Data Management Group
Annual Report
1997

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A co-operative project that is jointly funded by members of the Toronto Area Transportation Planning Data Collection Steering Committee:

GO Transit
Ministry of Transportation Ontario
Municipality of Metropolitan Toronto
Regional Municipality of Durham
Regional Municipality of Peel
Regional Municipality of Halton
Regional Municipality of Hamilton-Wentworth
Regional Municipality of York
Toronto Transit Commission

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1 INTRODUCTION

The Joint Program in Transportation is a research centre located at the University of Toronto, administered by the Faculty of Applied Science and Engineering, with a history spanning more than twenty-five years. The objectives of the Joint Program were originally and continue to be:

a) to encourage research relevant to improved transportation in Canada through the influence of research findings on investment planning, policy development, operations, and the development of human resources and expertise,
b) to serve government and the transportation industry by acting as a source of information, expertise and special purpose training programs,
c) to provide an environment within the university community that is productive to high quality teaching and research in the transportation field.

The Data Management Group is a long-term research activity at the Joint Program that has been instrumental in helping to fulfil the above mandate.

1.1 A Brief History of the Joint Program in Transportation

In 1970, the Canadian Transport Commission (CTC), at that time a regulatory body concerned with Federal Government policy on all aspects of the national transportation system, established a program to encourage research and teaching in the field of transportation at Canadian universities. Part of the program allocated funds to a fellowship program for postgraduate studies. The CTC designed a second part of the program to stimulate research at a small number of regional centres on transportation topics of national interest. The President of the CTC invited the presidents of each Canadian university to submit proposals for the establishment of organized research units or centres that would specialize in transport research across a broad spectrum of the physical and social sciences.

In response to this request, faculty members at the University of Toronto and York University collaborated on a joint proposal to take advantage of the complementary capabilities and interests of faculty at both universities. On the basis of submissions received from a large number of universities, the University of British Columbia, the University of Montreal, and the University of Toronto-York University Joint Program in Transportation were awarded development grants for an initial period of four years. Subsequently, development grants were extended to the University of Manitoba and the Canadian Marine Transportation Centre at Dalhousie University.

In addition to these development grants, the CTC established a special fund, known as negotiated research grants, that were available to the five established centres as well as to smaller groups at the Universities of Calgary, Saskatchewan, Waterloo, McMaster, Carleton, and New Brunswick. Annual competition was the basis of allocation of these funds. Special funds were also available on a case by case basis for the support of Senior Research Fellows, a program designed to encourage greater involvement of industry and government personnel in the university research program.

Initially, the CTC program for university support received the attention of senior officials of both the CTC and Transport Canada. It was treated, in effect, as a grant-in-aid program. Very little direction was given by the sponsors as to the nature of the research to be supported. As a result, a wide spectrum of projects was funded, ranging from the very technical to policy-oriented projects at the urban, regional, and national levels. Of the five major centres that received support from this program, the University of Toronto-York University Joint Program was the most comprehensive in terms of the disciplines covered.

Due to successive reorganizations within Transport Canada, responsibility for the university program (and the fellowship program) shifted from the CTC to the Transportation Development Agency and, with the disbanding of that agency, to the Transport Canada Research and Development Centre, and finally it moved to the Strategic Planning Branch of Transport Canada. With each organizational change, the degree of involvement by senior officials of the Federal Government in defining research priorities became more active. For example, the earlier emphasis on interdisciplinary research was eliminated, and the acceptability of urban transportation research (an area in which there are few, if any, federal responsibilities) diminished. Nevertheless, from 1970 until 1985 the university support program was an extremely important and effective mechanism for encouraging postgraduate transport education and research in Canadian universities, particularly on aspects of the transportation system that operated on a national scale.

In the spring of 1985, the Federal Government cancelled the entire Transport University Program. The impact on the University of Toronto-York University Joint Program in Transportation was catastrophic. During the following two years, relying upon accumulated surpluses to fund day-to-day operations was necessary while new avenues for future funding were explored. This period was characterized by a major reduction in administrative staff and the termination of employment agreements with all permanent research staff. At its peak (1983), aside from the Director, permanent research positions varied from five to six people supplemented by one Senior Research Fellow and the administrative staff of the Joint Program that included two secretaries, one administrative assistant, one librarian, and one editorial assistant. By 1987, the Joint Program supported the Director and one full time secretary.

Efforts to explore new opportunities for research funding materialized in mid-1988 with the establishment of the Data Management Group under the auspices of the Ministry of Transportation Ontario. The scope of the project was to test the feasibility of the Joint Program providing an information system for travel in the surrounding urban area. Initially, the Ministry agreed to be the sole funding agency for a pilot project over a period of two years (effective 1 August 1988). Within a few months, the Ministry changed the funding arrangement to include the Regional Governments in the area, as well as the Toronto Transit Commission. GO Transit became a funding partner in 1990. The project provided, and continues to provide, the necessary base support from which other research areas can be developed.

A review of the Annual Reports of the Data Management Group[1] convey the important impact this group has had in the professional community, the research community and on undergraduate and graduate education related to urban transportation planning. The staff compliment supported directly by the Data Management Group in 1997 was a half-time Director, three research associates, a computer system administrator plus several summer students.

1.2 A Brief History of the Data Management Group

The Data Management Group (DMG) was established in 1988 as a two-year demonstration project at the University of Toronto's Joint Program in Transportation. The DMG was established as an autonomous research group with the following objectives:

a) establish a common, centrally-accessible data base containing information on transportation activities, zone systems, transportation networks and land use activity,
b) provide a transportation data retrieval service to the participating agencies,
c) monitor the adequacy of available data and propose approaches for adding to or updating the data as mutually agreed upon by the agencies,

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[1] *Data Management Group Annual Report, Report 28, Joint Program in Transportation (September 1992)*
Data Management Group Annual Report 1993, Report 43, Joint Program in Transportation (January 1994)
Data Management Group Annual Report 1994, Report 49, Joint Program in Transportation (May 1995)
Data Management Group Annual Report 1995, Report 54, Joint Program in Transportation (May 1996)
Data Management Group Annual Report 1996, Report 59, Joint Program in Transportation (March 1997)

d) promote greater interaction between university researchers and practitioners concerned with the application of transportation data and methods of demand analysis to transportation planning in the Greater Toronto Area. This should also encourage the development of trained specialists in the field of transportation planning and operations,
e) promote the communication of transportation information and data obtained or administered by the Data Management Group to interested agencies and to the public,
f) further the improvement of transportation demand analysis, research, and forecasting in the Greater Toronto Area.

