Welcome to Planning Help!

How To...

Top

Introduction to Planning

This manual provides a guide for urban travel demand modeling with TransCAD. TransCAD breaks new ground as a tool for transportation planners in terms of GIS support for planning and modeling, and in streamlining and improving the demand modeling process.

TransCAD supports many styles of travel demand modeling including sketch planning methods, UTPS-style four-step demand models, advanced disaggregate modeling techniques, simultaneous models for multiple choices, and the most extensive set of traffic assignment models ever assembled for use by planners and traffic engineers. TransCAD has been designed and is continually enhanced in order to facilitate the implementation of best practices for travel forecasting and to provide a mechanism for advancing the state of the art in transportation modeling.

Modeling with TransCAD is not limited to urban or regional demand forecasting, but is equally feasible for modeling passenger and freight flows at the state, national and/or international level. Nevertheless, this manual focuses on urban passenger transportation as these applications are familiar to the greatest number of transportation professionals.

For more information, see:
Demand Forecasting in a GIS Context
Relational Data Management
Visualization of Model Inputs and Outputs
Customization and User Extensions
About This Manual

Top

Demand Forecasting in a GIS Context

TransCAD is the first geographic information system designed specifically for planning, managing, and analyzing the characteristics of transportation systems and facilities. As the premier GIS for transportation, TransCAD combines a complete and ever-expanding set of tools for travel demand modeling with unique capabilities for digital mapping, geographic database management, presentation graphics, and application of sophisticated transportation, operations research, and statistical models.

Travel forecasting models are used to predict changes in travel and utilization of the transportation system in response to changes in regional development, demographics, and transportation supply. Modeling travel demand is a challenging task, but one that is required for rational planning and evaluation of transportation systems.

Travel demand forecasting has evolved over a forty-year period as an art and a science with a substantial professional foundation and technical literature. Many of the advances in theory and practice have resulted from the application of new developments in econometrics and operations research to transportation applications. There are many new methods that have not yet been deployed in planning practice, and many outstanding and difficult theoretical and empirical questions in demand modeling.

The application of transportation models has always been a computationally intensive process. In its early development, travel demand forecasting on mainframes was a pioneering computer application. Travel demand forecasting remains today a challenging computational problem. The enormous computing power available on the desktop, at nearly the price of electricity, enables a graphic, interactive, GIS-based approach to transportation modeling that is accessible to every organization.

Much of the software that has been used in the past decade for urban transportation planning has simply been ported from the Urban Transportation Planning System (UTPS) without significant modification or enhancement. While UTPS was a considerable technical achievement in its day, planning model software is only just beginning to exploit the rapid advances in computing that have characterized the last decade. With each successive version of TransCAD we have aimed to preserve the best of the past, while providing improved solutions with better algorithms, more modern software technology, greater user convenience, and greater flexibility in modeling choices and possibilities.

For the classical models, we have closely followed the traditional calibration techniques. For newer models, the programs have been written at Caliper implementing methods that are believed to be best, based on the most current literature. There are also several important models in TransCAD based on computer programs provided by leading researchers, whose contributions have been prominently acknowledged. All models are written in the C language using 32-bit architecture for enhanced performance.

We have added estimation routines that support the models that are used for forecasting. The multiple regression and logit models can be used on any of the data stored in the TransCAD GIS and provide tools for open-ended model exploration and development.

TransCAD features a modern, multiple-window interface following Microsoft Windows standards. Importantly, the demand forecasting models and other TransCAD procedures now benefit from this powerful interface. Moreover, various Windows technologies such as OLE 2.0 and ODBC permit the integration of TransCAD and numerous other Windows applications, yielding greater productivity for planners and analysts.

Travel demand models are inherently spatial in character and their implementation is predicated upon the ability to manipulate spatial variables. Historically, a highly structured set of data files was designed to hold the requisite information. These files include vectors for productions and attractions, matrices for flows and travel impedance, and networks for highways and transit.

In a GIS, data are typically associated with point, line, or area features. These data structures match up reasonably well for representing special generators, geographic networks, and zone boundaries. However, transportation applications require many modified or specialized GIS features and functions for proper treatment of transportation networks, routes, and flow matrices. TransCAD was designed to achieve an appropriate integration of planning and GIS data structures and to facilitate the use of GIS technology and data in demand forecasting. In many instances, the GIS platform or its extensions provides a richer firmament for maintenance and use of transportation planning data than has previously been available.

GIS technology affords a significant advantage in network analysis and its associated data preparation tasks. In particular, TransCAD greatly reduces the effort that has traditionally been associated with network development. Because GIS databases describing the location of highways and streets are often available, these can be imported directly without tedious coding. In locations where highly accurate GIS line layers do not yet exist, the nationwide street and highway files included with every copy of TransCAD can be used as a significant point of departure for network development.

To the extent that digitizing is required, this function is fully supported, and can be performed over raster images derived from paper maps and aerial photography. TransCAD supports Active TopologyTM map editing, which reduces the numerous errors (e.g. undershoots and overshoots) that accompany CAD and non-topological desktop mapping files.

In TransCAD, networks have nodes at their correct geographic locations, avoiding many of the errors of coding networks in an arbitrary x-y coordinate system. Networks from systems that use x-y coordinate systems can be imported and made more accurate in the TransCAD environment.

A TransCAD network has a structure that is efficient for pathfinding and is similar to the type of files that is used in UTPS. In TransCAD, some network characteristics are automatically transferred from the geographic layer such as length, a link type code, and directionality. Any other user-selected data items can be included in a network file.

Direct provision is made for storing and editing turn prohibitions associated with different types of intersections and link cost functions associated with different types of links. Combined with the powerful, interactive geographic editing and relational database capabilities, this makes TransCAD the most efficient tool for developing network data files.

Because networks are separate from line layers in TransCAD, many different networks can be associated with the same geography. This makes it a simple matter to have networks whose characteristics vary by time of day or mode of transportation. Network update functions can be used for rapid scenario creation and analysis.

Other GIS extensions for planning include routes and matrices. For transit analysis, the route data structures allow for the most realistic empirical treatment of transit operations and make it possible for the same databases to be used for both planning and operations management purposes.

TransCAD matrices are used to store flow data and other measures such as travel times that pertain to entity-entity relationships that are difficult to handle with relational data tables. Matrices can have multiple layers so that flow information can be conveniently referenced to the same geographic features by purpose and/or by mode. Many procedures create matrices as outputs; for example, trip tables can be estimated from traffic counts.

The use of an area layer for zonal data belies the power of GIS for developing planning model data. Zones can be flexibly defined and edited at will by the analyst. Zones can correspond directly to Census geography, which is in many cases the best practice, and zonal boundary data can be imported directly from the geographic data readily available with TransCAD. Zones can be constructed of subzones, can contain other area units such as industrial parks or lakes, and can contain point data on special generators or survey respondents, with easy aggregation of data to the zone level.

With TransCAD, analysis can be performed at any spatial scale, freeing modeling from the limits of single-scale analysis. These limits can be significant when multiple scales are appropriate. Functions for geographic aggregation make it easy to integrate computations performed at more than one scale into the same analysis.

An important use of spatial processing is to compute zonal measures based on entities contained within zones or within buffers of zones. Measures such as land use acreage or travel time to the CBD can be easily computed and added to the zonal data tables. The percentage of transit riders within 1/4 mile of a bus stop is now easily estimated and used in analysis. Polygon overlay can be also used to convert from one zoning system to another. The use of geographic operators for preparation of inputs and for summarizing outputs is an important addition to the tools available to the transportation analyst.

A strategy for analysis entails a correspondence between the TransCAD data objects and the various model inputs and outputs associated with a model system. This is simple and natural for most models, including the four-step traditional schema. For a four-step demand model, there will be one or more zone layers that hold TAZ information, vectors and matrices that hold flow information, and various objects associated with transportation networks. Cross-object transformations are supported so that data can be moved easily from databases to the specialized data structures.

Top

Relational Data Management

A GIS provides a nearly ideal data management and visualization environment for travel demand model inputs and outputs. While it is possible to implement transportation analysis software without GIS support, an important aspect of the TransCAD GIS is that it provides superior database management for transportation analysis and an easy-to-use map interface for manipulating transportation data. The powerful database greatly enhances productivity.

TransCAD fully implements the relational database approach in support of model development. Attribute data may be freely joined to and detached from geographic layers as analysis requirements dictate. A spreadsheet-like view of data tables permits rapid editing and ease of calculating new variables. Relational data manipulation is easily integrated with robust and powerful geoprocessing for spatial queries, polygon overlay, and multi-band buffering.

Top

Visualization of Model Inputs and Outputs

Experience has shown that the map is a rich and highly efficient user interface for manipulating transportation data. Graphic visualization tools increase understanding of transportation data and model results as well as help to identify and correct erroneous data items. Charts and graphs can be produced from TransCAD data files and integrated with the powerful thematic maps to illustrate forecasts. Specialized visualization capabilities have been added that make TransCAD the most powerful visualization tool for transportation data. Also, there is full support for the production of presentation-quality graphic output in printed and electronic formats.

Top

Customization and User Extensions

Because travel demand forecasting applications vary tremendously and there is an ongoing need for improved modeling techniques, TransCAD was designed as an open platform that facilitates the addition of user-written and third party extensions. The Geographic Information System Developer's Kit, GISDK(tm), for TransCAD provides the tools for creating add-ins to TransCAD, macros to automate repetitive tasks, and the ability to implement custom model interfaces.

Add-ins can implement completely new modeling procedures that access TransCAD data. Add-ins can be written in the Caliper Script macro language, in another programming language, or in a mixture of macro and native code. In this way, TransCAD is designed to avoid the requirement of massive code-writing for new analysis methods, and provides a cost-effective means of implementing new travel demand models.

Top

About This Manual

This manual provides the information needed for effective travel demand modeling with TransCAD. We assume that you are already familiar with demand model concepts and with TransCAD basics, including its core GIS functionality. This manual is intended to be used in conjunction with the other components of the TransCAD documentation.

A variety of illustrative exercises are provided for use as tutorial material. There are both hypothetical and real world examples. The examples are designed to show how to use TransCAD and to help you understand its core operating concepts. For many planners, there will be helpful tutorials on the mechanics of implementing models. In educational settings, this manual can also be used in a one- or two- semester course on travel demand modeling.

This book also provides guidance with respect to the use of certain procedures and some discussion of the advantages and disadvantages of various alternatives. This guidance is intended to help you focus on key issues in model selection, rather than to prescribe all possible model schema. You are urged to keep in mind that the appropriateness of any model must be judged in

the proper context, and that the presence of a procedure in the TransCAD system is in no way an endorsement of its suitability in any application.

New and enhanced analytical procedures are continually being added to TransCAD. Supplemental procedures and the associated documentation will be published from time to time. Information on availability of supplemental procedures will typically be available on the Caliper World Wide Web site (http://www.caliper.com). Also, some advanced procedures are not part of the standard release, but may be made available on a limited basis for research and testing. Lastly, many additional capabilities have been added to TransCAD by users who have developed macros and other add-ins with GISDK and Caliper Script. If you need a procedure that does not appear to be in the package, please contact us to see if it is available from Caliper or a third party.

Preface

This part of the on-line help, based on *Travel Demand Modeling with TransCAD®*, is designed to help you learn and use the transportation planning procedures that are part of TransCAD. This manual is one of several books that comprise the documentation set for the Standard TransCAD Version. These books are:

- *TransCAD User's Guide*
- *Travel Demand Modeling with TransCAD* (this book)
- *Routing and Logistics with TransCAD*

For more information, see:
Before You Begin
About This Book
Installation Notes

Before You Begin

This book, and the procedures it describes, are designed for use by individuals who are familiar with TransCAD and its concepts and terminology. To use the procedures described in this book most effectively, you should know how to:

- Create and modify maps
- Display and edit data
- Create and work with TransCAD networks
- Use the TransCAD selection tools and commands
- Create joined views
- Create and work with TransCAD matrices
- Create, modify, and work with Route Systems

For an introduction to these subjects, see the following chapters of the *TransCAD User's Guide*:

- Chapter 3, Creating Maps
- Chapter 4, Layering Features on a Map
- Chapter 8, Displaying and Editing Data
- Chapter 10, Location and Attribute Queries
- Chapter 11, Joining Your Data to a Map
- Chapter 13, Networks and Shortest Paths
- Chapter 14, Network Settings
- Chapter 16, Route Systems
- Chapter 18, Working with Matrices

TransCAD procedures are intended for use by knowledgeable analysts. Users are urged to consult planning guides, textbooks, and the research literature for relevant background information on model definitions, solution methods, and appropriate applications. The technical references in this manual can guide you to sources for this important background information.

Top

About This Book

Travel Demand Modeling with TransCAD is both a learning and a reference tool. The chapters are organized loosely around the traditional four step forecasting process used in transportation planning:

- Trip Generation: Chapters 2, 3, 4, and 5
- Trip Distribution: Chapter 6
- Mode Split: Chapter 7
- P-A to O-D and Time of Day Transformations: Chapter 8
- Traffic Assignment: Chapters 9 and 10

In addition, there are three chapters that focus on the transit applications of TransCAD:

- Transit Networks, Best Transit Paths, and Path Attributes: Chapter 11
- Transit Assignment: Chapter 12
- O-D Matrix Estimation: Chapter 13
- Transit O-D Matrix Estimation: Chapter 14

And there are several chapters that are oriented towards data preparation and manipulation and model application:

- O-D Matrix Estimation: Chapter 13
- Data Preparation and Planning Utilities: Chapter 15
- Batch Mode: Chapter 16

Each of the chapters in this manual contains:

- Descriptions of the models and planning issues
- Complete instructions for using each procedure
- 60-Second Tutorials that provide hands-on practice

- Technical notes and references

There is also an Appendix A with references.

