

travel
modelling
group



ANNUAL REPORT, 2017-18

DRAFT

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1. INTRODUCTION

This document describes the activities of the Travel Modelling Group (TMG) during its seventh year of operation, 2017-18 (April 1, 2017 through March 31, 2018).

Section 2 describes the budget and resources of the TMG during the reporting period. Section 3 then provides an overview of TMG activities with a comparison to the proposed work plan for the year. Finally, Section 4 summarizes TMG accomplishments in 2017-18.

2. 2017-18 BUDGET & REVENUES

Table 2 1 presents the 2017-18 TMG expenditures and revenues. This budget supported two full-time technical staff persons (Bilal Yusuf, Network Modeller/Analyst and Brendan Reilly, software programmer/designer, one day a week of UTTRI's Senior Software Architect, James Vaughan and one graduate summer student research assistant (Pablo Orozco).

Table 2.1: 2017-18 Expenditures & Revenues

TMG Budget	2017-18				
Expenses	Amount				
Salaries ¹	\$173,760.00				
Supplies, Misc. Expenses	\$250.00				
Emme Licence Maintenance	\$3,000.00				
Contingency	\$0.00				
Overhead (@40%)	\$65,571.43				
Total Expenses	\$242,581.43				
Revenues	2017-18				
Member Contributions	Amount				
Metrolinx	\$64,000.00				
MTO	\$32,000.00				
City of Toronto	\$32,000.00				
City of Hamilton	\$19,000.00				
Region of Durham	\$19,000.00				
Region of Halton	\$19,000.00				
Region of Peel	\$19,000.00				
Region of York	\$19,000.00				
City of Mississauga	\$6,500.00				
Total Member Contributions	\$229,500.00				
Carry-Forward from Previous Year	\$20,017.55				
Additional Revenue (UofT Subsidy)	\$0.00				
Total Revenues²	\$249,517.55				
Percent Increment relative to 2014-15 base	0.9%				
Percent Increment relative to previous year	6.3%				
Total Revenues-Total Expenses	\$6,936.12				
Contributions-Actual Expenses	-\$13,081.43				
Notes:					
1. 2 full-time TMG staff salaries + benefits + 1 undergraduate summer research assistant + 1 day/week of James Vaughan for 2017-18 only.					
TMG staff salary increases based on an assumed increase of 4% per annum as of July 1 each year.					
2. "Total Revenues" include carry-forward from the previous year.					
University of Toronto In-Kind Contributions					
Principal Investigator Time					
Co-Investigator Time					
Office Space & telephones					
Total					
This excludes other UofT in-kind contributions to TMG that are very difficult to quantify. These include:					
Data Management Group support of TMG					
Internet access					
University of Toronto library access					
Administrative support					
TMG computers & software					

3. 2017-18 PROJECTS & ACTIVITIES

Table 3 1 presents that 2017-18 work plan as approved by the TMG Steering Committee. As indicated in this figure, the work plan tasks divided into 15 primary tasks. TMG activities in each of these areas are discussed in the following sub-sections.

