to handle external trips, that is either trips with one end in the state and the other end in another state or trips originating in another state that pass through the state on their way to their final destination which is also outside the state. There are three methods for handling those trips: conducting surveys at the states border and factoring the trips up to some future time period; developing external zones in neighboring states; or using a national model to predict external trips. However, there aren't any national models available at this time.

Developing a national model would greatly enhance state travel models. But this is not an easy task. A great deal of thought as well as resources would be needed. Before such a task is undertaken, there should be a design study undertaken that would explore various options and estimate the purpose of the model and what data is needed and the time and cost needed.

The design study should address the following:

- Define the purposes for the model.
- Determine whether passenger and freight travel should be integrated or handled separately.
- Determine the size and number of zones needed.
- Evaluate whether there is sufficient data available to develop the model.
- Determine whether the model handles a single mode or whether it should be multimodal.
- Determine whether the trips included are national and/or international.
- Estimate the time and costs for various options.

Development of a Validation Performance Standards for Statewide Models

Almost one-half of the states have either developed statewide travel models or they are actively considering developing them. These statewide models are used to forecast demand for most interstate and principal arterials found on the NHS in addition to key statewide facilities. Furthermore, statewide models are often the only source of forecasting demand on rural facilities otherwise not included in traditional urban models.

While there are well documented standards for urban models, no such standards exist for statewide models. This is of particular importance as statewide models are often used to evaluate financial and transportation impacts of proposed projects as well as to prioritize multimodal investments such as new interstate facilities, port access, and intercity high-speed rail.

Because statewide models play such an important role in planning large-scale intercity investments, it is important that these models be calibrated and validated to criteria specifically tailored to match the intended applications. The design study should address the following areas of concern:

- Acceptable ranges of parameters and values used as inputs to statewide models;
- Key market segments that should be addressed in statewide models;
- Suitable and unsuitable applications of statewide models;
- Potential sources of data to support and evaluate statewide models;
- Multimodal performance standards for trip generation/activity, trip length/duration, mode choice, corridor assignment, low volume roadway assignment, rural areas and facilities, multimodal demand and multimodal assignment;
- Comparison of urban and statewide planning model results and sensitivities; and
- Estimate the time and costs for various options.

Long-Distance Travel Data Collection

Since the passage of ISTEA in 1991, which required states to develop multimodal transportation plans, states have become more interested in developing statewide travel forecasting models. TRB's Committee on Multimodal Statewide Transportation Planning recognized the growing interest in this topic and they sponsored a conference on the subject in 1999. As a result of that conference, TRB established a subcommittee on this subject and began to identify research needs.

Last September, FHWA and the TRB subcommittee sponsored a Peer Panel in Sarasota, Florida, which brought together many of the states who have developed statewide models to discuss their models and to discuss some of the issues and problems they have to confront. Today, there are about 20 states that have or are developing statewide models and another 5 states that are interested in developing a model. Of all the issues that were discussed, one of their principal concerns was information on long-distance travel. The models that have been developed have relied heavily on data collected in the ATS for estimating long-distance travel. However, that information was collected in 1995 and it needs to be updated. Unfortunately, it is our understanding that there are some questions about whether the survey will be undertaken again.

Our sub-committee would like to express our support for continuation of the ATS. Although long-distance trips are a small percentage of total travel, they account for a high percentage of travel on our Interstate and interregional highways. Many states have formed coalitions to undertake multistate corridor studies for both highways and passenger rail. These studies need the information that the ATS provides. State travel models also need information on long-distance trips. External trip estimation is one of the weakest areas in state travel models and it is critical that the ATS continue.

APPENDIX A

Session Meeting Agenda

Statewide Travel Demand Modeling Peer Exchange
September 23–24, 2004
The Colony, Longboat Key Florida

Thursday, September 23

9:00 a.m.	Welcome—Greg Giaimo, Ohio DOT
9:05 a.m.	Challenges of Statewide Travel Forecasting—Alan Horowitz, University of Wisconsin, Milwaukee
9:45 a.m.	Participant Introductions and Modeling Status (2 to 5 min each)
10:45 a.m.	*Break*
11:00 a.m.	Participant Presentations (15 min each) Rob Schiffer, Cambridge Systematics, Inc. Tim Baker, Colorado Bob Gorman and Nancy McGuckin, FHWA Huiwei Shen, Florida
noon	*Lunch*
1:00 p.m.	Participant Presentations Continued (15 min each) Steve Smith, Indiana Rob Bostrom, Kentucky Eric Kalivoda, Louisiana Bob Frey, Massachusetts John Miller, Missouri Subramanian Sharma, New Hampshire Bob Miller, New Jersey
2:45 p.m.	*Break*
3:00 p.m.	Participant Presentations Continued (15 min each) Greg Giaimo, Ohio Bill Upton, Oregon Rick Donnelly, Parsons Brinckerhoff Janie Bynum, Texas
4:00 p.m.	*Adjourn*

Friday, September 24

8:00 a.m.	Participant Presentations continued (15 min each) Michael Nichols, Virginia Charlie Howard, Washington Donald Uelmen, Wisconsin Tom Cooney, Wilbur Smith
9:00 a.m.	Facilitated Discussion of Needs and Assignment to Breakout Groups
10:00 a.m.	*Break*

10:15 a.m.	Breakout Sessions to Draft Problem Statements
noon	*Lunch*
1:00 p.m.	Presentation of Research Statements
2:00 p.m.	Wrap up and adjourn

APPENDIX B

Participant Questionnaire Responses

COLORADO

II. Maintenance/Use of Model

II–5. Do you have a regular update cycle? If so, what gets updated at what intervals?

Traffic volumes, percentage of trucks, V/C ratios, DHVs, DDs, VMTs are updated every year. Highway capacities and growth factors are updated every 5 or so years. We use about 1.5 FTEs for this process.

II–6. What are the primary measures of effectiveness (MOE) used from the model?

Traffic volumes higher than a threshold, V/C ratios, VMT totals.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

Only to a limited extent.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

To a limited extent to obtain global measures such as total miles with congestion level higher than a threshold for every Transportation Planning Region. Formal regional planning for the different metropolitan areas is done by the different MPOs.

II–9. Is your model used for corridor planning? If so, give examples. If not indicate how this is handled.

Sketch corridor planning exercises have been conducted in the past, but this is normally not done. Consultants are generally used when more formal corridor studies are needed.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

Consultant has been used in the past for project prioritization along with considerations other than technical.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

Project-level traffic forecasts are normally conducted be consultant although they normally rely on available data in our databases.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

Operational studies are conducted by consultants.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

Economic development studies are done by consultants.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

Basic information exists in our databases but formal freight/intermodal studies done by consultants.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

Limited activity in our state in this kind of studies over the last few years.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not indicate how this is handled.

AQ conformity for the different urban areas is responsibility of the MPOs.

II–17. Is your model used for safety analysis? If so, give examples. If not indicate how this is handled.

Police accident records by category are assigned to the different highways segments on a yearly basis.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

Consultants normally used for these studies.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

Traffic impact studies conducted by consultants.

FLORIDA

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

- Zonal data—MPOs, University of Florida, and U.S. census
- Long-distance travel–tourist data and the NHTS
- Freight Flow—Reebie
- Networks—GDT and Caliper Corporation
- Network Attributes—FDOT's Roadway Characteristics Inventory (RCI)

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

No new data have been collected for the statewide model other than external data collected in 1990. However, many of the urban models, which are used in the statewide model, are based on recent small sample household O-D surveys.

I–3. Did you use national data sources such as NHTS?

NHTS is a source for long-distance travel data.

I–4. How much did the data collection effort cost?

N/A

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

None

I–6. How often are networks updated and from what sources?

No formal update program. Most updates come from MPO input.

I–7. What data couldn't you get that you wish you could?

- Better data on external travel
- Better data on long-distance travel
- Better data on special generators of statewide significance
- Better data on trucks and freight

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

Being done as a coordinated effort between in-house staff and consultants.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff).

One.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

No.

II–4. How much time is spent maintaining the model versus applying it?

Currently 90% maintenance and 10% application. Once calibration is completed, 40% maintenance and development and 60% application

II–5. Do you have a regular update cycle and if so what gets updated on what intervals?

No formal cycle.

II–6. What are the primary measures of effectiveness used from the model?

MOEs not yet developed.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

The models will be used to support the SIS for alternative analysis, corridor analysis, and prioritization of projects.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

Most regional planning is done using regional models. The turnpike uses the statewide models occasionally for areas where there is no regional model coverage.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

Turnpike has used the model for corridor planning.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

Not yet, but will be in the near future. We are developing measures of effectives for the five SIS goals: safety and security, operations, mobility, economic competitiveness, and environmental stewardship to prioritize project across modes. The statewide passenger and freight models will be used to supply data for the prioritization tool.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

Turnpike has used the model for project level planning.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

Don't think so and would not recommend the use for short-term operational improvements

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

No.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

Not yet.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

Might be used for this in the future.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not indicate how this is handled.

AQ conformity analysis is handled by MPO models.

II–17. Is your model used for safety analysis? If so, give examples. If not indicate how this is handled.

No.

II–18. Is your model used for toll studies? If so, give examples. If not indicate how this is handled.

The Turnpike does.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

No.

III. Implementation

III–1. Who developed the model?

The Corradino Group, USF, consortium of consultants, and Caliper Corporation.

III–2. How long did/will it take to develop?

The development efforts have been ongoing.

III–3. How much did/will it cost and how was funding obtained?

Approximately 1.5 million out of our work program and research funds.

III–4. Were there institutional hurdles to cross and if so what?

No.

III–5. Where did the impetus for model development begin?

Model development was designed to address transportation analysis issues at the statewide level and also in rural areas and areas where there is no urban or regional model coverage.

III–6. What were the main problems that the modeling effort was designed to address and how were these identified?

Statewide system planning, SIS project prioritization, and turnpike planning.

III–7. Was the model validated? Against which data and validation criteria? How well did it validate?

- It is being validated against existing counts.
- Original model had a high RMSE error.

III–8. How are validation criteria for statewide models different from urban models?

- Must be less stringent.
- Freeways, toll roads, and major arterials are important.
- Should not be used in urban areas; MPO models are more current and have more detail.

IV. Scale/Level of Detail

IV–1. What modes are modeled and which are network based?

In the current models, only highways are modeled. Within the next 2 years or so, we are hoping to include an intermodal network.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

TAZs as described above.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor, etc.) and why?

Passengers and truck flow with the goal of modeling auto and truck flows for the peak season.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model and how are they modeled?

- Currently no special generators.
- SIS generators have been added, but are not yet functional.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

Share TAZ geography.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

- In theory
- Practice unknown

V–3. Are the urban models incorporated as part of the statewide model and, if so, how?

Trip generation as noted above.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models, and, if so, are there institutional issues regarding dueling forecasts?

We don't recommend using the statewide model in locations where the MPO model is up to date.

VI. Freight/Commercial Vehicle Modeling

VI–1. Does the model consider trucks only or other modes and why?

- The model only assigns truck trips but does have a mode choice module.
- The major modes include carload rail, intermodal rail, and truck. These modes are in Reebie and are the major components.

VI–2. Why were certain modes excluded if any?

Not a significant impact on major roadways and very difficult to estimate.

VI–3. Is the model based on commodity flows? If so, what techniques are used? How is commodity flow translated to individual vehicles?

- Based on commodity flows.
- The model contains a tons-to-vehicle model that is a function of distance and commodity based on the VIUS.

VI–4. Does the model use matrix estimation techniques? If so, what data were used for estimating the matrix?

The new model might.

VI–5. Are traditional truck trip generation methods or quick response methods used?

- Statistical analysis of Reebie.
- Work being done currently involves the quick response method to generate non-freight truck trips.

VI–6. Is Reebie's data or CFS used? If so, how are the sectors not covered by these sources modeled or accounted for?

- Reebie.
- Other sectors not now in the model.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are models of long-distance or recreation/tourism integrated with the normal passenger TDMs?

Current plans are to add long-distance travel as a trip purpose.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs and if so what?

Generally urban modeling techniques used.

VII–3. What special data sources were required for these models?

Tourist data and NHTS.

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

Florida is especially interested in the peak tourist seasons. The peak season is not the same calendar time in all areas of the state.

INDIANA

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

The data for our statewide modeling effort comes from a variety of sources. The network data were obtained from the INDOT Road Inventory File a physical features and AADT inventory file. Using the routing system procedures of TransCAD this file provides the basis through a dynamic segmentation process for the geographic roadway network file. Travel information was obtained from a 1995 telephone home interview survey and updates from the 2000 census data. Socioeconomic information comes from the 2000 census data, Woods and Pool forecasts, Dun and Bradstreet data (used in earlier database development which now uses recently made available ES-202 data) and REMI base line and forecasts data. Truck data comes from the Indiana University CFS for freight movements and is supplemented by a ODME process to generate total truck trips. In the initial study a series of interviews at Interstate rest stops were conducted to attempt to develop some information on through trips. The results of this effort had limited success due to poor participation rates by commercial vehicles.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

The 1995 telephone home interview survey and the 1995 Dun and Bradstreet employment data.

I–3. Did you use national data sources such as NHTS?

Consultant used 2001 NHTS to supplement trip length distributions from 1995 home interview survey for gravity model calibration. Also information from the Corridor 18 model (National I-69 study by Wilbur Smith) was used to supplement long trip purpose data.

I–4. How much did the data collection effort cost?

The 1995 telephone home interview survey cost $100,000 and the 1995 Dun and Bradstreet employment data cost $60,000.

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

Traffic count information.

I–6. How often are networks updated and from what sources?

We use the INDOT Road Inventory File using the routing system procedures of TransCAD. This file provides the basis through a dynamic segmentation process for the geographic roadway network file to update the network every 2 to 3 years.

I–7. What data couldn't you get that you wish you could?

Information on external trips and an inventory of through truck trips from national sources.

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

As noted above INDOT uses extensive consultant support to maintain the model and for modeling applications. Once the new modeling procedures have been fully developed and staff training occurs, in-house applications are expected to increase.

II–2. How many staff are dedicated to maintaining/using the model? (Include estimates of partial time for multitasked staff.)

Currently, one staff member devotes approximately 10% of his time providing management oversight to the consultant support effort, one staff member devotes 25% of his time to model applications, and one other devotes approximately 15% of his time for model applications.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

No. However a need for additional staff has been recognized and the issue raised by FHWA.

II–4. How much time is spent maintaining the model versus applying it?

Since we use extensive consultant support, no in-house staff time is spent in model maintenance.

II–5. Do you have a regular update cycle? If so, what gets updated at what intervals?

Model has been updated periodically based on need. Recent model updates have been driven by requirements of the I-69 corridor study and then applied to entire state in follow-up activities.

II–6. What are the primary MOEs used from the model?

System-level VMT and VHT, and route-specific LOS.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

Model is used to produce VMT and VHT output of existing plus committed network and build networks for LOS deficiency analysis, corridor level, and systemwide economic analysis (in conjunction with a B/C add-on and an economic simulation model). The model was also used to produce future year growth factors to forecast future traffic volumes in a statewide interchange assessment study.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

II–9. Is your model used for corridor planning? If so, give examples. If not indicate how this is handled.

The statewide model has served as the basis for four corridor studies (I-69, SR101, SR37, and US231). In most applications additional zones and network have been added to the statewide model. However, the need for adding additional detail for the most recent model (with expanded detail in the number of zones and network) has not been assessed.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

The model output regarding link level LOS for build and no-build conditions is a factor in project prioritization. INDOT uses the FHWA HERS/ST with a 100% database to provide project level B/C analysis and implementation phasing input to supplement the TDM. The statewide travel model provide future year traffic for input into HERS/ST and the TransCAD GIS functions allow the display of HERS output on the roadway network level.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

The statewide model has not been used for project development level forecasting at INDOT. INDOT currently uses linear trend and spreadsheet models for areas outside MPO areas with operational models. In MPO areas INDOT works with the MPO in developing project development level traffic forecasting. A travel model forecasting tool to provide a quick traffic forecast using a historical trend traffic database and a build and no-build traffic forecast are being developed.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

No.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

The INDOT model was actually developed for the purpose of corridor-level economic development studies. The MCIBAS has been developed for the use of a TDM in evaluating impacts. Additional information on the INDOT MCIBAS application is available at the following websites: www.in.gov/dot/div/planning/lrp/update/EIreport.pdf.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

The Indiana University CFS model provides commodity information and the input for trucks in the statewide TDM. Freight planning applications have been limited to truck volumes studies.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

This applications have not been developed at this time.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not, indicate how this is handled.

Indiana will have two isolated rural non-attainment areas under the 8-h ozone. We anticipate the new updated statewide model will provide the travel data necessary for the AQ analysis.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

The model is used at a systemwide level for safety analysis. The NETBC B/C calculator computes accident reduction costs from model output VMT by functional classification/facility type.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

In the updated model a toll impendence factor is included. However, the model has not been used for any specific toll studies.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

No, at this time.

III. Implementation

III–1. Who developed the model?

The consultant team developing the model is Bernardin Lochmueller Associates and Cambridge Systematics with some assistance from Caliper Corporation.

III–2. How long did/will it take to develop?

The model has been under development since 1995. We have had three SPR funded studies; the MCIBAS for initial model development, the SIS which provided for model enhancements and the current specialized planning services and model development contract related to model development.

III–3. How much did/will it cost and how was funding obtained?

INDOT Long-Range Planning Section Cost (SPR funded) estimated = $1,500,000
I-69 Corridor Study (Project Funding STP) estimated = $1,200,000

KENTUCKY

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

- NHPN for roadway geography and characteristics outside Kentucky
- National HPMS for roadway characteristics outside Kentucky
- KyTC HIS for roadway geography and characteristics inside Kentucky
- ATS data for long-distance travel (Interstate and intrastate)
- 2000 nationwide TAZ-level census journey-to-work data
- TRANSEARCH TAZ-level commodity flow data (including flows to, from, within, and through Kentucky) by four-digit STCC and mode (truck, rail, water and air)
- NHTS for household trip rates, including Kentucky add-on samples
- 2000 census demographic data
- Woods and Poole nationwide CEDDS data (historic and forecast county-level socioeconomic data)
- Dun and Bradstreet census block-level 2000 employment data for Kentucky
- Claritas census blockgroup-level density classifications for Kentucky

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

None.

I–3. Did you use national data sources such as NHTS?

See above.

I–4. How much did the data collection effort cost?

- TRANSEARCH: 42,400
- NHTS Add-on Samples: 176,000

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

All but ATS can be periodically updated.