In 1989, the concept of a demonstration project was changed to specifically include the particular needs of all transportation planning agencies in the Metropolitan area stretching from Hamilton to Clarington, and funding of the Group was broadened from the Ministry of Transportation Ontario to include all of the following agencies;

GO Transit
Ministry of Transportation Ontario
Municipality of Metropolitan Toronto
Regional Municipality of Durham
Regional Municipality of Halton
Regional Municipality of Hamilton-Wentworth
Regional Municipality of Peel
Regional Municipality of York
Toronto Transit Commission

The funding agencies express their individual and collective needs through the administrative structure of the Data Management Group. All policy matters are the responsibility of the long standing Toronto Area Transportation Planning Data Collection Steering Committee (TATPDCSC) and technical guidance is provided by a technical advisory committee of TATPDCSC, the Transportation Research and Data Management Group (TRADMAG). A major review of the Data Management Group's activities at the University of Toronto was undertaken by the steering committee (TATPDCSC) in 1992 after three full years of collaborative funding. The objectives, activities and accomplishments of the Group in its first trimester received scrutiny by each of the funding agencies and concluded with a recommendation to continue support for another three years. Another major review took place at the conclusion of the second trimester and concluded the activities should be continued. This report attempts to summarize the Group's activities and accomplishments in 1997, the third year of the third trimester of the current funding arrangement.

In addition to the research activities of the Data Management Group, beginning in 1994, the Group assumed management responsibility for the 1996 Transportation Tomorrow Survey. The Survey is a separate research activity within the Joint Program in Transportation, but intimately linked with the activities of the Data Management Group. It is administered by the 1996

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Transportation Tomorrow Survey - Survey Technical Committee, which is made up of representatives of TATPDCSC plus representation from the other funding agencies:

City of Barrie
City of Guelph
City of Peterborough
Peterborough County
Regional Municipality of Niagara
Regional Municipality of Waterloo
Simcoe County
Town to Orangeville
Victoria County
Wellington County

This report contains a brief description of activities carried out in the calendar year 1997 as part of the 1996 Transportation Tomorrow Survey. The report also contains a description of related activities carried out within the Data Management Group in support of the travel survey.

2 1996 TRANSPORTATION TOMORROW SURVEY

The 1996 Transportation Tomorrow Survey (TTS) is the third in a series of area-wide travel surveys conducted in Toronto and the surrounding regions. The previous surveys were in the fall of 1986 and the fall of 1991. In the current survey, the Regional Municipality of Waterloo was surveyed in October and November of 1995 and the rest of the TTS was surveyed between September and December of 1996. A total of 115,000 households were successfully interviewed. The survey area, which was significantly larger than the previous surveys, included the Regional Municipalities of Niagara and Waterloo, the Cities of Barrie, Guelph and Peterborough, the Town of Orangeville, the County of Victoria and partial coverage of the Counties of Peterborough, Simcoe and Wellington. Parts of Dufferin and Northumberland Counties were included although those agencies did not participate in funding the survey. These areas were in addition to the six Regional Municipalities (Metropolitan Toronto, Durham, Halton, Hamilton-Wentworth, Peel and York) that make up the Greater Toronto Area (GTA) and which were surveyed in both 1986 and 1991.

2.1 Management Structure

The survey was undertaken on behalf of the Toronto Area Transportation Planning Data Collection Steering Committee (TATPDCSC) which was formed in 1977 to co-ordinate data collection activities between agencies. The membership of the committee consisted of representatives from the Ministry of Transportation Ontario, the six Regional Municipalities in the GTA, the Toronto Transit Commission and GO Transit. The final decision to proceed with a 1996 Transportation Tomorrow Survey was taken by TATPDCSC in late 1994. At that time, the administrative structure of the survey was approved. TATPDCSC assumed responsibility for all policy and funding matters. The Steering Committee delegated the technical responsibility to a Transportation Tomorrow Survey - Survey Technical Committee with representation from all participating agencies, and gave management responsibility to a management team associated with the Data Management Group. The Survey Technical Committee met regularly from early 1995 until early 1997 to give technical guidance to the management team. The management team was made up of three members, each with a long association with the Data Management Group; Peter Dalton, Jerry Ng, and Gerald N. Steuart.

During the data collection phases of the project, it was important for members of the Data Management Group to be associated with the survey so that continuity between data collection, a responsibility of the management team, and long term data processing, a responsibility of the Data Management Group, be established. All staff at the DMG were involved in various aspects of the

survey, including one of the staff being located at the survey site while the interviews were being conducted.

Every aspect of the survey was described in a series of working papers. The design of the survey is explained in a working paper as a potential aid in the conduct of any further travel surveys.[2] In addition, a complete description of all aspects of the conduct of the survey is available as a single report.[3]

2.2 Telephone Interview Phase

The 1996 Transportation Tomorrow Survey began in the fall of 1995 with a small team of 30 contacting residents in the Region of Waterloo from a site in the centre of Kitchener. The experience gained in making 10,000 telephone calls at that time led to the final design of a travel survey conducted in the fall of 1996. From mid-August until mid-December 1996, the survey employed 300 people and contacted 140,000 households in an effort to understand the travel habits of almost one-sixth of the population of Canada from a single site at 590 Jarvis Street in Toronto.

The team of telephone interviewers contacted households from Niagara Falls to Peterborough and from downtown Toronto to Barrie. The population in the survey area, which includes the Regional Municipalities of Durham, Halton, Hamilton-Wentworth, Waterloo, Niagara, Peel and York; the Municipality of Metropolitan Toronto; the Town of Orangeville; the Counties of Peterborough, Simcoe, Victoria and Wellington; and the Cities of Barrie, Guelph and Peterborough, in 1996 was 6.3 million people. They were estimated to make over 13.1 million trips on a normal working day.

The estimates of travel and its composition are compiled from the 115,000 completed telephone interviews. The procedures used by telephone interviewers to collect this information are described in a working paper.[4]

The 1991 TTS introduced an innovative data collection enhancement in the form of a computer assisting each interview. The computer selected the sample, displayed the necessary information, scheduled return phone calls, and recorded all the travel information directly into a computer file. The procedure

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2 *1996 Transportation Tomorrow Survey Working Paper Series, Report 3, Design Specifications, (March 1997)*

3 *1996 Transportation Tomorrow Survey: Design and Conduct of the Survey, Report 61, Joint Program in Transportation (December 1997), available as a PDF file at 'www.jpint.utoronto.ca'*

4 *1996 Transportation Tomorrow Survey Working Paper Series, Report 1, Interview Manual, (March 1997)*

was enhanced for the 1996 survey and a complete description is contained in a working paper.[5]

2.3 Coding Phase

The coding phase of the project transforms the spatial information, collected in the form of addresses and names of establishments, into a set of co-ordinates on a map. At the same time, checks are made on the validity of the data collected by the interviewers. The process, which began in September of 1996 and lasted until March 1997, is described in a working paper.[6]

2.4 Data Expansion and Validation

The details on urban travel was collected from 115,000 households, which represents approximately 5% of the households in the survey area. In order to estimate total travel, each piece of information is given a factor so that summaries represent the universe of all travel. The basis for this factor was the inventory of all households in an area compiled by Statistics Canada. The process of estimating the expansion factors is described in a working paper.[7]

Before any travel information was released, as many checks as possible were carried out on the data set. These checks were mainly against information contained in the 1996 census, and counts recorded on streets and transit vehicles throughout the survey area. These checks were carried out during May and June 1997. The process is described in a report.[8]

2.5 Results Available in June 1997

The travel data contained in the 1996 TTS was released for use by planning agencies on schedule in June 1997. In an effort to inform the transportation planning community about the existence and content of the data, two activities

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5 *1996 Transportation Tomorrow Survey Working Paper Series, Report 4, Software Documentation, (March 1997)*

6 *1996 Transportation Tomorrow Survey Working Paper Series, Report 2, Coding Manual, (March 1997)*

7 *1996 Transportation Tomorrow Survey Working Paper Series, Report 5, Data Expansion, (August 1997)*

8 *1996 Transportation Tomorrow Survey: Data Validation, Report 62, Joint Program in Transportation (December 1997), available as a PDF file at 'www.jpint.utoronto.ca'*

were undertaken. The first was a series of two seminars presented at the University of Toronto in July and August 1997. The seminars were designed to inform planners on how the survey was conducted, to present some preliminary results and to outline the procedures for gaining access to the data. Approximately 200 professionals from consulting, government and academia attended the seminars.