Table 3.1: 2017-18 Work Plan

TMG 2017-18 Work Plan		MONTH											Days Allocated		
No.	TASK	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total ¹	%
1	Multiclass road & transit assignment	4	1	1	1									28	5.3%
2	2016 base network	4	1	1	1	1								32	6.1%
3	Surface transit speed updating		2	2	2	2	1							36	6.8%
4	School trip destination & mode choice models		2	2	2	2	2	2						48	9.1%
5	Investigate auto and transit assignment convergence						2	2	2					24	4.5%
6	Correction procedures for TTS under-reporting of NWS travel		1	1	1	1	1	1	2					32	6.1%
7	Auto passenger travel modelling		1	1	1	1	1	2	2	2	2	2		60	11.4%
8	NWS destination choice		1	1	1	1	1	1	1	1	1	1	3	52	9.8%
9	Commercial Vehicle Generation Modelling						1	1	1	2	2	2	2	48	9.1%
10	GTAModel V4.1 upgrades								1	4	4	4	4	68	12.9%
11	TMG Toolbox Improvements	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	26	4.9%
12	XTMF Maintenance	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	26	4.9%
13	Documentation of TMG products	1	1	1	1	1	1	1	1	1	1	1	1	48	9.1%
14	Outreach & Training (2 workshops)						W1			W2				528	Total
15	Meetings: TMGSC (2) & TMGTAC (6)	TAC		TAC		TAC		SC	TAC		TAC	TAC	SC		
TMG Staff Average Weekly Time Allocation (Days)		11	11	11	11	11	11	11	11	11	11	11	11		
Suggested Workshops															
W1 Multiclass Assignment															
W2 Modelling Improvements															
Legend															
n	Light, on-going effort	n = approximate, average number of TMG days per week for this task													
n	Heavy, focussed effort	Includes allocation of time for documentation, meetings, etc.													
1 Estimated total days allocated to the task, assuming 48 working weeks per year (staff take 2 weeks vacation and the University closes for about 2 weeks/year).															

3.1 Multiclass Road & Transit Assignment

Multiclass road assignment has been coded into XTMF and tested. A generalized road assignment module has been developed that supports single-class and multiclass assignment and is available for general use.

Extensive testing of transit multiclass assignment procedures was undertaken, with very mixed results, especially when using congested assignment. It has proven to be surprisingly difficult to get plausible multiclass transit assignment parameter estimates. Run times also presented a major problem, as it took more than 40 minutes for each assignment, which further constricted the amount of testing that was possible, even when using multiple servers. This led to investigating the performance of the base Emme transit assignment procedure, which, in turn, led to considerable experimentation with more extensive use of the logit stochastic path assignment procedure than had previous been the case: see Section 3.16 for further discussion of the logit path choice work.

Despite these extensive investigations, a robust multiclass transit assignment procedure remains elusive. It is recommended that it not be implemented in GTAModel V4.1. This issue can be revisited in the future once a stable V4.1 model system has been developed.

3.2 2016 Base Network

The 2016 base network was completed, using the NCS16 coding standard. It is available for partner agency use and will be used in the GTAModel V4.1 update.

3.3 Surface Transit Speed Updating

After considerable experimentation and testing, a robust surface transit speed updating procedure has been developed and is available for partner agency use. It will be implemented in the GTAModel V4.1 update.

3.4 School Trip Destination & Mode Choice Models

This was a student-based task supervised by Prof. Khandker Nurul Habib focussing on investigating post-secondary student travel behaviour using the 2015 StudentMoveTO travel survey data.¹ It generated three papers, which are available upon request:

- The Importance of Peers in Student Cycling Choice: A Discrete Choice Model with Endogenous Social Interactions for the Choice of Owning a Bike by a University Student in Toronto.
- How Far to Live and With Whom to Live? The Role of Modal Accessibility on the Choices of Students' Living Arrangements and the Distance willing to Live from the University in Toronto.
- A Generalized Parallel Constrained Choice Model for Intra-Household Escort 1 Decision of High School Students.

3.5 Auto & Transit Assignment Convergence

The convergence properties of both the Emme auto and transit assignment procedures used in GTAModel V4.0 have been investigated. For auto assignment, the current TMG recommendation is to do a maximum of 80 iterations with a relative gap of 0.01. Based on our new analysis, we now recommend changing the relative gap level to 0.001 but keeping the maximum iteration criteria of 80. This will generally result in converge to a relative gap of approximately 0.002. At this new level, the maximum change in OD travel times is expected to be less than 0.5 minutes, and the maximum link volume change less than 100 vehicles, with the average being lower than 1 vehicle.

For transit assignment, it was found that the current number of iterations used, 5, was not enough to ensure that the network was converged. Based on our analysis, we now recommend using at least 10 iterations, and possibly up to 15, depending on the run time limits of the agency.

For further details concerning this analysis and its recommendations, see the technical report on the TMG web site.