I–6. How often are networks updated and from what sources?

The network has been designed to include a linear referencing system so that it can be more easily updated from DOT and HPMS files.

I–7. What data couldn't you get that you wish you could?

- Updated ATS data—the NHTS period trips do not provide the same level of detail as did the 1995 ATS.
- O-D data at major Kentucky border locations.

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

Consultants are used to maintain the model.

II–2. How many staff are dedicated to maintaining/using the model? (Include estimates of partial time for multitasked staff.)

Approximately one-half staff person is devoted to maintaining and using the model.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

No.

II–4. How much time is spent maintaining the model versus applying it?

Including consultant time, it might be 50/50. This one is difficult to assess since we haven't specifically tracked this.

II–5. Do you have a regular update cycle and if so what gets updated at what intervals?

Our intent is to update the model about every 5 years.

II–6. What are the primary MOEs used from the model?

RMSE, screen lines, matching control VMT totals.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

It has not been used recently for systems planning. When the original KySTM was built, it was used for statewide VMT but HPMS has since replaced that function. We are considering using it again as a check on VMT, for speed/travel time PMs and other systems PMs.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

Not sure what you mean by regional planning, an example might help. The KySTM has been used as an input to determine external trips for many county-level model development efforts. It has been used as a guide for growth rates on many planning efforts.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

This has been the most common use of the KySTM. Some of the more widely known corridor studies include the I-66 project and the I-69 project. Others include a proposed I-74 extension, I-64 improvements, a proposed I-875 (Kentucky to Tennessee) and many others.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

No, but this is a possibility for the new KySTM under development.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

Yes. It was recently used to develop growth rates for the widening of I-64 in Shelby County. This method was used over a growth rate approach because of the capacity constraint issue. Capacity constraint will be much more of an issue in the future thus necessitating the use of KySTM for many projects.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

Not sure what an operational level analysis is in the traffic forecasting framework. However the KySTM was used to optimize the location of potential commercial vehicle stations (weigh stations) by identifying the number of trucks that would use each location.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

No, but we are giving consideration to using the KySTM as an input to REMI model. We have not purchased the REMI model so many decisions have yet to be made.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

Not really. It has a truck component that will be greatly improved in the updated model. The new model will also have a rail layer and an intermodal site layer so the new model should be more usable for freight/intermodal purposes.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

No.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not indicate how this is handled.

It has been indirectly used by serving as a framework for the development of a county-level model which was then used for AQ conformity analysis.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

No.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

I think tolls were looked at in the I-66 corridor study. I don't know how this was done.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

No.

III. Implementation

III–1. Who developed the model?

Latest model (1997, updated in 1999 through 2001) was developed by WSA. They are also working on the current update begun in 2003. The original KySTM was done in-house but was designed by Alan Voorhees Associates.

III–2. How long did/will it take to develop?

The 1997 model took about 18 months to do and the update (a minor update) about 1 year. The current model will take about 18 months or longer.

III–3. How much did/will it cost and how was funding obtained?

The 1997 model cost about $190,000 and a minor update around $30,000. The latest model will cost a total of $342,000.

III–4. Were there institutional hurdles to cross and if so what?

Had to convince decision makers that travel models were worth the investment. Had to develop funding sources.

III–5. Where did the impetus for model development begin?

The 1991 model was developed in response to general forecasting needs. The 1997 model was developed in response to the need to study I-66. The current model is being developed due to general consensus that the model is indeed important and useful.

III–6. What were the main problems that the modeling effort was designed to address and how were these identified?

The main problem was the lack of traffic forecasting tools for major corridor planning.

III–7. Was the model validated? Against what data and validation criteria was it validated and how well did it validate?

The current model was validated using existing traffic counts and vehicle classification counts. It validated fairly well, mostly because matrix estimation was used to force assignments to match the counts.

III–8. How are validation criteria for statewide models different from urban models?

We have been using similar criteria such as screen lines and RMSE. Perhaps additional criteria such as the reasonableness of long-range trips should be used.

IV. Scale/Level of Detail

IV–1. What modes are modeled and which are network based?

- The KySTM focuses on highways, cars, and trucks. Current and forecast TRANSEARCH commodity flow data are available for other modes, but not modeled.
- Within Kentucky the network includes all arterial roads and, outside the modeled MPOs, all collector roads.
- To capture interstate auto and truck movements, the network also covers the continental United States and includes all major Interstate highways and, for the area surrounding Kentucky, all major arterials.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

- The KySTM uses a total of 3,644 TAZs.

- 882 TAZS are inside Kentucky MPO areas; these are defined using aggregations of MPO model TAZs.
- 2,762 are inside Kentucky but outside the MPO areas; these are defined using census block groups and census places.
- 1,109 are outside Kentucky; these are defined using counties and BEA zones.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor etc.) and why?

Purposes: short distance HBW, HBO, and NHB; long-distance tourist, business, and other; and heavy trucks. Each purpose contributes a significant amount of VMT on the rural statewide system. Data were available to support model development and application using this travel market segmentation scheme.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model and how are they modeled?

Yes. Military bases and major tourist attractions located in Kentucky but outside modeled urban areas.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

The statewide model network is not as detailed as the MPO models. The statewide model zones are aggregations of the MPO model zones.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

Yes, it was designed to do so.

V–3. Are the urban models incorporated as part of the statewide model? If so, how?

No, they are not.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

No, by design it does not.

VI. Freight/Commercial Vehicle Modeling

VI–1. Does the model consider trucks only or other modes and why?

The TRANSEARCH database is multimodal, but only heavy trucks are modeled.

VI–2. Why were certain modes excluded if any?

See above.

VI–3. Is the model based on commodity flows? If so, what techniques are used and how is commodity flow translated to individual vehicles?

The base and forecast year truck forecasts are based in part on TRANSEARCH commodity flow data. Commodity flow truck tonnages were converted to truck loads by using industry standard load factors.

VI–4. Does the model use matrix estimation techniques? If so, what data were used for estimating the matrix?

Matrix estimation was used with a gravity model-based seed distribution to estimate those heavy truck trips not accounted for by the base year TRANSEARCH truck trip table.

VI–5. Are traditional truck trip generation methods or quick response methods used?

Traditional trip generation methods are not used. Instead an econometric modeling procedure is used to forecast the TRANSEARCH commodity flows by mode. Future truck trips are derived from the commodity flow forecast.

VI–6. Is Reebie's data or CFS used and if so, how are the sectors not covered by these sources modeled or accounted for?

As discussed above, TRANSEARCH data were used, while matrix estimation is used to account for truck movements not covered by TRANSEARCH.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are models of long-distance or recreation/tourism integrated with the normal passenger TDMs?

They are treated as three separate purposes: long-distance tourist, business, and other.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs? If so, what?

- A linear referencing system is used to create/update roadway attributes and centroid connectors.
- Trips are allocated to centroid connectors for assignment, which effectively creates a sub-TAZ system.
- Multistep matrix estimation is used to account for base year heavy truck travel not included in the Reebie data.
- Fratar procedures (rather than trip generation and distribution) are used to forecast long-distance travel and HBW travel.

VII–3. What special data sources were required for these models?

- NHPN for roadway geography and characteristics outside Kentucky
- National HPMS for roadway characteristics outside Kentucky
- KyTC HIS for roadway geography and characteristics inside Kentucky
- ATS data for long-distance travel (Interstate and intrastate)
- 2000 nationwide TAZ-level census journey-to-work data
- TRANSEARCH TAZ-level commodity flow data (including flows to, from, within, and through Kentucky) by four-digit STCC and mode (truck, rail, water, and air)
- NHTS for household trip rates, including Kentucky add-on samples
- 2000 census demographic data
- Woods and Poole nationwide CEDDS data (historic and forecast county-level socioeconomic data)
- Dun and Bradstreet census block-level 2000 employment data for Kentucky
- Claritas census blockgroup-level density classifications for Kentucky

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

Not at this time.

LOUISIANA

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

See above.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

None.

I–3. Did you use national data sources such as NHTS?

Extensively—see above.

I–4. How much did the data collection effort cost?

Approximately $100,000, most of which was for the TRANSEARCH commodity flow data.

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

With one major exception, all of the government and commercial data used to develop and run the model is updated on a regular basis. The major exception is the ATS data. The ATS has been replaced by the NHTS, which collects data on both short-distance daily travel and long-distance period travel. Unfortunately, the NHTS sample framework and sample size was not designed to gather statistically valid data on state-to-state long-distance travel, as was the earlier ATS. Consequently, the NHTS period trips cannot be used to replace the earlier ATS data.

I–6. How often are networks updated and from what sources?

It is expected that the networks will be updated on a 4- to 5-year cycle. HPMS will be used to update the network outside Louisiana. LDOTD files will be used to update the network inside Louisiana.

I–7. What data couldn't you get that you wish you could?

Auto and truck O-D surveys at major state line crossings and MPO external stations, with the latter including identification of trip O-Ds outside the MPO.

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

On-call consultants are used to run and maintain the model.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff)?

1.5 LDOTD persons are dedicated to maintaining/using the model.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

The 1.5 persons identified above were reassigned from other duties.

II–4. How much time is spent maintaining the model versus applying it?

Not enough experience to really quantify yet. At this point it is anticipated that maintenance will be an almost continuous process. When the model is not being run it will be "maintained."

II–5. Do you have a regular update cycle and if so what gets updated on what intervals?

A 5-year cycle is anticipated for major updates (base year networks, socioeconomic data, commodity data, external network, etc). Minor updates (E+C networks, etc) will occur on a 1- to 2-year cycle or as needed.

II–6. What are the primary MOEs used from the model?

Same as for typical urban models: ADT, VMT, VHT, LOS, etc.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

It is. It was used recently to evaluate non-urban improvement alternatives for the statewide plan update.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

It has been designed to complement, not compete with, the urban models. As such, it provides information on traffic to, from, and through, but not within urban areas.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

It can be used directly for rural corridor planning and in some cases might be useful for urban corridor planning.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

It can be used directly for rural project prioritization, and in some cases might be helpful for urban project prioritization.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

It can be used for project-level traffic forecasts on the rural arterial system.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

It is not.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

It can be, particularly if used in conjunction with REMI or similar models.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

It can be—the model does forecast heavy truck traffic, both intrastate and interstate. Model users also have access to base and forecast year rail, air, and water TRANSEARCH commodity flow data.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

It can be—see previous question.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not, indicate how this is handled.

Not at this point in time.

II–17. Is your model used for safety analysis? If so, give examples. If not indicate how this is handled.

Not at this point in time.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

The model can be used for preliminary analysis of toll projects. It cannot be used directly for investment grade traffic and revenue studies.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

It can be used for traffic impact studies in rural areas. Such studies would likely require refinements to the network and zone systems.

III. Implementation

III–1. Who developed the model?

WSA

III–2. How long did/will it take to develop?

Two to 3 years.

III–3. How much did/will it cost and how was funding obtained?

Approximately $500,000.

III–4. Were there institutional hurdles to cross? If so, what?

The institutional hurdles, both internal and external, were minimal. Stakeholders were actively involved in the design and implementation of the model.

III–5. Where did the impetus for model development begin?

A need to systematically identify statewide roadway needs, and to evaluate and prioritize proposed improvements.

III–6. What were the main problems that the modeling effort was designed to address and how were these identified?

A design–build approach was used to develop the Louisiana statewide model. A series of three model design workshops were held to identify model users, uses, and data, and other resources. All model stakeholders, including technical and policy level staff from the DOT and all MPOs, were involved in the model design process, which resulted in a detailed blueprint for the model.

III–7. Was the model validated? Against what data and validation criteria? How well did it validate?

Yes, the model was validated against base year car and truck counts/VMT. Validation procedures and criteria were similar to those used for urban models. The model validated reasonably well.

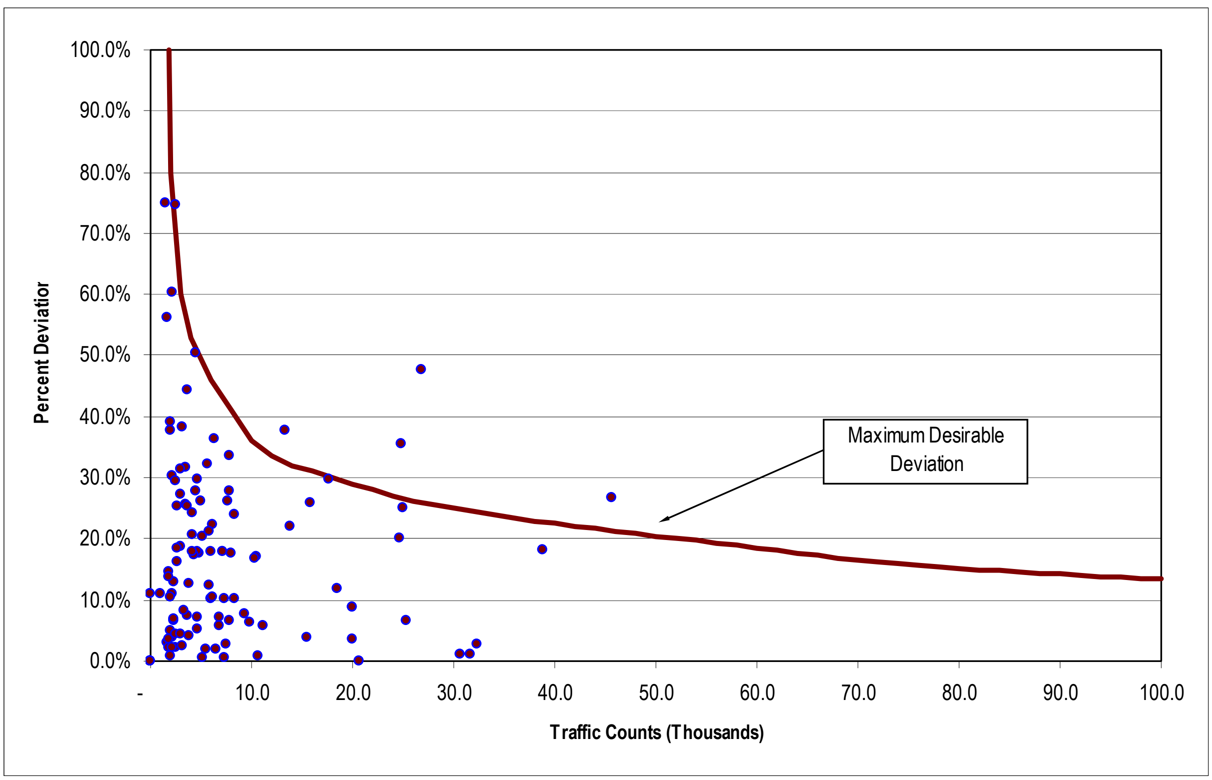

FIGURE B1 Percentage of deviation for auto calibration links.

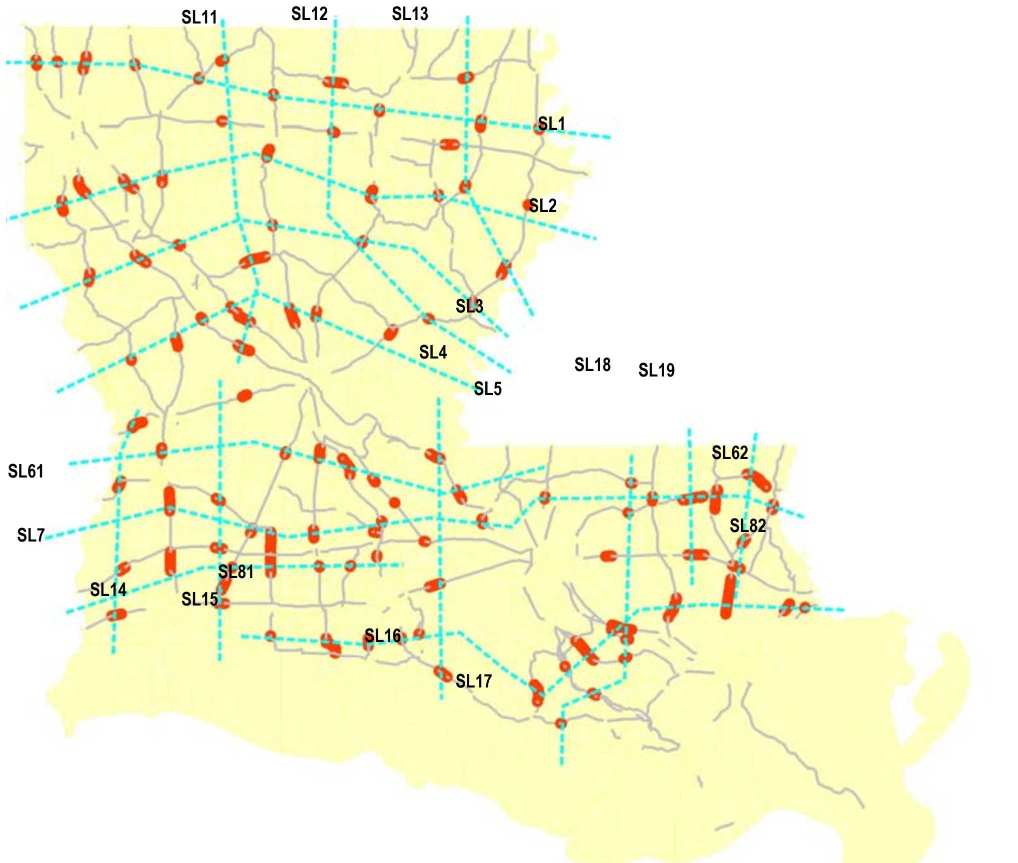

FIGURE B2 Screen line locations and calibration links.

III–8. How are validation criteria for statewide models different from urban models?

The criteria are very similar to those used for urban models. However, the model was designed to forecast traffic on rural and generally lower volume arterial roadways. Consequently the standards used reflect the higher (but acceptable) level of error associated with lower volume roadways.

