Improved Models for Better Decisions

Planning Models, Traffic Operations Models, and Activity-Based Models

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Decisions about spending public funds for transportation improvements often are informed by estimates and forecasts developed through mathematical models. The more closely these models represent reality and include important influencing factors, the more confidence we can have in spending decisions. Models that can provide a better basis for predicting how highway improvements affect congestion, for example, or that reflect the differences in forecasting freight demand and passenger transportation will provide a more reliable picture of future needs.

The process is neither simple nor inexpensive, which is why taking up the challenge at the national level makes sense. Traffic operations and planning models generally require both demand and supply inputs. Travel demand could be static (for planning models), dynamic (for planning and operational models), or in the form of activity schedules (for activity-based models). In virtually all applications, actual travel demand cannot be perfectly forecast and is subject to a variety of disturbances, including special events, day-to-day variation in individual behavior, (unfamiliar) visitor traffic, and diversion from temporary unavailability of alternative modes. On the supply side, the operational capacity of network elements could be assumed as fixed, random, or systematically varying with traffic conditions through actuated signal controls, ramp metering, dynamic tolls, and so forth. Unreliability sources that affect supply-side attributes consist of incidents, work zones, weather, traffic control, dynamic pricing, and variation in individual driving behavior. To address these and other concerns, several projects from the SHRP 2 Capacity and Reliability focus areas are working to improve existing planning models, operations models, and activity-based models.

Models for Predicting Nonrecurring Congestion

How can we predict what effect an improvement will have on travel time reliability? Alternately, how can we characterize reliability as a function of highway, traffic, and operating conditions? To answer these questions, the research team in SHRP 2 Project L03: Analytic Procedures for Determining the Impacts of Reliability Mitigation Strategies developed models for predicting nonrecurring congestion, which is caused by events such as traffic incidents and weather conditions.

Three methods were used to estimate nonrecurring congestion, all based on empirical procedures: The first involved before-and-after studies; the second was termed a “data poor” approach and resulted in a lean and easy-to-apply set of models; and the third was called a “data rich model” and used cross-section inputs including data on selected factors known to directly affect nonrecurring congestion.

Much of the effort for the study went into the creation of a cross-sectional dataset from which statistical models could be developed. The final analysis data set for statistical modeling is highly aggregated: each record represents reliability, traffic, and event data summarized for a section for a

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year. Reliability is measured as the variability in travel times over the course of a year. As such, the cross-sectional model is a macroscale model: It does not seek to predict the travel time for a particular set of circumstances; rather, the overall travel-time characteristics of a highway section in terms of both mean and reliability performance. The cross-sectional model is, therefore, appropriate for adaptation to many existing models and applications with the same aim, and can serve as the basis for conducting cost/benefit analysis; however, it is not appropriate for real-time travel-time prediction.

Status: Project L03 is complete. The final report, currently in publication, will be available on the SHRP 2 website and as a printed document.

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Incorporating Travel Time Reliability Performance Measures into Traffic Simulation Models and Planning Models

Project L04 has dual objectives: to develop the capability of producing measures of reliability performance as output in traffic simulation models and planning models; and to determine how travel demand forecasting models can use reliability measures to produce revised estimates of travel patterns.

Addressing reliability in models, particularly operations, generally requires three elements. First is a scenario manager which captures outside sources of reliability such as special events, bad weather, work zones, and daily variation in travel demand. Second are simulation tools (micro or macro) that internally account for unreliability (e.g., flow breakdown, accidents). Third is a vehicle trajectory processor, which derives vehicle trajectories or paths from the simulation output. Trajectories can be used to develop travel time distributions, which in turn can be the basis for travel time reliability metrics.

The project team is currently adapting and calibrating existing traffic simulation models and applying them to an urban network. A mesosimulation model will provide a regional perspective and a microsimulation model will provide a close-up portrayal. To accomplish this, the project team is working with a regional transportation agency. The simulation models are expected to use random seeds, reflect the basic variability in travel time due to operations at saturation (such as recurring congestion), and produce one or more reliability performance measures as output.

The models are being developed for two primary sets of users: (1) practitioners and researchers, who may have a keen interest in the fundamentals of the modeling application to incorporate reliability in the analysis; and (2) operations managers and planners in transportation agencies, who may be interested primarily in the procedures employed to estimate reliability and the practical outcome of actions to improve reliability.

As part of this project, a guide is being written that will define the state of the art for incorporating travel time reliability in simulation-based operational studies. The guide will not be limited strictly to microscopic traffic simulation models, but rather will include any simulation that can produce individual vehicle trajectories.

Status: This project is active. The expected completion date is September 2012.

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Freight Demand Modeling

Freight is growing in volume, economic importance, and complexity—particularly in relation to sophisticated modal and information technology advances. Understanding freight flows and forecasting them is critical to determining the need for future transportation capacity on the nation's highways or other modal infrastructure. However, most existing freight demand forecasting models and data sources are based on methods and tools developed for passenger transportation, which are not well suited for forecasting freight movements or volumes. The overall objective of SHRP2 project C20: Freight Demand Modeling and Data Improvement Strategic Plan is to foster fresh ideas and new approaches to designing and implementing freight demand modeling.