¹ StudentMoveTO was a web-based travel survey conducted in the fall of 2015. The sample frame was all undergraduate and graduate students enrolled at the four City of Toronto-based universities: The University of Toronto, Ryerson University, York University and OCAD University. The UofT component of the survey included the Scarborough and Mississauga campuses, in addition to the main St. George Campus. The survey was sponsored by the Presidents of the four universities. An overall response rate of 8.3% was obtained, resulting in 15,226 respondents. The survey database is maintained by the Data Management Group at the University of Toronto. See <http://www.studentmoveto.ca/> for more details.

3.6 TTS Trip Under-Reporting

Work on this task was deferred until a preliminary release of the 2016 TTS data was available. Trip reporting rates by location (Planning District), purpose, time period and person type for 2016 were examined in detail and compared to the trends in these rates observed in previous TTS's dating back to 1996 (a 20-year time period). A report documenting these findings has been prepared and will be discussed in detail at the first TMGTAC meeting in April 2018 to discuss the need and possible approaches for corrections of trip under-reporting in the TTS.

3.7 Auto Passenger Travel Modelling

A Fourth Year Engineering Science undergraduate student (Qingyi Wang) has been investigating auto passenger modelling in the GTHA for her BSc thesis. She has done a descriptive analysis of both taxi and "carpool" (passengers getting rides with non-household, non-commercial drivers) mode choice in the 2011 TTS, as well as a very preliminary look at reported Uber trips in a preliminary release of the 2016 TTS. She is investigating developing a work-trip mode choice model which splits the current GTAModel V4.0 "carpool" mode (which combines taxi and "true carpool" trips into a single mode) into separate taxi and carpool modes. Her thesis will be completed and submitted in early April 2018. It will provide input into the GTAModel V4.1 design.

3.8 Non-Work/School Destination Choice Modelling

This task was to be undertaken as part of the GTAModel V4.1 update. It has been deferred along with the rest of the update to the 2018-19 work plan.

3.9 Commercial Vehicle Generation Modelling

This task was intended to be a student-based project under the supervision of Prof. Matthew Roorda. Due to Prof. Roorda's time constraints and the unavailability of a suitable student to work on this project until very recently, this task is only just underway. A PhD student has now been assigned to this project and is "getting up to speed" on working with Emme and XTMF. A major task planned for the 2018-19 work year is the conversion by this student of the GGHM V4 Freight Model into XTMF. This work will be assisted by TMG staff and occur under the supervision of Prof. Roorda.

3.10 GTAModel V4.1 Upgrades

This task assumed the availability of the 2016 TTS data by mid-fall 2017. This did not happen due to delays in completing the cleaned, validated, weighted database. As a result, this task has been deferred to the 2018-19 work plan.

3.11 TMG Toolbox Improvements

A primary rationale for the TMG is to develop standard tools, procedures and templates for general use by member agencies. These tools are primarily of two types: XTMF-based modules and Emme/4 Modeller procedures. Tool development occurs in two primary ways. First, TMG staff constantly refine/extend existing tools and develop new tools through the course of their on-going model system development, network coding and testing and other work tasks. Second, recommendations for tool development are generated by the TMGTAC on an on-going basis.

The TMG Toolbox is open source software and is available to anyone through Github. Documentation for the tools is available on the TMG website.

3.12 XTMF Maintenance

As with the TMG Emme Toolbox, the constant evolution of XTMF to enhance its capabilities and use of use is an on-going activity. Version 1.4 is the current operational release. XTMF is open source software and is available on Github. Improvements introduced during the past year include:

- Version 1.4 (as of March 2018)
 - Upgraded run scheduler
 - Linked errors to the modules that generated them
 - Added the ability to target specific databanks in an EMME project
 - Added new language features to the ODMath framework
 - Improved parallel performance of ODMath for high core count computers
 - Converted previous documentation from PDF to a website
 - <http://tmg.utoronto.ca/doc>
 - Added a navigation bar while exploring model systems
 - Additional bug fixes
- Version 1.3 (June 2017)
 - Added Meta-Modules
 - Added the ability to have .Net Generics in a module with a full generic solver
 - Added a generic solution for 'RemoteDataSource' to remove the possibility of runtime type failures
 - Allowed theming of the user interface

3.13 Documentation of TMG Products

Up-to-date documentation of GTAModel V4.0, XTMF and EMME Toolbox modules is available on the TMG web site. Web site improvements and updating are on-going tasks.