IV. Scale/Level of Detail

1. A macro model that focuses on longer distance Interstate travel; covers the entire United States; includes NHS routes within and near Louisiana and Interstate routes within the remainder of the United States
2. A micro model that focuses on short-distance Intrastate travel; covers only Louisiana; and includes all arterials and collectors outside the modeled urban areas

TABLE B1 Auto Screen Line Validation Results

Direction	Screen Line	Number of Links	Counted Volume	Modeled Volume	Percent Difference
East–West Screen Lines (Evaluating N-S Travel Orientation)	1	9	62,218	65,181	5%
	2	8	35,048	33,538	–4%
	3	6	28,479	25,885	–9%
	4	6	15,097	15,109	0%
	Sub-Total	29	140,842	139,713	–1%
	5	6	32,817	31,786	–3%
	6	8	41,192	41,251	0%
	62	5	39,537	38,512	–3%
	7	6	24,657	23,689	–4%
	8	5	53,686	51,143	–5%
	82	6	51,019	55,376	9%
	Sub-Total	36	242,908	241,757	0%
North–South Screen Lines (Evaluating E–W Travel Orientation)	11	5	27,374	25,108	–8%
	12	3	29,880	28,266	–5%
	13	4	23,856	23,314	–2%
	Sub-Total	12	81,110	76,688	–5%
	14	4	44,463	42,646	–4%
	15	5	38,276	33,457	–13%
	16	4	47,706	43,206	–9%
	Sub-Total	13	130,445	119,309	–9%
	17	8	98,985	87,932	–11%
	18	2	27,816	26,050	–6%
	19	3	38,978	39,474	1%
	Subtotal	13	165,779	153,456	–7%
TOTAL		**103**	**761,084**	**730,923**	**–4%**

IV–1. What modes are modeled and which are network based?

Highways, cars, and heavy trucks.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

The Louisiana statewide model includes two networks: a macro network covering the entire United States and a more detailed micro network covering only Louisiana. The 539 macro network TAZs are county level within Louisiana and the contiguous BEA zones; TAZs for the remainder of the United States are BEA zones. The micro model uses 1,300 TAZs. Outside of the modeled urban areas, the micro network TAZs are census places and census block groups; inside the modeled urban areas aggregations of urban model TAZs are used.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor etc.) and why?

Purposes: short distance HBW, HBO, and NHB; long-distance tourist, business, and other; and heavy trucks. Each purpose contributes a significant amount of VMT on the rural statewide system. Data were available to support model development and application using this travel market segmentation scheme.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model and how are they modeled?

Yes.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

The statewide model network is not as detailed as the MPO models. The statewide model zones are aggregations of the MPO model zones.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

Yes, it was designed to do so.

V–3. Are the urban models incorporated as part of the statewide model and if so how?

No, they are not.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

No, it does not. The zone system and roadway density are not sufficient to generate reliable facility-level forecasts within the modeled MPO areas.

VI. Freight/Commercial Vehicle Modeling

VI-1. Does the model consider trucks only or other modes? Why?

The model forecasts TAZ-level heavy truck traffic. County-level 2000 and 2030 TRANSEARCH commodity flows by four-digit STCC and mode (truck, rail, air, and water) are also available, but not modeled.

VI–2. Why were certain modes excluded, if any?

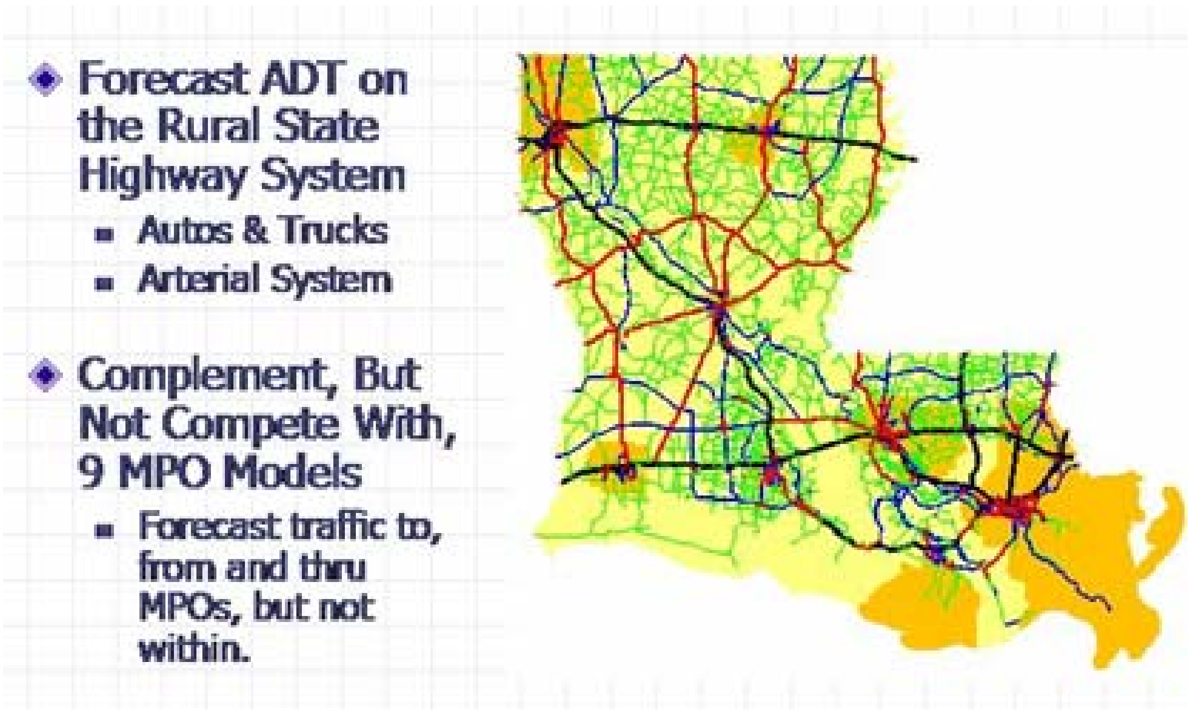

FIGURE B3 Model objectives.

To minimize budget and schedule requirements, the model was designed to focus on highways, cars, and trucks.

VI-3. Is the model based on commodity flows? If so, what techniques are used and how is commodity flow translated to individual vehicles?

The base and forecast year truck forecasts are based in part on TRANSEARCH commodity flow data. Commodity flow truck tonnages were converted to truck loads by Reebie using load factors they developed.

VI–4. Does the model use matrix estimation techniques and if so what data were used for estimating the matrix?

Matrix estimation was used with a gravity model-based seed distribution to estimate those heavy truck trips not accounted for by the base year TRANSEARCH truck trip table.

VI–5. Are traditional truck trip generation methods or quick response methods used?

Year 2000 TRANSEARCH commodity and truck flows were developed by Reebie. Year 2030 commodity and truck flows were developed by DRI/WEFA. Fratar was used to forecast non-TRANSEARCH truck movements.

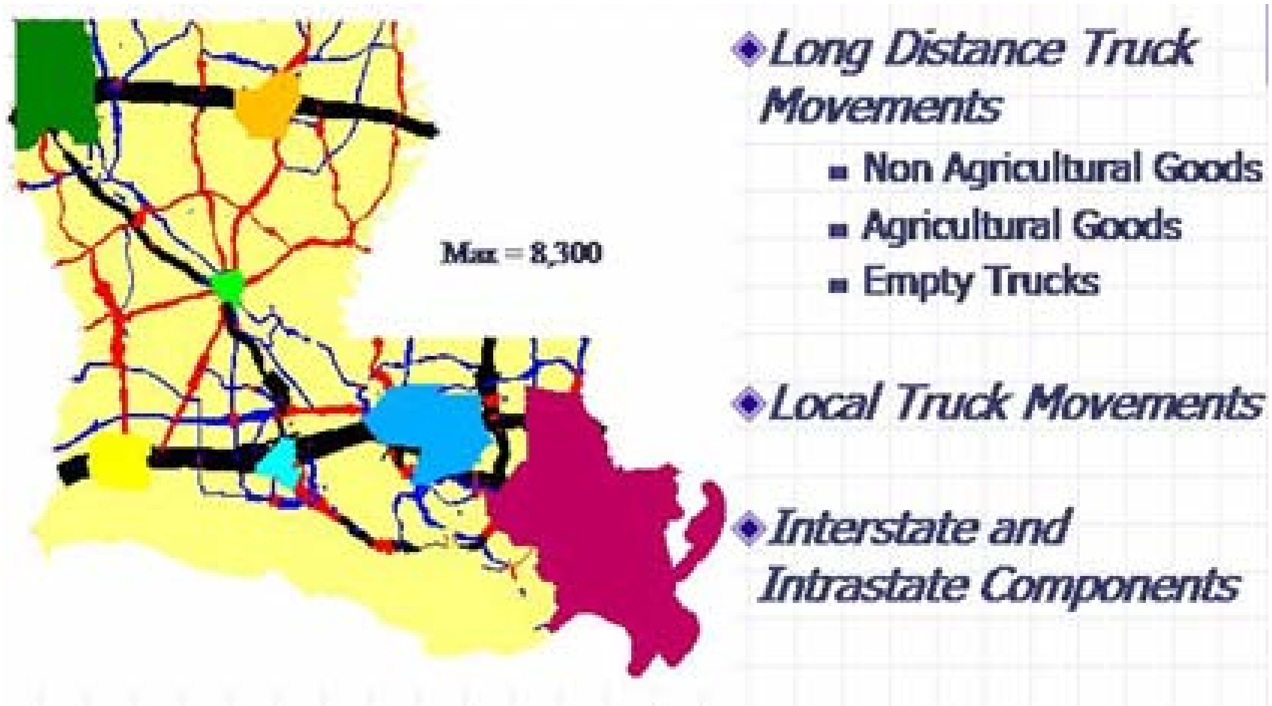

FIGURE B4 Daily truck traffic, year 2000 average.

VI–6. Is Reebie's data or CFS used? If so, how are the sectors not covered by these sources modeled or accounted for?

See above.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are models of long-distance or recreation/tourism integrated with the normal passenger TDMs?

They are treated as separate purposes: short distance HBW, HBO and NHB; and long-distance tourist, business and other.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs? If so, what?

Several: matrix estimation was used to account for base-year heavy truck travel not included in the Reebie data. Fratar procedures (rather than trip generation and distribution) are used to forecast long-distance travel and HBW travel.

VII–3. What special data sources were required for these models?

- NHPN for roadway geography and characteristics outside Louisiana
- National HPMS for roadway characteristics outside Louisiana

- LDOTD data files for roadway characteristics inside Louisiana
- ATS data for long-distance travel (Interstate and intrastate)
- 1990 nationwide tract-level census journey-to-work data
- TRANSEARCH TAZ-level commodity flow data (including flows to, from, within, through, and near Louisiana) by four-digit STCC and mode (truck, rail, water, and air)
- NPTS for household trip rates
- 2000 census demographic data
- Woods and Poole nationwide CEDDS data (historic and forecast county-level socioeconomic data)
- Dun and Bradstreet census block-level 2000 employment data for Louisiana
- Claritas census block group-level density classifications for Louisiana

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

Not at this point in time.

MASSACHUSETTS

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

MassHighway's Road Inventory Database, Census 2000, ES-202 (employment), Massachusetts Institute for Social and Economic Research, NPTS, and traffic count data from Massachusetts, Rhode Island, New Hampshire, and Connecticut.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

All were existing sources that were used for model development, but none were collected specifically for the model.

I–3. Did you use national data sources such as NHTS?

Yes, the 1995 NPTS was used, which included an add-on portion for Massachusetts. And of course, U.S. census data was used extensively as well (summary files, CTPP, PUMS).

I–4. How much did the data collection effort cost?

We did not conduct any surveys, so cost was only related to collecting existing data (processing existing data were more accurate). An estimate would be $150,000 to $200,000 of consultant and DOT staff time combined.

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

So far no "ongoing" data has been collected to support/update the model (however traffic count data from permanent count stations, collected ongoing for other uses, will be used by the model). Data such as population and employment will be collected as available for comparisons to forecast years. Current forecasts will be revisited in 2005, and the necessary TAZ updates (to population, households, and employment) will be incorporated into the model sets.

I–6. How often are networks updated and from what sources?

So far there have been no network updates, as we just received the new model sets recently. However, we anticipate annual updates to networks to reflect the status changes of "regionally significant" projects. The amount of network updating will vary greatly from year to year depending on the level of changes to these projects. Update sources will include MPO regional transportation plans and TIPs.

I–7. What data couldn't you get that you wish you could?

Updated trip data from a household survey (which wasn't available due to cost). Also, more detailed and reliable employment data at the zonal level (we had some issues with obtaining usable ES-202 data).

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

So far there has been no maintenance, as we just received the new model sets recently. However, after some period of orientation with the consultant, it is expected that all maintenance will be done in house.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff).

Currently only one person is dedicated to using the model, and at only about at 25% of his time. This will definitely increase over the next year with additional modeling requirements, maintenance, and applications. Future estimates would be 1 to 1½ FTEs.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

Not yet, although temporarily, in 2003, two additional staff members were assigned part-time to model development activities. This situation will be repeated late in 2004 and beyond for other model development and maintenance.

II–4. How much time is spent maintaining the model versus applying it?

Consultants have just completed developing the model, so there has been no real maintenance yet. Therefore 100% application so far. Future estimates would be approximately 75% application, 25% maintenance.

II–5. Do you have a regular update cycle? If so, what gets updated on what intervals?

So far there is no regular update cycle, as we continue to evaluate the relatively new original model. By Spring 2005, a new milestone year (2010) will be needed for AQ conformity, and socioeconomic TAZ data will need to be updated. Also, some network link updates will occur as needed as new "regionally significant" projects come online.

II–6. What are the primary MOEs used from the model?

So far we have only looked at VMT and congested speeds as part of our AQ conformity work. As we get more familiar with the new model, we plan to examine V/C ratios, peak-period congested speeds (right now we've only used 24-h average speeds), VHT, system and corridor delay, and other measures as needed.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

No. We may explore these uses in the future. Coordinated system planning, especially among different modes, has been sporadic, as several different agencies have transportation planning responsibilities. However, emphasis on system planning will increase as part of the new transportation priorities of the governor's administration.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

No. We may explore these uses in the future. Currently, regional planning activities are handled through specific studies (in house or consultant), and by working directly with the MPOs.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

Not yet, but soon. One of our upcoming studies will deal with an Interstate corridor, and results from the statewide model will be used for both general measures of travel and congestion (VMT, LOS, etc.) and background volumes for interchange operational analyses. In the past, corridor planning has been handled through specific studies (in house or consultant).

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

No, not yet at least. Projects are prioritized with a new set of evaluation criteria incorporating many factors (safety, mobility, condition, community effects, economic development, etc.). At some point, results from the statewide model may be used to help quantify some of these factors.

II–11. Is your model used for project-level traffic forecasts? If so, give examples. If not, indicate how this is handled.

Yes. The statewide model is one of the tools used. Base and future volumes from the model are examined in the context of actual traffic volumes at a project location. MPO models, where available, are examined as well, along with standard growth factors. Depending on available traffic counts and the accuracy of the model(s), a final project level forecast estimate is based on any one (or a combination) of these methods.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

No. MassHighway uses Corsim, SyncRO, Highway Capacity Software (HCS), etc., for operational level studies. The statewide model may be used for background volumes and growth factors for these types of studies in the future.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

No. The statewide model is not used for economic development studies at this point. Again, background volumes, growth factors, VMT, and/or other output from the model may be used for these types of studies in the future.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

No, not at this time. However, we will explore these uses in the future, especially with the increased interest and emphasis on intermodal transportation strategies in Massachusetts. Specific studies separate from the model have addressed freight and intermodal issues in the past.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

No. Again, we will likely explore these uses in the future. Currently, rail, air, and port planning are handled by different agencies in Massachusetts.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not indicate how this is handled.

Yes, AQ conformity analysis has been the first and principal use of the statewide model so far. The model is run for the base (2000) and milestone (2007, 2015, 2025) years. MassHighway coordinates with each MPO to ensure that all regionally significant projects are represented in the statewide model for the appropriate milestone year (based on when the projects will be completed). VMT and congested speed are identified for each link after traffic assignment. All functionally classified roads are included, while centroid connectors are used as a rough estimated for local roads. A post-processing routine is performed in TransCAD, where lookup tables of emission factors by speed are cross-classified against the VMT for each link. This produces daily estimates of volatile organic compounds (VOCs), NO_x, and CO, which are then factored relative to base year HPMS statistics per Environmental Protection Agency conformity regulations:

2000 HPMS VMT = adjustment factor
2000 Modeled VMT for VOC, NOx, and CO

A seasonal adjustment factor is also applied to model output (to estimate "worst condition" summer emissions). Based on numerous geographic identifiers for links, the model output can be expressed in a variety of ways (by MPO, county, town, state, non-attainment area, etc.). This allows any MPO area, for example, to be "windowed out" if necessary. Transit emissions are calculated "off-model" and added in separately. Factored results are then compared to emission budgets for Massachusetts' two non-attainment areas to determine AQ conformity.

This process is a significant improvement over previous methods, which relied solely on the MPO regional TDMs (with uncoordinated results) to produce the emission estimates. The new process has greater accuracy and flexibility, and is more streamlined cost-effective as well.

The statewide model has also been used to develop a mobile source emission budget for the state improvement plan (SIP), and will be used for this purpose again in 2005.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

No, there have not been any uses of the statewide model for safety analysis (so far). Safety is usually handled through data collection and specific studies or analyses.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

No, and have not had the need for any. Some toll sensitivity analyses may be done by another agency (Massachusetts Turnpike Authority) with separate models.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

No. MassHighway uses Corsim, SyncRO, HCS, etc., for traffic impact/operational studies. The statewide model will be used for background volumes and growth factors in several upcoming studies, although not directly related to traffic impacts of specific developments.

III. Implementation

III–1. Who developed the model?

Consultants. MassHighway had a contract with Cambridge Systematics (no subs).

III–2. How long did/will it take to develop?

About 5 years. Final documentation is currently being completed.

III–3. How much did/will it cost and how was funding obtained?

Consultant services = $635,000. Staff time approximately $165,000. Total = $800,000.

III–4. Were there institutional hurdles to cross? If so, what?

Some. There were significant delays (on our side) in drawing up a contract with the consultant for various reasons. The biggest hurdle was in getting acceptable locational employment data from the Massachusetts DET (confidentiality issues). There were miscellaneous issues with information technology (IT) related to file naming structures and obtaining the necessary computer hardware to fully run the model. Most of these IT issues have been worked out.

III–5. Where did the impetus for model development begin?

Within MassHighway's Planning division. In the mid-1990s, two contracts were originally slated to begin and run simultaneously: (a) regional technical assistance for TDMs (for the MPO models), and (b) development of a statewide model.

III–6. What were the main problems that the modeling effort was designed to address and how were these identified?

There was a primary need to be more responsive to AQ requirements. Modeling statewide needed to be more coordinated, with more consistency among model inputs and assumptions, source data, trip generation rates, etc. These problems were known from working with the MPOs and through model users group meetings, but were later more formally identified through a detailed inventory/survey of all the MPO models.