Installation Notes

The TransCAD travel demand modeling procedures described in this manual are installed as part of the standard TransCAD package. No separate installation step is required. The travel demand modeling procedures appear on the Planning menu. To see this menu, choose the **Procedures-Planning** command.

If you purchased the base TransCAD package, which does not include the travel demand modeling procedures, you need to upgrade to the complete, standard TransCAD package to use these procedures.

Trip Generation - Production

The goal of trip generation is to predict the number of trips that are generated by and attracted to each zone in a study area. This stage of the transportation planning process is only concerned with the number of trips that start and end in each zone, and not with making the connections between origins and destinations of trips.

In trip generation, methods are applied to predict *productions* and *attractions* or *origins* and *destinations*. The zone that contains the home end of home-based trips or the origin end of non-home-based trips is considered to have *produced* the trip, while the destination zone where an out-of-home activity will be undertaken is considered to have *attracted* the trip. Whether you use origins and destinations or productions and attractions is dictated by the data available and the method used. It does not matter which you predict, as long as you keep track of your units, and you realize that assignment requires an origin-destination matrix. Productions and attractions may be converted to origins and destinations using the P-A to O-D procedure. The terms production/attraction and origin/destination will be used interchangeably in this manual, although the user should keep in mind the differences.

The trip generation stage is made up of several components. This chapter discusses the production side of trip generation. Chapter 3, Trip Generation - Attraction, discusses trip attractions, including the ITE trip rates. Chapter 4, Trip Balancing, covers balancing, in which productions and attractions are manipulated so that trips are conserved in a study area. Chapter 5, Quick Response Method for Trip Generation, discusses the TransCAD Quick Response Method (QRM) trip generation procedure, which allows you to quickly and easily derive balanced productions and attractions through the use of default models and parameters.

For more information, see:

Top

About Trip Production

The goal of trip production is to estimate the total number of trips, by purpose, produced or originating in each zone. Trip production is performed by relating the number or frequency of trips to the characteristics of the individuals, of the zone, and of the transportation network. TransCAD allows you to perform many types of trip generation analysis, from simple cross-classification methods to more complicated statistical analysis.

For more information, see:
Methods
Units
Trip Purposes
Explanatory Variables and Data Sources

Top

Methods

There are three primary tools that are used in modeling trip production:

- **Cross-Classification**: Cross-classification methods separate the population in an urban area into relatively homogenous groups based on certain socio-economic characteristics. Then, average trip production rates per household or individual are empirically estimated for each classification. This creates a lookup table that may be used to forecast trip productions.
- **Regression Models**: Two types of regression are commonly used. The first uses data aggregated at the zonal level, with average number of trips per household in the zone as the dependent variable and average zonal characteristics as the explanatory variables. The second uses disaggregate data at the household or individual level, with the number of trips made by a household or individual as the dependent variable and the household and personal characteristics as the explanatory variables.
- **Discrete Choice Models**: Discrete choice models use disaggregate household or individual level data to estimate the probability with which any household or individual will make trips. The outcome can then be aggregated to predict the number of trips produced.

Instructions for using the basic statistical tools for trip production of tabulation, regression, and binary logit are provided in Chapter 19, *Tabulations and Statistics*, of the *TransCAD User's Guide*. Some of that material is repeated here for convenience, and is illustrated with tutorial exercises that focus on trip production.

Units

Trip production in passenger transportation can be thought of in terms of person trips or vehicle trips. It is typically preferable to focus on the individual as the behavioral unit of relevance for several reasons:

- Individuals make trip frequency decisions, not vehicles
- Trip production for non-motorized modes can be important in some analyses
- Person trips can be converted to vehicle trips, if necessary, at later stages in the analysis, preferably after mode choice

Trip production models may be based on households or individuals. More often than not, household-based computations are used. However, when more detailed data are available, use of individual rates may provide greater accuracy in capturing levels of trip making and their corresponding behavioral determinants.

Trip Purposes

Trip making is highly varied, reflecting the diverse activities pursued by people in their work and non-work activities. For purposes of analysis, however, trips are typically grouped in terms of categories or purposes; while this may disguise the variety of activities pursued, it greatly simplifies model development.

The number of purposes that should be used depends fundamentally on the analytic purpose at hand and the data available. In determining the trip purposes to model, all of the steps in the modeling process, not just trip production, need to be considered.

However many purposes are utilized for modeling, it is sound practice to treat work trips as separate from other forms of trip making. The journey to work is typically the most important trip to model correctly, due to the large amount of travel accounted for by this purpose and the fact that work trips most commonly occur during the congested, peak travel periods. Adding peak period capacity through construction is typically the most expensive transportation investment and the type of project that warrants the most detailed analysis.

A common and minimal classification of trips involves work trips, home-based non-work trips, and non-home-based other trips. This classification of trip productions is utilized in the so-called "quick response" methods.

Explanatory Variables and Data Sources

There are many different factors that influence trip production, including:

Factor	Example
personal characteristics	gender
	age
	personal income
	occupation
household characteristics	family size
	auto ownership
	number and age of children in the household
	household income
zonal characteristics	land use
	residential density
	accessibility
transportation network characteristics	level of service

The most common inputs for trip production models are household and personal characteristics, either at a disaggregate level or aggregated to the zonal level. Transportation network characteristics and land use patterns are not often used, thereby making the assumption that transportation level-of-service is not an important factor affecting trip rates. Thus, most trip production models cannot predict the impact of future accessibility and land use changes. However, inclusion of these variables should be considered, especially since the GIS environment reduces the difficulty in capturing land use and accessibility factors.

The source of input data for the models can vary widely. The best situation is when local survey data of sufficient quality, timeliness, and quantity are available for use. Even without locally-initiated surveys and data collection efforts, much local data for home-based work trips can be extracted from data provided in the Census Transportation Planning Package (CTPP) at an aggregate level, Public Use Microdata Sample (PUMS) at a disaggregate level, and National Person Transportation Survey (NPTS) data. At worst, when no local data are available and time or money constraints eliminate the option of collecting new data, models of travel patterns from similar regions can be applied to the local area. In addition, there are sources of data based on national averages such as NCHRP 187 (Sosslav, 1978) and the Travel Estimation Techniques for Urban Planning (NCHRP 365, Martin 1998).

Top

Cross-Classification

Cross-classification methods of calculating productions separate the population in an urban area into relatively homogenous groups based on certain socio-economic characteristics. For example, one may classify households in an area by both family size (1, 2, 3, 4, >5 persons/HH) and by auto ownership (0, 1, >2 autos/HH), which results in 15 classifications. Average trip-production rates (the estimated number of trips that will be taken by a household or individual) are empirically derived from either disaggregate or aggregate data sets for each of the classifications. In the example above, 15 average trip rates would be derived.

Once trip rates are known for each classification, these trip rates are usually applied to each zone. The average characteristics of each zone are used to determine the classification to which the zone belongs, which then determines the trip rate to apply to the houses or individuals in the zone. Using this method, one trip rate is applied to all people in the zone.

Alternatively, each zone may be subdivided into a few classifications by using the proportion of households within a zone that have a certain characteristic. Using this method, more than one average trip rate is used to estimate productions for any one zone. For example, a zone may be divided into households without cars and households with cars. In this case, two average trip rates will be applied to each zone.

For more information, see:
Cross-Classification in TransCAD
Error Checking
Sub-Groups Within Zones
Generating Trip Rates and Cross-Classification Tables
Using Default Cross-Classification Tables
Quick Response Method
Editing Default Trip Tables

Top

Cross-Classification in TransCAD

To do cross-classification in TransCAD, you need two types of input. The first is a trip rate table that defines the classifications you wish to use and includes trip rates for each classification. You also need to have data on the average values of the classification parameters within each zone in the study area. For example, if your classifications are based on auto-ownership and number of people in the household, then you must know the average auto-ownership and average number of people per household for each zone.

You may create classifications based on any number of characteristics (such as auto-ownership, distance to transit, etc.) and you may define any number of trip purposes (home-based work, home-based non-work, etc.). To use a trip rate table in TransCAD, it must adhere to certain specifications. Say you use n characteristics to define your classifications and m trip purposes. The trip rate table has one column for each of the n characteristics. These n columns in the trip rate table are used to create one record for each possible classification. The entries in the columns must be real values (or integers), and they represent the *upper bound* of the range included in the classification. The lower bound in the range is the next lowest value entered in the column. The records do not have to be in any particular order.

The final m columns in the trip rate table hold the trip rates for each classification, where a different column is used for each trip purpose. These columns must be the right-most columns of the trip rate table, and the field name must begin with "R_".

The zone database may either be data that are attached to a geographic layer, or it may be a separate database. It must include data on all of the characteristics on which you form the classifications (in the example case, Autos/HH, Persons/HH, and Income/HH), as well as information on the size (often the number of households) of each zone.

If the zone database is not attached to a geographic layer, the first field of the database must be a unique integer ID field.

For more information, see:
To Compute Productions Using Cross-Classification

Top

⟩ *To Compute Productions Using Cross-Classification*

1. Open your trip rate table and your zone database.

2. Choose *Planning-Trip Productions-Cross-Classification* to display the Cross-Classification dialog box.

3. Choose the map layer or database that contains the zone data from the Zone Data drop-down list.

4. Choose All Zones or a selection set of records to use from the Records drop-down list.

5. The trip rates in the cross-classification table have units such as trips per household or trips per person. Choose the field in the zone database that contains the size of the zone (e.g. number of households or number of people) from the Zone or Subzone Size(s) scroll list.

6. Choose the trip rate table you wish to use from the Trip Rate Table drop-down list. After you make the selection, the trip purposes defined in the table will automatically be displayed in the Trip Purposes scroll list, and the classification parameters will automatically be displayed in the Match Fields Frame. If this does not happen, check that your trip rate table is formatted properly and that you have selected at least one item from the Zone Size drop-down list.

7. Choose one or more trip purposes for which you want to calculate productions from the Trip Purposes scroll list.

8. In the Rate Table Fields scroll list in the Match Fields frame, you need to indicate where to find the average zone data that corresponds to the characteristics by which the classifications are made. Do this by clicking on a row in the scroll list and choosing the corresponding zone database field from the Zone Data Field or Value editable drop-down list. Note that you may also type in a real numeric value instead of selecting a field from the database.

9. Click OK. TransCAD displays the Store Output Table In dialog box.

10. Type a file name and click Save. TransCAD computes the productions for the trip purposes and zones, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD shows a dataview of the cross-classification results joined to the zone database. The results of the cross-classification procedure are in the right-most columns of the dataview.

Error Checking

Missing entries in the output file signify that the data provided for the zone database is either missing or out of the range specified in the cross-classification table. These records will be listed in the log file.

Sub-Groups Within Zones

Frequently in cross-classification the members of a zone will be divided into two or more homogenous groups. One common way of doing this is to provide information on the proportion of people or households within a zone that have a particular attribute. For example, instead of saying that the average auto-ownership in a zone is 1.1 autos, you can say that 20% of the households in the zone have 0 autos, 50% have one auto, and 30% have 2 or more autos. Cross-classification is then applied to each of the subgroups within the zone.

This can be done in TransCAD in a manner very similar to that described above. The trip rate table has the exact same format and the same dialog box is used, but the zone database is slightly different, and more information is entered in the dialog box.

As described before, the zone database may either be data that is attached to a geographic layer or it may be a separate database. However, the first field of the database must be a unique integer ID field. The zone database includes data on all of the characteristics on which the classifications are based for each of the subzones. In addition, it contains information on the size of each subzone. The zone database can have only one record per zone, so the subzone information for each zone is provided in a single record.

In an example zone database with subzone information, each zone has been divided into two subzones: households without cars and households with cars. For each zone, one trip rate will be applied to the group of households that own at least one car and another trip rate will be applied to the group of household that do not own cars. A trip rate table for this zone database could have three classifications: number of autos in the household, people in the household, and the income of the household.

When applying cross-classification to sub-zones, a field from the zone database or a value must be entered for each characteristic used to classify the zones. You will want to enter a value instead of a field if, by definition, the subzone type has a constant value for all zones in the database. For example, for a subzone type consisting of households without cars, the average autos per household will always be 0.

For more information, see:

) *To Compute Productions Using Cross-Classification with Subzones*

1. Open your trip rate table and your zone database.

2. Choose *Planning-Trip Productions-Cross-Classification* to display the Cross-Classification dialog box.

3. Choose the map layer or database that contains the zone data from the Zone Data drop-down list.

4. Choose All Zones or a selection set of records to use from the Records drop-down list.

5. The trip rates in the cross-classification table have units such as trips per household or trips per person. Choose the field in the zone database that contains the size of the subzones from the Zone or Subzone Size(s) list.

6. Choose the trip rate table you wish to use from the Trip Rate Table drop-down list. The trip purposes defined in the table are automatically displayed in the Trip Purposes list, the classification parameters are automatically displayed in the Match Fields frame, and those fields that you selected as the subzone sizes are automatically added to the **Match Fields for** drop-down list.

7. Select the trip purposes for which you want to calculate productions from the Trip Purposes scroll list.

8. In the Rate Table Fields scroll list in the Match Fields frame, you need to indicate where to find the average subzone data that corresponds to the characteristics by which the classifications are made. For each subzone type, do the following:

    -   Choose the subzone type from the **Match Fields for** drop-down list.
    -   Click on each characteristic listed in the Rate Table Field scroll list and type a value in or choose a field from the Zone Data Field or Value editable drop-down list.

10. Click OK. TransCAD displays the Store Output Table In dialog box.

11. Type a file name and click Save. TransCAD computes the productions for the trip purposes and zones, aggregated across subzones, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD shows a dataview of the zones joined with the cross-classification results. The results of the cross-classification procedure are in the right-most columns of the dataview.