In addition, two summary reports were prepared. The first[9] summarizes household, population and trip information at the level of a region or county. The report is available for general circulation. The Data Management Group prepared a second report[10] that mirrors the information contained in previous TTS Summary reports for the areas in the six regions around the Greater Toronto Area. At this point in time, circulation of the second report is limited to participants on the Transportation Tomorrow Technical Steering Committee.

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9 *1996 Transportation Tomorrow Survey: 1996 Travel Survey Summary, Report 64, Joint Program in Transportation, (November 1997), available in abbreviated form at 'www.jpint.utoronto.ca'*

10 *1996 Transportation Tomorrow Survey: 1996, 1991 & 1986 Summary Report for the GTA, Report 65, Joint Program in Transportation, (November 1997), not available for general circulation.*

3 INFORMATION PROCESSING

The Data Management Group currently administers the data files on urban travel contained in the 1986, 1991 and 1996 Transportation Tomorrow Surveys as undertaken collectively by all the funding agencies. The data files on the 1986 travel contain detailed information on 370,000 trips taken by 171,086 individuals residing in 61,453 households, the data files for the 1991 survey contain 157,349 trips taken by 72,538 individuals residing in 24,507 households, while the equivalent data files for the 1996 survey contain 657,971 trips taken by 312,781 individuals residing in 115,193 households. The data are stored on a computer in the form of a relational data base[11], which allows for extraction of the data in any format quickly and efficiently. These data form the factual basis for transportation planning studies carried out by and for local, regional and provincial agencies in the area encompassed by the six regional governments in the Greater Toronto Area.

A cornerstone task for the DMG since its inception is the processing of data requests relating to the TTS data. The following section describes a direct access system developed by the staff at the DMG. In addition to this system, the Group continues to process requests for information that are unique in some aspect and cannot be processed by direct access. A summary of these special data requests processed in 1997 is provided in Section 7 - Data Requests.

3.1 Data Retrieval System (DRS)

Given that a majority of the participating agencies have an electronic connection using a normal telephone line from one of their own computers to the Data Management Group's computer system, a data retrieval system (DRS) has been developed to extract commonly used information from a variety of data sets. The procedure allows data summaries to be prepared for use on the Group's computer system or transferred for use on their own computer. The DRS software allows the user to access the system remotely and choose from a menu that appears on the computer screen.

3.1.1 Zonal Data

A collection of summary information is available on the data retrieval system for several commonly used spatial definitions: 1989 GTA zones, 1991 GTA zones, 1996 GTA Zones, Planning Districts (Wards in the City of Toronto) and Regions. The GTA zone system, which in turn was a refinement of the original TARMS

[11] *1996 Transportation Tomorrow Survey: Data Guide Version 2.1, Report 60, Joint Program in Transportation (August 1997), available as a PDF file at 'www.jpint.utoronto.ca'*

(Toronto Area Regional Modelling Study) zones, has been the commonly used spatial definition for a large number of data requests. A GTA zone system has been the standard for many years for spatial aggregation in a wide variety of planning studies. The agencies are in the process of updating the zone system to a new 1996 GTA Zone system with 1,677 zones. Any aggregations of the above can be easily specified by the user. These data, stored in an efficient form, speed up data access significantly when information by zone is the only requirement. The data base currently includes:

- geographic information, including a centroid location and zonal area,
- TTS households, by various characteristics for 1986, 1991 and 1996,
- TTS persons, by gender and employment status for 1986, 1991 and 1996,
- TTS trips, by various trip categories for 1986, 1991 and 1996,
- preliminary forecasts, for internal use only.

3.1.2 Census POR POW Data

Information from the 1991 Census on the linkages of place of residence to place of work at the level of GTA Zones is available to the funding agencies and to organizations engaged in planning activities under the direction of one of the funding agencies.

3.1.3 TTS Trip matrix

This option in the data retrieval system allows the user to prepare a matrix, either a full matrix, an origin vector or a destination vector, of trips by any aggregation of GTA zones. The summary can specify any particular time of day, purpose of trip or travel mode from the 1986, 1991 or 1996 travel surveys. These summary tables are used primarily as input to travel demand modelling.

3.1.4 Cross tabulation

The cross tabulation feature of the data retrieval system is the most flexible but the most time consuming method of accessing the travel data from:

- 1986, 1991and 1996 Transportation Tomorrow Surveys,
- 1964 Metropolitan Toronto and Region Transportation Survey,
- 1991 Census POR-POW (Place of Work-Place of Residence) data,
- GO Rail Passenger Surveys (multiple years), and
- GO Bus Passenger Surveys (multiple years).

Data can be summarized according to any combination of selection criteria with up to three categories. As an example, one could select all transit passengers travelling to the financial district of Toronto in the morning peak period (selection criteria) from every region outside the City of Toronto, by age categories and gender (category selection). The categories can include GTA zones, MTARTS zones or aggregations.

3.1.5 Updating the DRS

The operating Data Retrieval System (DRS) has proven to be a valuable analytical tool since its development in 1992. During 1997, the necessary modifications to the system were carried out to incorporate the 1996 TTS data.

The system proved to be sufficiently flexible to accommodate the 1996 Transportation Tomorrow Survey data without major revisions. Placing the new data base in DRS as soon as it was available provided rapid access to the 1996 TTS data by DMG staff and transportation planning agencies.

At the same time, development work was undertaken on the use of internet browsers as the method of presenting data retrieval procedures. The concept was to develop a prototype using something as simple as the zonal data base component of the current DRS. This development exercise demonstrated the need to make some changes to both the computer hardware and software systems. These changes are described in Section 5 of this report.

3.2 Cordon Count Data Retrieval System (CCDRS)

The collective results from a regular program of detailed traffic counts undertaken over several years by various Regional Governments in the Greater Toronto Area on the road and transit system are a rich source of valuable data for a wide range of transportation planning projects. Each agency collecting the counts processes its data in accordance with its own requirements. The net result is a series of data sets, which can often be difficult to either access or integrate. The initial Cordon Count Data Retrieval System was a pilot project undertaken in 1994 to demonstrate the efficiency of storing ground count data in a centrally housed data base. To a great extent, the need for the project was based on the need to search and present cordon data in a consistent manner. This central assembly of data saves time for agencies studying projects which cross regional boundaries and greatly reduces regional staff time associated with ground count data requests.