III–7. Was the model validated? Against what data and validation criteria? How well did it validate?

MassHighway and the consultant team developed model validation standards that were used to test alternative model specifications and to determine the adequacy of the model system. The standards included

1. Specific targets for the percentage difference between base year model results and observed data.
2. Comparisons between base and forecast year model results.
3. Miscellaneous checks for reasonableness. The following are some of the specific validation/calibration actions. For trip generation, total person trips/household and person trips by purpose were compared to other data sources such as NCHRP 365 and FHWA's *Model Validation and Reasonableness Checking Manual*. For trip distribution, modeled average trip lengths by purpose were compared to observed data from the NPTS, and were within 5% of

observed based on the FHWA manual. For highway assignment, VMT fell within the standard ranges of 30 to 60 VMT/household and 10 to 24 VMT per capita, as outlined in the FHWA manual. Base-year model volumes on screen lines were within 10% of traffic counts. Base-year modeled volume RMSE was within 40% to 50% of the counts. Modeled VMT by functional class was also examined, and fell within the FHWA standards (7% of observed for freeways, 15% for arterials, and 25% for collectors).

III–8. How are validation criteria for statewide models different from urban models?

No real difference so far. For now we expect the MPO staff to use the same types of validation criteria, with the same ranges of acceptability, as we do for the statewide model. The MPOs may use some different or additional validation/calibration measures, but this is not as much of a concern anymore since we now have the capability to model any area of the state (in a consistent fashion through a single model).

IV. Scale/Level of Detail

IV–1. What modes are modeled and which are network based?

Only highway modes (car and truck) are modeled based on the network. For transit, detailed trip tables are imported from the Boston region model. The statewide model network currently contains empty, "dummy" transit links (subway and commuter rail lines) for possible future network-based modeling.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

Land use (population, households, employment) is expressed at the TAZ level for trip generation. TAZs are aggregated from the 2000 census block group geography. There are 3,500 internal TAZs in the statewide model (3,069 in Massachusetts, 272 in Rhode Island, and 159 in New Hampshire).

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor, etc.) and why?

Standard passenger and freight (by truck), plus long-distance passenger by three purposes: work, personal business, and vacation. Taxi and transit park-and-ride trip tables from the Boston region MPO model were also included. Consultant had recommended these sectors based on data availability, existing surveys, and previous work done for other models.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model and how are they modeled?

No. However, airport trips for Logan (Boston) are included in the regional model trip tables that are imported in the statewide model, so these types of trips are included in terms of special generator treatment.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

The statewide model contains aggregated TAZs from some of the MPO models; MPO model networks are generally more detailed with local road links, while the statewide model contains only functionally classified roads (no local street links). TAZs and base-year data for the New Hampshire portion of the model were taken directly from the statewide model. Rhode Island TAZs and data were developed in a similar manner to those in Massachusetts.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

No, but it will be. No timetable set yet for this.

V–3. Are the urban models incorporated as part of the statewide model and if so how?

Just with our largest MPO model (Boston), and only partially. Certain Boston MPO model trip tables are used directly as part of the statewide model (for transit), while some special generator information is used as well.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

Yes, it does provide independent estimates. No major institutional issues so far. Depending on the application, MassHighway will defer to the MPO models in their areas. No significant levels of comparisons have been done yet between results of “dueling” forecasts.

VI. Freight/Commercial Vehicle Modeling

VI–1. Does the model consider trucks only or other modes and why?

Only trucks are considered based on original data availability and level of interest.

VI–2. Why were certain modes excluded if any?

Other freight modes (rail, water, pipeline, etc.) were not used because data for them was unavailable or too costly to obtain, or the flows were not significant enough to consider. Also, there was little use for them from a policy perspective.

VI–3. Is the model based on commodity flows? If so, what techniques are used? How is commodity flow translated to individual vehicles?

No, not based on commodity flows.

VI–4. Does the model use matrix estimation techniques and if so what data were used for estimating the matrix?

No. No surveys were done, so no matrices were estimated.

VI-5. Are traditional truck trip generation methods or quick response methods used?

As stated above, traditional methods are used, with quick response rates for generation and transit-oriented development factoring.

VI–6. Is Reebie's data or CFS used? If so, how are the sectors not covered by these sources modeled or accounted for?

Neither of these sources was used due to cost or time constraints.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are models of long-distance or recreation/tourism integrated with the normal passenger TDMs?

Long-distance trips are treated as three distinct household trip purposes: long work trips, long personal business trips, and long vacation trips. Each uses household data and certain types of employment by zone as a variable in trip generation.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs? If so, what?

No, cross classification and standard regression techniques were used.

VII–3. What special data sources were required for these models?

The long-distance trip attraction models consisted of regression equations that were estimated using expanded (weighted) trip data from the NPTS and base-year zone level estimates of employment by sector.

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

No. The statewide model simulates typical spring/fall average weekday conditions. One MPO region with heavy recreational and tourist uses has a summer model (and another MPO has similar plans), but the statewide model simulates the same time of year for the entire state and all its regions.

MISSOURI

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

The ArcInfo network of roadways and the traffic volume information from our transportation management systems (TMS) is the primary source of data for the statewide model. The 2000 census data were also vital. Other sources include a small sample household survey, MPO data from their models, employment data, and HPMS data from MoDOT.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

The household survey information was collected specifically for the model development.

I–3. Did you use national data sources such as NHTS?

In the absence of household survey information, the CTPP, the PUMS, the NPTS, the *NCHRP Report 187: Quick Response System (QRS)*, *ITE Trip Generation Manual,* and the *Quick Response Freight Manual* were all resources used.

I–4. How much did the data collection effort cost?

Approximately $20,000 was spent on data collection (labor and materials).

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

The network of roadways and traffic count information is continually updated/modified and is used to update the model. The employment and population information is also provided for model modification.

I–6. How often are networks updated and from what sources?

The networks are being updated about every 2 years based on past experience.

I–7. What data couldn't you get that you wish you could?

A better, more complete roadway network with good traffic count data would be great to have. In addition, better truck movements would aid in projections. Good O-D information is also data that would aid in model output.

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

The model is 100% maintained by consultant to date.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff).

No personnel in house are dedicated to maintaining and using the model. I do have two FTEs that will be using the model for traffic projections in the near future, but this will represent a small percentage of their work effort.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

No staff has been added or reassigned from other duties as a result of the statewide model. In the past, MoDOT has had an employee trained to use the model, but this individual has changed jobs and is not available for this activity.

II–4. How much time is spent maintaining the model versus applying it?

We currently use a consultant for both maintaining and using/applying the model. Again, I intend to use two internal staff members to do both maintenance and use in the very near future (percentage of effort has not been decided).

II–5. Do you have a regular update cycle and if so what gets updated on what intervals?

Again, updating the model has occurred about every 2 years with traffic count information, but this is not necessarily a regular cycle.

II–6. What are the primary MOEs used from the model?

Information gained from the I-70 corridor study had been very beneficial. On a limited scale, we have used the traffic projections for other bypass projects.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

The model has been used for system planning in limited capacity to date. It was used for I-70, but for smaller scale projects the traffic projections have been used to supplement other efforts. We have had some confidence issues with the output at times.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

We have used the model for a few bypass studies and these are generally around 10 mi in length, but this is to supplement other work.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

As stated prior, we have used the model in Phase 1 for the I-70 corridor study. This involved many scenarios, because we have two other east–west routes both north and south of I-70. We intend to use the updated model for an I-44 corridor study within a year or two.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

The model has not been used for project prioritization to date. Projects are prioritized based on efforts resulting from the "Planning Framework" at MoDOT. This involves many steps from all 10 districts and their planning partners [regional planning commissions (RPCs) and MPOs within their region].

II–11. Is your model used for project-level traffic forecasts? If so, give examples. If not, indicate how this is handled.

The model has been used for the I-70 corridor and a handful of other projects, but generally projects are evaluated using a hands-on approach. This involves much data gathering to determine turning movements and growth for a specific route. The results from this effort are used by many internal employees for design purposes (pavement thickness and number of lanes are determined by these traffic projections).

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

Operational level studies have been conducted using other software (FREESIM and SyncRO have been widely used to date).

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

The model has not been used for economic development studies to date. This function has generally been done by the Department of Economic Development, but with the model update we may be able to provide input into this.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

The model has not been used for freight/intermodal planning to date as this has been done through independent studies.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

The model has not been used for rail/air/port planning to date as this has been done through independent studies.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not indicate how this is handled.

The model has not been used for AQ conformity issues. This has been done by the larger MPOs through use of their individual models.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

The model has not been used for safety analysis. Depending on the safety study, this is done using our safety management system which allows an individual to quickly get safety data that is site specific.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

The model was used, but modified a great deal to allow evaluation of the impact of toll use on I-70.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

The model is not used to date for traffic impact studies. We use the HCS, SyncRO, and other tools to do traffic impact studies currently.

III. Implementation

III–1. Who developed the model?

The model was developed by the Louis Berger Group, Inc.

III–2. How long did/will it take to develop?

The model was developed in approximate 2 years (Phase 1 and 2). It is updated about every 2 years. We are currently in the late stages of a model update/modification.

III–3. How much did/will it cost? How was funding obtained?

The model cost about $500,000 in Phase 1 and 2. Almost another $500,000 has been spent since the initial development due to updates and modifications.

III–4. Were there institutional hurdles to cross? If so, what?

There did not seem to be many institutional hurdles. External to MoDOT involved cooperation from other agencies for the data collection stages, but this was not an issue.

III–5. Where did the impetus for model development begin?

The model with initiated from transportation planning within MoDOT. This was done in order to complete Phase 1 (I-70 corridor study) and Phase 2 (complete the statewide model to minimize the number of models being developed on a project-by-project basis).

III–6. What were the main problems that the modeling effort was designed to address and how were these identified?

The model was developed in order to do a study on I-70. The other issue was having one model for statewide traffic projections and this issue was successfully addressed.

III–7. Was the model validated? Against what data and validation criteria? How well did it validate?

The model was validated through two stages. The first stage involved comparison of model output to traffic counts, VMT data compared to HPMS data, trip-length distributions compared to known trip-length data for work trips from CTPP data, and screen line, cutline, and cordon counts. The second stage involved using the trip table from the first stage as a seed and was iteratively adjusted using actual counts until the resulting trip table replicated the actual counts (based on a maximum entropy algorithm).

III–8. How are validation criteria for statewide models different from urban models?

The statewide model has a "larger picture" network to work with (more of an arterial system in place), while the urban model may be have a very comprehensive network of roads in place for their urban area. The urban model may link to the statewide model for counts entering their network from the arterial roadways (this has not always seemed to be correct). The statewide model consists of very few local roadways (functional class) and may not have all collectors, while the urban model will most likely consist of all functional class roadways within their urban boundaries.

IV. Scale/Level of Detail

IV–1. What modes are modeled? Which are network based?

The highway (car/truck) are the only mode in place.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

The TAZs represent geographical areas in the model from which and to which trips are allocated. Each dwelling unit in the study area produces and attracts trips. Because of limitations, dwellings (or households) are aggregated into TAZs. Census geography used in the modeling process are blocks, block groups, tracts, and counties. There are 115 counties in Missouri, including St.

Louis City. Trips are assumed to be produced and attracted in each TAZ by a point within called a centroid. The centroid is connected to the network to allow the trips to be distributed to other TAZ centroids.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor, etc.) and why?

The information relating to the traveling public will relate to the passenger travel with some commercial travel. I do not believe we are set up to deal with freight movement at this time. Because of the Lake of the Ozarks, recreation is considered.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model? How are they modeled?

The model may have special generators such as the lake area, but I do not believe this is considered for the most part.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

The base-year network was built from MoDOT's ArcInfo database and also from existing MPO models when appropriate.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

No.

V–3. Are the urban models incorporated as part of the statewide model and if so how?

No.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

We have used MPO model forecasts where possible for an MPO urban area, but errors have been identified by the traffic projections group when dealing with a project in an urban area. We have on occasion questions the projections from the urban model output.

NEW JERSEY

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

Since this model is an aggregation of various other New Jersey Regional Models, the main data were the individual models themselves. The original truck trip table was created using DRI-McGraw Hill commodity flow data. The commodity data was then converted to county-level truck trips by using the 1987 Truck Inventory and Use Study. Due to certain deficiencies described above this process was later revised to use more traditional trip generation techniques.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

Truck classification data was collect in order to validate the model. Travel surveys taken on NJ31/US202 were also used to validate the model. This data was used to supplement data from existing surveys and counts.

I–3. Did you use national data sources such as NHTS?

No national data was used.

I–4. How much did the data collection effort cost?

Since most of the data came from existing transportation models and counts the statewide model specific data collection cost was minimal.

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

Classified counts are collected in order the model for specific studies. There is no schedule for periodic data collection. Updates have been done on an as-needed basis.

I–6. How often are networks updated and from what sources?

As stated above, the networks are updated periodically to provide detail for specific projects.

I–7. What data couldn't you get that you wish you could?

We have had and continue to have difficulty acquiring carrier-specific freight data.

II. Maintenance of the Model

II–1. Are consultants used to help maintain the model or is it done in house?

Consultants maintain this model mainly through task order agreement on an as needed basis.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff)?

Since this model is used on a project-specific basis, approximately one in-house staff position is dedicated to the maintenance and application of this model. (This time is broken down over several staff members).

II–3. Was any staff added or reassigned from other duties because of the statewide model?

No, but the consultant will add staff as needed to maintain/use this model as needed.

II–4. How much time is spent maintaining the model versus applying it?

The majority of the time is devoted to applying the model for specific projects.

II–5. Do you have a regular update cycle and if so what gets updated on what intervals.

There is no regular update cycle.

II–6. What are the primary MOEs used from the model?

This model produces VMT and 24-h volumes which are then compared to count data and other model assignments.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

Yes. The model has been used for system planning to analyze the impact of completing New Jersey's Interstate highway system.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

Yes. It has been used for larger level regional/corridor analyses on studies for Central Jersey and the Portway.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

Yes. As stated above, the model has been used for larger level regional/corridor analyses on studies for Central Jersey and the Portway.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

It is not used for project prioritization. The department uses a capital investment strategy which is supported by a CMS for project prioritization.

II–11. Is your model used for project-level traffic forecasts? If so, give examples. If not, indicate how this is handled.

No. MPO models are primarily used for project-level traffic forecasts unless the project is located by a model boundary.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

It is not usually used for operational level studies. The MPO models are used for this type of analysis unless the study area in close to the model border. This is when the statewide model is used.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

No, but it has been used to study the impact of certain toll/pricing strategies.

II–14. Is your model used for freight planning? If so, give examples. If not, indicate how this is handled.

Yes, the primary function of this model is freight planning. This model was used in various studies to determine the truck volumes on the network.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled?

No, but this model has been used to study the transportation infrastructure of the Portway area.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not, indicate how this is handled.

AQ planning is handled through the regional models and an AQ post-processor (PPSuite/Mobile 6).

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

No, the safety projects are analyzed thru the department's Safety Management System.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

This model has been use to gauge the impact of various pricing strategies.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

No, this is beyond the capability of a statewide model. These studies are usually addressed using an MPO model or even an Access Permitting Process.

III. Implementation

III–1. Who developed the model?

The NJDOT supported by a consultant team which consisted of URS Corporation, Gellman Research Associates, and Cambridge Systematics.

III–2. How long did it take to develop?

Including updates and new initiatives, approximately 3 years.

III–3. How much did it cost?

The total cost of this model was approximately $500,000.

III–4. Institutional hurdles?

This effort was supported within the DOT and government in general. The major hurdles were encountered from the trucking community. It was difficult to obtain any type of routing or any business specific data.

III–5. Where did the impetus for model development begin?

This model was developed in response of the NJDOT's need for a regional forecasting tool to analyze the statewide truck and auto impacts in New Jersey.

III–6. What were the main problems the modeling effort was designed to address?

As mentioned above, the model was conceived to address the movement of trucks on a regional level.

III–7. Was the model validated? Against what data and criteria? How well did it validate?

The trip generation was validated against data from previous studies. Data from Phoenix and Chicago were used since New Jersey possesses many of the characteristics of these two cities. The highway assignment was validated against existing highway and bridge data.

III–8. How are validation criteria for statewide models different from urban models?

Traditional auto-only models can be validated using various types of data. Journey to work data, travel surveys, and traffic counts are the most popular ways to validate an auto assignment. Validating truck assignments are more difficult since trucks do not behave the way autos do.

IV. Scale/Level of Detail

IV-1. What modes are modeled and which are network based?

Autos and trucks are modeled on the highway network.

IV-2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

Census tracts are the base for the model.

IV-3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor) and why?

The model was primarily built to model truck movement across the state. Auto trips are also modeled. Modeling autos has been useful since our more detailed MPO models do not encompass the entire state and will not be useful when certain projects are close to the model's border.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model? How are they modeled?

Intermodal facilities (rail yards, ports, and airports) are considered special generators which are designated as external zones. Truck terminals, warehouses, and pipelines are also considered special generators.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks.

Yes. Since the model is an aggregation of five different regional models, the zonal system and the network are the same with some minor differences.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

No. The statewide model is stand-alone and does not offer feedback to the original models.

V–3. Are the urban models incorporated as part of the statewide model and if so how?

Yes. See above.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

We normally use the MPO model to estimate auto trips, except in areas where the study area is close to that model's border. In those cases, the statewide model will be used. The statewide model is used to estimate truck traffic throughout the state. This model is used primarily for statewide planning purposes. When the statewide model and the MPO models have been run for the same study area, the results have been similar for autos.

VI. Freight/Commercial Vehicle Modeling

VI–1. Does the model consider trucks only or other modes and why?

The model considers trucks and autos since both modes influence each other.

VI–3. Is the model based on commodity flows? If so, what techniques are used? How is commodity flow translated to individual vehicles?

The original model was based on commodity flows. We noticed the key drawback with the commodity flow method was that the data only represented primary commodity flow and that distribution related truck traffic was excluded. The trip generation process was later revised to estimate truck trips as a function of employment by type with the addition of special generators.

VI-4. Does the model use matrix estimation techniques? If so, what data are used for estimating the matrix?

No, matrix estimation was not used to develop the trip table.

VI-5. Are traditional truck trip generation methods or quick response methods used?

The statewide model uses traditional truck trip generation methods. See above

VI–6. Is Reebie's data or CFS used? If so, how are the sectors not covered by these sources modeled or accounted for?