Generating Trip Rates and Cross-Classification Tables

You can generate your own trip rate tables if you have disaggregate survey data at the individual or household level, with information on both the characteristics on which you want to base your classifications (e.g. auto ownership) and data on the number of trips made for different purposes.

If you want only one or two trip rates, you can obtain average trip rates by selecting observations from your survey that fit the given classification. Then use **Dataview-Statistics** to obtain the average trip rates and variance for the selection set. These rates can then be entered into a trip-table and used for trip production. For more information, see "Summary Statistics" in Chapter 19, *Tabulations and Statistics*, in the *TransCAD User's Guide.*

However, if you want to create an entire trip rate table, then it is easier to use the Create Cross-Classification Table Procedure, which is described in Chapter 15, *Data Preparation and Planning Utilities*. With this procedure, you specify the characteristics by which you want to classify the population and the cut-off values between classifications, and TransCAD generates a trip rate table from your database.

Using Default Cross-Classification Tables

TransCAD provides several default cross-classification tables that you may use for your analysis. The source of these tables is the Travel Estimation Techniques for Urban Planning, NCHRP Report 365. While use of these default tables allow you to quickly and easily derive trip production values, the user should be aware that these tables are based on data collected from throughout the United States, and may not be representative of travel in the study area. Thus, the default tables should be used only if time or budget constraints make it impossible to obtain data from the study area.

The default tables are located in the Tab folder within the TransCAD program folder. There are seven lookup tables. **All are binary files, with the file name beginning with "crcl_".** The remaining part of the file name indicates the classifications that are in the table: p = urban area population, a = autos per household, s = household size in persons, and i = income per household.

The following table summarizes the available default production trip rate tables:

File Name	Classifications				Trip Purposes				
---	Urban Pop	Income/HH	HH Size	Autos/HH	ADPT/HH	ADVT/HH	HBWPT/HH	HBOPT/HH	NHBPT/HH
CRCL_P	x				x	x	x	x	x
CRCL_PA	x			x	x				
CRCL_PI	x	x			x		x	x	x
CRCL_PS	x		x		x	x	x	x	x
CRCL_PIA	x	x		x	x		x	x	x
CRCL_PAS	x		x	x	x		x	x	x

CRCL_PIS	x	x	x		x		x	x	x

where:

ADPT/HH   = Average daily person trips per household
ADVT/HH   = Average daily vehicle trips per household
HBWPT/HH   = Home-based work person trips per household
HBOPT/HH   = Home-based other person trips per household
NHBPT/HH = Non-home-based person trips per household

You may modify the default trip tables. However, be sure that the modified table still satisfies the requirements of cross-classification tables described in the previous section.

For more information, see:
To Compute Productions Using Default Cross-Classification Tables

Top

) *To Compute Productions Using Default Cross-Classification Tables*

1. Open both the default trip rate table that you wish to use and your zone database.

2. Choose *Planning-Trip Productions-Cross-Classification* to display the Cross-Classification dialog box.

3. Choose the map layer or database that contains the zone data from the Zone Data drop-down list.

4. The trip rates in the default cross-classification table are in units of trips per household. Choose the field in the zone database that contains the number of households from the Zone or Subzone Size(s) scroll list.

5. Select the default trip rate table you wish to use from the Trip Rate Table drop-down list. The trip purposes defined in the table are automatically displayed in the Trip Purposes scroll list, and the classification parameters are automatically displayed in the Match Fields frame.

6. Choose the trip purposes for which you want to calculate productions from the Trip Purposes scroll list.

7. In the Rate Table Fields scroll list in the Match Fields frame, you need to indicate where to find the average zone data that corresponds to the characteristics by which the classifications are made. Do this by clicking on a row in the list and choosing the corresponding zone database field from the Choose Zone Data Field or Value editable drop-down list.

8. Click OK to display the Store Output Table In dialog box.

9. Type a file name and click Save. TransCAD computes the productions for the trip purposes and zones by using the default trip table that you selected, and displays a Results Summary dialog box:

To do this...	Do this...

View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD shows a dataview of the zones joined with the cross-classification results. The results of the cross-classification procedure are in the right-most columns of the dataview.

Quick Response Method

TransCAD includes a default trip rate table from NCHRP 187 (Sosslau et al., 1978) that you may use to calculate productions using the QRM Trip Production procedure. Note that this default trip table does not fit the specifications required for the Trip Production Cross-Classification Model, and thus cannot be used in that procedure.

The default table is a cross-classification table, **segmented by the size of the urban area, household (HH) income, and auto-ownership,** and includes trip rates for three trip purposes: home-based work, home-based other, and non-home-based. The output of the model is the number of person-trips produced per zone for each of the three trip purposes.

While having default trip rate values makes this procedure easy to apply, be aware that the trip rate values are based on data collected from throughout the United States, and these rates may not match the travel patterns for the study area. Thus, the QRM method should only be used for preliminary analysis or when constraints on time or budget make it impossible to obtain local data.

There are four types of cross-classification applications that you may use with the default tables:

- **None (Use Average Rates) -** Trip production rates are calculated according to average daily person trips per household. The income level and car ownership level of the household are not considered. You must have the following data in your zone layer to use this method:

  - Total number of households in the zone

- **Income per Household -** The trip rate is calculated based on the average income of the households residing in the zone. You must have the following data in your zone layer to use this method:

  - Total number of households in the zone
  - Average income per household in the zone

  You may also apply an inflation index to the average incomes in the zone layer.

- **Autos per Household** - The trip rate is calculated based on the car ownership of the households residing in the zone. You must have the following data in your zone layer to use this method:

  - Total number of households in the zone
  - Average autos per household in the zone

- **Income per HH and Auto Ownership Split -** Total households are segmented within each

zone by auto ownership. The trip rate is calculated based on the average income of households residing in the zone and on the proportion of households within each zone in each auto-ownership classification. You must have the following data in your zone layer to use this method:

- Total number of households in the zone
- Average income per household in the zone
- The percentage of HH in the zone for the auto-ownership classifications of 0, 1, 2, or 3+ autos per household

Equations Used in QRM Procedure

None (Use Average Rates) $T_k = HH \cdot \overline{R} \cdot f_k$

Income per Household $T_k = HH \cdot R_I \cdot f_k$

Autos per Household $T_k = HH \cdot R_C \cdot f_k$

$$T_k = \sum_{z=0}^{3} HH \cdot P_z \cdot R_{Iz} \cdot f_k$$

Income per HH and Auto Ownership Split

where:

T_k = Trip rate for trip purpose k

HH = Total number of households in the zone

$\overline{R}$ = Average trip production rate

R_I = Average trip rate for average zone income level I

R_C = Average trip rate for average zone car ownership level C

R_{Iz} = Average trip rate for households with z cars who live in a zone with average income of I

R_{Cz} = Average trip rate for households with z cars who live in a zone with average car ownership of C

P_z = Proportion of households in the zone with z cars

f_k = Proportion of total trips of trip type k

TransCAD provides a default trip production table in the Tab folder, called PROD_TGP.DBF. If you have not altered this file in any way (including changing the location of the file), then TransCAD will automatically initialize the procedure to use the default table and "Prod Default (NCHRP 187)" will already be chosen as the production lookup table.

For more information, see:
To Estimate Trip Productions Using QRM

Top

) To Estimate Trip Productions Using QRM

1. Open the area layer that includes the necessary zonal data.

2. Choose **Planning-Trip Production-Quick Response** to display the
    QRM - Trip Production dialog box.

3. Choose the layer that contains the necessary zone data from the Apply To drop-down list.

4. Type a population value (in thousands) in the Urban Area Pop edit box.

5. Choose the classification method you want to use for production from the Classify By
    drop-down list.

6. Choose the field that contains the number of households from the Total HH drop-down list.

7. Make other settings as follows:

For this method...	Do this...
Income/HH	Type an income value (in thousands) or choose a field from the Inc/HH editable drop-down list, and type an inflation value in the Inflation Index edit box
Autos/HH	Choose the field that contains the number of autos per household from the Auto/HH drop-down list
Inc/HH & Auto-Own. Split	Type an income value (in thousands) or choose a field from the Inc/HH editable drop-down list, type an inflation value in the Inflation Index edit box, and choose the fields that contain the percentages of households with 0, 1, 2, and 3+ cars from the respective drop-down lists

8. Click OK to display the Store Output Table In dialog box.

9. Type a file name and click Save. TransCAD computes the productions for the trip purposes and
    zones, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays a dataview of the cross-classification results joined to the zone database. The
results of the cross-classification procedure are in the right-most columns of the dataview.

Editing Default Trip Tables

You can edit the QRM trip production default file to include your own data or to include different
types of trip purposes. In order to use the TransCAD QRM trip production procedure, the file must

conform to certain specifications. The following are guidelines for editing the QRM trip productions table, prod_tgp.dbf, in the Tab folder of the TransCAD program folder:

- The first 12 column purposes are fixed. You cannot delete, rearrange, or change the purpose of any of the columns.
- Any of the data in the cells may be altered.
- Rows may be added or deleted.
- The trip rates in any row are applied to all zones that have all classification values less than or equal to the classification values (e.g. Income/HH) entered in the row, but greater than the next smallest classification value.
- An empty cell in the field that defines the classifications signifies that the trip rates are averaged over all values of the classification (i.e. the classification is ignored).
- The Percentage of Average Daily Person Trips by Purpose columns can be changed to include any number of trip purposes, as long as you have at least one column (i.e. one trip purpose). In addition, 100 percent of the trips must be accounted for in these columns.

NOTE: If you do not want to permanently alter the default files, then choose *File-Save As* and save the file as a dBASE file under a different name.

For more information, see:
To Use the Edited Trip-Rate Files in Trip Production

Top

⟩ *To Use the Edited Trip-Rate Files in Trip Production*

1. Open the edited trip-rate files that you wish to use.

2. Follow all steps in the procedure To Estimate Productions Using QRM, except that instead of using the default lookup table, choose the edited lookup table in the Lookup Table drop-down list.

TransCAD uses the edited lookup tables to calculate the trip productions for each trip type generated in each zone, and stores the results in a binary file.

Top

Regression Methods

Regression methods can be used to establish a statistical relationship between the number of trips produced and the characteristics of the individuals, the zone, and the transportation network.

Two types of regression are commonly used. The first uses data aggregated at the zonal level, with average number of trips per household in the zone as the dependent variable and average zonal characteristics as the independent (explanatory) variable. The second uses disaggregate data at

the household or individual level, with the number of trips made by a household or individual as the dependent variable and the household and personal characteristics as the independent variables.

The best situation is when data for the study area are available that include relevant independent variables (e.g. socio-economic and accessibility factors) and data on frequency of trips for various trip purposes. In this case, you can estimate a regression model that is specifically made for the study area instead of transferring models from another area.

For more information, see:
Estimating a Trip Production Regression Model
Forecasting from a Regression Equation for Trip Production
Transferring Regression Models into TransCAD Model Files

Top

Estimating a Trip Production Regression Model

To estimate a trip production regression model, you provide the dataset to use to estimate the model, specify the dependent variable, and specify all of the independent variables. TransCAD then estimates the coefficients of the model and creates two output files:

- A report file that lists the estimated parameters and goodness-of-fit and importance measures.
- A file containing the values of the estimated model parameters.

The second file is called a model file. It has an extension of .mod and is formatted so that it can be used to evaluate the model for forecasting purposes. The model file is described in more detail later in this chapter and also in Chapter 19, *Tabulations and Statistics*, in the *TransCAD User's Guide*.

For more information, see:
To Estimate Regressions in TransCAD

Top

⟩ *To Estimate Regressions in TransCAD*

1. Open the dataview or database that has the data that you wish to use to estimate the regression equation.

2. Choose **Statistics-Model Estimation** to display the Model Estimation dialog box.

3. Click the Regression radio button.

4. Click the Dependent tab to display the Dependent page, and choose [Work Trips Per HH] as the dependent variable from the scroll list.

5. Click the Independent tab to display the Independent page.

6. Choose the independent variables by Ctrl-clicking on the fields in the Available Fields scroll list.

7. Click Add. The fields are added to the Estimation Fields scroll list. If you make a mistake, you can click Clear to start over, or click on a field in the Estimation Fields scroll lists and click Drop to exclude the field from the regression.

8. Click OK to display the Save Model As dialog box.

9. Type a file name click Save.

10. TransCAD estimates the model, creates a model file containing the model parameters (so that you can later apply the model for forecasting), and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file to see a formatted report of the estimation results, including goodness-of-fit measures, estimates of the coefficients, and t-statistics. Close the Notepad program when you are done.
Close the dialog box	Click Close.

Top

Forecasting from a Regression Equation for Trip Production

Once you have developed the regression equation, you want to be able to use it for policy analysis by forecasting the dependent variable under various scenarios. To do this, you need to create a database that has the values of the independent variables for the various scenarios you want to test. Then you can use this database and a model file to forecast trip productions. The model file contains the estimated parameters of the regression equation and is produced by the model estimation procedure. Alternatively, you can create your own model file, as is explained in the next section.

When you evaluate regressions, the forecasted dependent variable gets stored in a field in the database. If you need to add a new field to your database, you can use the *Dataview-Modify Table* command.

For more information, see:
To Evaluate Regressions in TransCAD (with a . mod file)

Top

⟩ To Evaluate Regressions in TransCAD (with a .mod file)

1. Open the map or database that contains the independent variables on which you want to apply the model.

2. Choose **Planning-Trip Production-Apply a Model** to display the Open Model File dialog box.

3. Choose a model file and click Open. TransCAD displays the Forecast dialog box.

   The explanatory (independent) variables and coefficients from the .mod file are listed in the scroll list.

4. Choose the database that contains the independent variables from the Apply To drop-down list.

5. Choose the field in which you want to store the forecasted dependent variable from the Results In drop-down list.

6. Choose All Records or a selection set from the Using drop-down list.

7. For each independent variable, TransCAD needs to know where to find the forecasted value on which it will apply the model. Click on each variable in the scroll list and choose the field that contains the forecasted values from the drop-down list below the scroll list. You can also change the parameter for each variable by typing a new value in the Settings edit box.