The first operational prototype was on a Windows 3.x based client-server architecture. The data retrieval system (FoxPro and MapInfo) ran on a local 486DX microcomputer operating under OS/2. Each user remotely accesses the computer via a high speed modem line and remotely controls the operation of the machine via RLINK; a software package which allows the remote users screen to effectively become the screen of the central computer. A custom interface was written at the DMG to access the data. The interface was written in FoxPro for Windows and offers several high-level features. The interface is very user-friendly and permits the user to interactively set up search criteria. To assist in the set-up of the search criteria, graphical assistance is provided through a link to MapInfo. This allows the user to map station information, which can assist them in making an error free specification. The results of the search are offered in either ASCII or Dbase formats, which simplifies the presentation and manipulation of the data.

Through the above system, cordon count data can be extracted by specifying the region, count year, time interval, vehicle type, location by screenlines and count

stations, etc. Although the system demonstrates the potential of this data and its storage and will be used as the prototype for any further development, this type of software configuration is too limiting for a final configuration owing to speed, cost, and compatibility with other data retrieval systems. The development of access through a web browser was attempted in 1997 with only limited success. As with the development of DRS, the exercise demonstrated the need to make some changes to both the computer hardware and software systems. These changes are described in Section 5 of this report.

In the interim, until a web browser can be developed, the data from all cordon counts undertaken by all regions were assembled. All available cordon count information has been placed in the prototype CCRDRS and is currently available to participating agencies. A restriction of the current system is that only one user can be processing a request at a time.

3.3 TTS Data on a World Wide Web Site

The World Wide Web site at

http://www.jpint.utoronto.ca

was created in 1995 and is maintained by the Joint Program in Transportation. The site is used by the Data Management Group to present most of the information from the Transportation Tomorrow Survey Summary Reports and other pertinent information about the Group. The travel information was updated to include the 1996 TTS information in the fall of 1997. The format was changed to reflect the change in distribution policy for the 1996 data. Travel is summarized by Region, rather than by Planning District. Where possible, information is presented in a common format for all three years of TTS.

One of the functions of the Data Management group is to improve accessibility to transportation data, not only to agencies within the GTA, but to other agencies and persons interested in the urban structure and travel characteristics of residents of the Greater Toronto Area. Most of these interests can be satisfied with a reference to our web site. Any particular request for information is processed in accordance with our access policy and is summarized in Section 7 of this report.

Development of the browser equivalent of DRS, described in the previous section, raises the issue of security and access control. Procedures to provide secure access through the internet and to provide restricted access where applicable, are currently being developed. The intention is to place reference documents on the web site for the convenience of users of the data, particularly the most recent data guide.

The number of times a site has been accessed is one measure of success of a web site. The site mentioned above transmitted the introductory page 1600

different times in 1997. Access to the introductory page is an indication of the number of new user attempts to access the site. The site has been linked to a number of sites in North America that relate to transportation, particularly urban transportation.

4 TECHNICAL SUPPORT

The concept of a university research centre providing shared computer resources and technical support in the development and operation of a large scale computer simulation of urban travel began as a small co-operative research initiative between the Ministry of Transportation, Municipality of Metropolitan Toronto and the Data Management Group in 1989.[12] A primary objective of the research project was to investigate the feasibility of sharing the computer resources necessary for large-scale simulation, as this was recognized as a necessary condition for sharing technical procedures. The requisite software to run such a simulation had already been selected by Metro Toronto as appropriate for their particular needs, EMME/2 from INRO Consultants Inc. in Montreal, and it appeared to satisfy the immediate needs of the Ministry.

The Group purchased a small computer that could serve many users at the same time and purchased a version of the software that had the same feature. The results were very encouraging and appeared to provide the justification for planners to use the same analysis framework which would promote sharing information and analytical techniques while still providing the flexibility for tailoring the application to suit particular needs. The concept of sharing the analysis framework has grown from the original two planning agencies in 1988 to include in 1997:

Municipality of Metropolitan Toronto
- Planning Department (2 lines)
- Transportation Department

Regional Municipality of Durham
Regional Municipality of Peel (2 lines)
Regional Municipality of York (2 lines shared with):
- City of Vaughan
- City of Markham
- City of Richmond Hill

Regional Municipality of Halton
Regional Municipality of Hamilton-Wentworth (data access only)
Office of the Greater Toronto Area
GO Transit
City of Mississauga
City of Toronto
Toronto Transit Commission

[12] *Metro Toronto EMME/2 Development Project, Report 9, Joint Program in Transportation, January 1990.*

Ministry of Transportation Ontario
Demand Management and Forecasting Office
Consultant's access
Central Region
Freight and Economics Research Office

The users are now served by a completely integrated system of four computers plus all the requisite equipment for high-speed access to these computers from remote sites. The computer system is administered by the Group including all maintenance and regular back up procedures to protect the integrity of the extensive information base.

4.1 Policy for EMME/2 and DRS Access

A major advantage to all planning agencies of sharing computer resources is the sharing of labour intensive features in the simulation process. The most widely shared resource is the computer representations of the road and transit networks. The process began by converting a road network that had been developed over a period of years by the Metro Toronto Planning Department for use on another computer system. The co-ordinate system was standardized so that trip information and the network data were recorded to the same base. This also allowed information to be added and edited throughout the entire region using a common co-ordinate system. Each Regional Government assumed responsibility for creating their own representation of a road network using collectively agreed to principles and co-ordinated by the Data Management Group. Users agree collectively on the timing and magnitude of changes to the network, such as the development in 1996 and 1997 of an integrated road and transit network. A representation of the entire road network can then be shared by all planning agencies. The network representation is kept up to date by the Group and new versions are announced to all users.

Access to the system can be allocated by any of the participating agencies to another agency, in particular, a private consultant that is engaged in a planning study for that government agency. This aspect has proven to be successful, as many of the local consulting firms have been provided with access and technical support. The Group provides assistance to any of these agencies, public or private, in setting up their computer system for access to EMME/2. Continuous improvements to the computer system and the remote access procedures are being tested and implemented when appropriate.

4.2 Development of an Integrated Road and Transit Network

In 1996, the Data Management Group began the task of integrating the road and transit networks into a single multi-modal network. At the same time, the

network was updated to represent the current 1996 road and transit system in the area defined by the participating six regional governments. The Transportation Research and Data Management Group (TRADMAG) initiated the project as part of a co-operative modelling effort. TRADMAG appointed a steering committee for this project (GTA Modelling Group). This committee provides the technical direction to be certain the results of network and model development are in agreement with their collective needs.

Staff at the Data Management Group undertook the tasks of information collection, implementation and distribution of results. The project was carried out in a series of stages. First, all regional governments and the Toronto Transit Commission were asked to provide details of all updates from the 1991 road and transit networks. Second, with the aid of the part-time undergraduate students, a first draft of the integrated network was prepared. The staff used custom designed macros and software routines to aid in this process of integration in an effort to maintain the integrity of the 1991 road and transit networks that represents years of development and checking. Third, in conjunction with the members of the steering committee, the staff continued to refine the network and coincidentally develop a set of network coding standards. All tasks were completed in 1997. A combined network representing the 1996 road and transit system in accordance with the agreed upon coding standards is currently available on the DMG's computer system for general use. The 1996 Transportation Tomorrow Survey used this network as an aid in the validation of survey results.