CFS data was referred to when commodities were converted to truckloads.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are modes of long distance or recreation/tourism integrated with the normal passenger TDMs?

The MPO models contain recreational modes.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs and if so what?

Time of day, toll pricing, and recreational trip purposes would need to be modeled.

VII–3. What special data sources were required for these models?

Recreational surveys, number of rooms for hotels/motels, household occupancy for rental houses, locations of attractions.

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

The statewide model produces 24-h volumes.

NEW HAMPSHIRE

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

NHDOT GPS-based highway inventory, U.S. census Tiger files, field data collection of highway data, other data provided by NHDOT, transit schedules and fare structures from transit agencies, socioeconomic data from U.S. census, New Hampshire Department of Employment Security, U.S. census PUMS for New Hampshire, Dun & Bradstreet employment database for New Hampshire, New Hampshire Office of State Planning population and housing forecasts, and employment forecasts, household surveys, transit onboard survey, vehicle intercept survey, and stated-preference survey.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

Household activity and travel, transit onboard, vehicle intercept, and stated-preference.

I–3. Did you use national data sources such as NHTS?

Not sure.

I–4. How much did the data collection effort cost?

Approximately, $500,000 of the $2 million model development contract is related to data collection. Roadside O-D surveys, transit rider surveys, and other field data collection effort such as additional traffic counts cost approximately $174, 000. The household activities and travel survey cost $285,000.

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

The intent was to update the socioeconomic data every 5 years using projections from New Hampshire Department of Employment Security and New Hampshire Office of State Planning to support the model. However, the model was implemented only in 1998 and we expect now to use the 2000 census data to update the model.

I–6. How often are networks updated and from what sources?

Future highway network for the model included all planned highway improvements scheduled to be completed by 2020.

I–7. What data couldn't you get that you wish you could?

Freight data was difficult to get and as such the freight component of the model was not developed.

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

Since its implementation on 1998 no maintenance has been done.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff)?

NHDOT does not have any dedicated staff to maintain the model.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

No.

II–4. How much time is spent maintaining the model versus applying it?

See answer to II–1.

II–5. Do you have a regular update cycle? If so, what gets updated on what intervals?

We had planned on a 5-year update cycle. However, no updates have been done since 1998.

II–6. What are the primary MOEs used from the model?

None.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

Yes. See discussion above.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

So far the statewide model has been used to estimate traffic growth in different regions to support design. MPO models are used to evaluate impacts in the metropolitan areas. Also, some rural planning commission are in the process of developing a model for the region.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

Yes. See discussion on use of the model for I-93 widening and NH Route 16 Corridor Preservation Plan.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

No. Project prioritization is done as part of the state TIP process.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

Model is used to check growth rates for different regions and these rates are used to develop traffic forecasts for projects.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

No. The department uses SyncRO to do operational analysis.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

No. As part of the planned model update NHDOT is planning to incorporate land use forecasts, which could be used to assess the economic development potential.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

No. NHDOT does not have a freight planning office.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

No.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not, indicate how this is handled.

No. MPO models are used for AQ conformity analysis.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

No.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

The model has the ability to analyze impacts of toll increase, but it has not been done so far.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

No. MPO models are used to study the traffic impacts of large developments in the metropolitan regions.

III. Implementation

III–1. Who developed the model?

Cambridge Systematics, Inc., was the prime consultant.

III–2. How long did/will it take to develop?

The model development took about 4 years.

III–3. How much did/will it cost and how was funding obtained?

The total cost of the model development was about $2 million and was funded using Congestion Mitigation and Air Quality funds. This estimate does not include department staff time.

III–4. Were there institutional hurdles to cross? If so, what?

None that I can think of.

III–5. Where did the impetus for model development begin?

A technical steering committee formed in 1994 to assess the impacts of transportation projects and to coordinate local and regional travel demand planning and management came up with the recommendation for the statewide model.

III–6. What were the main problems that the modeling effort was designed to address? How were these identified?

The model was developed to analyze the impacts of major highway projects (such as new corridors, widening of existing alignments, etc.). Also, NHDOT hoped that the model could be used to identify potential new or improved transportation services (such as bus, rail) and strategies designed to reduce reliance on single occupant vehicles (SOV).

III–7. Was the model validated? Against what data and validation criteria? How well did it validate?

The model was validated using the quick and simple procedures outlined in the FHWA publication "Calibration and Adjustment of System Planning Models." The following measures were used: percent error regionwide, percent error by functional classification, and correlation coefficient.

III–8. How are validation criteria for statewide models different from urban models?

In New Hampshire both statewide and MPO models use the same validation criteria.

IV. Scale/Level of Detail

IV–1. What modes are modeled and which are network based?

Highway, transit, and rail.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

In general, internal zones were defined to be consistent with municipal boundaries, census tracts and/or block groups, and zone boundaries for the models maintained by RPCs or MPOs in New Hampshire.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor, etc.) and why?

The model was developed to estimate person trips by auto, transit, and rail. Recreational trips were not addressed even though tourism is a major part of the economy. The model update will look at tourism trip purposes.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model? How are they modeled?

The only special generator in the mode was the Manchester Airport that was undergoing major expansion during the 1990s. The model update will look at integrating land use as part of the modeling process.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

There are three MPO regional models in New Hampshire and the statewide model zones were created as aggregates of MPO zones.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

Procedures were developed to provide external station traffic estimates for the MPO models.

V–3. Are the urban models incorporated as part of the statewide model? If so, how?

No.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

Yes, it does provide independent estimates. We defer to the MPO model in their areas, however, there have already been instances where the statewide model estimates and MPO model estimates vary considerably.

OHIO

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

ODOT Roadway Information Database, federal multimodal networks, ES-202, county assessor files, Ohio Department of Natural Resources land coverage files, census, household survey, establishment surveys, TRANSEARCH, IMPLAN, roadside surveys, and travel time studies.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

Household surveys, establishment surveys, roadside surveys, travel time studies.

I–3. Did you use national data sources such as NHTS?

Yes, federal network, TRANSEARCH. Did not need NHTS due to large survey program.

I–4. How much did the data collection effort cost?

Close to $6 million of the model development contract is related to data collection/assembly. However, it should be remembered that the household survey samples were greatly inflated for the individual MPO areas, probably about $2 million would have been saved if the sample was designed for statewide only (which probably would have been redirected to the establishment survey). This cost does not include the cost of the 10,000 or so households surveyed by the three large urban areas in Ohio (add about $1 to $2 million for that) or the extensive roadside surveys that were conducted in the late 1990s (about $4 million). These costs also don't include in-house staff time associated with these activities. This probably amounts to somewhere in the $750,000 to $1 million neighborhood (most of this time was spent on the roadside surveys).

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

The intent is to try to update highway networks, employment, and population on an annual basis. Major updates involving the other data sources will be less frequent (maybe every 10 years).

I–6. How often are networks updated and from what sources?

The intent is annual, that's been difficult so far due to the changes in the roadway files that are ongoing. Networks are updated from ODOT's roadway information database in a semi-automated fashion. It is hoped when that evolution is complete that those files will be completely compatible with the needs of network routing software. Major efforts include addition of ramps to the database and directionalizing the inventory.

I–7. What data couldn't you get that you wish you could?

More complete/detailed commercial vehicle data, including non-commodity related travel.

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

The interim model is maintained in house. Some consultant help may be required for the advanced model.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff).

Two people work on the interim statewide model, one about 50%, the other about 20%. The final advanced model will probably cause these numbers to increase.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

One new staff person was added. Two were requested and initially approved but the other never materialized. Of course, this was after our section shrunk from about 13 to 8 people during the reorganizations in the 1990s (the advent of PC-based models and graphical network editors allowed the original staff reduction).

II–4. How much time is spent maintaining the model versus applying it?

With the interim model it's probably close to 50/50.

II–5. Do you have a regular update cycle and if so what gets updated on what intervals?

Trying to update employment and network every year. May also start updating population. Will probably do something similar for the advanced model with less frequent update of other portions (probably every 10 years).

II–6. What are the primary MOEs used from the model?

Twenty-four-hour car and truck volume is fed to our congestion management post processor. This uses various data from our count program to divide the volumes by direction and hour. After going through a peak-spreading model, a series of 21 Bureau of Public Roads-style curves are used to derive congested travel times. From this, VMT, VHT, V/C ratio, exceeding the congestion threshold, VMT exceeding the threshold, LOS (calculated using a series of different criteria based on speed or V/C ratio depending on the roadway type), growth rates and delay by three categories are output for every roadway as well as county, ODOT district and statewide summaries.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

Yes, see the discussion above regarding long-range planning activities.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

Yes, see the discussion above regarding bypass studies.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

Yes, see the discussion above regarding the Turnpike study. It was also used for some other corridor studies such as US-22, US-30, and US-62.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

It's main impact on project prioritization was being used to help designate Macro Corridors in the statewide LRP update since these corridors receive bonus points in the project funding process.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

Yes, see the discussion above regarding design traffic.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

The interim model is not used for this level of analysis. Operational studies outside MPO areas are usually conducted using SyncRO and turning movement counts.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

The interim model has not been used for that directly. It is intended that the advanced model will have some capability in this regard.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

Many of the studies handled by the interim model have been primarily interested in trucks and this model can say something about that but it would be a stretch to call it freight planning, let alone intermodal. It is intended that the advanced model will be able to address these issues. Currently the level of freight/intermodal planning is pretty low. ODOT commissioned a freight study a few years ago that used TRANSEARCH to come up with some broad conclusions about this.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

No, and not currently handled, again, advanced model will address.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not indicate how this is handled.

The interim model will be used to develop VMT estimates in non-MPO non-attainment counties for use in the SIP update and conformity. For this purpose only volumes on collectors and higher will be used. The interim model is too coarse to say anything about the local roads which will be handled using HPMS county trend line projections. For use in the detailed air shed modeling related to the SIP, those local road projections will probably be disaggregated using population densities.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

The interim model isn't used for this directly. Safety studies are handled somewhat independently from the congestion analysis conducted by this section, though information from the two are correlated as part of our safety/congestion program.

II–18. Is your model used for toll studies? If so, give examples. If not indicate how this is handled.

Yes, see the above discussion regarding the turnpike study.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

No, traffic impact studies are generally more of an operational level analysis which uses ITE trip generation, HCS, and SyncRO.

III. Implementation

III–1. Who developed the model?

Consultants, Parsons Brinckerhoff is the prime with subconsultants AECOM, Battelle, Caliper, Decision Data and Solutions, Economic Geographics, Hunt Analytics, Nustats, Ohio State University, and Transportation Resources Management.

III–2. How long did/will it take to develop?

About 8 years.

III–3. How much did/will it cost and how was funding obtained?

Not counting in-house staff or data collection (see section II) about $2.5 million. Staff time will probably end up around $200,000.

III–4. Were there institutional hurdles to cross and, if so, what?

Not internally, the main issues were with obtaining ES-202 for the Ohio Department of Jobs and Family Services. There are some slight issues with obtaining computer hardware through our IT people. We've been lucky to have good support and funding from the top. The Director of ODOT used to be the Deputy Director of Planning and some changes in the way they did the accounting resulted in a large surplus of planning funds that motivated me to go for the "big" model.

III–5. Where did the impetus for model development begin?

Modeling and Forecasting section staff. However, questions were being asked by management that we recognized would best be addressed with such a model (which we made sure to make clear whenever such questions were asked).

III–6. What were the main problems that the modeling effort was designed to address? How were these identified?

We conducted a user needs study involving various areas of ODOT Central Office, the ODOT District, and MPOs. This resulted in a long list of issues. However, two stood out: identifying/measuring congestion and economic growth. We then took that to the director who modified it by adding analysis of truck flows.

III–7. Was the model validated? Against what data and validation criteria? How well did it validate?

The interim model volumes were validated versus ODOT's standard assignment validation criteria contained in our "Traffic Assignment Procedures" manual available on the web. This mainly involved %RMSE by volume group and VMT by functional class. This was mainly just a reporting exercise, however, because the interim model used matrix estimation to refine a seed trip table so it was guaranteed to match counts to some extent. The advanced model will go through the same set of validation as well as disaggregate validation of individual model components.

III–8. How are validation criteria for statewide models different from urban models?

So far not at all, however, once we get into the specifics of validating individual model components there will be differences since we don't have the economic and land-use type models in our MPO models.

IV. Scale/Level of Detail

IV–1. What modes are modeled and which are network based?

Highway, rail, port, air in advanced model, highway only (car truck) in interim.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

TAZs as described above, land use is given as percentages of zone area by type as opposed to maintaining parcel level.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor, etc.) and why?

Interim model is just car and truck. Advanced model will have all the mentioned sectors, though recreation isn't a big focus since this is a typical day (spring/fall) model.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model? How are they modeled?

Interim model does not. Advanced model may, this has not been determined yet.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

The interim model zones were created as aggregates of MPO zones in the MPO areas, however, the MPO zones were a moving target due to the 2000 model updates in MPO areas.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

It will be.

V–3. Are the urban models incorporated as part of the statewide model? If so, how?

No.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

Yes, it does provide independent estimates. We defer to the MPO model in their areas, however, there have already been instances of the statewide model pointing out problems with the MPO model.

VI. Freight/Commercial Vehicle Modeling

VI–1. Does the model consider trucks only or other modes and why?

Other modes are considered though the emphasis is on trucks. A key issue may be trying to reduce truck traffic by encouraging use of other modes.

VI–2. Why were certain modes excluded if any?

There will be no pipeline mode because it is difficult to model/obtain data for and has little relevance from a public policy perspective (if a pipeline exists it's used, they don't send a tank truck).

VI–3. Is the model based on commodity flows? If so, what techniques are used? How is commodity flow translated to individual vehicles?

Yes, see the above discussion, results from ODOT's previous freight study and VIUS information will be used for the conversion.

VI–4. Does the model use matrix estimation techniques? If so, what data were used for estimating the matrix?

The interim model used it to obtain the base year trip table (the forecast trip tables were basically fratared).

VI–5. Are traditional truck trip generation methods or quick response methods used?

The interim model used quick response methods to obtain the portions of the seed trip table not covered by the roadside surveys.

VI–6. Is Reebie's data or CFS used? If so, how are the sectors not covered by these sources modeled or accounted for?

Reebie's TRANSEARCH data were used; see the discussion under the data section regarding the establishment survey for discussion of supplementing this data.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are models of long-distance or recreation/tourism integrated with the normal passenger TDMs?

Long-distance trips basically function as additional household trip purposes. There is a separate visitor trip model.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs? If so, what?

Main differences were in the data collection, otherwise they will be modeled as described above.

VII–3. What special data sources were required for these models?

Used a special, longer period two-stage survey (first was a retrospective screening followed by a prospective detailed survey). Data on non-household visitors was obtained in the household surveys. Originally it was planned to include some hotel surveys but the budget precluded this.

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

For cost reasons, only modeling an average weekday, obviously recreation and tourism travel would be much greater in the summer and we may try some type of add on module in the future.

OREGON

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

For the most part the data used for the model was Oregon specific. Many data collection efforts specifically for modeling were conducted through joint efforts sponsored by the OMSC, ensuring consistent collection methodologies and model applications. Data collection for local and statewide models include the following.

- Several research and data collection projects are trying to assess ways to support freight movement within and through the Oregon economy. These include commodity flow data collection, freight shipper and carrier survey, truck intercept survey, and a truck generation and distribution survey.
- Household Activity and Travel Survey—Conducted in 1994 by ODOT and the five Oregon/southwest Washington MPOs, these surveys resulted in a rich database of activity and travel information for almost 12,000 households.
- Oregon Travel Behavior Survey—Additional data was collected in 2000 for an eight-county area in Oregon to support small-scale regional transportation models being built for areas outside the MPOs.
- Recreation/Tourism Activity Survey—Sponsored by ODOT in 1997 to address information gaps in recreation/tourism travel and to provide a better picture of recreational travel behavior within the state.
- Continuous Oregon Survey for Oregon Models (COSMO)—This effort is just beginning to collect additional time series information on household activities and travel. A pilot survey will occur over the next several months and the first year of the actual survey is projected to start in July or August 2005.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

The data collection efforts were geared towards model building. However, care during each data collection phase was taken to insure compatibility with other efforts. Several different projects have been able to use parts of these data for other applications. For example, the Port of Portland uses commodity flow and truck data for a variety of purposes.

I–3. Did you use national data sources such as NHTS?

No, data used for the models was collected in Oregon.

I–4. How much did the data collection effort cost?

It is difficult to pull out the actual cost of data collection specific to the statewide modeling effort. The data collected has always been for multiple processes and agencies and collection has been funded through interagency agreements. Records for actual costs are therefore not readily accessible. The following estimates are very approximate costs for the total effort for each task:

- COSMO pilot project: $250,000;
- Freight commodity flow data collection: $390,000;
- Freight shipper and carrier survey: $300,000;
- Truck intercept survey: $175,000;
- Oregon Travel Behavior Survey: $125,000;
- Recreation/Tourism Activity Survey: $150,000; and
- Household Activity and Travel Survey: $1,000,000.

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

COSMO is intended to be an ongoing survey/data collection effort that will be a line item for budgets for ODOT and MPOs on an annual basis. A process for special topic surveys will be defined as part of the longitudinal panel survey component of COSMO.

I–6. How often are networks updated and from what sources?

These models have not been in place long enough to require network updates. This issue will need to be addressed by ODOT in the near future. The anticipated updates will occur at the beginning of any new application or once a year.

I–7. What data couldn't you get that you wish you could?

Contents of containers is the largest data set that has been difficult to obtain. The Oregon models need to know the commodity being moved for the economic model to work correctly. No readily accessible records have yet been found to help identify container contents.

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

Maintenance of the model is accomplished by a combination of staff and consultants and consultants are an integral part of the Oregon modeling team. Three consulting firms work under specific and flexible services contracts for specific assistance:

- PB Consult—development and application of the statewide TLUMIP model;
- DKS Associates—preparation of strategic plan, protocol and user manuals, staff support for application of Oregon Small Urban Models; and
- MW Consulting—OMSC staff support, political/outreach strategy for model application, facilitation/mediation assistance.

It should be noted that integrating consultants and in-house staff into an effective modeling team is not a lot different than simply managing in-house staff. Both require clear and regular articulation of the vision, regular reporting structures to ensure effective use of time and resources, regular and consistent communication, training for proper procedures and behavior, and a strong hand tempered with compassion. Hiring a good consultant project manager that integrates well with other team members is just as important as hiring good in-house staff.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff).

