The MTO Greater Golden Horseshoe Model

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A Workshop on Travel Demand Modelling in the GTHA
Agenda

• Overview of Modelling System
  – Model hierarchy
  – Model features
  – Model process
• Advancing the State of Practice
  – Comprehensive land use forecasting
  – Tour-based approach
  – Land use-transportation link
• Questions
Overview of Modelling System
The GGH Model

- Developed in 2008 for the Ministry of Transportation, Ontario
- Comprehensive “best practices” regional transportation model for a large rapidly growing “mega-region”
- Designed to be sensitive to Provincial Growth Plan objectives promoting sustainable transportation and reduced urban sprawl:
  - Balanced, efficient transportation system
  - Encourage transit, walk and cycle modes
  - Integrated transportation-land use planning
  - Protect environment
- Applications to Date:
  - Metrolinx “Big Move”
  - Metrolinx Benefit Cases
  - MTO EAs
The GGH Model is a regional forecasting tool, where does this fit within a modelling hierarchy?

- **Regional Model**
  Strategic, multi-modal, 4-stage model, covering entire urban area

- **Sub-area / Corridor Model**
  Detailed, multi-modal network assignment model, covering the study area
### Two Levels of Models

<table>
<thead>
<tr>
<th></th>
<th><strong>Strategic Regional Model</strong></th>
<th><strong>Sub-area / Corridor Model</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>Entire metropolitan area, addressing travel within and through the region</td>
<td>Sub-area/corridor, addressing travel within and through the corridor / sub-area</td>
</tr>
<tr>
<td>Application</td>
<td>Long-range regional land use and transportation planning</td>
<td>Evaluation of alternatives within the corridor to support project appraisal and EAs</td>
</tr>
<tr>
<td>Modelling Tool</td>
<td>Macro modelling software like Emme</td>
<td>Could be in the same macro model platform, or an operational (meso/micro) model platform such as DYNAMEQ, VISSIM or Madituc for transit.</td>
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GGH Model Approach

- Four-stage modelling process time-tested and still relevant today, but demands on models have grown
- Traditional tools, originally developed in the 1950s for highway planning, have typically not focused on sustainable transportation
- Transit/walk/cycle modes do not have the freedom of the private automobile presenting challenges:
  - Complex trip-making
  - Land use, household structure, employment status, demographics strong influence transit use
  - largely transit captives in suburban areas
- The deck can be stacked against sensitivity to transit in traditional four stage models

The GGH Model is built to more accurately capture the factors that impact the use of sustainable modes
Model Features

- Traditional Four-stage model with special features
- Model Area
  - Entire GGH covered by over 3000 traffic zones
- Designed to be sensitive to Growth Plan and other policy initiatives
GGH Model Overview

**Ten trip purposes:**
- Work (4): general office, manufacturing, professional, retail/sales/services
- School (3): post-secondary, secondary, elementary
- Shopping
- Other
- Non-home based

**Ten modes/sub-modes:**

- Auto Drive
- Auto Passenger
- Transit
- Walk / Bicycle
- Transit Walk Access
- Transit Auto Access
- Commuter Rail Walk Access
- Commuter Rail Auto Access
- ...
Model Process

**Inputs**
- Calibrated to 2001 TTS Survey
- Land Use inputs based on 2001 census

**Trip Generation & Auto Ownership:**
- Auto ownership based on ordered logit model, based on household type, component person types (i.e. worker/student/non-worker types), neighbourhood features, proximity to rapid transit
- Detailed cross-classification to obtain trip rates by purpose with segmentations by household structure, person type, auto ownership; also regression equations
Trip Distribution

- Work Journeys
  - Gravity model segmented by occupation (4 categories)
  - Impedance from mode choice model “log-sum”
- Post-Secondary School
  - Gravity model using same log-sum term as the work model
- Elementary & Secondary School
  - Singly-constrained logit destination choice models
- Other, Shopping & Non-Home-Based
  - Trip-based approach, using a fratar distribution
Model Process <cont>