4.3 Application of EMME/2 to Transit Planning

The Data Management Group and the Toronto Transit Commission began preliminary discussions in 1995 on the feasibility of using EMME/2 procedures in transit service planning. The opportunity may exist at this time for the Data Management Group to provide support for the TTC's particular needs in computer simulation within the EMME/2 structure in a manner similar to the other funding agencies. In 1996 and 1997, two major steps were taken to initiate a full-scale evaluation of the suitability of EMME/2 for transit service planning at the TTC.

First, a small group of TTC and DMG staff undertook the task of defining the requirements of a simulation model to match the planning needs of the TTC. The immediate need is to assist in the evaluation of service changes in the TTC network. In turn, this implies the need for a disaggregate assignment and an ability to investigate the details of simulated route choices of transit users. The process must be sensitive to the changes in the various time components of a transit trip; access, waiting, transfer, in-vehicle and egress. Some custom designed output from the normal EMME/2 disaggregate assignment procedure is anticipated.

Second, staff from the TTC and DMG worked together to develop a representation of the TTC's transit network in EMME/2 that represents the level of detail necessary and appropriate for planners addressing the issues of service planning. In the process of developing a network, the group identified any changes that would be required in procedures currently used by the TTC. Implementation of the changes began in 1996 and were completed in 1997. The network, data files and EMME/2 macro procedures were developed to represent different time periods in a typical weekday. A TTS data extraction routine was developed and applied to produce input data files for the disaggregate assignment procedures. Appropriate training was provided to the TTC staff on the operation of these disaggregate assignment procedures. The 1996 integrated network was used as the base for a TTC network and customized for the particular needs of service planning. General calibration procedures were developed on the basis of numerous EMME/2 assignments. Detailed run characteristics and output parameters from the calibration runs have been documented. An internal report was prepared by the TTC.

4.4 Technical Support and Training in EMME/2

Staff at the Data Management Group continued to provide technical support to all authorized users of EMME/2 on the Data Management Group's computer system. This support varies from simple questions about connection problems to more complex questions about macro development in Release 8. In particular, significant support was provided to: Halton Region in the development of an afternoon peak model, Durham Region in implementing the simplified GTA model, TTC as described above, and the Ministry of Transportation in the operation of a GTA model and the development of a model for commercial vehicles.

After Release 8 of EMME/2, which is currently operating on the DMG computer system, INRO will no longer supply user's manuals. In anticipation of this, a copy of the entire manual was placed on the DMG's computer system in the directory */usr/local/emme2/e2book*. The files are in Acrobat Reader format (.pdf) and can be downloaded to a user's local pc or read on the UNIX system. The procedure for browsing on the UNIX system requires Xwindow capabilities. Details on how this is possible are available from the DMG staff. Each chapter of the manual is a separate file. The DMG is investigating methods for current users to gain access to new documentation from the developer. In addition, several macros and other utilities that may be of general use are available on the system. Details are available from DMG staff.

The need for extensive training on the EMME/2 system no longer exists as most of the users train their staff in-house. The self-administered tutorial, developed from earlier training sessions, is now used almost exclusively by students. In 1997, ten undergraduate and eight graduate students at the University of Toronto undertook the EMME/2 training.

5 COMPUTER SYSTEM SUPPORT

Some advantages of the concept of sharing a central computing facility among all funding agencies have been described in previous sections. The success of such a concept is dependent on three important conditions: a fast and reliable method to access the central system, ease of use, and a level of computing service that is consistent with current technology.

A concern shared by all users is security. The computer system serving the Data Management Group maintains a tight control on the users given access privileges. Each user is asked to use a login name and change their password frequently. When an account has been dormant for a period of time, the system administrator tries to contact the individual associated with the account. If this is not possible, action is taken to limit access for this user. At the end of 1997 there were approximately 110 active accounts; 70 were identified with a provincial, regional or local government office, 10 were identified with DMG staff, 20 were identified with private consultants, and 20 were identified with various research projects.

5.1 Access to Computing Services

Access to computing services at the Data Management Group is currently provided in one of three ways. The first method, and the one used for the longest period of time, is by a conventional telephone connection and a modem. The method uses conventional modems that support communication at 9,600 or 19,200 baud, depending on when the service was installed. Currently, the Regions of Durham, Peel, Halton, Hamilton-Wentworth, TTC and York are connected using a high-speed modem (28,800 baud). The method is reliable and provides an access speed that is consistent with the demands placed on a graphical interface. The Regions of Metropolitan Toronto, Peel and York have been provided with software to support Xwindow graphical interface, which allows them to operate a terminal emulation while running EMME/2 in a 'Windows 3.x' environment. Early results indicated the modem service must be connected through the parallel port rather than the conventional serial port. Investigations in 1997 have shown that newer Pentium II processors are capable of handling the complex protocol requirements. These and other connections will be continuously monitored and tested at the DMG. In addition, a more reliable connection with better security is being investigated.

A second method, used by the Ministry of Transportation, is through a dedicated data line supplied by the telephone company. The method is more costly to install but can support multiple users. The Ministry is also using eXceed. This connection also provides a connection to a local area network (LAN) operated

throughout the Ministry. The development of a reliable connection between the UNIX based system at the Data Management Group and the LAN operating with a system based on IBM standards was problematic at first, but changes in 1997 have made the system very reliable.

The third method, used by the two connections to Metropolitan Toronto's Planning Department, is based on the new digital telephone service provided by Bell Canada in some areas. Staff at Metro Planning tested the eXceed software in 1996 and 1997 and found it to be adequate for EMME/2 access. Preliminary results seemed to indicate the service was too expensive for the improvements that were possible. Subsequent to these experiments, the DMG tested the equipment and came to the conclusion that when properly installed ISDN (digit service) can be very cost effective for heavy users.

5.2 Improvements in Service

A series of system improvements were carried out in 1996 in an effort to improve the level of service provided to the funding agencies. The effectiveness of these improvements were not as substantial as planned in 1996 because of staff changes at the Data Management Group. In 1997, with a full staff compliment, these improvements were reviewed and made effective.

The new Sun Ultra 1 allocated to the needs of the MTO has proven to be faster and more stable platform under heavy load than the previous Sun Sparc 2. A relocation of some activities on the computer network has improved the performance. The Sparc 10 was initially allocated to the task of a support computer in the development of an intranet service, as described in Section 3.4. Limitations of this platform and the decision to develop a new data base management system for TTS data led to the acquisition of another Sun Ultra. This system will be used for operating the new data base system (Oracle) in parallel with the old (Empress) for some time. This is to be certain that the users are not faced with unexpected system failures.