The modeling team includes 10 staff. This staff is responsible for the majority of modeling in Oregon, including everything outside the three larger MPOs. All of the statewide modeling is done in coordination with consultant staff. An equivalent of about five consultant staff work almost full-time for this program. The combined consultant and agency staff dedicated to research and development, and applications is about eight FTE.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

When this effort started in 1994, no staff was identified to work on the statewide model. To support the program, two staff were reassigned and two new positions were established. The consultant team also increased staff to support the program.

II–4. How much time is spent maintaining the model versus applying it?

Because of continuing development, minimal maintenance is preformed on the current model. So it's is typically used for applications. The focus is on completing development of the transitional model.

II–5. Do you have a regular update cycle and if so what gets updated on what intervals?

The Gen1 model has been operational for about 18 months. The Gen1 model was a proof of concept model and it was not intended to have a long life cycle. The transitional model may also follow this pattern as the program continues to move incrementally toward an ultimate model structure. This was determined to be the safest way to proceed. When the final model structure is achieved, a regular update cycle will be defined. Oregon urban models typically have a maximum of a 5-year update cycle for models that are in continual use.

II–6. What are the primary MOEs used from the model?

The models are capable of producing a number of measures. Measures used at any particular time depend on the nature of the questions being asked. Examples include VMT by travel market segment, VHT by travel market segment, shipping costs by area, total production by area, employment by area, land prices by market segment and area, and trips by travel market segment.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

The model was used to evaluate the economic, transportation, and land use effects of a proposal to build a new cross-state freeway. It was also used to estimate the effects of bridge deterioration and resulting weight restrictions on Oregon's jobs and economy. The latter project resulted in funding and implementation of a major bridge reconstruction program. More detail on these projects is included in the case studies under other questions.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

The model was used to analyze the potential induced growth and travel effects of a proposed highway bypass. It was also used to evaluate alternative land use and transportation futures as part of a long-range visioning project for the Willamette Valley.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

The Gen1 model was used in a couple corridor planning applications. An example was to evaluate the induced growth effects of a proposed highway bypass. The information generated by the model is being used to defend a challenge of the project.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

Information from the model helped to develop a strategy for prioritizing projects and corridors to minimize economic and job loss impacts through a major bridge reconstruction program.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

Project-level forecasts typically come out of the local (urban and small city) models. The Gen1 model does not have the level of geography required to do projects. The transitional model will have a greater level of detail and could be used in some areas for project work. It is important to avoid a situation of battling models. The intention with the statewide model is not to contradict local modeling efforts but rather to provide supporting and complementary information.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

The model has not been used for operational level studies. This type of analysis at a system level is typically done using simple relationships developed from national studies (e.g., Texas Transportation Institute) or more detailed analysis using microsimulation or *Highway Capacity Manual* methods.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

The model was used to estimate the effects of transportation policies on jobs and the Oregon economy. The most notable examples are the studies of the effects of bridge deterioration on jobs and the economy (both statewide and regional) and the effects of a proposed cross-state freeway on the economy.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

Truck freight concerns were a significant part of the bridge study. The Gen1 model addresses several truck weight classes but it does not address other freight modes. These will be addressed in the transitional model.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

These efforts are conducted by the ports authorities. The Gen 1 model is not set up for this work. The transitional model will help but it will not replace the current efforts.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not, indicate how this is handled.

Currently, local models are used in all the AQ work. The Gen1 model does not include emissions applications nor does it produce data typically used in AQ analyses. The transitional model may have the level of resolution to assist in environmental analyses. Additional work is planned to expand the model capabilities at a later date.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

Not at this time. The ODOT Safety Section performs all safety-related analysis.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

The effects of tolling have not been studied with the Gen1 model. However, the effects of a VMT tax on the economy, land use, and transport were studied in the Willamette Valley Livability Forum study. Both the Gen1 and transitional models could be used to study toll effects.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

The Gen1 model does not have the geographic resolution to perform this type of analysis. The transitional model will work fairly well for this type of analysis in some areas but it will be most helpful in providing input data for local models. Typically local models are used for this type of application.

III. Implementation

III–1. Who developed the model?

Parsons Brinckerhoff/PB Consult, with Hunt Analytics and ECONorthwest were the primary developers. An international peer review panel was established at the outset and has continued throughout the project to provide regular review and direction. Bill Upton, as ODOT project manager, has been a full member of the model development team from the beginning.

III–2. How long did/will it take to develop?

The Gen1 model was started in 1996 and first applied to the Willamette Valley Forum project in 1999. It has since been used to address several policy issues. The transitional model was completed in July 2004 and will be tested through the remainder of 2004.

III–3. How much did/will it cost and how was funding obtained?

Funding for the ODOT modeling program is about $1.1 million per year. This includes all modeling efforts for small cities, urban areas, counties, and the statewide efforts. It also includes staff, consultants, data collection, research, development, implementation and applications. Initial funding for the program was solely state gas tax. The program is now funded through FHWA SPR funds and state gas tax match.

III–4. Were there institutional hurdles to cross and if so what?

See lessons learned.

III–5. Where did the impetus for model development begin?

ODOT historically responded to the broad public view that roads are key to a mobile, accessible and prosperous America. Beginning in the 1970s, several mandates dealing with how projects are selected and designed resulted from public concerns about the environmental and social impacts of road construction. These include ISTEA, NEPA, CAAA, Oregon Transportation Plan, Oregon Transportation Planning Rule, and the Oregon Clean Air Conformity Rule. Generally, these require an open public process, agency coordination, and alternative solutions. The mandates prescribe the process of considering how transportation infrastructure investments are decided and designed, and specified measures to ensure compliance and coordination.

To address these mandates, changing how to think about providing transportation services is important. Recognizing that land use, economic, and transportation decisions and investments are related and interdependent is a big step towards addressing the intent of the mandates. The historic mathematical models used by ODOT engineers and planners were inadequate to analyze and predict the multi-dimensional environment that is now being considered. New methods to analyze travel behavior, location preferences, market forces, infrastructure, and policies were needed since past decisions were made without sophisticated modeling tools. ODOT embarked upon a comprehensive Oregon Modeling Improvement Program in 1994 to consider how to meet these new rules and regulations.

III–6. What were the main problems that the modeling effort was designed to address and how were these identified?

The TLUMIP project had four important goals. These goals were designed to provide the basis for a truly statewide system of land use and transportation analysis that is comprehensive, consistent and coordinated and that address key elements of ODOT's mission in the areas of statewide transportation planning and statewide planning. Goals and objectives included:

Goal 1. Develop long-term economic, demographic, passenger, and commodity flow forecasts for statewide and substate regions, and maintain databases needed for periodic updates.

Goal 2. Integrate statewide- and metropolitan-level land use data bases, land use modeling, and spatial analysis methods to support transportation and statewide planning in the state of Oregon.

Goal 3. Establish methods for evaluating key policies in the Oregon Transportation Plan, implementing the Statewide Transportation Planning Rules and assessing progress made toward achieving goals implicit in Oregon's Statewide Benchmarks.

Goal 4. Develop the tools, guidelines, and institutional support necessary for ODOT and other planning agencies to sustain the models and data bases needed for integrated land use and transportation facility analysis.

Objective 1.: Provide a framework for improving land use forecasting methods and developing true integration and feedback between TDMs and land use allocation models at the substate and metropolitan level.

Objective 2. Improve and enhance growth management, corridor planning, and congestion management system studies that rely on long-range economic forecasting, land use allocation models, and data that can be generated by the Land Use Model Integration Program.

Objective 3. Improve and enhance the Oregon Highway Monitoring System's analytical processes (OHMS).

Objective 4. Provide technical support for the Highway Plan update, reengineering of Project Selection and Development, and special projects (such as the Willamette Valley Strategy) that advance comprehensive transportation planning in the State of Oregon.

The design of the first generation models began with an assessment of the policy and investment issues they should be able to address. The need to evaluate unique Oregon issues, such as urban growth boundaries, influenced the design of the model. Key Oregon policy makers were interviewed to define important issues that the model should address. The study team, with help from the Peer Review Panel and OMSC members, identified eleven key issues. See attached table listing analysis issues and desired capabilities to address policy issues.

Following development of the first generation models, and capitalizing on the promising aspects of both models, a second generation modeling system is being developed. Modeling requirements were thoroughly reviewed and a new model specification developed. This underwent extensive revision through the peer review process. The resulting design brought the parallel tracks in the first generation model into a single unified development effort. The goals and objectives established for this second-generation model include:

Goal 1. Develop a set of integrated land use and transportation models that will enable ODOT and the MPOs to do analysis needed to support land use and transportation decision making.

Goal 2. Develop and maintain databases needed to make periodic long-term economic, demographic, passenger, and commodity flow forecasts for statewide and substate regions.

Goal 3. Develop the expertise, guidelines, and institutional support necessary to sustain the models and data bases needed for integrated land use and transportation facility analysis.

Objective 1. Provide training on the integrated transportation and land use models.

Objective 2. Connect the statewide and substate models with the metropolitan area models.

Objective 3. Transfer the statewide and substate model to a platform that is extensible and can be modified by ODOT in the future.

Objective 4. Integrate rail transportation into the statewide and substate model.

Objective 5. Develop a working metropolitan model that integrates transportation and land use components.

Objective 6. Establish data linkages between the statewide, substate, and metropolitan models and analytical software for assessing highway system performance.

Objective 7. Establish university research linkages.

III–7. Was the model validated? Against what data and validation criteria? How well did it validate?

Research of current practices surprisingly found no existing clearly defined model calibration or validation criteria for integrated land use-transportation modeling. The modeling team and Peer Review Panel together developed several criteria for assessing model performance for the Gen1 model:

1. Match production by sector and zone.
2. Match number of trips and average trip distances by trip purpose.
3. Minimize zone-specific constants by sector.
4. Network flows to match counts by mode of transportation, with emphasis on interurban routes.
5. Match increments of land to changes in land price.
6. Match CTPP distribution for commuting flows.

Each criterion has a specific numeric target. The network flows, for example, must fall within specified ranges based on total observed volume. Some targets are more liberal than for traditional urban travel models, owing to the complexity of the integrated models and their coarser geographic detail.

Several subjective performance tests were also developed. Each required the model to produce sensible and reasonable results. Additional criteria for which specific numeric targets could not be defined include:

7. Destination and route choice response behavior.
8. Trip generation sensitivities.
9. Path and transportation cost testing.

The statewide model is judged to perform well by meeting the calibration targets. The criteria appear realistic regardless of the geographic scale applied. However, the criteria are oriented primarily towards the normal (transportation) system validation criteria used in traditional urban travel forecasting models. Additional thinking is needed to develop model criteria for the activity and location parts of the model. Even in their present form, though, the standards can be useful performance measures for any integrated land use–transportation model.

III–8. How are validation criteria for statewide models different from urban models?

The urban models are equilibrium and follow standard validation and calibration methods. With the integrated models, not all modes are equilibrium so conventional methods do not work. The criteria used for the statewide model is described in the preceding question.

IV. Scale/Level of Detail

IV–1. What modes are modeled and which are network based?

The Gen1 model includes auto, bus, passenger rail, and truck modes. All are network-based.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

The Gen1 statewide model divides Oregon and Clark County, Washington into 122 zones. Over half (67) are located wholly or largely in the Willamette River Basin. Almost half of these (35) are within or encompass significant portions of metropolitan areas. An additional 25 external zones represent areas outside the modeling area where products flow to or from. Many of the corridors identified for evaluation by the model are only partially within the traditional urban travel modeling areas, and some corridors connect two metropolitan areas.

The Transitional Model operates at a finer zone system then the Gen1 model. This model has a close representation of detail in urban areas as do the MPO models. Overall the state is divided into about 3300 TAZs.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor etc.) and why?

Passenger travel purposes in the model include low-, middle-, and high-income commuters, recreation, other, NHB work and non-HBO.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model? How are they modeled?

The model does not include special generators. Gen1 models the economy and its trading relationships are expressed through 15 sectors, including 12 business, and 3 household sectors. Although this economic sector description is very generalized, it includes all economic activities. The transitional model splits the economic sectors into more detailed categories.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

Within the urban areas, the TAZs for the Gen1 models were developed by grouping several urban TAZs together into single zones. Information can be shared but at a very aggregated level. The network for the Gen1 model is a stripped down version of the urban models.

The transitional model is an extremely close representation of both the zone system and network within the urban areas. A maintenance concern is keeping this consistency over time.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

The program is definitely going in this direction but it not there yet.

V–3. Are the urban models incorporated as part of the statewide model and if so how?

There is a very close representation on a geographical basis in the transitional model. The zones and network are similar and it is anticipated that information passed between the models will increase.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

Although the both models produce independent traffic assignment, they are not typically used for any applications. The local area model forecasts are used as the standard for application and analysis.

VI. Freight/Commercial Vehicle Modeling

VI–1. Does the model consider trucks only or other modes and why?

The Gen1 model only considered trucks because it was a prototype model and truck freight comprises 80% of all freight movement in Oregon. The most benefit was from concentrating on truck movements. The transitional model is multimodal.

VI–2. Why were certain modes excluded if any?

Modes were excluded in the Gen1 model to make the effort more manageable within the budget and time available for developing the model.

VI–3. Is the model based on commodity flows? If so, what techniques are used? How is commodity flow translated to individual vehicles?

For both the Gen1 and transitional models, commodity flows are generated by economic transactions. In the Gen1 model, tons of commodities are converted into trucks based on the truck payloads and specified parameter of the percentage of trucks that are empty. The transitional model splits total tons into a distribution of shipment weights. These are then loaded onto trucks and routed using the “traveling salesman” approach.

VI–4. Does the model use matrix estimation techniques and if so what data were used for estimating the matrix?

No.

VI–5. Are traditional truck trip generation methods or quick response methods used?

Truck trip generation is based on the economic flows, the relationship of economic flows to tons for each sector's commodity movements, the payload of trucks and some other factors (see above).

VI–6. Is Reebie's data or CFS used? If so, how are the sectors not covered by these sources modeled or accounted for?

CFS data were used for the development of the model.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are models of long-distance or recreation/tourism integrated with the normal passenger TDMs?

Integration between the statewide and metropolitan models is a current work item.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs? If so, what?

The model structure is very different than metropolitan models. Key elements are described in preceding questions.

VII–3. What special data sources were required for these models?

A variety of economic and land use data not commonly used for metropolitan models. See preceding questions.

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

No.

VIRGINIA

I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

See the previous question.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

Aside from the special generator data, much of the data utilized for the statewide model was obtained through existing information. Approximately $2000 was spent to purchase employment data from Woods and Poole and Dun and Bradstreet.

I–3. Did you use national data sources such as NHTS?

As outlined previously the primary data resources utilized for the statewide model were derived from national sources. The 2001 NHTS was used to develop intrastate trip rates however the local (VA) data set was relatively small therefore the rates utilized in the model are representative of national values. In addition the data for long distance trips was not as comprehensive therefore the 1995 ATS was used.

I–4. How much did the data collection effort cost?

Aside from the special generator data collection approximately $2000 was spent to purchase employment data from Woods and Poole and Dun and Bradstreet.

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

Although we are still in the development stage it is intended to utilize similar already established resources from which the model was originally developed in order to maintain and update the model. The in-state highway network will be updated utilizing the linkage to our HTRIS database that maintains current roadway information. The non-VA portion will be updated as per the NHPN. It is anticipated that VDOT will continue to purchase the Reebie data on a regular basis as a part of its freight activities. An established VDOT database of completed (and planned) projects will be utilized for developing future year network(s). An initial list has already been developed.

I–6. How often are networks updated and from what sources?

The frequency of updates for the in-state highway network has yet to be determined however as it is accomplished through a linkage to VDOT's HTRIS database the frequency of updates should not be problem.

I–7. What data couldn't you get that you wish you could?

In order to develop a full multimodal freight model information on intermodal movements is needed which does not appear to be available to the extent necessary to estimate intermodal shifts. There are various pieces of data that can be obtained that were not (see discussion on data needs).

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

Although the intent is to maintain the model in-house it may well be necessary to retain consultant(s) to assist in updating and/or maintaining the statewide model.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff).

It appears that a staff of one is the average manpower that will be allotted at this time. However some additional staff time will be available as needed.

II–3. Was any staff added or reassigned from other duties because of the statewide model?
Although additional staff was not directly assigned due to the statewide model alone several staff have been reassigned and one added for our new modeling section, which intends to coordinate and maintain the MPO as well as the statewide model.

II–4. How much time is spent maintaining the model versus applying it?

As we are still under development this is unknown

II–5. Do you have a regular update cycle and if so what gets updated on what intervals?

As outlined previously the model update/maintenance cycle has not been formally established but will be somewhat dependent on the update schedule of the various data sets i.e., NHPN, NHTS, Census, Reebie data etc. upon which the model was built.

II–6. What are the primary measures of effectiveness used from the model?

It is intended to utilize the volumes from the model to develop v/c, vmt, and vht for use in other applications. In addition the model will deliver freight movements (truck volumes and tons of freight moving by rail by origin and destination) as well as rail passenger volumes.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

As outlined previously, it is intended to utilize the model for the prioritization of transportation projects for the statewide planning process based on passenger and freight movements forecasted by the model.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

It is intended to utilize the statewide model for any applications such as alternatives analysis and corridor studies in any areas of the state not covered by a regional MPO model. In the past it has been a common practice to construct “super models” (aggregations of two or more MPO models) in order to accomplish study regions not covered by MPO models.

II–9. Is your model used for corridor planning? If so, give examples. If not indicate how this is handled.

See response to previous question.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

One of the primary intended uses of the model is to provide inputs to our statewide plan prioritization process, which has not been done heretofore at the statewide level.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

The statewide model outputs will likely be employed in rural areas of the state. Currently MPO models are employed where available otherwise traffic counts and historical growth trends coupled with local knowledge have been used to develop traffic forecasts.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

The statewide model will not be utilized for operations level analysis. This has been accomplished in the past by utilizing the initial volumes from MPO volumes where models are available, otherwise traffic count data which are fed into a simulation package or HCS depending on the application.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

It is anticipated that the statewide model may provide some inputs for future economic studies such as for the I-81 corridor.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

It is intended to utilize the statewide model to address some freight issues, primarily truck related. However, intermodal issues cannot be addressed other than as a policy input. In the past little freight planning has taken place on a statewide or even regional level.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

The primary intent of the model is to provide estimates of vehicle (auto and truck) travel. However, the model will provide passenger rail travel as well as freight demand at ports (air and sea) as well as point-to-point rail movements, which hopefully can be utilized in future studies, or to address policy issues.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not indicate how this is handled.