**Mode Choice**
- Home-based work and school
  - Models the home-destination-home tour as a joint mode choice across the two time periods, using service levels for the two peak periods in an integrated manner
  - Nested logit model with 8 modes for work and post-secondary school purposes (lower transit nest)
  - Park-and-ride station choice model (logit)
- Other trip purposes
  - Modeled with multinomial logit models
- Range of variables to maximize explanatory power and sensitivity
  - Level-of-service, cost, spatial/land-use, vehicle ownership and demographic variables

**Trip Assignment**
- EMME user equilibrium auto and transit assignments for the a.m. and p.m. peak periods
Advancing the State of Practice in the GTHA
Important Advances

1. Comprehensive land use forecasting

2. Tour-based approach

3. Explicit land use – transportation interactions
1. Comprehensive Land Use Forecasting

- Land use cohort model predicts changes based on a series of assumptions on the ageing of the population, immigration rates, changing industry mix and labour force productivity.
- Reflects future trends:
  - Age distribution of the population will change significantly
  - Dwelling preferences changes by age of household
  - Growth Plan imposed shifts in structural types permitted
  - Employed by industry mix will change significantly
- Models the organic demographic change that occurs over a 30 year period.
- Is a significant advance over more simplistic land use projections that have been used in the past.
Model Projections Reflect Changing Socioeconomic and Demographic Conditions

Travel affected by:
- Household structure
- Age
- Income
- Type of job

Influences:
- Housing type
- Auto ownership

Changing Household Structure (2001 - 2031)

Changing Age Structure (2001 to 2031)
Growth Plan Initiatives Reflected in Land Use/Housing Type Model Inputs

Type of housing defined for each area, reflecting household structure, income, etc., consistent with the Growth Plan and municipal plans.

Type of Housing, 2001 and 2031

Toronto

Rest of Greater Toronto Area
Model Projections Reflect Changing Employment

1976 to 2031 Ontario Employment Base

Manufacturing

Professional, Scientific and Technical Services

Business and Building Support Services

Other Primary

Agriculture
What is a Tour?

- A tour is a complete movement leaving home and returning home again.

Why Tour Based?

- Focuses analysis on the primary movement that generates the trip (i.e. work or school), while filtering out the noise of relatively unimportant stops within the journey.
- As a result, provides significantly more explanatory power relative to conventional trip-based models.
- Need to model both a.m. and p.m. peak periods.
- Can be a precursor to more complex activity-based model systems.
3. Land Use – Transportation Integration

Challenge:

- How to model significant increases in transit use in rapidly growing suburban areas and transform the region?

Response:

- Focused “Growth Plan-sensitive” tools with detailed segmentations to capture key relationships and markets:
  - Travel by different types of people
  - Relationships with land use, urban form, density
  - Capture travel experience, not just cost and travel time
## Connection between Land Use Type and Network Accessibility

### Land Use Area Type Classification:

<table>
<thead>
<tr>
<th>Land Use Area Type</th>
<th>Range</th>
</tr>
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<tbody>
<tr>
<td>Central Business District</td>
<td>&gt;200 people+ jobs/ha</td>
</tr>
<tr>
<td>Urban - High Density</td>
<td>120 – 200</td>
</tr>
<tr>
<td>Urban – Low Density</td>
<td>80 – 120</td>
</tr>
<tr>
<td>Suburban – High Density</td>
<td>50 – 80</td>
</tr>
<tr>
<td>Suburban – Low Density</td>
<td>10 - 50</td>
</tr>
<tr>
<td>Rural</td>
<td>0 - 10</td>
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</tbody>
</table>

- Land Use Area Type used to help define transportation network attributes:
  - Walk time to transit
  - Walk/cycle characteristics
  - Arterial road characteristics
  - Transit route characteristics
- Example: walk time to transit is 30% greater in suburban versus urban areas
Summary

• GGH Model is a state of practice forecasting model for the GTHA
• Has several important features allowing it to have increased sensitivity to sustainable modes of travel as well as to the impacts of land use changes as prescribed under the Growth Plan
  – Detailed land use forecasting
  – Tour-based approach
  – Land use – transportation link

Questions?