A model approach

The story behind the deployment of a multipurpose traffic simulation framework for the 400-Series freeways and major arterial roads in the Greater Toronto Area

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he Ontario Ministry of Transportation (MTO), one of North America’s most prominent transportation agencies, has often turned to innovative methods to handle traffic growth and congestion issues in the Greater Toronto Area (GTA). Over the past 12 years, MTO has grown more reliant on microsimulation as the analysis tool of choice for the majority of its traffic planning and operational review projects. This accumulated experience has now led MTO to a new approach for its analytical needs – namely the development of a multipurpose, multilayer traffic simulation framework for the freeway and major arterial road network in the GTA.

Macroscopic modeling has proved its worth over many years for the forecasting of future travel demand in support of MTO’s highway planning and programming. In recent years, microsimulation has also become a valuable element of the traffic engineers’ toolbox. For example, in 2009, MTO was faced with 75 overnight closures of the eastbound Highway 401 express lanes to rehabilitate an 8km-long section between Kipling Avenue and the Basketweave (a section of Highway 401 whose name derives from the cross-cutting design of the road). A microsimulation analysis demonstrated that the work could instead be conducted through two weekends of full closures without causing operational breakdowns of the highway, saving around CAD1.9 million (US$1.76 million). Comparison of the microsimulation results with performance data collected during the closures proved the efficacy of the model as a decision-support tool, and has led to awards and wide recognition throughout the industry.

A THREE-TIER FRAMEWORK

Today, many transportation agencies choose microsimulation analysis as a key requirement. It is used to evaluate the benefit of proposed highway or interchange improvements, provide travel-time estimates in the forecasting of high-occupancy vehicle (HOV) use, and evaluate the impact of lane closures in workzones. It is also used for analyzing the operation of toll facilities, HOV lanes, roundabouts, and other features not easily evaluated via macroscopic models.

The experience accumulated through such projects has now led to the idea of consolidating all relevant modeling in a comprehensive traffic simulation framework. The aim of this framework is threefold:

First, it ensures consistent modeling results across studies (which is currently an issue due to variability in the software packages used and the quality of the models produced). Secondly, it minimizes overlap and duplication in model development and testing thus making efficient use of MTO’s modeling budget. Finally, it facilitates timely decision support by MTO management.

The framework was conceived so as to enable the most appropriate model (in terms of level of detail and efficiencies of scale) to be used.

LEVELS OF MODELING

Most transportation modeling to date has focused on macroscopic or microscopic models. The simulation framework being adopted by MTO, however, involves three levels (macro, meso, and micro). This third ‘middle’ layer provides more detail than macro models for network-wide analysis of traffic operations/management strategies, HOV forecasting, intersection-level traffic estimations, etc. It also improves efficiency where analysis does not require the full detail of macro models, or where a very large area is being modeled. Delcan and MRCs task was to develop requirements and evaluate software tools for a three-layer framework.

A macroscopic level incorporating the broader region’s Emme-based travel demand forecasting model is already available through MTO’s previous initiatives. It is large-scale (extends beyond the GTA) and is suitable for area-wide, strategic planning analysis. It is a useful input for the other layers of modeling in this project.

A microscopic level is being developed under the current project. This has a high level of detail and is suitable for analysis of traffic and transit operations in highway corridors or sub-areas.

Microscopic modeling is a relatively recent development and has been somewhat limited in use on behalf of MTO until this project was started. It filled a void between the two other layers, enabling evaluations that might require more detail than a macroscopic model can provide and yielding improved efficiency over a macroscopic model. For example, an HOV forecasting study completed just before this project began required a cumbersome, manually driven interaction between the available macroscopic and microscopic models. The need to interact arose as neither model was on its own sufficient or suitable for the problem at hand. Using a macroscopic model alone would not provide the required discrimination in travel-time estimates while a microscopic model of the GTA system would have been onerous to develop and time-consuming to run. This project could have been completed with improved reliability of results and at a much lower cost if a microscopic model had been available.

RIGHT TOOL FOR THE JOB

After evaluating the various software platforms available, Aimsun (from TSS – Transport Simulation Systems) was selected for proof-of-concept (POC) testing as the mesoscopic/microscopic software platform. It was chosen to be compliant with the framework’s functional specifications, has a common network and database that supports all levels of modeling, and has a good interface with the existing Emme travel demand model.

For MTO, it was also important to choose a product that had proven consistency in results from micro and meso layers, plus powerful, efficient windowing-in on sub-areas for detailed analysis. In short, the outcome of the evaluation was a pleasant surprise: virtually all of the functional specifications developed for the framework could be met by a single package, and those that could not were already a firm part of the product roadmap.

FINDINGS AND BENEFITS

Delcan and MRC developed a POC model to validate the three-layer approach and to confirm that Aimsun indeed meets the detailed functional requirements of the MTO. The POC is currently undergoing approval by MTO. The evaluation included several key aspects. One of the first requirements was to ensure interfacing with the Emme-based demand forecasting model. For MTO, it was also important to choose a product that had proven consistency in results from micro and meso layers, plus powerful, efficient windowing-in on sub-areas for detailed analysis. In short, the outcome of the evaluation was a pleasant surprise: virtually all of the functional specifications developed for the framework could be met by a single package, and those that could not were already a firm part of the product roadmap.

With the approval of the Ministry being imminent, the geographic expansion of the framework eastwards has already started. Eventually, the framework will include the entire highway system in the GTA.

"Our consultants have proved to me that efficiencies can be gained by consolidating our traffic modeling in a multipurpose, multilayer simulation framework and by adopting a fast, efficient microscopic modeling engine as the ‘heart’ of our simulation software platform,” says Goran Nikolic, MTO’s head of Traffic Planning & Modeling. He views the framework as MTO’s preeminent analytical tool for future traffic planning, operational reviews and strategic decision-making – potentially, MTO’s implementation of the integrated corridor management concept.

Studies that have been recently completed or are now underway include consideration of HOV lane implementation first as a use for new highway lanes. Microsimulation has been used to confirm HOV lane access zone and terminus locations, forecast HOV lane use, and evaluate measures to improve operations, such as speed change lanes between the HOV and general-purpose lanes. Prior to the multilayer Aimsun framework, these tasks involved cumbersome manual interlinking between macroscopic and microscopic models and extensive updating and revisions to two separate models with independent networks and databases. With the new framework, such operations can be conducted seamlessly and most efficiently, making extensive use of the fast microscopic level within a prebuilt framework. In the case of HOV forecasting, network-wide shifts to HOV use – dealt with at the macroscopic level – had to be considered separately from conversion to HOV within the corridor, addressed at the microscopic level. With the Aimsun framework, this can be properly considered at the same time using the microscopic level. The same also applies to studies that included evaluation of HOV and HOT lanes, and general-purpose lanes as alternative uses of new highway lanes.

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