The current UNIX system of Sun computers consists of:

Ultra 1 Model 140	- dedicated exclusively to MTO activities
Ultra 1 Model 200	- for EMME/2 users other than MTO
Ultra 1 Model 200	- for data base activities and web development
Sparc 1	- Empress data base development and staff workstation
Sparc 2	- backup, data base support (DRS) and research
Sparc 2	- test machine for new operating system and security
Sparc 10	- EMME/2 technical support and staff workstation
Sparc 4/330	- (original machine) student and research support

System backup is an essential part of any shared computer system. On a shared system, when a file is deleted for any reason, it is not recoverable except

from the files on tape from the last backup. Backups are carried out daily on the computer system at the DMG. If for any reason, the backup does not work, then all users on the system are at risk of not being able to recover their files. This is in addition to the risk of any disk failure. The backup system has been put under increasing strain as the amount of disk space continues to increase. The system of seven Sun UNIX servers now support over 50 gigabytes of disk space. In an effort to ease the strain on the system and improve reliability, a new backup unit was purchased in 1996 and installed on the system. This new backup system was operated in tandem with the old until 1997. Currently all backups are successfully carried out with compression on a single 30 gigabyte backup tape.

5.3 New Administrative Structure

The administration and servicing of a computer network with a UNIX operating system together with a large number of clients on a wide area network, such as the computer system at the Joint Program in Transportation, requires a particular set of skills. The Faculty of Applied Science and Engineering operates a central computer network for all undergraduate teaching that has many similarities with the network at the Joint Program, albeit larger. This group now allocates one of their staff to maintaining and improving the DMG system. The staff member's first priority is the operation and maintenance of the computer system serving the DMG and its funding agencies. Additional resources would be available from ECF when needed and the staff assigned to the Joint Program would reciprocate when needed. In this first year of operation, the staff member has spent 100% of his time on the system at the DMG. Our speculation is that 1998 should provide the necessary experience to determine how much of his time is needed in the long term.

6 RESEARCH

A portion of the funding provided to the Data Management Group is allocated to unspecified research on topics related to urban transportation. In addition to these funds, the very research nature of the DMG's activities is conducive to encouraging other research projects, some of which receive funding from other sources. The research support that is made possible by the existence of the Data Management Group include; access to the TTS data, access to the EMME/2 network and modelling system, access to software (SAS, ArcInfo, Empress, etc.), and technical support in the use of these data and software.

The following itemized list includes only those activities that were carried out in 1997 and that are directly related to the activities of the Data Management Group.

6.1 Related Research Projects

Dr. Amer Shalaby, a recent graduate from the Department of Civil Engineering has been awarded an NSERC Industrial Fellowship. The fellowship is specifically for young researchers to gain some experience in industry while carrying out their research. Dr. Shalaby will hold the fellowship with the Toronto consulting firm of IBI. His area of research is “Exploring Person Travel Trends in the Greater Toronto Area” and will make extensive use of the TTS data. He anticipates that at least two reports on his findings should be available in mid-1998. In addition to spending 80% of his time on research, he is to spend 20% on activities within the IBI Group.

Two large projects have recently been awarded to the Joint Program in Transportation, both of which have Professor Eric J. Miller as the Principal Investigator, and both of which include external participation.

A three year National Science and Research Council (NSERC) Collaborative Research Grant was awarded in 1995 for a three year period. The research team includes academics from the University of Toronto, McMaster University, University of Laval and the University of Calgary. The topic, “Integrated Transport - Land Use Modelling for Environmental Analysis” received funding at $160,000.00 per year for the three years.

A second project was awarded in 1997 by the U.S. Transportation Research Board in response to proposals received for Transit Co-operative Research Project H-12, “Integrated Urban Models for Simulation of Transit and Land-Use Policies”. The project team includes academics from the Universities of Toronto

and Calgary and the private consulting firm Delcan. The project funding is $US 100,000.00.

6.4 Graduate Student Theses

Shalaby, A.S., "Investigating Mode Split for the Work Trip: Role of Relative Level of Service and Interaction with Mobility Dimensions", Ph.D. Thesis, Department of Civil Engineering, University of Toronto, 1997.

Briggs, R.S., "Comparative Analysis of Empirical and Theoretical Access Walking Distances Using Geographical Information Systems", M.A.Sc. Thesis, Department of Civil Engineering, University of Toronto, 1997.

6.5 Graduate Student Thesis Work Currently in Progress

Peiravian, F., "Road Network Modelling for Environmental Impact Analysis" (Ph.D.)

Alvarado, G., "Volume Delay Functions for the GTA Network", (M.Eng.)

7 DATA REQUESTS

The data housed at the DMG is accessed primarily by the funding agencies. In addition to the data requirements of the Regions, the Municipalities which comprise each Region, are permitted access via their Region's connection. Consultants working on behalf of the Regions and Municipalities are encouraged to make use of the data sets. As part of the DMG's funding and mandate, researchers at the Joint Program in Transportation and the Department of Civil Engineering at the University of Toronto are provided with access. Lastly, private groups wishing to access the data are provided with restricted access whereby a DMG staff member, for a nominal fee, performs data searches.

Access to the data sets varies according to the data required and the complexity of the request. Over the past 6 years, an on-line Data Retrieval System has been developed which provides direct access to the 1986, 1991 and the 1996 Transportation Tomorrow Survey data by the users (DRS - see Section 7.1). The DMG staff (see Section 7.2) undertakes more complex requests. This one-off approach to data retrieval allows users to expand their requests which consequently maximizes the overall use of the data. The following summarizes the demand for the data in 1997 and offers details on some of the custom data searches completed.

7.1 DRS Data Extraction Summary

The following table summarizes the demand for the on-line Data Retrieval System. The number of queries is significant and could not be cost effectively served in a manual fashion. It is interesting to note that typically users are making several data queries each time they log on the system.

Summary of DRS Data Requests

Month	Number of Data Queries	Number of Sessions
January	38	16
February	24	16
March	70	28
April	78	33
May	24	14
June	86	23
July	138	49
August	63	24
September	147	54
October	194	56
November	117	40
December	78	32
Total	1057	385

DRS Users in 1997

City of Scarborough

City of Mississauga

GO Transit

IBI Consulting Group

Ministry of Transportation Ontario

Municipality of Metropolitan Toronto

Peter Dalton Consulting

Professor Eric Miller

Regional Municipality of Durham

Regional Municipality of Hamilton-Wentworth

Regional Municipality of Peel

Regional Municipality of Waterloo

Regional Municipality of York

Toronto Transit Commission

Totten Simms Hubicki Associates

University of Toronto undergraduate and graduate students

7.2 Data Requests Summarized by Agency

In addition to the data requests that are served directly through the on-line interactive TTS Data Retrieval System (DRS), the DMG staff processed the following requests. The diversity of the requests illustrates the robust nature of the Transportation Tomorrow Survey Data sets as currently housed at the DMG.

7.2.1 Participating Agencies

JANUARY

1996 TTS morning trips originated from or destined to specified GTA zones were requested by the Planning Department of the Region of Durham.

MARCH

The Planning Department of Metro Toronto requested the Straight-line distances between zone centroids of the Metro zone system. Average trip length for 1986 TTS morning peak and all day auto driver trips were also requested for internal study.

iTrans Consulting Inc. requested the average home-to-work trip distances in the GTA broken down by travel mode for the project "Review and Assessment of Ontario's Carpool Lot Program" with the Ministry of Transportation.

APRIL

1986 TTS average trip distances broken down by trip purpose, travel mode, employment status of trip makers and household location were requested by the Planning Department of Metro Toronto for internal study. In addition, total number of employed and unemployed people were also requested at household zonal level.