3.14 Outreach & Training

A critical component of TMG activities in all phases of its work must be training, technology transfer and outreach. In order to succeed, TMG must be responsive to its collaborating partners' needs. It must also get the tools that it is developing into the hands of its partners for their use. The TMG's role is intended to be one of tool developer, not to be the user of these tools on behalf of its partners in operational applications (except perhaps in special cases). 2017-18 activities in this area included:

- On-going updating and elaboration of the TMG web site.
- Documentation of all procedures, etc. developed by the TMG.
- Seven meetings were held with TMGTAC to discuss work in progress, next steps in the work plan and to disseminate work plan results. In addition to presentations at these meetings by TMG staff, the June 7/17 meeting included an overview presentation by Prof. Baher Abdulhai concerning dynamic traffic assignment (DTA) methods.
- One training session/workshop was held for TMG partners on December 6/17 dealing with a detailed discussion of DTA methods, including current UTTRI research developing a DTA model for the GTHA.

3.15 Committee Meetings

In addition to the TMGTAC meetings discussed in Section 3.14, two meetings with the TMG Steering Committee (TMGSC) were held (on October 4/17 and March 7/18) to discuss work plan progress, budget, overall TMG directions for work and other administrative and supervisory matters.

3.16 Other Activities

As briefly noted in Section 3.1, an unexpected activity this year was a very detailed investigation of how Emme actually identifies feasible paths through the transit network for a given origin-destination (O-D) zone pair. It was discovered that the normal assignment procedure often does not “find” the paths reported by transit users in the 2011 TTS database. A significant reason for this is the aggregate, centroid-to-centroid nature of the model, which can distort the model’s “view” of feasible paths from one zone to another. Adding additional centroid connectors from each zone centroid to the road network can help mitigate this problem.

The largely deterministic nature of the base Emme “strategy” methods for determining paths also, however, plays a significant role in this problem. This can be mitigated to a considerable degree by more extensive use of the “logit path choice” option within Emme, which permits a more probabilistic, “multi-path” assignment of trips between O-D pairs. A full implementation of this approach, in which probabilistic path choices occur at every node in the system would be computationally prohibitive to implement in a large transit network such as the GTHA’s. In TMG’s testing, this full logit approach took 35 hours for a 5 iteration transit assignment on a 36 core server, which is not feasible for an operational model. However, the use of a limited implementation of logit at key nodes in the network (centroids and transfer points between transit service, such as GO-to-TTC) significantly improves the assignment procedure’s performance at modest computational cost. The inclusion of logit also allows for the model to have smoother responses to the testing of various scenarios, rather than large, discontinuous switches in route choices. This new logit path choice procedure has been tested and is recommended for implementation in GTAModel V4.1.

4. SUMMARY OF 2017-18 ACCOMPLISHMENTS

Table 4 1 summarizes the key accomplishments by the TMG during 2017-18.

Table 4.1: TMG Accomplishments 2017-18

Task	Deliverable	Status
1	Multiclass road & transit assignment	Completed
2	2016 base network	Completed
3	Surface transit speed updating	Completed
4	School trip destination & mode choice models	3 papers completed
5	Investigate auto and transit assignment convergence	Completed
6	Correction procedures for TTS under-reporting of NWS travel	On-going
7	Auto passenger travel modelling	On-going
8	NWS destination choice	Deferred to 2018-19
9	Commercial vehicle generation model	Started Jan/18, continuing in 2018-
10	GTAModel V4.1 upgrades	Deferred to 2018-19
11	TMG Toolbox Improvements	On-going
12	XTMF Maintenance	On-going
13	Documentation of TMG products	On-going
14	Outreach & Training (TMGTAC meetings + 1 workshop)	Completed
15	Meetings: TMGSC (2) & TMGTAC (7)	Completed