It is intended to use the statewide model to develop the various inputs for the conformity process in non-attainment regions for non-MPO areas of the state. In the past HPMS data have been used to develop inputs for conformity.

II–17. Is your model used for safety analysis? If so, give examples. If not indicate how this is handled.

The statewide model outputs may be utilized for safety analysis in rural regions. Safety studies to date have utilized accident rates etc. developed on a statewide basis from our TMS.

II–18. Is your model used for toll studies? If so, give examples. If not indicate how this is handled.

The statewide model may be utilized for toll studies in rural areas such as the I-81 corridor. Most of the toll studies to date have been situated in MPO regions where the MPO model was employed.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

The statewide model could possibly be utilized to examine traffic impacts of a very large scale. Otherwise traditional methods will be employed using ITE rates etc.

III. Implementation

III–1. Who developed the model?

Wilbur Smith is the prime consultant who did the bulk of the work. BMI was utilized to develop the land use inputs to the model and Street Smarts produced the special generator information.

III–2. How long did/will it take to develop?

The model has taken 4 years to develop to this point with completion anticipated in early fall of this year.

III–3. How much did/will it cost and how was funding obtained?

The cost is ~ $1.5 million, obtained through available SPR funds.

III–4. Were there institutional hurdles to cross? If so, what?

There were very few hurdles to undertaking this project.

III–5. Where did the impetus for model development begin?

The impetus for the statewide model began with a push from modeling staff in order to address certain ongoing issues.

III–6. What were the main problems that the modeling effort was designed to address? How were these identified?

The primary issues the model was intended to address was the inability to provide travel forecasts for rural highways, both passenger and truck. In addition it was desirable to be able to provide a means of examining freight issues as well as forecast freight movements.

III–7. Was the model validated? Against what data and validation criteria? How well did it validate?

The model was validated to base year (2000) VDOT truck counts for the truck model however this was largely a reporting exercise as the original truck trip assignment was developed through matrix estimation which was calibrated to truck counts. The total vehicle assignment (autos + trucks) is still being developed. For the initial model RMSEs were examined. Results were in the range of 70% to 80% for minor arterials to interstate facilities. In addition screen lines were established and the model outputs compared with traffic counts. The screen line model volumes were largely within 10% of the counts.

III–8. How are validation criteria for statewide models different from urban models?

It is somewhat unclear on as to what validation criteria are applicable for statewide models, i.e., same standard as MPO models? In addition as our model is not expected to model inside MPO boundaries it is uncertain how the criteria should be applied. For example, we have O-D studies for various MPO regions, which could be used to validate the operation of statewide model, but it is unclear as to whether this is applicable.

IV. Scale/Level of Detail

IV–1. What modes are modeled and which are network based?

The model estimates passenger travel for both autos and rail and freight travel for trucks. Although not explicitly modeled, freight flows (point-to-point) for other modes (water, air, rail) are forecasted. Only highways, autos and trucks and passenger rail are fully modeled at the network level.

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

The macro model utilizes county-level zones within the state of Virginia, which are aggregated to the BEA regions outside the state and combined at further distances to aggregates of BEA zones. Even further out states and aggregates of states are utilized for the zonal structure. The micro model, which covers the Virginia portion of the model, utilizes aggregates of MPO zones inside the urban areas and census tracts and places outside of the urban regions.

For trip assignment only, the zones are split (to a total of 9,425 zones) which provides improved trip assignments.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor, etc.) and why?

At the macro level interstate trips are modeled with three trip purposes, business-related, non-business, and other trips. At the micro (in-state) level, intrastate trips include short daily trips (<100 min) with the standard HBW, HBO, and NHB purposes and longer periodic trips (>100 min) which considers business, tourist, and other trip purposes.

These trip purposes were chosen in order to best represent the aspects of travel in Virginia as well as those for which data could be obtained.

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model? How are they modeled?

The model utilizes special generators that are presently undergoing revision. The initial list contained universities, military installations as well as tourist attractions such as Virginia Beach. This list will be streamlined to include similar attractions but only those locations that fall outside of the MPO areas and are of sufficient size to warrant inclusion in the model, i.e., >500 trips per day or more.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

See previous question.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

That is the intent.

V–3. Are the urban models incorporated as part of the statewide model? If so, how?

No.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

No. The intent of the model is to estimate intercity/inter-MPO travel in the rural areas of the state. The MPO models will continue to serve as the official source of travel forecasts within the MPO regions. The statewide model is not of sufficient detail to provide urban travel forecasts.

VI. Freight/Commercial Vehicle Modeling

VI–1. Does the model consider trucks only or other modes and why?

Although not explicitly modeled, freight flows for other modes (water, air, rail) are forecasted based upon Reebie data and can be used to address various policy questions such as the effect on truck movements due to shifts to/from other modes.

VI–2. Why were certain modes excluded, if any?

Although it was desired to include the rail mode for freight, time and budget constraints have precluded this aspect from inclusion in the model. In addition it appears quite difficult to obtain data to model rail freight movements as well as data pertaining to modal shifts etc. The degree of in-state passenger air mode travel was considered too small of a share to be included in the statewide model.

VI–3. Is the model based on commodity flows? If so, what techniques are used? How is commodity flow translated to individual vehicles?

The statewide model utilizes the two primary components of commodity flow data purchased from Reebie Associates for the truck model. The overhead (through) commodity flow table, is utilized to derive through truck trips and the Virginia TRANSEARCH database, with flows for commodities with origins or destinations within Virginia to derive the interstate and intrastate truck trips. The commodity flow tables were converted into truck trips using truckload factors according to the STCC type then disaggregated from the state or BEA zone level to the macro TAZ level. A factor of 1/365 was used to reduce the truck flow tables to average daily truck trips. As mentioned previously, since the Reebie data does not contain trucks not involved in the shipment of freight, the initial truck table was supplemented with an estimate of local (in-state) truck trip generation, developed based upon relative zonal population and employment totals. An O-D matrix estimation process was employed to adjust the truck trip table to match the modeled link volumes with the observed truck counts.

VI–4. Does the model use matrix estimation techniques? If so, what data were used for estimating the matrix?

For the truck portion, matrix estimation utilizing Reebie data calibrated to truck counts was used to produce the initial truck trip table.

VI–5. Are traditional truck trip generation methods or quick response methods used?

For the truck portion, matrix estimation based upon truck count data was used to produce the final truck trip table.

VI–6. Is Reebie's data or CFS used and if so, how are the sectors not covered by these sources modeled or accounted for?

Reebie data purchased for the state of Virginia was the primary source of freight data used in the model. As mentioned previously, since the Reebie data does not contain trucks not involved in the shipment of freight, the initial truck table was supplemented with an estimate of local (in-state) truck trip generation, developed based upon relative zonal population and employment totals. An O-D matrix estimation process was employed to adjust the truck trip table to match the modeled link volumes with the observed truck counts.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are models of long-distance or recreation/tourism integrated with the normal passenger TDMs?

These are simply additional trip purposes included in the normal trip-making characteristics for the households in the various regions of the state.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs? If so, what?

The application of Reebie data as well as the estimation of local truck trips to supplement the Reebie data were not normally done in MPO model development

VII–3. What special data sources were required for these models?

See previous list of data. No special data was collected (other than Reebie which was already obtained) for the model development.

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

No. The average annual travel is the intended period for consideration.

WASHINGTON

I. Data

Discuss the data requirements of your statewide modeling effort and the most significant data issues you face. If you have no model, indicate the data sources used in your planning/traffic forecasting process.

In the absence of a statewide model, travel forecasts for state highways in MPO areas have relied on respective MPO's regional travel demand forecast models. The WSDOT has 176 permanent counting locations throughout the state that collect traffic data 24/7. In areas that are not in an area covered by a regional traffic model a trend analysis using the historical count information from appropriate permanent traffic counting sites is performed to estimate the growth rate for traffic forecasts.

I–1. What were the primary sources of data for your statewide modeling effort?

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

I–3. Did you use national data sources such as NHTS?

I–4. How much did the data collection effort cost?

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

I–6. How often are networks updated and from what sources?

I–7. What data couldn't you get that you wish you could?

II. Maintenance/Use of Model

How is your model maintained and what is it primarily used for? If you have no model, indicate how the various analytical tasks identified below are conducted and the staffing requirements.

For the various tasks listed below, we use respective MPO's regional travel demand forecast models if available. In most cases, we contract these tasks to consultants.

II–1. Are consultants used to help maintain the model or is it done in house?

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff).

We have approximately two FTE staff working on maintaining traffic count database, developing trend line forecasts and related system performance analysis to support ongoing planning activities.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

II–4. How much time is spent maintaining the model versus applying it?

II–5. Do you have a regular update cycle? If so, what gets updated on what intervals?

We update trend line traffic projections every 2 years to coincide with the funding cycle.

II–6. What are the primary MOEs used from the model?

The key measures we use are vehicle and person hours of delay and speed.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

For the Mobility program, the HSP includes a mix of strategies that address congestion. Congestion is typically defined by when, how often, and for how long a driver is delayed or stopped. With the varying geographic conditions of the state, defining congestion on a statewide basis is a difficult task, as is the problem of identifying highway segments for the purpose of qualifying for congestion relief investment. In the past, WSDOT compared each highway's peak hour V/C ratio. This method demonstrated congestion levels only during the peak hour but many segments of highways experience congestion outside of the "peak hour," something the V/C method does not measure.

A more refined deficiency analysis tool was developed and used in the 2003–2022 HSP. This tool is a post processor utilizing outputs such as growth rates, volumes, etc., from regional travel demand forecasting models in urban areas, and trend line forecasts based on hourly traffic counts and historic data where travel demand forecasting models were not available. Currently,

- There is an agreement at WSDOT that macro-level models do not analyze systems in enough detail to evaluate impacts on congestion patterns and conditions from specific operational or capital investments;
- The problem of congestion must be addressed both through new construction and operational improvements in existing facilities. Measurements are needed that can capture the effectiveness of these strategies;
- Congestion measures must distinguish between congestion caused by incidents ("non-recurrent" congestion) and congestion caused by inadequate capacity ("recurrent" congestion);
- Existing ITS data collection can be leveraged to provide a resource for a variety of applications, including performance monitoring.
- Real-time traffic flow data has the potential to provide very accurate measurements of average speeds and both recurring and nonrecurring delays, which can then be used to directly measure congestion.

WSDOT's Congestion Measurement Approach

In December 2001 WSDOT implemented new congestion measurement principles. These principles are

- Use real-time measurements (rather than computer models) whenever possible.
- Measure congestion due to incidents as distinct from congestion due to inadequate capacity.
- Show how reducing congestion caused by incidents improves travel time reliability.
- Demonstrate both long-term trends and short-to-intermediate term results.
- Communicate possible congestion fixes using an "apples-to-apples" comparison with the current situation (for example, if the trip takes 20 min today, how many minutes shorter will it be if we add a freeway lane or improve the interchanges?)
- Use plain English to describe measurements.

WSDOT's approach focuses on measuring system efficiency and travel time reliability, and communicating progress that the public can see and experience in the short and intermediate term. The point is to report the effectiveness of all the congestion management and relief programs the agency is undertaking. Operational data were the only data source with the level of real-time detail required for developing measurements and assessing investments.

More detailed information describing the above congestion measurement principles is attached to this questionnaire. This paper also identifies limitation, continuing research, and data analysis related to these new congestion measurement principles.

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

Traffic forecasts to support regional planning efforts were developed using respective regional models if available. For example, the planning effort done for the Regional Transportation Investment District (includes King, Pierce, and Snohomish Counties) used the Puget Sound Regional Council's travel demand forecast model.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

Traffic projections developed from MPO models or from trend line method are used in corridor planning. Examples of such efforts include corridor EIS, Route Development Plans and Corridor Feasibility Studies.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

Washington State law requires that an evaluation process be followed to differentiate among projects in order to select those that will produce maximum "value"[1] and provide a rationale for investment tradeoffs between programs under budget constraints. WSDOT has developed a methodology for evaluating mobility projects, that utilizes the results of a regional four-step model (developed by the MPO) or a speed-volume curve based on hourly traffic counts.

A project's value cannot be totally expressed in monetary terms. Values, which can be expressed, include travel delay reduction, accident reduction, vehicle efficiency, and elimination of environmental impacts created by past highway projects which created blockages to the movement of fish, pollution caused by storm water runoff, and excess noise levels adjacent to neighborhoods. Other project values, which WSDOT considers, include ease of moving freight, direct economic benefit, pedestrian and transit linkages, and partnership opportunities with local and federal transportation agencies.

The department encourages their regions to use the following methodology to evaluate different design alternatives as part of their process to select the preferred design alternative.

The prioritization methodology consists of two primary components:

1. Screening Criteria—The systems plan functions as the first screening criterion. Project requests not contained in the systems plan are ineligible for further prioritization. Because the state highway systems plan must guarantee conformity to AQ requirements, any proposal that would worsen AQ in a non-attainment area would also fail the initial screening.

[1] The term "value," as used here, is meant to encompass all the benefits of transportation improvements, including those that are not typically assigned a dollar value.

2. B/C Ratio or Cost Efficiency—The cost efficiency of a project includes the present value of the project's benefits, which can be measured and divided by the project costs. In this category, projects with higher scores are more favorable. The basic equation for the B/C ratio is

$$B/C = \frac{PV_B}{PV_C}$$

where

B/C = benefit/cost ratio,
PV_B = present value of the project's benefits, and
PV_C = present value of the project's cost.

Costs include ROW, engineering, construction, and operation and maintenance. ROW and construction costs only include the depreciation for 20 years in order to be consistent with the benefits. To expedite the time required to evaluate projects, WSDOT developed a software package called the Mobility Project Prioritization Process B/C Tool to estimate a project's cost efficiency.

Benefit highlights of values that can be quantified and what data were necessary to make the calculation are discussed below:

Travel delay benefits consider the reduction in delay for individuals and trucks for 24 h per day, Monday through Friday. Data necessary to calculate the savings include

- AADT count distribution by hour
- Truck percentage
- Vehicle occupancy rate
- Number of existing lanes in each direction
- Number of proposed lanes in each direction
- Type of proposed lane(s) if applicable (HOV, general purpose, two-left turn)
- Type of other improvement such as park and ride lot, access control, synchronized signals, or other ITS measure

Accident reduction considers the number of accidents for the last 2 or 3 years and estimates the number of accidents and accident severities that would be reduced by the improvement. Data needed to estimate the reduction in accidents and severity include

- Number of accidents during the last 2 years,
- Severity of the accidents during the last 2 years, and
- Accident reduction factor based on local experience.

Vehicle operating efficiency (cars, buses, and trucks) includes the improvement in operating costs due to the reduction in travel delay. No additional data were necessary as it is calculated as a function of travel delay.

Environmental impacts considers the elimination or reduction in environmental impacts that currently exist due to previous constructed transportation projects. The data needed to estimate the reduction in environmental impacts include

- Number and cost of barrier removal to the passage of fish,
- Area of impervious surface and the cost to retrofit with a best management practice, and
- Number of noise receptors and the cost to retrofit the noise level below the acceptable level.

WSDOT has developed the following additional set of criteria to evaluate the value of factors, which they are difficult to quantify.

Criteria for Benefit Evaluation System

- Safety benefits: The projects must solve one or more of the identified needs within the department's HSP such as
  - High accident location
  - High accident corridor
  - Pedestrian accident corridor
  - Runoff the roadway
  - At-grade intersections on high-speed, multilane, accessed controlled NHS routes
- Measurable congestion relief benefits: A minimum of 100 h of delay per day now (year 1)
- Freight benefit: The highway facility is located on a T-1 freight route (more than 10 million tons per year) or a T-2 freight route (4 to 10 million tons per year). Also a T-3, T-4, or T-5 route if it connects a port or industrial site to a T-1 or T-2 route.
- Direct economic development benefit: A company has committed to bring new jobs into the community if this highway improvement occurs.
- Transit/pedestrian benefit: The project includes a HOV lane, direct transit access to the freeway, a bicycle path, significant network of sidewalks, or a series of bus pullouts and pedestrian refuges.
- Water/habitat fix: The project solves an existing fish barrier blockage identified by Washington State Fish and Wildlife and in the HSP, an existing noise deficiency identified in the HSP, an existing storm-water retention deficiency identified in the HSP, an animal migration corridor with a large number of collisions with animals as identified by the EAO and an identified flood problem as identified by EAO.
- Partner funding: The project includes a contribution from a local agency or a developer. This category does not include normal federal highway funding or special federal demonstration funds (see next category).
- Special federal program: The project includes federal funding as a result of a separate federal appropriation bill. These funds are in addition to the normal federal funding which the department receives as part of the federal apportionment act.

Projects, which meet the criteria in the categories above, receive a check mark. WSDOT combines combine the cost efficiency value and checks marks in order to develop a prioritized list of projects.

II–11. Is your model used for project-level traffic forecasts? If so, give examples. If not, indicate how this is handled.

WSDOT rely on MPO's regional models to generate traffic forecasts for project-level traffic forecasts, such as opening year and design year volume forecasts. In the absence of a regional model, trend line method is deployed.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

Again, WSDOT primarily rely on MPO regional models to generate forecasts for operational studies.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not, indicate how this is handled.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

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I. Data

I–1. What were the primary sources of data for your statewide modeling effort?

NHTS, CTPP, census, O-D travel surveys, TRANSEARCH 2001 database, Reebie Inc., WisDOT roadway centerline and attribute database (STN and WISLR), school enrollment (from the Department of Public Instruction), and employment data from the Department of Workforce Development.

I–2. Which sources were collected specifically for the modeling versus obtained from other sources?

NHTS (17,610 household samples), CTPP(statewide element), O-D travel surveys, Woods and Poole (forecasted economic data), Census journey-to-work data detailed by city, village, and town statewide

I–3. Did you use national data sources such as NHTS?

NHTS, Woods and Poole, TRANSEARCH 2001, and Reebie Inc.

I–4. How much did the data collection effort cost?

- NHTS (add-on samples): $2,500,000
- Travel surveys (44 gateway stations): $132,000
- Truck survey (Rochelle): $15,000
- Consultant contract amount of $895,000 and in-house staff time are not included under I–4.

I–5. What, if any, data were collected in an ongoing manner for support/update of the model?

Traffic counts, truck counts, and speed data to track the progress and validity of our model on an annual basis. Adjustments will be made using the subarea analysis tool, not a complete revalidation and recalibration of the model statewide.