MAY

100 records from the household, person and trip tables in the 1991 TTS data base were requested by the Ministry of Transportation in evaluating the opportunities of the data to private sectors.

JUNE

1986 TTS morning peak O-D matrices for local transit trips including and excluding Bloor subway trips were requested by iTrans Consulting Inc. for the "407 Transitway Study" with the Ministry of Transportation.

Total number of work trips originated from Burlington and destined to Metro Toronto, Hamilton-Wentworth, and GTA were requested by the Region of Halton from the 1996 TTS data.

JULY

1996 TTS data base records excluding the fields with UTM co-ordinates were requested by the Ministry of Transportation.

1996 TTS all day auto driver trips originated from or destined to Barrie were requested by Read Voorhees & Associates Ltd. for a project with the Works Department of the City of Barrie.

Total number of residents of City of Burlington who worked in Metro Toronto and Hamilton-Wentworth were requested by The Spectator for the Region of Halton. In addition, trips made by residents of Burlington to Metro Toronto and Hamilton-Wentworth broken down by travel mode and destination purpose were also provided.

The Region of York requested the total number of persons broken down by age cohort, possession of driver's licence, car availability and area municipality in York region for a study of seniors. These data were extracted from the 1986, 1991 and 1996 TTS data bases. In addition, 1986 TTS 24-hour home-based-discretionary O-D matrix for trips made by people aged 65 or over was also provided.

AUGUST

Number of vehicles, number of licensed drivers, trips and average trip distances broken by trip purpose and travel mode from the 1996 TTS, were requested by the Planning Department of Metro Toronto at Metro ward level.

1996 TTS data base records excluding the fields with UTM co-ordinates were requested by the Region of Peel.

Read Voorhees & Associates Ltd., retained by the City of Barrie Works Department, requested household and person information for Barrie from the

1996 TTS. In addition, O-D trip matrices broken down by trip purpose and travel mode were also provided.

The Region of York requested the total number of dwelling units and population of the GTA zone 922. In addition, number of persons who lived and/or worked in that zone broken down by employment status were also provided.

SEPTEMBER

The Ministry of Transportation requested the average trip distances for morning peak home-to-work GTA trips from the 1986, 1991 and 1996 TTS data.

Number of trips made by Metro Toronto residents broken down by travel mode were requested by the Planning Department of Metro Toronto from the 1991 and 1996 TTS.

The City of Burlington requested the 1996 TTS morning peak period and all day trip matrices, broken down by trip purpose and travel mode, for the "South Aldershot/Highway 403 Corridor - Secondary Plan Study". Data were provided to McCormick Rankin Corporation, which was retained for the project.

The Region of York requested the total number of trips made by residents of York region and made to York region from the 1996 TTS data.

OCTOBER

Metro Toronto Planning Department requested the employed labour force and employment for each regional municipality from the 1996 TTS data.

1996 TTS household, person, trip and transit records (excluding UTM co-ordinates and some other fields) for GTA residents were requested by the Planning Department of Metro Toronto in dbf format.

1986 TTS household, person, trip and transit records (excluding UTM co-ordinates and some other fields) for GTA residents were requested by the Planning Department of Metro Toronto in dbf format.

McCormick Rankin Corporation requested the 1996 TTS p.m. peak O-D trip matrix at the specified zone system for the City of Burlington "South Aldershot/Highway 403 Corridor - Secondary Plan Study".

Total number of persons and persons who worked at home, broken down by gender, municipality and region of household, were requested by the Region of Halton from the 1996 TTS data.

NOVEMBER

Average trip distances for trips made within Metro Toronto on the TTC system from 1986, 1991 and 1996 TTS data were requested by TTC for an internal study.

iTrans Consulting Inc. requested the 1996 TTS p.m. peak hour auto driver trip matrix for the cities of St. Catharines and Welland. The data were for the Ministry of Transportation "Highway 420 Environmental Assessment Study".

The Ministry of Transportation requested the average trip rates broken down by age cohort from the 1996 TTS data.

An equivalency file converting GTA zone system to Hamilton zone system was requested by the Region of Hamilton-Wentworth.

DECEMBER

1991 GTA zone boundary file with zone numbers was provided to the Region of Halton in MapInfo format.

Tranplan Associates requested the 1996 TTS population, employment, employed labour force and number of dwelling units aggregated to the 80 superzone system for the update of the “1995 Oakville Transportation Study”.

1996 TTS O-D trip matrices broken down by time period, trip purpose and travel mode, aggregated to the 80-zone system, were provided to Tranplan Associates for the “1995 Oakville Transportation Study”.

7.2.2 University Research

GTA centroids based on 1986 TTS trip activity for auto and transit trips were requested by David Rice, an undergraduate student from the Department of Civil Engineering, University of Toronto. The UTM co-ordinates of origins for morning peak transit trips destined to planning district 1 were also provided.

The UTM co-ordinates of origins for home-to-work transit trips were requested by David Rice, an undergraduate student from the Department of Civil Engineering at the University of Toronto.

1991 TTS demographic information for public transit users was requested by Mimi Ng, an undergraduate student from the Department of Geography at the University of Toronto.

1986 and 1991 TTS household and person information for the Region of Hamilton-Wentworth at municipality level were requested by Darcy Pugsley, an undergraduate student from the University of McMaster for his thesis "Car Ownership and Use in Hamilton CMA".

1986 TTS work trip records with household and person information were requested by Ron Buliung from McMaster University for his Master's thesis "Accessing Commuting in the GTA".

1986 TTS, 1991 TTS and 1991 Synthesized trips broken down by time period, travel mode, origin and destination for the specified GTA zones were requested by Professor Pierre Filion from the School of Urban and Regional Planning at the University of Waterloo for a research project on GTA suburban downtowns.

46 Planning District boundary file in Arc/Info format was provided to Ron Buliung from McMaster University for his Master's thesis "Accessing Commuting in the GTA".

1996 TTS shopping trip records were requested by Professor Richard Soberman from the Department of Civil Engineering at the University of Toronto.

Person and trip information from the 1996 TTS data were requested by David Block from York University for his Master's thesis.

1986 TTS, 1991 TTS, 1991 Synthesized and 1996 TTS trips broken down by time period, travel mode, origin and destination for the specified GTA zones were requested by Professor Pierre Filion at the School of Urban and Regional Planning at the University of Waterloo for a research project on GTA suburban downtowns.

1996 TTS person and transit trip records with selected attributes were requested by Milos Vasic, a graduate student from York University, for a project for his statistics course.

1996 TTS demographic and trip data were requested by Richard Gilbert from the Centre for Sustainable Transportation for his research paper "Urbanization and Transportation in the Toronto Region".

Percentage of persons who had free parking available at work in several wards in Metro Toronto according to 1996 TTS were requested by Trevor Fleck, an

undergraduate student at Innis College at the University of Toronto for his course work.

1996 TTS morning peak trip matrices broken down by travel mode were requested by Ramesh Jagannathan from Carleton University for his Master's thesis.