8. Click the Regression radio button.

9. Click OK.

TransCAD performs the evaluation and fills the chosen field with the forecasted results.

Top

Transferring Regression Models into TransCAD Model Files

Sometimes you may not have local data for developing models, and you want to transfer a model from another study area. In this case, if you have local data corresponding to the independent variables in the model, you can use the model to predict the number of productions generated in one of two ways.

If it is a simple linear model of the form:

$$y = \beta_o + \sum_{i=1}^{k} \beta_i x_i$$

then you can create a model file to use in the regression evaluation procedure provided by TransCAD. The model file tells TransCAD what the independent variables and parameters are.

Model files have the extension .mod. The first line of the model file contains a description, which is for your reference only. The remainder of the model file has one line for each explanatory field in the table. Each line consists of two items of information, separated by a comma: the exact field name of the independent variable that was used to estimate the parameters, and the value of the parameter. The model file must include a constant variable called "CONSTANT"; if you don't have a

constant in the model, then enter "0.0" as the parameter.

Here is a sample model file:

> My model file
> CONSTANT, -1.42
> Num Autos, 1.69
> HHSize, 1.46
> Num Ch<5, -1.65
> Num Workers, 0.75

that describes this model (taken from the *Manual of Regional Transportation Modeling Practice*):

> Trips/HH = -1.42 + 1.69*[Num Autos] + 1.46*[HHSize] - 1.65*[Num Ch<5] + 0.75*[Num Workers]

This model file can be applied to any database that includes the independent variable data: autos per household, household size, number of children under age five in the household, and number of workers in the household.

You can create a model file in any text editor. Alternatively, you can use the **Statistics-Create Model File** command; see Chapter 19, *Tabulations and Statistics*, of the *TransCAD User's Guide* for more information. Note that you can also use formula fields to evaluate a regression equation; see Chapter 8, *Displaying and Editing Data*, of the *TransCAD User's Guide*.

Top

Discrete Choice Methods

Since individuals choose whether to make specific trips, discrete choice models such as binary logit can be used to predict trip production. With binary logit, the probability that an individual will choose to make a trip (as opposed to not traveling) can be expressed as:

$$P_n(1) = \frac{1}{1 + e^{\beta(x_{0n} - x_{1n})}}$$

where:

$P_n(1)$ = the probability with which person *n* will make a trip

β = the vector of coefficients that is estimated by the model

x_{1n} = the vector of explanatory variables in person n's utility of making a trip

x_{0n} = the vector of explanatory variables in person n's utility of not making a trip

From the estimated coefficients, you can see how the explanatory variables will impact the probability with which an individual will make a certain trip. In addition, you can aggregate the disaggregate probabilities to obtain the proportion of the population that will take this type of trip, and thus generate the aggregate number of trips produced by a zone.

A brief description of how to apply binary logit models to trip production follows. For more information on the theory and application of binary logit models, see Chapter 17, *Tabulations and Statistics*, of the TransCAD User's Guide. Some useful references on binary logit are provided at the end of Chapter 7, *Mode Split and Choice Analysis*. Chapter 7 also discusses applications of multinomial logit in TransCAD.

For more information, see:
To Estimate a Binary Logit Model
Interpreting the Results of a Logit Model
Evaluating a Binary Logit Model
Transferring Logit Models into TransCAD
Aggregating Discrete Choice Results for Forecasting

Top

⟩ To Estimate a Binary Logit Model

1. Open the dataview or database that has the data that you wish to use to estimate a binary logit model.

2. Choose **Statistics-Model Estimation** to display the Model Estimation dialog box.

3. Click the Binary Logit radio button.

4. Click the Dependent tab to display the Dependent page, and choose [Work Trips Per HH] as the dependent variable from the scroll list.

5. Click the Independent tab to display the Independent page.

6. Choose the independent variables by Ctrl-clicking on the fields in the Available Fields scroll list.

7. Click Add. The fields are added to the Estimation Fields scroll list. If you make a mistake, you can click Clear to start over, or click on a field in the Estimation Fields scroll list and click Drop to exclude the field from the binary logit model.

8. Click OK to display the Save Model As dialog box.

9. Type a file name and click Save.

10. TransCAD estimates the model, creates a model file containing the model parameters (so that you can later apply the model for forecasting), and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file to see a formatted report of the estimation results, including goodness-of-fit measures, estimates of the coefficients, and t-statistics. Close the Notepad program when you are done.
Close the dialog box	Click Close.

Top

Interpreting the Results of a Logit Model

A model yielded the following results:

Parameter	Estimate	T-Statistic
Constant	-0.474	-2.4
Sex	0.267	2.1
Age	-0.047	-19.1
Married Female	0.314	2.8
Married Male	1.594	12.4
Fem w/ Child<6	-1.742	-11.4
Education	0.211	13.8

with a goodness-of-fit (Adjusted Rho Squared) of 0.22. The variables **Sex, Age, Married Female, Married Male, Fem w/ Child<6** are all dummy variables (i.e. equal to 1 or 0). Note that all of the coefficients are significant at a 95% confidence level (t-statistic > 2).

This logit model predicts the probability with which an individual will make a work trip according to the following equation:

$$P_{(trip)} = \frac{1}{1 + e^{0.474 - 0.267(\mathbf{Sex}) + 0.047(\mathbf{Age}) - 0.314(\mathbf{MarFem}) - 1.594(\mathbf{MarMale}) + 0.742(\mathbf{Chld < 6}) - 0.211(\mathbf{Educ})}}$$

From the estimated coefficients, you can see how the explanatory variables will impact the probability with which an individual makes a trip to work. For example, the coefficient for education (0.211) suggests that, all else being equal, people with more education are more likely to make work trips than those with less education. Note that none of the signs from the model seem unreasonable. You can also use the equation above to calculate how a change in an explanatory variable will impact a person's probability of making a work trip. For example, a person with a high school diploma (Educ=10) who has a 50% probability of making a work trip would, all else being equal, have a 70% probability of making a work trip if he or she had a Bachelor's Degree (Educ=14).

Top

Evaluating a Binary Logit Model

Once you have developed the logit equation, you will want to apply it to various scenarios. To do this, you need to create a database that has the values of the independent variables for the various scenarios you want to test. Then you can use this database and a .mod file as inputs to the Model Evaluation procedure to obtain the forecasted trip productions. The .mod file is an output of the Model Estimation procedure, and it contains the names of the independent variables and the estimated parameters.

For more information, see:

) *To Evaluate a Binary Logit Model*

1. Open the dataview or database that has the data on which you want to apply the logit model.

2. Choose **Planning-Trip Production-Apply a Model** and select the .MOD file.

3. Choose the database that contains the independent variables from the Apply To drop-down list.

4. Choose the field in which you want to store the forecasted results from the Results In drop-down list.

5. Choose All Records or a selection set from the Using drop-down list.

6. For each independent variable, click on the variable name in the scroll list, then select the field that contains the forecasted values from the drop-down list below the scroll list.

7. Click the Binary Logit radio button.

8. Click OK.

TransCAD performs the evaluation and fills the chosen field with the forecasted results.

Transferring Logit Models into TransCAD

You can transfer a previously-estimated binary logit model into TransCAD using a model file, a text file that tells TransCAD what the explanatory variables and parameters are. The model file can be used in the Model Evaluation procedure to forecast productions.

Model files have the extension .mod. The first line of the model file contains a description, which is for your reference only. The remainder of the model file has one line for each explanatory field in the table. Each line consists of two items of information, separated by commas: the exact field name of the explanatory variable as it is written in your local database, and the value of the parameter. The model file must include a constant variable called "CONSTANT"; if you don't have a constant in the model, then enter "0.0" as the parameter.

Here is an example model file:

> 60 Sec Tutorial Model File: Logit Model of Work Trip Production
> CONSTANT, -0.474
> HHInc(1000s), 0.002
> Sex, 0.267

Age, -0.047
Married Female, 0.314
Married Male, 1.594
Fem w/ Child<6, -1.742
Education, 0.211

Aggregating Discrete Choice Results for Forecasting

The output of a binary choice trip generation model is the probability with which a particular individual will make a trip. However, what is useful in planning is not the individual's probability of making a trip but rather the overall number of trips generated in an area. Thus, the discrete choice output must be aggregated to produce an aggregate forecast. There are several methods that can be used, all of which are easy to implement in TransCAD. For a description of the methods, see Chapter 7, *Mode Split and Choice Analysis*.

Technical Notes on Trip Generation - Production

Building sound trip production models entails the use of appropriate statistical and econometric methods. This includes using relevant theory to specify model relationships, explanatory variables, and classification schemes.

Care should be taken to specify causal models and avoid tautological (i.e., circular) relationships. In specifying variables for use in trip production models, it is important to keep in mind that there will need to be forecasts of these variables for future years. Alternatively, if you is using cross-classification, you will need to forecast the number of persons or households in each category for the forecast year.

For more information, see:
Cross-Classification
Zonal Regression Models
Work Trip Production Models
Advanced Practice with Choice Models

Cross-Classification

In advanced practice, cross-classification can be based on statistical estimation. Indeed, a cross-classification in this context is simply a regression on dummy variables. If the base data are available, it can be informative to check cross-classification variables and levels for statistical significance. Testing should consider interaction effects, as these may account for important non-linearities in trip production. Ortuzar and Willumsen (1994) provide a good discussion of the issues to consider in developing a cross-classification model.

In more advanced practice, logit-based classification models can be estimated. See Agresti (1984), for example, as a reference on methods for ordinal, categorical analysis. There are also specialized clustering methods that might be useful in choosing categories and their respective levels.

Top

Zonal Regression Models

There are a number of econometric issues raised in estimation of aggregate, zonal trip production equations. Attention to these issues at the outset of model development will help avoid a number of common pitfalls.

First, trip production is bounded from below by zero. Some regression fits will predict negative values of trips. When this occurs, it may be necessary to stratify observations or to use some form of transformation of data prior to model estimation. Forcing the fitted regression line to pass through the origin by dropping the constant is not a good practice as it leads to biased regression coefficients. There are more advanced alternatives such as probit models but these have not always yielded good results.

Zonal regressions often suffer from the problem of heteroscedasticity. That is, the residuals are often a function of zone size or are otherwise correlated with magnitude of the dependent variable (i.e. trip productions). This condition can be detected using the statistical and graphic tools provided in TransCAD. One possible remedy is to use rates based on a measure of zone size that is used to divide both the dependent and independent variables. Formulation of model equations in terms of rate variables instead of zonal totals is desirable because we are not interested in explaining arbitrary variations in trip productions that result from variation in zone size (Kern and Lerman, 1977). Even though it may result in a lower R-squared, the rate-based equation is more likely to satisfy the ordinary least squares assumption of homoscedastic residuals (Douglas and Lewis, 1970).

All zonal regressions are likely to reflect aggregation effects directly resulting from the particular zoning system used. In other words, if one were to change the zoning scheme, the estimated model parameters would be likely to change. In geography, this is sometimes referred to as the modifiable area unit problem. At a minimum, one should respect this phenomenon by utilizing the same zones for estimation as you use for prediction.

In a GIS framework, it is easy to estimate and apply different model parameters for different geographic areas and for other types of selection sets. This can yield significant improvements in model accuracy.

In connection with examining geographic variations in regression model parameters, it can also be useful to test for spatial autocorrelation of the residuals. This is directly supported as a statistical procedure in TransCAD. Spatial autocorrelation of the residuals occurs when the errors from the

regression model are correlated for contiguous zones. This problem also leads to biased coefficients and predictions, and should be checked for whenever possible.

Work Trip Production Models

In many planning studies, work trip production models are of critical importance as they directly influence peak-period traffic levels. Work trip production models are basically models of labor force participation, and should therefore have model specifications that explain this phenomenon (Slavin, Liss, and Ziering, 1991). Gender, age, and ethnicity will often be among the appropriate explanatory variables.

As in the tutorial example based on the PUMS data, it is recommended that disaggregate models (e.g. binary logit) be used for predicting work trip production. Using separate equations for men and women has been successful in empirical work.

A common mistake is to use income as an explanatory variable for work trip production. Income is derived from working and not the other way around.

Advanced Practice with Choice Models

Disaggregate trip frequency models involving multiple trips per day merit more complex econometric models. While the multinomial logit model can be used to predict the specific number of trips to be made (e.g. for shopping), these alternatives would clearly be correlated. Better alternatives would be serial or integer logit (Sheffi, 1979) or possibly nested logit.

For a considerable period of time, it has been clear that for many types of trip making, trip frequency is not determined in isolation but is related to other travel choices such as that of destination or mode. Evaluation of simultaneous models can be implemented in TransCAD, using either the nested logit evaluation procedure described in Chapter 7, *Mode Split and Choice Analysis*, or a user-implemented add-in written in Caliper Script. The latter alternative would be appropriate for most simultaneous, multi-equation models.

Trip Generation - Attraction

The goal of trip attraction is to predict the number of trips attracted to each zone or to a particular land use. The methods available for estimating trip attraction are very similar to those used for trip

production. In fact, all of the methods described in Chapter 2, *Trip Generation - Production*, may also be used for trip attraction. In addition, TransCAD provides a procedure for using ITE Trip Generation rates.

For more information, see:
About Trip Attraction
Trip Attraction Regression Models
ITE Attraction Rates (ITE Trip Generation)
Technical Notes on Trip Attraction

Top

About Trip Attraction

In many ways, estimating trip attractions is similar to estimating trip productions because the problem is the same: predicting the number of trips attracted by relating the number or frequency of trips to the characteristics of the individuals, the zone, and the transportation network. Thus, the methods described in Chapter 2, *Trip Generation - Production* (cross-classification, regression, and discrete choice) may also be used to estimate the number of trips attracted to a zone.