In this project, a Freight Demand Modeling and Data Improvement Strategic Plan was developed to advance a broad new direction for improving freight planning; promoting continuous innovation for breakthrough solutions to freight analytical and data needs; and fostering a collaborative approach for private, public, and academic stakeholders. The plan was developed through an inclusive process of public and private stakeholders from the U.S. and international freight planning communities, culminating in the Freight Modeling and Data Innovation Symposium conducted in September 2010. A robust approach was followed to define needs and innovations, and to shape the long-term goals. The hallmark of this effort was considering the current state of the practice to maximize input from practitioners and decision makers. This entailed a review of research conducted on freight modeling and data improvement as well as analysis of current practices within the industry (both domestic and international).

The Freight Demand Modeling and Data Improvement Strategic Plan identifies a compelling direction for the freight planning community centered on meeting the immediate needs of decision makers. The pragmatic focus on application and results also recognizes the parallel need to foster continued innovation and breakthroughs among researchers. This confluence of steady improvements in practice and continued research focus will be the basis for long-term improvements to freight modeling and data. This research project focused on defining the critical gaps in models, data, and decision making as the means to formulate a strategic and cohesive road map to guide the long-term initiatives identified throughout the research process.

Project Status: This project is complete. The final report and the strategic plan, currently in publication, will be available on the SHRP 2 website and as printed documents.

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Integrated, Advanced Travel Demand Models

SHRP 2 has two projects (C10A: Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-grained, Time-Sensitive Network [Jacksonville, Florida]; and C10B: Partnership to Develop an Integrated Advanced Travel Demand Model with Mode Choice Capability and Fine-Grained, Time-Sensitive Networks [Sacramento, California]) that will improve modeling and network processes and procedures in order to address policy and investment questions, and to facilitate further development, deployment, and application of these procedures. In addition, these models will produce a transferrable product, process, and sample data set that can be adapted for use elsewhere or used for research; incorporate SHRP 2 Capacity products from projects on pricing and operations into the model capabilities; incorporate travel time reliability into the modeling capabilities; demonstrate the application of outputs of the integrated model to estimate greenhouse gas emissions; and demonstrate the dynamic integrated model set in a real-world environment. Both model sets will reflect changes in the nature of demand, mode choice (including “new modes” such as work or shopping at home and nonmotorized travel), destination choice, timing, route of travel as a response to highway network congestion, roadway management strategies, road pricing, transit service, parking policies, and other public policies aimed at reducing congestion. Both sets will also deal with the consideration of reliability in travel choice.

Jacksonville, Florida: An Advanced Travel Demand Model and a Fine-grained, Time-Sensitive Network

In project C10A, the project team has partnered with the North Florida Transportation Planning Organization, whose region covers the Jacksonville metropolitan area. Jacksonville is the fifth most populous of Florida’s 26 metropolitan planning organization (MPO) regions and is anticipated to grow to 1.6 million people by 2030. Jacksonville is the eastern terminus of Interstate 10, and Interstate 95 passes through the city, leading to substantial freight and interregional passenger car volumes on the region’s transportation backbone. This local, regional, and interregional travel demand, when coupled with a road network that includes five major downtown bridges, leads to challenging traffic dynamics and interesting time-of-day and route choices.

The model system being tested comprises three primary components: DaySim, the TRANSIMS Router and Microsimulator, and the Motor Vehicle Emission Simulator (MOVES). DaySim is a travel demand forecast model that predicts household and person travel choices at a parcel-level on a minute-by-minute basis. The TRANSIMS Router and Microsimulator are dynamic traffic assignment and network simulation software that tracks vehicles on a second-by-second basis. MOVES is the next generation mobile source emission model being developed by the U.S. EPA. MOVES will estimate emissions from mobile sources and will replace MOBILE as the approved model for state implementation plans and regional or project-level transportation conformity analyses. The integrated model system will be established by enhancing and linking these model components in order to provide sensitivity at greater level of spatial and temporal resolution to the key policies.

The travel demand model to be used for this project is coded in a software framework called DaySim. DaySim was initially implemented in Sacramento, California, by the Sacramento Area Council of Governments (SACOG). It is being enhanced in Jacksonville to interface with the TRANSIMS Router. In addition, the project was amended to test transferability of model parameters to other cities (Tampa, Florida).

Status: This project is active. The expected completion date is February 2012.

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Sacramento, California: An Integrated Advanced Travel Demand Model with Mode Choice Capability and Fine-Grained, Time-Sensitive Networks

In project C10B, the project team has partnered with SACOG, the designated MPO for the Sacramento metropolitan area. Sacramento has light rail in addition to a bus system, providing a more varied modal environment for model development.

The project team will combine capabilities of an activity-based travel demand model with a traffic simulation model. The integrated model will combine the SACSIM activity-based model, the DynusT traffic microsimulation model, and the MOVES mobile source emission model. The Sacramento model will include a schedule-based transit simulation for assigning transit trips.

SACSIM is a complete modeling system that includes a disaggregate activity simulator called DAYSIM. DynusT is a recently-released, open-source license traffic simulation package already used in a number of areas, and it lends itself well to the integration with both SACSIM and MOVES. DynusT is a true disaggregate simulation model that tracks individual vehicles and transit travelers through the network—consistent with tracking traveler activities in a travel demand model. MOVES is designed to estimate emissions at scales ranging from individual roads and intersections to large regions.

The software architecture provides users the capability to access the integrated system from any web browser. The goal is to ensure that the integrated model software is efficient, modular, and maintainable so as to reduce the risk that changes to one model component will affect the operation of the model as a whole. The complete, integrated model will be available to the transportation community under open-source licenses.

Status: This project is active. The expected completion date is February 2012.

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