1991 and 1996 TTS work trip matrices for the City of Burlington and the Region of Hamilton-Wentworth were requested by Hanna Maoh, a graduate student from the School of Geography and Geology at McMaster University for a validation study of the "Integrated Model for Urban Landuse Transportation and Environmental Analysis".

1996 TTS trip records with demographic information for trips originating from or destined to the Pearson Airport were requested by Murtaza Haider, a graduate student from the Department of Civil Engineering at the University of Toronto, for the research paper "Airport Ground Access Study" with Professor Richard Soberman.

7.2.3 Private

BA Consulting Group Ltd.
Tabulations of household size by number of vehicles in household and dwelling unit type for GTA zones 238 and 239 were requested from the 1986 TTS data.

1991 TTS O-D trip matrices broken down by trip purpose, travel time period and travel mode were requested for the residential development application in the Bayview Avenue and Sheppard Avenue vicinity. In addition, tabulations of household size by number of vehicles in household and dwelling unit type for several GTA zones were also provided from the 1986 TTS data.

KPMG
1996 TTS total number of trips and trip length frequencies, for all day and work trips destined to Planning District 1, broken down by origin and travel mode were requested.

8 LIST OF PUBLICATIONS

No	Title
1	The Transportation Tomorrow Survey: Design and Conduct of the Survey (December 1987)
2	The Transportation Tomorrow Survey: Data Validation (August 1988)
3	The Transportation Tomorrow Survey: Version 2.2 Data Guide (August 1988)
4	The Transportation Tomorrow Survey: An Overview of Travel Characteristics in the Greater Toronto Area (December 1988)
5	The Transportation Tomorrow Survey: Travel Survey Summary for the Greater Toronto Area (June 1989)
6	The Transportation Tomorrow Survey: Trip Diary Survey Analysis (January 1990)
7	The Transportation Tomorrow Survey: Trip Diary Survey Data Guide Version 1.1. (January 1990)
8	Developing Transportation Networks using Area Master Files and AutoCAD (July 1989)
9	Metro Toronto EMME/2 Development Project (January 1990)
10	EMME/2 Matrices, Macros, Graphics (June 1990)
11	EMME/2 Access Policies and Guidelines (June 1990)
12	Transportation Tomorrow Survey Version 3 Data Guide - Empress format (March1990) Transportation Tomorrow Survey Version 3 Data Guide - Supplement: Text format (March 1990)
13	1989 Greater Toronto Area Zone Boundaries (March 1990)
14	1979 Tarms Zone Boundaries (March 1990)
15	Updating Transportation Tomorrow Survey Data to Version 3 (April 1990)
16	Analysis of Transportation Tomorrow Survey Data Bias: Due to Use of Informants (April 1991)
17	Greater Toronto Area Road Network Coding Manual (April 1991)
18	EMME/2 Library (April 1991)
19	Transportation Tomorrow Survey Data Retrieval System User's Manual (May 1991)

No.	Title
20	Development of an Integrated, Multimodal Mode Choice and Route Assignment Model (June 1991)
21	Development of an Individual Trip Assignment Model for Application to Commuter Rail and Regional Bus Transit (June 1991)
22	Zone Boundary Aggregation Procedure User's Manual (October 1991)
23	1990 EMME/2 Transit Network Version 2.0 Coding Standards (November 1991)
24	Mode Choice Behaviour in the Greater Toronto Area: Analysis of 1986 Transportation Tomorrow Survey Data (June 1992)
25	1991 Transportation Tomorrow Survey: Data Guide - Version 2.1 (June 1992)
26	1991 Transportation Tomorrow Survey: Design and Conduct of the Survey (October 1992)
27	1991 Transportation Tomorrow Survey: 1991 Synthesized Trip Matrices Version 1.0 - Data Guide (February 1993)
28	Data Management Group Annual Report (September 1992)
29	1991 Transportation Tomorrow Survey Seminar: Preliminary Comparisons with 1986 (July 1992)
30	The Use of Direct Data Entry for Travel Surveys (August 1992 - draft)
31	A Summary of Changes in the Travel Characteristics of the Greater Toronto Area, 1986 to 1991 (December 1992)
32	Under-reporting of Trips in Telephone Interview Travel Surveys (January 1993)
33	Demand for Aircraft Gates (January 1993)
34	Travel Trends in the City of Mississauga 1986 to 1991 (June 1993)
35	Travel Trends in the City of Mississauga 1986 to 1991 - Appendix Trip Tables (June 1993)
36	1991 Transportation Tomorrow Survey: Preliminary Comparison of Changes between 1986 and 1991 by Regional Municipality (November 1992)
37	EMME/2 GO transit Network Version 1, Coding and Procedures Manual (November 1990)
38	Advanced EMME/2 Training Manual (September 1993)
39	Departing Passenger Arrival Patterns at Air Terminals (October 1993)

No.	Title
40	Quantitative Analysis of Urban Transportation, Energy Use & Emissions: Phase I Final Report (May 1993)
41	Quantitative Analysis of Urban Transportation, Energy Use & Emissions: Phase I Executive Summary (December 1993)
42	1991 Transportation Tomorrow Survey: Version 3.0 Data Guide (October 1993)
43	Data Management Group Annual Report 1993 (January 1994)
44	Modelling Central Area Work Trip Modal Choice and Parking Demand (June 1992)
45	1991 Transportation Tomorrow Survey Version 4 Data Guide (July 1994)
46	1991 & 1986 Travel Survey Summaries for the Greater Toronto Area (June 1994)
47	GTA Network Coding Standard (February 1995)
48	GTA Transportation Plan - Base Year (1986) Network Coding (April 1995)
49	Data Management Group Annual Report 1994 (May 1995)
50	Urban and Travel Changes in the Greater Toronto Area, and the Transferability of Trip Generation Models (July 1995)
51	Performance of Trip Generation Models of Morning Peak-Period Travel in Long Range Forecasting (August 1995)
52	The Subarea Planning Macro: Development of a Method for Subarea Planning in the EMME/2 Software Environment (April 1996)
53	The Greater Toronto Area Travel Demand Modelling System, Version 1.0 Volume II: Model Documentation (March1997)
54	Data Management Group Annual Report 1995 (May 1996)
55	The Greater Toronto Area Travel Demand Modelling System Version 1.0 Volume I: Model Overview (June 1996)
56	The Greater Toronto Area Travel Demand Modelling System, Version 1.0 Volume III: User's Manual (June 1996)
57	Investigating Mode Split for the Work Trip: Role of Relative Level of Service and Interaction with Mobility Dimensions (November 1996)
58	A Parametric Analysis of Arterial Travel (August 1996)
59	Data Management Group Annual Report 1996 (March 1997)

No.	Title
60	1996 Transportation Tomorrow Survey: Data Guide Version 2.1 - document (August 1997)
61	1996 Transportation Tomorrow Survey: Design and Conduct of the Survey - PDF document (December 1997)
62	1996 Transportation Tomorrow Survey: Data Validation - PDF document (December 1997)
63	Under Reporting Analysis of the 1996 Transportation Tomorrow Survey -- Not available for distribution at this time--
64	1996 Transportation Tomorrow Survey: 1996 Travel Survey Summary (November 1997)
65	Not available for distribution
66	1996 GTA Zone Boundaries - PDF document (January 1998)