In production models, estimates are primarily based on the demographics of the population within a zone. For attraction models, the variables that have been found to have the best explanatory power are those based on characteristics of the land use, such as office and retail space or the employment levels of various sectors. As with production models, characteristics of the transportation network are rarely used, which means that the models cannot reflect impacts on trip attractions from changes in accessibility. However, variables such as CBD dummies or distance from the CBD are sometimes included. Also similar to production models, information on the work trip is relatively easy to acquire from such sources as the US Census (Part 2 of the Census Transportation Planning Package contains data on the work zones) or locally initiated surveys. Thus, models of work trip attractions should always be estimated directly using data from the study area, instead of applying models based on national averages or based on another study area.

Regression models are the primary method used to estimate trip attractions, because of the high correlation between the trips made and explanatory variables such as employment and office/retail space (particularly for work trips). Cross-classification can also be used for trip attraction, in which the classification is usually based on the employment sectors, and sometimes on employment density. However, it can be difficult to collect the disaggregate data on which to generate the cross-classification table; for example, it is much easier to collect a statistically valid sample of households than of offices or retail shops. This has made cross-classification a rarely used tool for trip attractions. The use of discrete choice has also been limited by the difficulty of collecting disaggregate data for attraction, although logit models could be applied at the aggregate level.

This chapter will cover the application of regression models to trip attraction, and the use of attraction rates as provided in the ITE Trip Generation publication. For information of cross-classification, regression, and discrete choice, see Chapter 2, *Trip Generation - Production*.

Top

Trip Attraction Regression Models

Often regression models based on either employment levels or amount of office and retail space are used to model trip attractions.

For work trips, an excellent data source is Part 2 of the Census Transportation Planning Package (CTPP).

For more information, see:
Regression Equations Based on National Averages

Regression Equations Based on National Averages

TransCAD provides two different sets of regression equations that have been developed based on national averages: Travel Estimation Techniques for Urban Planning (NCHRP 365, Martin, 1998) and the Quick Response Method Tables (NCHRP 187, Sosslau et al., 1978). Be aware that these equations are averages, and may not be relevant for the study area.

The Travel Estimation Techniques for Urban Planning Report (NCHRP 365), distributed by National Cooperative Highway Research Program, provides the following estimated equations to predict person-trips attracted:

HBW Attr.	=	1.45(Total Employment)				[hbw.mod]
HBO Attr. CBD	=	2.00(CBD RE)	+ 1.7(SE) +	0.5(OE) +	0.9(HH)	[hbo_cbd.mod]
HBO Attr. NCBD	=	9.00(NCBD RE)	+ 1.7(SE) +	0.5(OE) +	0.9(HH)	[hbo_ncbd.mod]
NHB Attr. CBD	=	1.40(CBD RE)	+ 1.2(SE) +	0.5(OE) +	0.5(HH)	[nhb_cbd.mod]
NHB Attr. NCBD	=	4.10(NCBD RE)	+ 1.2(SE) +	0.5(OE) +	0.5(HH)	[nhb_ncbd.mod]

Where:

HBW	= Home-based work
HBO	= Home-based other
NHB	= Non-home-based
CBD RE	= Retail Employment in the Central Business District Zones
NCBD RE	= Retail Employment in the Non-Central Business District Zones
SE	= Service Employment
OE	= Other Employment (Basic and Government)
HH	= Households

You can apply these equations either by creating a formula field by choosing ***Dataview-Formula Fields***, or by using the .mod files provided with TransCAD in the Tab folder in the TransCAD program folder. The names of the .mod files are listed to the right of the equations above. See Chapter 19, *Tabulations and Statistics*, in the *TransCAD User's Guide* for more information on how to use .mod files.

QRM Regression

As with QRM Trip Productions, TransCAD includes a default attraction model from NCHRP 187 that you may use to estimate attractions. For attractions, QRM uses a regression equation that estimates the number of person-trips attracted to a zone based on the retail and non-retail levels of employment in the zone and on the number of dwelling units in the zone. The equations are:

HBW Attractions	=	1.7(Retail Employm't)	+	1.7(Nonretail Employm't)			
HBNW Attractions	=	10.0(Retail Employm't)	+	0.5(Nonretail Employm't)	+	1.0(Dwelling Units)	
NHB Attractions	=	2.0(Retail Employm't)	+	2.5(Nonretail Employm't)	+	0.5(Dwelling Units)	

To apply these equations, you can either create a formula field or use the QRM Trip Attraction Procedure. The advantage of using the procedure is that you can apply all three equations in one step.

To use the QRM Trip Attraction Procedure, you must have the following information in the zone-layer:

- Retail Employment in the Zone
- Non-Retail Employment in the Zone
- Dwelling Units in the Zone

TransCAD provides a default QRM trip attraction table (attr_tgp.dbf) in the Tab folder in the TransCAD program folder, which specifies the three regression equations written above. Note that this is not a .mod file, so it cannot be used with the Apply a Model Procedure. If you have not altered this file in any way (including changing the location or name of the file), then TransCAD will automatically initialize the procedure to use the default table; ATTR_TGP (NCHRP 187) will already be chosen as the attraction lookup table.

For more information, see:
To Apply the QRM Trip Attraction Equations
Editing the Default Attraction Trip Table

⟩ *To Apply the QRM Trip Attraction Equations*

1. Open the table or area layer that includes the necessary zonal data.

2. Choose **Planning-Trip Attraction-Quick Response** to display the QRM Trip Attraction dialog box.

The default lookup table is automatically chosen.

3. Choose the file that contains the necessary zone data from the Apply To drop-down list.

4. Choose All Records or a selection set from the Using drop-down list.

5. Choose other settings as follows:

To define this...	Do this...
The number of dwelling units in each zone	Choose a field from the Dwelling Units drop-down list
The retail employment in each zone	Choose a field form the Retail Emp. drop-down list
The non-retail employment in each zone	Choose a field from the Nonretail Emp. drop-down list

6. Click OK to display the Store Output Table In dialog box.

7. Type a file name and click Save. TransCAD calculates the trip attractions for home-based work, home-based non-work, home-based other, and non-home-based trips, stores the results in a binary file, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD joins the file to your zonal data, and displays the joined view. Scroll to the far right of the dataview to see the results.

Top

Editing the Default Attraction Trip Table

You may edit the trip attraction QRM default file to include your own data or to include different types of trip purposes. In order to use the TransCAD QRM procedure, the files must conform to certain specifications. For the attractions trip table (attr_tgp.dbf located in the Tab folder in the TransCAD program folder):

- The row purposes are fixed. You cannot change the order or add/delete rows.
- Any data in cells other than those in the first column may be altered.
- You may have any number and types of trip purposes, as long as you have at least one. If you are going to use the production, attraction, and balancing dialog boxes, then the trip purposes (including the column name and the order) must be the same as in the productions trip rate table.

NOTE: If you do not want to permanently alter the default files, then choose *File-Save As* and save the file as a dBASE file under a different name.

Top

ITE Attraction Rates (ITE Trip Generation)

The Institute of Transportation Engineers collects, processes, and publishes data that have been collected throughout the United States on the number of vehicle trips that a particular land use attracts. TransCAD includes a complete database of the information in the 5th edition (plus supplement) of the ITE Trip Generation Report, and provides a procedure with which you can easily calculate trip attraction values for a single land use or for mixed land uses.

The ITE data provide two methods to calculate attractions, using:

- The weighted average trip generation rate, which is the number of trips attracted to the land use per one unit of the independent variable
- The regression equations provided by ITE, which relate the number of trip attractions as a function of the independent variable

In both of these cases, the independent variable is a measure of the size of the facility; for example, the number of employees or square feet of floor area. These data are provided for over 120 land uses, and most land uses have data for more than one dependent variable. In addition, the trip rates and regression equations are provided for nine different time periods, based on whether the count was done on a weekday, Saturday or Sunday, and whether traffic was counted all day (24 hours) or during the AM peak hour of the adjacent street, the PM peak hour of the adjacent street, or the peak hour of the generator.

For more information, see:
Methods of Computing Attractions from ITE Data
Preparing Data for ITE Trip Generation
Results of ITE Trip Generation
Mixed Land Uses
Modifying ITE Data

Top

Methods of Computing Attractions from ITE Data

The ITE data provide both average rates of trip generation and regression equations. In TransCAD, you can choose which method to apply from the following options:

- Average Rates: Apply the weighted average trip rates listed in the ITE data for all records.
- Regression Equations: Apply the regression specified in the ITE data, if available, for all records. If there is no regression equation, then average rates are automatically used.
- Land Use or Zone Specific: Apply either the trip rate or the regression equation according to a user specification provided in the input database. Thus, different methods can be applied based on the land use and/or zone.

Another piece of information that the ITE data provide is the percentage of each count that was recorded as entering the site and the percentage that was recorded as exiting the site. In the ITE Trip Generation Using ITE Rates dialog box, you can specify if you want the output counts broken down into those entries to and exits from the site.

Top

Preparing Data for ITE Trip Generation

To calculate ITE rates in TransCAD, prepare a land use database (which can be part of a geographic layer, but does not have to be) with the following properties:

- The first field in the database must be a unique integer ID field.
- For each land use you want to use, you need to know the following:
  1. The ITE land use code
  2. The independent variable you want to use, and the integer code of this variable. Note that not all independent variables are available with all land uses.
  3. The size of the land use site as measured in the number of units of the independent variable.
     NOTE: Refer to the ITE reports or the file ITEDATA.BIN in the Tab folder in the TransCAD program folder for the necessary codes.
- Each land use you want to use requires 3 columns in the database in the following order:
  1. The first column has the column name "C###_VAR" (where "###"is the ITE land use code), and the entry is the integer code of the independent variable.
  2. The second column has the column name "C###_VALUE" (where "###"is the ITE land use code), and the entry is the size of the land use as measured in number of units of the independent variable.
  3. The third column has the column name "C###_MOD" (where "###"is the ITE land use code), and the entry is "0" if you want to use the weighted average trip generation rate for this particular record or "1" if you want to use regression for this particular record. This field is used only if you chose the Land Use or Zone Specific method in the ITE Trip Generation Using ITE Rates dialog box. If you do not plan to use this method, leave all entries blank (the field must be present).
- All of the ITE columns must be grouped together in the database. For example, an appropriate grouping would be: C010_VAR, C010_VALUE, C010_MOD, C222_VAR, C222_VALUE, and C222_MOD, with no other interspersed columns.

Results of ITE Trip Generation

The ITE Trip Generation Procedure creates:

- A report file, called ITE_ATTR.REP, which lists the data of the run, the inputs and the name of the data output file
- Another report file, called ITE_ATTR.LOG, which lists any input land uses for which data could not be found in the ITE lookup table
- A dataview, with the attractions table joined to the input zone database and displayed in a joined view

The column names in the joined view indicate the hours for which the attractions apply:

HOUR1 = Weekday

HOUR2 = Weekday: Peak Hour of Adjacent Street Traffic, One Hour Between 7 and 9 AM
HOUR3 = Weekday: Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 PM
HOUR4 = Weekday: AM Peak Hour of Generator
HOUR5 = Weekday: PM Peak Hour of Generator
HOUR6 = Saturday
HOUR7 = Saturday: Peak Hour of Generator
HOUR8 = Sunday
HOUR9 = Sunday: Peak Hour of Generator

If you chose to break down the counts into entries and exits, then two additional columns are reported for each hour that was chosen, labeled ENTRY plus the hour number and EXIT plus the hour number.

For more information, see:
To Compute Attractions with ITE Data

Top

⟩ *To Compute Attractions with ITE Data*

1. Open the database that has the information on your land uses and independent variables.

2. Choose **Planning-Trip Attractions-ITE Attraction Rates** to open the Trip Generation Using ITE Rates dialog box.

3. Choose the land use database from the Database drop-down list. The land uses listed in the database are displayed in the Land Uses scroll list.

4. Choose to use All Records or a selection set from the Records drop-down list.

5. Choose the land uses for which you want to calculate trip attractions by Ctrl-clicking on the land uses in the Land Uses scroll list.

6. Choose the method you want to use from the Choose Method radio list.

7. Check the Include Enter/Exit Volumes in Output box if you want to know how many trips entered and exited the land use site.

8. Choose the days and hours for which you want trip attraction values by checking the appropriate boxes in the Choose Hours frame.

9. Click OK to display the Store Output Table In dialog box.

10. Type a file name and click Save. TransCAD computes the trip attractions for each record in your land use database, stores the results in the file you specified, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the results in a joined view. Scroll to the far right of the dataview to see the results.

Mixed Land Uses

For each record in your land use database, you can include any number of land uses. TransCAD will generate attractions for each type of land use included in the record, total the attractions, and present the total attractions for the record in the output.

Modifying ITE Data

You may edit the ITE database (ITEDATA.BIN) to include your own data, by either changing the data in existing entries, or adding more records to include new land uses or different independent variables or hours for existing land use. The column purposes and location in the file cannot be changed.

