HOW WE GO

Niagara Region Transportation Master Plan

Regional Travel Forecasting Model Update Summary

IBI Group in association with
Parsons and Brook McIlroy

NIAGARA 2041

Fostering an environment for Economic Prosperity

1 Introduction

The Niagara Region Travel Forecasting Model is a tool used to predict and analyze travel behaviour in the Regional Municipality of Niagara and in the western municipalities of the Greater Toronto and Hamilton Area (GTHA). Since the mid-1980s, the model has been used by the Region to provide traffic forecasts for new transportation initiatives, analyze the impact of new policies, and provide quantitative backing for strategic and operational studies (e.g. traffic impact assessments, environmental assessments).

The Region's model was last updated in 2008 and implemented in TransCAD. The model simulated p.m. peak hour traffic on roads within Niagara Region, the City of Hamilton, and parts of Halton Region and western New York State. The improvements introduced at that time included re-estimation to 2006 Transportation Tomorrow Survey (TTS) data, and modest refinements to the zone system and road network. This memorandum summarizes the work performed to substantially redevelop the model into a state-of-practice multi-modal forecasting tool that is sensitive to socio-demographic changes, transportation policy, and new infrastructure.

2 Purpose

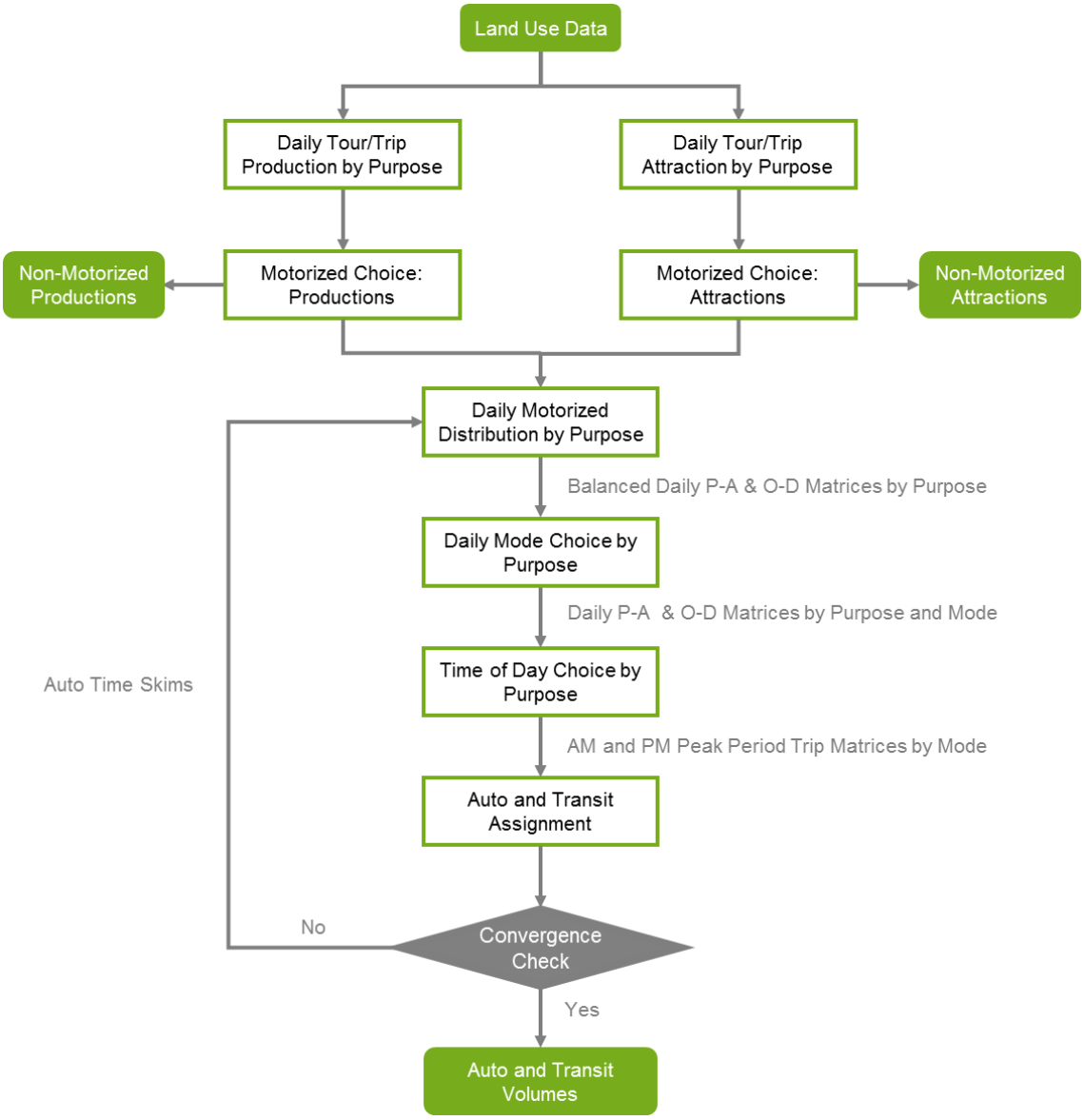
The Travel Forecasting Model is a tool used to quantify changes in travel behaviour, congestion, transit ridership, and many other metrics in response to changing demographic and transportation conditions. The model is able to predict the changes in the total number of trips in the Region in response to a growing population, along with their destination, travel mode, and route. This information is used to inform the planning of new transportation infrastructure by assessing where it will be needed the most.