I–6. How often are networks updated and from what sources?

Every year for E+C and E+C+P Networks dependent on MPO TIPs and WisDOT investment program changes. Major update done on a 6-year cycle to correspond to WisDOT's Six-Year Highway Improvement Program.

I–7. What data couldn't you get that you wish you could?

O-D truck survey data for the creation of the I-I trip table for commercial travel, especially travel information on non-commodity trucks.

II. Maintenance/Use of Model

II–1. Are consultants used to help maintain the model or is it done in house?

Maintenance and model application, interpretation, and analysis will be conducted by in-house staff.

II–2. How many staff are dedicated to maintaining/using the model (include estimates of partial time for multitasked staff).

Three FTEs.

II–3. Was any staff added or reassigned from other duties because of the statewide model?

One new staff addition. Modeling staff committed to maintenance and application, post-consultant, will be coming from three different functional areas: traffic forecasting, MPO planning, and intercity system planning sections.

II–4. How much time is spent maintaining the model versus applying it?

We estimate it will be

- Model maintenance/enhancements: 33% and
- Application, interpretation, and analysis: 67%.

II–5. Do you have a regular update cycle and if so what gets updated on what intervals?

Probably a 5- to 6-year update cycle to correspond to our programming cycle.

II–6. What are the primary MOEs used from the model?

Our statewide model will be an AADT model. The MOEs used will be VMT, VHT, crash reductions, user cost savings, etc. On the Measures of Congestion the following will be used: V/C ratio, LOS, average speed, delay (time and money), fuel consumption, etc.

II–7. Is your model used for system planning? If so, give examples. If not, indicate how this is handled.

Yes, it will be used for systemwide corridor planning to analyze modal diversion impacts and route diversion impacts under various transit and highway improvement scenarios. For example, if we improve a major statewide corridors from a two-lane 55-mph corridor to a 65-mph four-lane expressway/freeway corridor complete with community bypasses what are the traffic impacts in terms of attracted AADT volumes and from what competing parallel routes contribute diverted traffic and what is the magnitude of those volumes (SR-26, US-8).

II–8. Is your model used for regional planning? If so, give examples. If not, indicate how this is handled.

For AQ regional emissions and conformity analysis for rural isolated counties that do not contain a MPO. There are several ways the model is used for regional transportation analyses:

1. For AQ regional emissions and conformity analysis for rural isolated counties that are outside a MPO area;
2. Toll road feasibility analysis for the conversion of the Interstate system to tollways; and
3. For community bypass proposal studies.

II–9. Is your model used for corridor planning? If so, give examples. If not, indicate how this is handled.

Definitely, to analyze modal diversion impacts with the introduction of new intercity transit modes, route diversion impacts based on lane and design improvement alternatives within the same corridor and between competing corridors, and "hot-spot" crash rate corridors for the potential investment in passing lanes.

II–10. Is your model used for project prioritization? If so, give examples. If not, indicate how this is handled.

Not exactly. The conversion of model assignments to facility design year forecasts will be a primary use of the traffic simulation model. The adjusted AADT outputs of the statewide model will then be input to our program budget allocation tool, the congestion module of our meta-manager model, to identify highway needs that assists our transportation district offices with their decision making process as to what projects are selected for programming and construction investment. The ultimate goal of our statewide modeling process is to have a seamless integration whereby a computerized process is established that converts model assignments to facility forecasts (AADTs) that are then input to the department's Traffic Analysis Forecasting Information System which feeds directly into the needs identification tool, the congestion module of our meta-mnager model.

II–11. Is your model used for project level traffic forecasts? If so, give examples. If not, indicate how this is handled.

Yes, it will be used to generate project level forecasts for mainline and intersecting facilities to be used by planning, by programming, and by design sections within the department. Good examples include major corridor forecasts for future capacity expansion, bypass forecasts for preliminary assessment of whether to move forward or not with planning and environmental work, cordon line forecasts for MPO control totals for external traffic for model and trip table development, etc.

II–12. Is your model used for operational level studies? If so, give examples. If not, indicate how this is handled.

Not used for this type of analysis.

II–13. Is your model used for economic development studies? If so, give examples. If not, indicate how this is handled.

Yes, it will be used in terms of Traffic Impact Analysis for planned economic developments that will be treated as special generators in the model. For example, exclusive TAZs have been set aside for proposed Wal Mart distribution centers to measure their traffic impact on adjacent local and state facilities for an AADT period.

II–14. Is your model used for freight/intermodal planning? If so, give examples. If not, indicate how this is handled.

Yes, our statewide model does have an exclusive freight component for the primary modes of rail and truck. We have included it for two primary reasons: (*a*) We want to be able to forecast truck movements and volumes on the state and local highway systems, and (*b*) we want to look at the potential for intermodal shifts and tradeoffs. Our freight network and zonal system is nationwide to account for global market impacts on freight movements by mode (truck and rail) into and out of Wisconsin.

II–15. Is your model used for rail/air/port planning? If so, give examples. If not, indicate how this is handled.

Not per se. But we plan to analyze highways that access these intermodal facilities to gauge congestion and design needs and determine if improvements are warranted and the type of design improvement needed.

II–16. Is your model used for AQ conformity analysis? If so, give examples. If not, indicate how this is handled.

Yes, for regional emissions and conformity analysis and for SIP budget development for rural non-attainment counties like Door, Kewaunee, and Manitowoc in northeastern Wisconsin. We plan to use the subarea tool of TP+ to conduct a more detailed zonal and network analysis for these counties to obtain model VMT for input to the MOBILE6 emissions model. It is our intention to develop an AQ post-processor module to handle all calculations.

II–17. Is your model used for safety analysis? If so, give examples. If not, indicate how this is handled.

It could be. A B/C postprocessing module is being developed for systemwide, corridor-level, and project-level improvements with crash rate reductions used on the benefit side of the ledger to evaluate potential improvements from an economic perspective. It remains to be seen whether this capability will augment or supplant the current safety analysis module used in the meta-manager model needs identification process.

II–18. Is your model used for toll studies? If so, give examples. If not, indicate how this is handled.

Yes. Pops up periodically to analyze conversion of our Interstate system to a closed loop or open loop tollway design system.

II–19. Is your model used for traffic impact studies? If so, give examples. If not, indicate how this is handled.

Not for full-blown design and operational analysis for a traffic impact analysis for daily and peak-hour period(s). But AADT control totals will be developed as initial inputs to the process that account for modal and route diversion impacts.

III. Implementation

III–1. Who developed the model?

The consultant team of Cambridge Systematics (prime) and HNTB Corporation.

III–2. How long did/will it take to develop?

Initiated in October 2002 and will finish up by January 2005 for total development period of 26 months.

III–3. How much did/will it cost and how was funding obtained?

Total cost = $850,000 with 100% state dollars used that comes from the department's multimodal fund account. These costs are only for the consultant contract and do not account for in-house staff time that at times can be substantial especially for GIS personnel.

III–4. Were there institutional hurdles to cross? If so, what?

The model development process was influenced by several institutional hurdles, but the contracted budget for the consultant was not one of them. The consultant's budget was capped at $895,000, so being on budget is not a major issue but being on schedule is. Two institutional issues we did have to address were (*a*) a change in state government administration that delayed the roll out of our long-range plan due to the need for the administration to get an understanding of what direction transportation and economic development should move, and (*b*) getting the cooperation of our two largest MPOs, which were concerned about overlaps in our statewide model and their MPO model, potentially leading to conflicting travel forecasts for the same facility.

III–5. Where did the impetus for model development begin?

From the Bureau of Planning (LRTP development) and Bureau of State Highway Program Development staffs (facility forecasts for design and needs identification for program allocation).

III–6. What were the main problems that the modeling effort was designed to address? How were these identified?

To ascertain systemwide modal diversion and route diversion traffic impacts and tradeoffs under a multiproject improvement scenario. To analyze the highway impacts associated with increasing truck volumes over our key backbone routes.

III–7. Was the model validated? Against what data and validation criteria? How well did it validate?

The model was validated against 1999, 2000, and 2001 AADTs using numerous screen lines and cut lines statewide, These screen lines and cut lines were based on the location of ATRs that provide continuous volume, class, and speed data for validation purposes. We used the Travel Model Improvement Program Model Validation and Reasonableness Checking Manual as our standards guide for model validation. The primary measure use is the %RMSE.

III–8. How are validation criteria for statewide models different from urban models?

Not that different as to the application of validation criteria, measures, and standards used with MPO models. Difference is the coverage area and level of complexity related to zonal system, network, and planning objectives.

IV. Scale/Level of Detail

IV–1. What modes are modeled and which are network based?

- Modes modeled: autos, trucks, bus, and rail
- Passenger network-based modes: autos, bus, and rail
- Freight network-based modes: rail and trucks

IV–2. To what level of geography (such as TAZs) is land use aggregated and how many are there?

Level of geography: place level (city, village, town). Internal TAZs for Wisconsin equals 1,642. External TAZs going nationwide equals ____.

IV–3. What sectors of the traveling public are modeled (such as passenger, long-distance passenger, freight, other commercial travel, recreation/visitor, etc.) and why?

- Passenger: auto, truck, bus
- Long-distance passenger: auto, truck, bus
- Freight: truck and rail

IV–4. Does the model have special generators? What types of land uses are appropriate special generators in a statewide model? How are they modeled?

Yes. Related to major truck production and attraction terminal like distribution centers of Wal Mart and Lowe's and Menards and to the major global intermodal (truck–rail) terminals like the Union Pacific facility in Rochelle, Illinois. Each major generator, that by definition generates a minimum of 500 truck trips daily, will have its own TAZ defined to handle the traffic impacts of these generators.

V. Statewide/Urban Model Integration

V–1. Do the statewide and urban models share geographic systems such as zones or networks?

1. TAZs: The MPO TAZs are a subset of the statewide TAZ system. Equivalency tables have been developed that relate statewide TAZ numbers to MPO TAZs, surface dynamics, and PAAs. For example, the Southeastern Wisconsin Regional Planning Commission (Milwaukee) planning area model has 1431 TAZs, but our state model aggregated them into 103 TAZS.
2. Networks: There is much more detail (system density and mileage) within the MPO models. The statewide model does contain all collectors and higher but only as connecting links of the rural system so as to maintain connectivity and interconnectivity.

V–2. Is the statewide model used to develop external station forecasts for the urban models?

Yes through our TAFIS system based on Box-Cox regression all external forecasts by external station have been generated by the department for MPO control total input.

V–3. Are the urban models incorporated as part of the statewide model and if so how?

Yes. Based on MPO unique model, land use, and mode choice options, each MPO will generate their own assignments and facility forecasts. From the statewide model, the systemwide impacts associated with route and modal diversion traffic impacts will be given to each respective and impacted MPO to account for these impacts in the development of final traffic/corridor/facility forecasts. These final facility forecasts are integrated into our TRADAS/TAFIS/meta-manager Model project and programming process via special traffic segmentation coding within the statewide model that will override our traffic forecasting system of project-level design AADT forecasts which then are input to the congestion module of our program prioritization tool to that ultimately determines infrastructure investments.

V–4. Does the statewide model provide independent estimates of traffic in areas covered by urban models? If so, are there institutional issues regarding dueling forecasts?

Yes, it does make independent traffic forecasts within MPOs, but these numbers are not released to anyone. Before any traffic forecasts are used for planning, design, environmental, and programming purposes or released to the public a consensual forecast is predetermined if it impacts our State Trunk Highway Network (STN). For all local, non-state trunk system forecasts within a MPO planning area, the MPO is charged with their development, analysis, and release.

VI. Freight/Commercial Vehicle Modeling

VI–1. Does the model consider trucks only or other modes and why?

The freight model for Wisconsin considers all freight modes including truck traffic (truck, less-than-truck, and private truck), rail traffic (rail carload and rail intermodal) air freight, and water freight modes. Why? One of the primary goals of this statewide planning and modeling effort is the development of a comprehensive (passenger + freight) and multimodal TDM.

VI–2. Why were certain modes excluded if any?

Time and data collection constraints and model constraints in looking at such modes as pipelines.

VI–3. Is the model based on commodity flows? If so, what techniques are used? How is commodity flow translated to individual vehicles?

The Wisconsin freight model component is estimated based on commodity flow data. The trip generation and trip distribution relationships are first built relying on the commodity flow data. As an additional separate step, commodity flows are translated to trucks as follows:

- The "tons to trucks" payload factors are developed based on Wisconsin's VIUS records, account for both STCC commodity and distance class, and also takes into account the number of empty trucks by each category.
- The payload factors developed from VIUS were examined and updated before being applied to the 2001 Wisconsin Commodity Information Management System (CIMS) to develop weighted factors by the commodity groups established for the model.
- An "annual to average daily" factor was also used to convert annual to daily truck movements.

VI–4. Does the model use matrix estimation techniques and if so what data were used for estimating the matrix?

At this point of the modeling process, we have relied exclusively on the four-step process and have not used matrix estimation techniques that are based on truck counts.

It is possible that we may rely on fratar growth factors and matrix estimation techniques if they are required during the validation of the freight model. In such a case, data on truck traffic from the Traffic Analysis and Forecasting Information System (TAFIS) database would be used to "validate" the truck trip table that we obtain from the four-step model process.

VI–5. Are traditional truck trip generation methods or quick response methods used?

The Wisconsin freight model relies on a four-step model that utilizes commodity flow data for trip generation and distribution. We have grouped the commodity flow data into a total of 25 commodity groups. The zone system used consists of 72 Wisconsin counties and 60 TAZs for the rest of the United States and North America.

In the trip generation phase, production rates were developed by relating the tonnage generated for each commodity to the corresponding SIC-2 digit level employment category. Attraction rates were also for each commodity category. Outliers were identified and treated as special generators.

In the trip distribution phase, the FAF network was used to obtain average trip lengths by commodity and trip length frequency distributions by commodity. Gravity models were estimated for each commodity.

VI–6. Is Reebie's data or CFS used and if so, how are the sectors not covered by these sources modeled or accounted for?

Reebie commodity flow data were used.

VII. Long-Distance/Recreational/Tourism Travel

VII–1. How are models of long-distance or recreation/tourism integrated with the normal passenger TDMs?

Separate I-I trip purpose that can be assigned, analyzed, and forecasted.

VII–2. Are any techniques needed not normally associated with metropolitan TDMs and if so what?

Main difference is the structure of the trip generation phase between statewide and MPO models. With the structure of the TAZ system created for the statewide model, some of the model parameters like intrazonal trips and nearest neighborhood factor will need adjusting during the validation/calibration process. In terms of forecasted data some allocation methodologies need to be established and agreed upon before proceeding. For example, long-range employment forecasts from the Woods and Poole source can be obtained by Standard Industrial Classifications/North American Industry Classification System classification but only at the county-level. A suballocation methodology has to be established to redistribute by city, by village, by town within each county.

VII–3. What special data sources were required for these models?

NHTS long-distance data set and O-D travel surveys with detailed trip purpose data that social/recreation trips were part of our survey design and collection efforts. ATR datasets and factor group maps that show the seasonal variation in traffic associated with major summer tourism routes.

VII–4. Are special times of year modeled that aren't normally considered in metropolitan travel modeling?

APPENDIX C

List of Acronyms

AADT	annual average daily traffic
AQ	air quality
ATR	automatic traffic recorder
ATS	American Travel Survey
B/C	benefit/cost
BEA	Bureau of Economic Analysis
CBD	central business district
CEDDS	Complete Economic and Demographic Data Source
CFS	Commodity Flow Survey
CMS	congestion management system
COSMO	Continuous Oregon Survey for Oregon Models
CTPP	Census Transportation Planning Package
DET	Division of Employment and Training (Massachusetts)
DOT	department of transportation
EAO	Environmental Affairs Office (Washington)
EIS	environmental impact statement
FAF	freight analysis framework
FHWA	Federal Highway Administration
FSUTMS	Florida Statewide Urban Transportation Modeling System
FTE	full-time employee
GDS	graphics design system
GIS	geographic information system
GPS	Global Positioning System
HBO	home-based office
HBW	home-based work
HCS	highway capacity software
HERS	Highway Economics Requirements System
HIS	highway information system
HOV	high occupancy vehicle
HPMS	Highway Performance Monitoring System
HSP	highway system plan
HTRIS	Highway Traffic Records Information System
INDOT	Indiana DOT
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
IT	information technology
ITE	Institute of Transportation Engineers
ITS	intelligent transportation system
KySTM	Kentucky Statewide Traffic Model
KyTC	Kentucky Transportation Cabinet
LDOTD	Louisiana Department of Transportation and Development
LOS	level of service

LRTP	long-range transportation plan
MBTA	Massachusetts Bay Transportation Authority
MCIBAS	Major Corridor Investment Benefit Analysis System
MDOT	Michigan DOT
MoDOT	Missouri DOT
MOE	measure of effectiveness
MPO	metropolitan planning organization
MSA	metropolitan statistical area
NHB	non-home–based
NHDOT	New Hampshire Department of Transportation
NHPN	National Highway Planning Network
NHS	National Highway System
NHSTMS	New Hampshire Statewide Travel Demand Model System
NHTS	National Household Travel Survey
NJDOT	New Jersey DOT
NPTS	Nationwide Personal Transportation Survey
O-D	origin–destination
ODME	O-D matrix estimation
ODOT	Ohio DOT
ODOT	Oregon DOT
OMI	Oregon Modeling Improvement Program
OMSC	Oregon Modeling Steering Committee
PM	performance measure
PUMS	Public Use Microdata Sample
RCI	Roadway Characteristics Inventory
RMSE	root-mean-square error
ROW	right-of-way
RPC	regional planning commission
SIP	state improvement plan
SIS	strategic intermodal system
SOV	single occupant vehicles
SPR	state planning and research
STCC	Standard Transportation Commodity Code
STN	state trunk network
TAFIS	traffic analysis and forecasting information system
TAZ	travel analysis zone
TDM	travel demand models
TIP	transportation improvement plan
TLUMIP	Transportation and Land Use Model Integration Project
TOC	technical oversight committee
TRB	Transportation Research Board
V/C	volume to capacity
VDOT	Virginia DOT
VHT	vehicle hours traveled
VIUS	Vehicle Inventory and Use Survey
VMT	vehicle miles traveled

VOC	volatile organic compounds
WisDOT	Wisconsin DOT
WISLR	Wisconsin Information System for Local Roads
WSA	Wilbur Smith Associates
WSDOT	Washington State DOT

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