The columns are as follows:

Field Name	Type	Purpose
CODE*	I	ITE land use code [If you add new land uses, make sure you give it an integer land use code that is not already used - see ITE Table 2]
PAGE	I	page number in the ITE Trip Generation Report
LANDUSE	C	name of the land use
INDEPVAR	C	name of the independent variable
INT_VAR*	I	integer name of the independent variable
HOUR*	I	integer value of the hour that the data applies to
TRIP_RATE 1	R	average trip rate
LOW_RATE	R	lowest trip rate reported
HIGH_RATE	R	highest trip rate reported
STD_DEV	R	standard deviation of the reported trip rates
#_STUDIES	I	number of studies reported
AVG_X	R	average value of the independent variable in the reported studies
SMALL_SMPL	I	equal to '1' if ITE cautions that this landuse-independent variable-hour combination has a very small sample size (<=5 data points).
Regression Equation:		
T_TRANSFORM	I	equal to '0' if there is no transformation of the dependent variable, equal to '1' if the natural log is taken of the dependent variable [ln(trip rate) = ...]
BETA 2	R	the value of the coefficient of the independent variable in the regression equation

X_TRANSFORM	I	equal to '0' if there is no transformation of the independent variable, equal to '1' if the natural log is taken of the independent variable, equal to '2' if the inverse is taken of the independent variable [1/X]
CONSTANT 2	R	the value of the constant in the regression equation
R_TRANSFORM	I	indicates a transformation on the right side of the equations (constant + beta*independent variable); equal to '0' if there is no transformation, equal to '1' if the natural log is taken, equal to '2' if the inverse is taken
[R-SQUARED]	R	the R-squared of the regression equation
PERC_ENTER	I	the percentage of the counts that were entering the site - missing is assumed to be fifty percent

If you add new records to the database, you must include data in those fields with asterisks by the field name, and you must include either the average trip rate value (*1*) and/or the specifications of the regression equation (at least those with a *2*).

If you do not want to permanently alter the ITE Database, then choose **File-Save As** to save the file under a different name.

For more information, see:
To Use a Modified ITE Database

Top

⟩ *To Use a Modified ITE Database*

1. Open your modified ITE database.

2. Choose **Planning-Trip Attractions-ITE Attraction Rates** to open the Trip Generation Using ITE Rates dialog box.

3. Click Options to display the Change Database dialog box.

4. Choose the database from the ITE Trip Rate Database drop-down list, and click OK.

5. Continue with Step 3 of the procedure To Compute Attractions with ITE Data.

Top

Technical Notes on Trip Attraction

The most appropriate trip attraction modeling approach will usually depend on the specific planning or forecasting problem being tackled and on the availability of local data.

For long range planning, there will typically be at least two trip attraction equations, one for work trips and the other for non-work trips. If zonal employment is known, it will typically be the best

measure of person work trips attracted to the zone. Therefore, there may be no need for a model; a default model is that every employee attracts a work trip. This is only an approximation, of course. Some individuals work at home and do not travel to work. Also, some employees make more than one work trip to the same zone each day. Nevertheless, it is unlikely that an elaborate statistical model would be useful for predicting work-destined, person trip attraction.

If the model is to be based on vehicle trips attracted, then the 1990 Census work trip and employment data provide a dependent variable that is not identical to out-of-home employment and is likely to vary based upon employment levels and utilization of ridesharing and use of other modes.

Separate trip attraction models are recommended for special generators within a region, such as airports and other facilities that attract significant traffic. These can use the ITE rates, but are best based upon specific local surveys and counts.

In many areas, there is insufficient survey data to characterize non-work travel and zonal non-work trip attraction. Also, if there is substantial change in development patterns, the 1990 Census work trip and employment data may be no longer be very accurate. An interesting alternative for obtaining a dependent variable for trip attraction (and also for trip production) is to estimate an all-trip purpose zone-to-zone matrix from traffic counts as described in Chapter 13, *O-D Matrix Estimation*, and to use the row sums (or column sums) as the quantity to be regressed against zonal demographics.

Top

Trip Balancing

In trip generation, separate models are used to predict productions and attractions. This invariably leads to a discrepancy between the number of trips produced in an area and the number of trips attracted to an area. To conserve trips, balancing methods are used so that the number of attractions equals the number of productions.

For more information, see:
Balancing Trips

Top

Balancing Trips

TransCAD provides a procedure to balance trip productions and attractions, in which productions and attractions from several trip purposes can be balanced in one step. The procedure offers the following methods for balancing:

- Hold Productions Constant: productions are held constant and the attractions are adjusted so that their sum equals the sum of the productions
- Hold Attractions Constant: attractions are held constant and the productions are adjusted so that their sum equals the sum of the attractions

- Weighted Sum of Productions and Attractions: both productions and attractions are adjusted so that their sums equal the user-specified weighted sum of productions and attractions
- Sum to User Specified Value: both productions and attractions are adjusted so that their sums equal a user-specified value

When you balance trips, you can choose specific zones, called **special generators**, for which you do not want the original production values to change in the balancing process. Similarly, you can specify zones as **special attractors** where the attraction values should not change. To use these options, you create selection sets of the zones that comprise the special generators and the special attractors. You can also use the same selection set for both.

For more information, see:
To Balance Production and Attractions
Options for the Trip Balancing Output File
Good Practice for Balancing Trips

⟩ *To Balance Production and Attractions*

1. Open the map layer or view that contains the vectors (production and attraction fields) that you wish to balance.

2. Choose **Planning-Balance** to display the Vector Balancing dialog box.

3. Choose the layer to balance from the Dataview drop-down list.

4. Choose All Records or a selection set from the Records drop-down list.

5. Add or edit the vectors to be balanced. Each row in the Vector scroll list represents a set of two vectors that you want to balance, so that each vector sums to the same value. If you have *n* trip purposes you will need to have *n* rows in the scroll list. Make changes as follows:

To do this...	Do this...
Add a row	Click Add
Remove a row	Highlight the row and click Drop
Change the vectors	Highlight a row and choose the vectors to be balanced from the Vector 1 Field and Vector 2 Field drop-down lists

6. Choose a method for each trip purpose by highlighting a set of vectors you wish to balance and doing as follows:

To do this...	Do this...
Hold productions constant	Choose Hold Vector 1 from the Method drop-down list
Hold attractions constant	Choose Hold Vector 2 from the Method drop-down list
Use a weighted sum of productions and attractions	Choose Weighted Sum from the Method drop-down list and type the vector 1 weight in the Vect 1 Weight (%) edit box
Adjust productions and attractions to a specific value	Choose Sum to Value from the Method drop-down list and type a value in the Sum to edit box

7. To use special generators or special attractors, choose the special zones as follows:

If your method is this...	Do this...
Hold Vector 1	In the Vector 2 Options frame, click the Hold values in radio button and choose a selection set of special attractors from the drop-down list.
Hold Vector 2	In the Vector 1 Options frame, click the Hold values in radio button and choose a selection set of special generators from the drop-down list.
Weighted Sum or Sum to Value	To use special generators, click the Hold values in radio button in the Vector 1 Options frame and choose a selection set of special generators. To use special attractors, click the Hold values in radio button in the Vector 2 Options frame and choose a selection set of special attractors.

8.   Click OK to display the Store Output Table In dialog box.

9.   Type a file name and click Save. TransCAD balances the productions and attractions using the method you chose, stores the results in the file you specified, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the results in a dataview.

Options for the Trip Balancing Output File

By default, the balancing procedure creates a new file for storing the balanced productions and attractions, and the values are stored as real values. However, you may choose to store the values as integers in a new table, or you may overwrite the original values in the zone database.

When you overwrite the original values, the new values will be stored in the original format of the fields (i.e., real or integer). Be careful with this option, because it will delete the original data.

For more information, see:
To Change the Trip Balancing Output Options

⟩ To Change the Trip Balancing Output Options

1.   Do the first two steps in the procedure To Balance Production and Attractions.

2.   Click Options to display the Balancing Options dialog box.

3.   Choose options as follows:

To do this...	Do this...
Store the balanced productions and attractions as integers	Click the Write new table file and store as radio button and choose Integer from the drop-down list
Overwrite the original values in the zone database	Click the Fill dataview fields radio button

4. Click OK to return to the Vector Balancing dialog box.

5. Continue with Step 3 of the procedure To Balance Production and Attractions.

Top

Good Practice for Balancing Trips

In practice, the production models are considered to be more accurate predictors of reality, so productions are held constant or nearly constant while the attractions are adjusted. If you have reason to believe that the original productions or attractions from some zones are better than others (for example because of better data collection methods), then you may want to select these zones as special generators, and allow the other zones to adjust for balance.

Top

Quick Response Method for Trip Generation

The TransCAD Quick Response Method (QRM) Trip Generation Procedure allows you to quickly and easily derive balanced productions and attractions. Trip productions are estimated using cross-classification methods, with classifications based on household income and auto-ownership. Trip attractions are estimated from a regression equation based on retail employment, non-retail employment, and dwelling units.

The use of default lookup tables in quick response allows the production of trip generation variables quickly and with very little information. However, the default parameters are derived from data collected throughout the United States, and these rates may not fit the travel patterns in your study area. Thus, QRM should only be used for preliminary analysis, or when time or budget constraints make it impossible to obtain local data.

For more information, see:
QRM Trip Production
QRM Trip Attraction
QRM Trip Balancing
Performing QRM Trip Generation

Top

QRM Trip Production

TransCAD includes a default trip-rate table from NCHRP 187 (Sosslau et al., 1978) that you may use to calculate productions. It is a cross-classification table segmented by the size of the urban area, household income, and auto ownership. The default table includes trip-rates for three trip purposes: home-based work, home-based other, and non-home-based. The output of the model is the number of person trips produced per zone for each of the three trip purposes.

With the quick response default tables, there are four different classification schemes you may apply:

None (Use Average Rates): Trip production rates are calculated according to average daily person trips per household. The income level or car ownership level of the household is not considered. You must have the following data in your zone layer to use this method:

- Total number of households in the zone

Income per Household: The trip rate is calculated from the average income of the households residing in the zone. You must have the following data in your zone layer to use this method:

- Total number of households in the zone
- Average income per household in the zone

You may also apply an inflation index to the average incomes in the zone layer.

Autos per Household: The trip rate is calculated from the car ownership of the households residing in the zone. You must have the following data in your zone layer to use this method:

- Total number of households in the zone
- Average autos per household in the zone

Income per HH and Auto Ownership Split: Total households are segmented within each zone by auto ownership. The trip rate is calculated from the average income of households residing in the zone and the proportion of households within each zone in each auto-ownership classification. You must have the following data in your zone layer to use this method:

- Total number of households in the zone
- Average income per household in the zone
- The percentage of households in the zone in the auto-ownership classifications of 0, 1, 2, or 3+ autos per household

Top

QRM Trip Attraction

As with QRM Trip Productions, TransCAD includes a default attraction model from NCHRP 187 that you may use to estimate attractions. For attractions, the default model is a regression equation that estimates the number of person trips attracted to a zone, based on the retail and non-retail levels of employment in the zone and on the number of dwelling units in the zone.

To use the QRM Trip Attraction Model, you must have the following information in the zone-layer:

- Retail employment in the zone
- Non-retail employment in the zone
- Dwelling units in the zone

Top

QRM Trip Balancing

Since separate models are used to predict productions and attractions, this leads to a discrepancy between the number of trips produced in an urban area and the number of trips attracted in an urban area. Trip distribution requires balanced productions and attractions, so a balancing procedure must be performed before going on to the next step in the four-step planning process.

TransCAD provides a procedure to balance trip productions and attractions by trip purpose in the QRM Trip Generation Procedure. You can choose to either hold productions constant and adjust attractions only, or hold attractions constant and adjust productions only. In practice, the production models are considered to more accurately predict reality, and so productions are held constant while the attractions are adjusted.

Top

Performing QRM Trip Generation

There are several commands that you can use when applying QRM. You can generate productions, generate attractions, and balance the results in one dialog box, as described in this chapter. Alternatively, if you are only interested in applying one aspect of QRM, you may generate only productions (using the command **Planning-Trip Productions-Quick Response** as described in the procedure To Estimate Trip Productions Using QRM in Chapter 2, *Trip Generation-Production*), or generate only attractions (using the command **Planning-Trip Attractions-Quick Response** as described in the procedure To Apply the QRM Trip Attraction Equations in Chapter 3, *Trip Attraction*). These commands use dialog boxes that are subsets of the full QRM dialog box explained below. You may use the general balancing procedure to balance already generated productions and attractions (using the command **Planning-Balancing** as described in Chapter 4, Trip Balancing).

TransCAD provides a default trip production table and default trip attraction table in the TAB directory within the TransCAD program directory. If you have not altered this file in any way (including changing the location of the file), then TransCAD will automatically initialize the procedure to use the default tables: PROD_TGP (NCHRP 187) and ATTR_TGP (NCHRP 187) will already be chosen as the production and attraction lookup tables, respectively.

For more information, see:
To Estimate Balanced Productions and Attractions Using QRM
Designating Special Zones in the QRM Procedure
Editing the Default Trip Tables

⟩ To Estimate Balanced Productions and Attractions Using QRM

1. Open the table or area layer that includes the necessary zonal data.

2. Choose **Planning-Quick Response Method** to display the QRM - Trip Generation and Balancing dialog box.

3. Choose the layer that contains the necessary zone data from the Apply To drop-down list.

4. Choose All Records or a selection set from the Using drop-down list.

5. Type a population value (in thousands) in the Urban Area Population edit box.

6. Choose the classification method you want to use for production from the Classify By drop-down list.

7. Choose the field that contains the number of households from the Total HH drop-down list.

8. Make other settings as follows:

For this method...	Do this...
Income/HH	Type an income value (in thousands) or choose a field from the Inc/HH editable drop-down list, and type an inflation value in the Inflation Index edit box
Autos/HH	Choose the field that contains the number of autos per household from the Auto/HH drop-down list
Inc/HH & Auto-Own. Split	Type an income value (in thousands) or choose a field from the Inc/HH editable drop-down list, type an inflation value in the Inflation Index edit box, and choose the fields that contain the percentages of households with 0, 1, 2, and 3+ cars from the respective drop-down lists

9. Choose the appropriate attraction input fields as follows:

To define this...	Do this...
The number of dwelling units in each zone	Choose a field from the Dwelling Units drop-down list
The retail employment in each zone	Choose a field form the Retail Emp. drop-down list
The non-retail employment in each zone	Choose a field from the Nonretail Emp. drop-down list

10. Choose a balancing method as follows:

Method	What it does...
None	Does not balance the productions and attractions
Hold Productions	Productions are held constant and the attractions are adjusted so that their sum equals the sum of the productions
Hold Attractions	Attractions are held constant and the productions are adjusted so that their sum equals the sum of the attractions

11. Click OK to display the Store Output Table In dialog box.

12. Type a file name and click Save. TransCAD calculates the trip productions and attractions for each trip type generated in each zone, balances these trips by the method you chose, stores

the results in a binary file, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the results in a joined view. Scroll to the right to see the results.