The primary driver of this model update is to re-estimate and calibrate the model to new travel behaviour data made available through the release of the data from the 2011/12 TTS. However, this update also introduces substantial improvements that:

- increase the model's sensitivity to land use and network changes in support of the Region's Transportation Master Plan;
- add the facility to forecast transit travel; and
- model both the a.m. and p.m. peak periods.

3 Architecture

The updated model follows the same four-stage structure common to most urban transportation forecasting models: generation, distribution, mode choice, and assignment. However, as illustrated below, there are additional sub-models that are included to improve the model's accuracy and to add sensitivity to various inputs.



The function of the modules presented above are summarized below:

- **Tour/trip production and attraction** calculates the number of daily tours and trips produced by and attracted to each of the model's internal traffic zones. Trips and tours are always "produced" at home, while they are "attracted" to some other destination (e.g. work, school etc.) Different

production and attraction rates are calculated for the following trip and tour purposes:

  - Home-based work tours (sub-divided into three occupation types);
  - Home-based school tours (sub-divided into two categories by age);
  - Home-based other trips; and
  - Non-home-based trips.

  Per the above, only home-based work and home-based school travel are modelled as tours, while home-based other and non-home-based travel are modelled as trips.

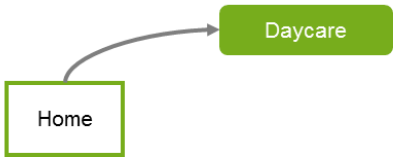
- **Motorized choice** uses a binary logit model to determine the number of motorized productions and attractions by zone. Non-motorized productions and attractions (i.e. walk and bicycle trips) are saved, but are not used in any subsequent modelling steps.
- **Tour/trip distribution** determines the number of daily tours between each production and attraction (for home-based work and home-based school purposes) and the number of daily trips between each origin and destination (for home-based other and non-home-based purposes). Balancing is performed in Emme and tours/trips are distributed using gravity (work, other) and proportioning (school, non-home-based) models.
- **Mode choice** determines the percentage mode split for daily tours/trips between each of the model's zones. Different multinomial logit models for each trip purpose are applied to carry out this calculation.
- **Time of day choice** uses factors derived from the TTS to allocate daily productions and attractions into different time periods throughout the day. Trip matrices from the a.m. (6:00–8:59) and p.m. (15:00–17:59) peak periods are retained for assignment.
- Trips are **assigned** to the network to determine auto and transit volumes on each network link. Auto travel times are then fed back to the tour/trip distribution model, and the process loops until sufficient convergence is achieved between iterations of the model.

3.1 Tour-Based Framework

As previously noted, home-based work and school travel is modelled at the level of tours, while home-based other and non-home-based trips are modelled at the level of trips. The table on the following page defines these different terminologies and constructs a hypothetical home-based work tour from its constituent trips.

A **trip** is the movement from a single origin to a single destination for a given purpose.

Home-Based Other Trip

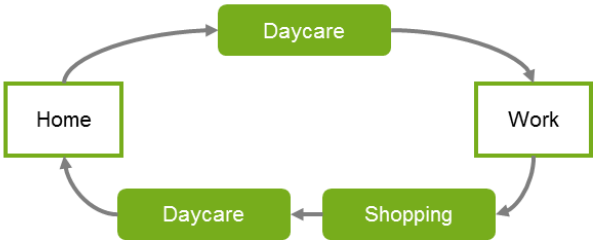


A **journey** is a "primary movement" from a "primary origin" to a "primary destination". A journey consists of one or more trips. Journeys typically represent "half tours". For example, a tour consisting of trips from home to daycare, daycare to work, work to shopping, shopping to daycare, and daycare to home can be defined as consisting of two journeys: a home-to-work journey (which involves two trips) and work-to-home journey (which involves three trips).

Home-to-Work Journey

A **tour** is a linked set of trips in which the destination of the second trip is the origin of the first trip, etc. A tour begins and ends at the same location, referred to as the **anchor point** for the tour. Most tours are **home-based**; i.e., they begin and end at home. Tours with other anchor points (notably the workplace) are also possible. Tours are also referred to as **trip chains**.

Home-Based Work Tour



The key advantage of the concept of the tour is that it allows the model to maintain behavioural linkages between home and work where there are intermediate stops on the journey. Work is the main reason for the tour and provides stronger basis for estimating work travel. Additional stops between home and work (which break journeys into more than one trip) are generally secondary to these primary movements.

4 Summary of Improvements

In addition to improvements to the overall architecture, the new model includes the following procedural and structural improvements:

- **Zone system:** A completely new traffic zone system was developed for this model, replacing the former Traffic Analysis Zone and Model Analysis Zone systems. To the extent feasible, zones were designed to follow natural and man-made features, to contain relatively homogeneous land use, to be compatible with more aggregate geographic zone systems (e.g. municipal boundaries), and to evenly distribute population and employment, with additional resolution around areas with future growth potential and higher-order transit. This process resulted in a total of 456 zones within the Region.
- **Network development:** The existing model's road network was substantially updated to incorporate several improvements. These include an overall refinement of the road network (i.e. an increase in the number of links represented in the model), improved representation of free flow speeds to account for delay experienced at traffic signals, re-coding of centroids and centroid connectors, and, for the first time, explicit modelling of the Region's transit networks. Both road and transit networks were coded to the specifications of the University of Toronto's Travel Modelling Group (TMG) Network Coding Standard.
- **TTS re-expansion:** Many models in the GTHA scale land use inputs (population and employment estimates by zone) to match TTS control totals. This update has undertaken the opposite process in recognition of the issues inherent in TTS land use data (particularly for employment). As such, a basic re-expansion of the TTS was undertaken to match population and employment control totals more closely to land use inputs.
- **Under-reporting factors:** This update includes explicit adjustments to the TTS database to account for trip under-reporting arising from two sources. The first factor accounts for the fact that, on the whole, TTS survey respondents tend to under-report trips made by other members of their household—particularly for home-based other and non-home-based trips. The second factor accounts for an overall under-reporting of non-work, non-school trips.
- **Disaggregation of tour/trip purposes:** There exist substantial differences in behaviour within work and school trips that were not captured by the previous model. Consider, for example, the differences in travel behaviour between a construction worker and an office worker. To account for this, work and school trips are disaggregated in this update to account for internal variations. Work trips are disaggregated into three occupation categories, while school trips are disaggregated by age (corresponding to post-secondary and elementary/secondary students).

- **School trip distribution:** The updated model distributes school trips according to a singly-constrained proportioning model. Using a seeded base-year matrix, trips are scaled to match future-year productions while continuing to constrain growth in trip destinations to zones that contain schools. This ensures that future year distribution is sensitive to growth in new population centres, which is particularly important in high-growth areas.
- **Mode split:** Previous iterations of the Region's model did not explicitly model mode choice. Only auto trips were modelled, with transit and active modes removed from trip tables on the basis of static factors. In this model update, logit mode split models explicitly simulate the choice between active, transit, and auto modes for a variety of trip purposes.
- **GO Rail:** In recognition of proposals to expand GO Rail service into Niagara Region, this update includes functionality to predict future travel on GO rail through the main logit mode choice model.