Top

Designating Special Zones in the QRM Procedure

In planning, there are often specific zones for which estimates of productions and attractions are already available before trip generation methods have been applied. For these special zones, production and attraction values should not be calculated in the trip generation process, and the pre-existing productions or attractions should not be altered in the balancing process. This is often the case with external zones, in which it is assumed that the flows are known and constant. This may also be the case for internal zones for which an extensive survey or traffic count was administered, and thus more reliable values of productions and/or attractions are available than those that would be calculated in trip generation.

To use special zones in TransCAD, you must have an integer field in the zone database that specifies whether zones are "special" or not. You may specify the values of the flags, but the default is to flag the special zones with 1 and the regular zones with 0. You also must have a field in the zone database that has the "known" production values for the special zones, and another field for the "known" attraction values for the special zones.

If you designate a zone as special and either (1) a missing value is found in the special production field or (2) no special production field is specified, then a production value will be calculated from the QRM cross-classification tables. The same applies for attractions. In this way, you may designate zones for which only the production value is known or only the attraction value is known.

For more information, see:
To Use Special Zones in QRM Trip Generation

Top

⟩ To Use Special Zones in QRM Trip Generation

1. Do Steps 1-8 in the procedure To Estimate Balanced Productions and Attractions Using QRM.

2. Choose either Hold Productions or Hold Attractions from Balancing Method drop-down list.

3. Check the Use Special Zones box or click the External Settings button. TransCAD displays the Define Special Zones dialog box.

4. Choose the field that contains the special zone flags from the Zone Type Flag drop-down list.

5. Type the code that you are using to define non-special zones in the Regular Zone Code edit box.

6. For each trip purpose in the scroll list for which you want to apply special zones, highlight the row and choose the fields containing the known production and/or attraction values from the Production Field and Attraction Field drop-down lists.

7. Click OK to return to the QRM - Trip Generation and Balancing dialog box.

8. Continue with Step 10 in the procedure To Estimate Balanced Productions and Attractions Using QRM.

Top

Editing the Default Trip Tables

You may edit the trip generation default files to include your own data or to include different types of trip purposes. In order to use the TransCAD Trip Generation Procedure, the files must conform to certain specifications. For the productions trip-rate table, prod_tgp.dbf, located in the Tab folder in the TransCAD program folder:

- The purposes of the first 12 columns are fixed. You cannot delete, rearrange, or change the purpose of any of the columns.
- Any of the data in the cells may be altered.
- Rows may be added or deleted.
- The trip rates in any row are applied to all zones that have all classification values less than or equal to the classification values (e.g., Income/HH) entered in the row, but greater than the next smallest classification value.
- An empty cell in the field that defines the classifications signifies that the trip rates are averaged over all values of the classification (i.e., the classification is ignored).
- The Percentage of Average Daily Person Trips by Purpose columns can be changed to include any number of trip purposes, as long as you have at least one column (i.e., one trip purpose). In addition, 100 percent of the trips must be accounted for in these columns. If you are going to use the QRM- Trip Generation and Balancing dialog box, then the trip purposes (including the column name and the order) must be the same as in the attractions trip-rate table.

For the attractions trip-rate table, attr_tgp.dbf, located in the Tab folder in the TransCAD program folder:

- The row purposes are fixed. You cannot change the order or add/delete rows.
- Any of the data in cells other than those in the first column may be altered.
- You may have any number and types of trip purposes, as long as you have at least one. If you are going to use the QRM - Trip Generation and Balancing dialog box, then the trip purposes (including the column name and the order) must be the same as in the productions trip-rate table.

NOTE: If you do not want to permanently alter the default files, then choose *File-Save As* and save the file as a dBASE file under a different name.

For more information, see:
To Use the Edited Trip-Rate Files in Trip Generation

Top

) To Use the Edited Trip-Rate Files in Trip Generation

1. Open the edited trip-rate files that you wish to use.

2. Follow the steps in the procedure To Estimate Balanced Productions and Attractions Using QRM except, instead of using the default lookup tables, choose the edited lookup tables in the Production and Attraction Lookup Table drop-down lists.

TransCAD will use your edited lookup tables to calculate the trip productions and attractions for each trip type generated in each zone, balance these trips by the method you chose, and store the results in a binary file.

Top

Trip Distribution

Trip distribution models are used to predict the spatial pattern of trips or other flows between origins and destinations. Models similar to those applied for trip distribution are often used to model commodity flows, retail trade, and store patronage.

TransCAD provides numerous tools with which to perform trip distribution, including procedures to implement growth factor methods, apply previously-calibrated gravity models, generate friction factors, and calibrate new model parameters.

For more information, see:
About Trip Distribution
Growth Factor Methods
Evaluating a Gravity/Entropy Model
Calibrating a Gravity/Entropy Model
Tri-Proportional Trip Distribution Models
Technical Notes on Trip Distribution

Top

About Trip Distribution

Trip distribution models are used to predict the destination choices of trip makers. Usually, in trip distribution, a new flow matrix is forecasted based on estimates of future productions and attractions and measurements of current flows or measurements of the generalized cost of each trip.

Aggregate trip distribution models are used to predict flows between origin and destination zones. Two basic categories of aggregate trip distribution methods predominate in urban transportation planning:

- **Growth factor methods**: These involve scaling an existing matrix by applying multiplicative factors (often derived from predicted productions and/or attractions) to matrix cells. These methods are usually encountered when there is no information available concerning the network interzonal distances, travel times, or generalized costs.
- **Gravity model**: The typical inputs include one or more flow matrices, an impedance matrix reflecting the distance, time, or cost of travel between zones, and estimates of future levels of productions and attractions. The gravity model explicitly relates flows between zones to interzonal impedance to travel.

The gravity model was originally motivated by the observation that flows decrease as a function of the distance separating zones, just as the gravitational pull between two objects decreases as a function of the distance between the objects. As implemented for planning models, the Newtonian analogy has been replaced with the hypothesis that the trips between zones i and j are a function of trips originating in zone i and the relative attractiveness and/or accessibility of zone j with respect to all zones.

Modern derivations of the gravity model illustrate that it can be motivated as the most likely spatial arrangement of trips, given limited information available on zonal origin totals, zonal destination totals, and various supporting assumptions or constraints about mean trip lengths (Wilson, 1970).

Many different measures of impedance can be used, such as travel distance, travel time, or travel cost. There are also several potential impedance functions to use to derive the relative attractiveness of each zone from the impedance. Popular choices are the exponential and inverse power functions typically used in entropy models, and the gamma function often recommended in US planning practice. As an alternative to impedance functions, one can use a friction factor lookup table (essentially a discrete impedance function) that relates the impedance between zones to the attractiveness between zones.

Prior to applying a gravity model, one has to calibrate the impedance function. Calibration of aggregate trip distribution models entails estimation of model parameters, including one or more impedance function coefficients. Calibration typically entails an iterative process that computes coefficients such that the gravity model replicates the trip length frequency distribution and matches base year productions and/or attractions.

For more information, see:
Practical Issues

Top

Practical Issues

Growth factor methods do not take into account any information about the transportation network, and thus cannot reflect impacts of changes in the network. This may be reasonable for very short-term forecasts, but invalid for medium- to long-term forecasts for which the network has changed or to forecast scenarios that include changes in the network. Since most transportation planning involves analysis of transportation networks, gravity models or more sophisticated destination choice models should be used. TransCAD provides geographic databases for the entire U.S., powerful tools to create geographic databases and networks, and procedures to calculate interzonal impedances from both roadway and transit networks.

In aggregate analysis, the choice of the impedance function should be based on the mathematical properties of the function and the data distributions to be modeled. In practice, the selection of the functional form of the model should be based on the shape of the measured trip length distribution; consequently, examination of empirical trip length distributions is an important input to the decision process. Both smooth impedance functions and discrete functions (i.e., friction factors) can be used, as well as hybrid functions combining functions or utilizing smoothed discrete values.

There are standard default values that are often used for the parameters of impedance functions. However, these values are derived from national averages and may not be pertinent to the study area. Thus, it is recommended that you use the TransCAD calibration procedures to obtain estimates of the coefficients of the impedance functions.

Distribution models should be estimated and applied for several trip purposes. The rationale for this is that both the alternatives and the willingness of individuals to travel differ greatly by purpose. Note that a single matrix file in TransCAD can contain more than one matrix. This makes it easy to apply trip distribution for all trip purposes with one run of a procedure.

The TransCAD trip distribution models can be flexibly applied to either production-attraction or origin-destination flows. These terms are used interchangeably throughout this section.

Top

Growth Factor Methods

In growth factor methods, an existing zone-to-zone trip matrix is scaled by applying multiplication factors to matrix cells. A single factor can be used for every cell in the matrix (called a uniform growth factor) or factors may be derived for each zone, based on estimated productions and attractions.

For more information, see:
Uniform Growth Factor
Singly-Constrained Growth Factor
Doubly-Constrained Growth Factors (Fratar Balancing)
Advantages and Limitations of Growth Factor Methods

Top

Uniform Growth Factor

The uniform growth factor model assumes that the only information available is a growth rate for the entire study area. For instance, if travel is expected to increase by 50% from the time at which the base matrix was estimated to the forecast year, then each cell in the original P-A matrix is multiplied by 1.5 to obtain the forecasted P-A matrix.

To apply a uniform growth factor, you need:

- A base P-A matrix
- The value of the growth factor

A growth factor is simply the value used to multiply each cell in the matrix.

Uniform growth factors are applied in TransCAD using the standard commands for matrix manipulation, which are found in the Matrix menu and described in Chapter 18, *Working with Matrices*, in the *TransCAD User's Guide*.

For more information, see:
To Apply a Uniform Growth Factor

Top

⟩ *To Apply a Uniform Growth Factor*

1. Choose the matrix view that contains the base-year P-A matrix.

2. Choose *Matrix-Contents* to display the Matrix File Contents dialog box.

3. Click Add Matrix to add a new matrix to the matrix view.

4. Highlight the new matrix in the Matrix Name scroll list and click Rename to display the Rename Matrix dialog box.

5. Type a new name and click OK. TransCAD renames the matrix and updates the Matrix Name scroll list.

6. Click Close to close the Matrix File Contents dialog box.

7. Choose the matrix you just added from the drop down list in the main toolbar.

8. Choose *Matrix-Fill* to display the Fill Matrix dialog box.

9. Click the Formula tab to display the Formula page.

10. Enter a formula in the Formula edit box of the form:

    [Base P-A Matrix]*(growth factor)

    You can type the formula or use the drop-down lists to construct the formula.

11. Choose the cells to fill, using the Cells to Fill radio list.

12. Click OK.

TransCAD fills the matrix with the growth factor adjusted values. The current matrix view is the forecast trip matrix.

Singly-Constrained Growth Factor

If you have forecasts of either productions or attractions for each zone, you can apply the growth factor method at a more disaggregate level than with the uniform growth factors.

The singly-constrained growth factor method applies a different growth rate to each zone. Rates are applied such that the sum of the trips produced by each zone (i.e., the sum of each row) equals the forecasted total production for each zone. Alternatively, the rates that are applied could be based on forecasted total attractions for each zone, in which the sum of the trips attracted by each zone (i.e., the sum of each column) equals the forecasted attractions for each zone.

Suppose that you have a base production and attraction matrix, and you have a forecast of the number of trips produced by each zone i, P_i. In this case, you can apply a singly-constrained growth factor, in which you modify the base flows such that each zone produces P trips.

In order to obtain the forecast production-attraction matrix, each i, j cell in the base production-attraction matrix is scaled by the forecasted trips produced from zone i divided by the base year trips produced by each zone. The equation is:

$$T_{ij} = \left[\frac{P_i}{\sum\limits_{\text{all zones } z} t_{iz}} \right] \cdot t_{ij} \qquad \text{for all } i, j$$

where: T_{ij} = the forecast flow from zone i to zone j

P_i = the forecast productions for zone i

t_{ij} = the original (base year) flow from zone i to zone j

The result is that the trips produced by each zone (i.e., the sum of each row) equal the forecasted total production for each zone. Through this method, the original production-attraction matrix is scaled to match the forecasted productions for each zone.

The prior example assumes that the productions for each zone are known (or have been forecasted). This is called a production-constrained growth factor, since the forecast

production-attraction matrix is required to match a set of productions.

An analogous situation occurs when information about forecast attractions to each zone is available. This is called an attraction-constrained growth factor. A different scaling ratio (i.e., forecast attractions divided by base year attractions) is then applied to each column of the base year matrix to produce the output matrix. Each column sum in the forecast matrix is equal to the forecast attractions of the respective zone.

Typically, productions are easier to forecast and the forecasted productions are considered to be more reliable than the forecasted attractions. Thus, production-constrained growth factors are more frequently used than attraction-constrained growth factors.

If both forecasted productions and attractions are available, then you can apply a doubly-constrained growth factor, which is described in the next section.

To apply a production-constrained growth factor, you need:

- A base production-attraction matrix
- A zone layer with estimated productions for each zone
- A selection set of the zones that you want included in the output matrix

To apply an attraction-constrained growth factor, you need:

- A base production-attraction matrix
- A zone layer with estimated attractions for each zone
- A selection set of the zones that you want included in the output matrix

The output for either production- or attraction-constrained growth factor is:

- A zone-to-zone trip matrix

The productions and/or attractions must be stored in fields that are either contained in a zone layer or in a table that is joined to a zone layer. The input selection set is created from this zone layer. This selection set determines the zones that are to be included in the output trip matrix. There will be a row and a column in the resulting matrix for each zone in the selection set; the ID from the zone layer will be used as the row and column IDs of the output matrix.

The IDs for all of the zones in the input selection set must be included in both the row and column IDs of the base production-attraction matrix. Note that the default is to include all of the zones in the layer in the output trip table. If that is what you want, then you do not have to create a selection set. Otherwise, you must choose a selection set of zones in the Growth Factor Balancing dialog box.

If there are any missing entries for productions, then the corresponding row will be constrained to zero; that is, no trips will be produced by the zone. This is also true for missing entries for attractions.

You can apply the growth factor model to several matrices within the same matrix file.

For more information, see:
To Apply a Production-Constrained Growth Factor

Top

⟩ To Apply a Production-Constrained Growth Factor

1. Open the matrix file that contains the base P-A flow matrices for each trip purpose (one matrix per purpose).

2. Open the layer that contains the study area zones. The zone layer must either have a field containing the forecast productions for each trip purpose type or be joined to a database that has such fields.

3. Open the zone layer dataview with the production fields or, if it is already open, make it the current view.

4. Choose **Planning-Trip Distribution-Growth Factor Method** to display the Growth Factor Balancing dialog box.

5. Choose the matrix that contains base year production-attraction flows from the Matrix File drop-down list. The matrices contained in this matrix file are shown in the Matrices scroll list in the middle of the dialog box.

6. If your study area zones are a subset of your zone layer, choose the selection set containing the study zones from the Records drop-down list.

7. Click the Production radio button under Constraint Type.

8. For each matrix (i.e., trip purpose P-A matrix) that you want to update, do the following:

   - Click on the matrix in the Matrices scroll list.
   - Check the Use [matrix name] box.
   - Choose the field containing the forecast productions from the Production Field drop-down list.

9. Click OK when you are done to display the Save As dialog box.

10. Type a file name for the output (forecast) matrix and click Save.

11. TransCAD applies the growth factor model and displays the Results dialog box.

12. Click Close. TransCAD displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the output matrix.

Doubly-Constrained Growth Factors (Fratar Balancing)

Instead of updating the base P-A matrix to match just forecasted productions or forecasted attractions, you can apply a doubly-constrained growth factor model in which the growth factors are applied such that the resulting P-A matrix conforms to both forecasted productions and attractions. This type of model is also known as Fratar Balancing.

The forecast matrix should then be such that the sum of each row (i.e., trips produced per zone) is within a given convergence criterion of the corresponding forecast production for that zone, and the sum of each column (i.e., trips attracted per zone) is within a given convergence criterion of the corresponding forecast attraction. The goal is to solve the following equation:

$$T_{ij} = t_{ij} \cdot a_i \cdot b_j$$

subject to:
$$\sum_j T_{ij} = P_i$$
$$\sum_i T_{ij} = A_j$$

where: T_{ij} = the forecasted flow produced by zone i and attracted to zone j

t_{ij} = the base year flow produced by zone i and attracted to zone j

a_i = the balancing factor for row i

b_j = the balancing factor for column j

P_i = the number of trips produced by zone i

A_j = the number of trips attracted to zone j

The solution to this problem may be converged upon iteratively. Each iteration consists of scaling rows to match the P_i 's and then columns to match the A_j 's. It repeats until the convergence criterion is satisfied or until a maximum number of iterations is reached.

To apply a doubly-constrained growth factor (Fratar Balancing), you need:

- A base production-attraction matrix
- A zone layer with estimated productions and attractions for each zone
- A selection set of the zones that you want included in the output matrix

The output is:

- A zone-to-zone trip matrix

The productions and attractions must be stored in fields that are either contained in a zone layer or in a table that is joined to a zone layer. The input selection set is created from this zone layer. This selection set determines the zones that are to be included in the output trip table. There will be a row and a column in the resulting trip table for each zone in the selection set; the ID from the zone layer will be used as the row and column IDs of the output matrix.

The IDs for all of the zones in the input selection set must be included in both the row and column IDs of the base production-attraction matrix. Note that the default is to include all of the zones in the layer in the output trip table. If that is what you want, then you do not have to create a selection set. Otherwise, you must choose a selection set of zones in the Growth Factor Balancing dialog box.

Note that the productions and attractions must be balanced for the set of zones on which the model is applied. This means that the sum of the productions and the sum of the attractions for the input selection set (or for all of the zones, if a selection set is not used) must be equal. If this is not the case, use the balancing procedure described in Chapter 4, *Trip Balancing*, to obtain balanced productions and attractions.

If there are any missing entries for productions, then the corresponding row will be constrained to zero; that is, no trips will be produced by the zone. This is also true for missing entries for attractions.

You can apply Fratar Balancing to several matrices within the same matrix file.

For more information, see:
To Apply Doubly-Constrained Growth Factors (Fratar Balancing):

Top

⟩ To Apply Doubly-Constrained Growth Factors (Fratar Balancing):

1. Open the matrix file that contains the base P-A flow matrices for each trip purpose (one matrix per purpose).

2. Open the layer that contains the selected study area zones. The zone layer must either have a field containing the forecast productions and attractions for each trip purpose or be linked to a database that has such fields.

3. Open the zone layer dataview with the production fields or, if it is already open, make it the current view.

4. Choose **Planning-Trip Distribution-Growth Factor Method** to display the Growth Factor Balancing dialog box.

5. Choose the matrix that contains base year production-attraction flows from the Matrix File drop-down list. The matrices contained in this matrix file will be shown in the Matrices scroll list in the middle of the dialog box.

6. If your study area zones are a subset of your zone layer, choose the selection set containing the study zones from the Records drop-down list.

7. Click the Doubly radio button under Constraint Type.

8. Type the maximum number of iterations to perform in the Iterations edit box, and type the convergence criterion in the Convergence edit box. Default values of 10 and 0.001 are provided.

9. For each matrix (i.e., trip purpose P-A matrix) that you want to update, do the following:

   - Highlight the matrix in the Matrices scroll list
   - Check the Use [matrix name] box
   - Choose the field containing the forecast productions from the Production Field drop-down list
   - Choose the field containing the forecast attractions from the Attraction Field drop-down list.

10. Click OK when you are done to display the Save As dialog box.

11. Type a file name for the output (forecast) matrix and click Save.

12. TransCAD applies the growth factor model and displays the Results dialog box.

13. Click Close. TransCAD displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the output matrix.

Top

Advantages and Limitations of Growth Factor Methods

The main advantage of growth factor methods is their ease of use; no information on the transportation network is necessary. However, this implies a major limitation: growth-factor methods cannot reflect changes in transportation network variables such as travel time and costs. In addition, growth factor models do not attempt to explain behavior in any way.

Top

Evaluating a Gravity/Entropy Model

The gravity model is the most widely used trip distribution model. This model explicitly relates flows between zones to interzonal impedance to travel. The assumption behind the gravity model is that the number of trips produced by zone i and attracted to zone j is proportional to:

- The number of trips produced by zone i
- The number of trips attracted to zone j
- A function (often called the impedance function) of the relative spatial separation or impedance

between the zones

Many different measures of impedance can be used, such as travel distance, travel time, or travel cost. There are also several potential impedance functions to use to derive the relative attractiveness of each zone from the impedance. Popular choices are the exponential and inverse power functions typically used in entropy models, and the gamma function sometimes recommended in U.S. planning practice. As an alternative to using impedance functions, you can use a friction factor lookup table (essentially a discrete impedance function) that relates the impedance between zones to the attractiveness between zones. The values derived from the impedance function and the impedance are called **friction factors**, and the matrix containing the friction factors for each i, j pair is called the **friction factor matrix**.

As with growth factor methods, the gravity model can be singly-constrained to either productions or attractions or doubly-constrained to both productions and attractions. In a singly-constrained gravity model, the flow between zones is calculated from one of the following equations, depending on whether the balancing is constrained to productions or attractions:

$$T_{ij} = P_i \cdot \frac{A_j \cdot f(d_{ij})}{\sum_{\text{all zones } z} A_z \cdot f(d_{iz})}$$
(constrained to productions)

$$T_{ij} = A_j \cdot \frac{P_i \cdot f(d_{ij})}{\sum_{\text{all zones } z} P_z \cdot f(d_{zj})}$$
(constrained to attractions)

where: T_{ij} = the forecast flow produced by zone i and attracted to zone j

P_i = the forecast number of trips produced by zone i

A_i = the forecast number of trips attracted to zone j

d_{ij} = the impedance between zone i and zone j

$f(d_{ij})$ = the friction factor between zone i and zone j

A simple derivation of these equations is provided at the end of the gravity model section. When the doubly-constrained gravity model is applied, an iterative process is used that alternatively balances the rows (productions) by evaluating the first equation and then balances the columns (attractions) by evaluating the second equation, until either a convergence criterion is met or a maximum number of iterations is reached.

Note that like the growth factor method, the rows and columns are balanced to match given values of productions and/or attractions for each zone. However, the method of balancing the trips used in the gravity model has three important differences:

- The gravity model takes into account the spatial separation of zones (cij)
- Estimates of both productions and attractions for each zone are required, even when applying a singly-constrained model
- Application of the gravity model does not consider base year flow between zones. However, the calibration of the impedance function or friction factor lookup table does require a base year flow matrix

For more information, see:

Evaluating a Gravity Model - An Example

Here's an example of how to apply a gravity model to obtain a zone-to-zone trip matrix for a city with 5 zones. Start with an impedance matrix and either an impedance function such as:

$$f(d_{ij}) = 28507 \cdot d_{ij}^{-0.020} \cdot e^{-0.123(c_{ij})}$$

or a friction factor lookup table to obtain a friction factor matrix. With the friction factor matrix and forecasted productions and attractions for each zone (from trip generation), you can generate a trip table using the gravity model.

TransCAD provides many procedures to make it easy for you to apply this process, including:

- Multiple shortest paths and skims to generate impedance matrices
- Synthetic friction factors to generate friction factor matrices
- Trip generation procedures to generate productions and attractions
- Gravity model evaluation to produce the trip table
- Gravity model calibration to calibrate the parameters of an impedance function or to calibrate a friction factor lookup table.

Preparing Data for the Gravity Model

The following data are necessary to apply the gravity model:

- Pi : the number of trips produced by (or originating in) each zone i

- A_i : the number of trips attracted to (or terminating in) each zone j

- d_{ij} : the impedance between each i , j pair of zones

- $f(d_{ij})$: the friction factor between each i , j pair of zones

Productions and Attractions

The forecasts of the number of trips produced and attracted by each zone provide the values to which the rows and columns of the production-attraction matrix are balanced. The productions and attractions must be either stored in a zone layer or in a table that is joined to a zone layer. These values are the output of trip generation, and you can refer to the trip generation chapters in this book for methods of forecasting productions and attractions.

Impedances

Many different measures of impedance may be used to represent the amount of difficulty to travel between any pair of zones. Frequently-used measures of impedance are travel time, travel distance, or cost. Impedances may be a combination of these measures and/or a combination of the impedance of different modes. For the TransCAD procedures, the impedances must be stored in a zone-to-zone matrix.

An impedance matrix can easily be generated in TransCAD by applying the Multiple Shortest Path and Transit Shortest Path procedures on a network of the study area. These procedures generate shortest paths between multiple origins and multiple destinations and create matrix files containing the impedance of traversing each path. See Chapter 9, *Networks and Shortest Paths*, in the *TransCAD User's Guide* for more information on these procedures. In addition, you can translate impedance tables to TransCAD matrices using the **Matrix-Import** command. See Chapter 16, *Working With Matrices*, in the *TransCAD User's Guide* for more information.

Generating a Friction Factor Matrix

Once you have an impedance matrix, you can generate the friction factor matrix. A friction factor matrix contains the friction factor for travel between each pair of zones. Friction factor matrices are created from an impedance matrix and either an impedance function or a friction factor lookup table.

Friction factors are inversely proportional to impedance: as the travel time between zones increases, the friction factor decreases. While you could use a simple inverse of the impedance (or of the impedance squared) in the gravity model, more complicated functions have been shown empirically to perform better.

Popular choices of the impedance function are the exponential and inverse power functions typically used in entropy models, and the gamma function recommended in U.S. planning practice. The equations are as follows:

exponential $\qquad f(d_{ij}) = e^{-c(d_{ij})} \qquad\qquad c_{>0}$

inverse power $\qquad f(d_{ij}) = d_{ij}^{-b} \qquad\qquad b_{>0}$

gamma (combined) function $\qquad f(d_{ij}) = a \cdot d_{ij}^{-b} \cdot e^{-c(d_{ij})} \qquad a_{>0},\ c_{>=0}$

Note that each of these functions require the specification of parameters to be used in the model: exponential requires one (c), inverse power requires one (b), and gamma requires three (a, b, and c). If you wish to use one of the above equations, you must specify the parameters.

The aim is to select an impedance function and its corresponding parameters such that the gravity model reproduces the trip length (cost) distribution (TLD) of the study area. There are several ways to arrive at the parameters. The preferred method is to calibrate the chosen impedance function to match the travel patterns of the study area, or to use parameters that have previously been calibrated for the study area; see Calibrating a Gravity/Entropy Model for a discussion of calibration and how to calibrate the gravity model in TransCAD. Alternatively, you can use parameters

suggested by national studies or parameters estimated for other urban areas. For example, Travel Estimation Techniques for Urban Planning (NCHRP365, 1998) suggests that the gamma function be used with the following parameters:

Travel Estimation Techniques for Urban Planning Gamma Function Parameters

Trip Purpose	a	b	c
HBW	28507	-0.020	-0.123
HBO	139173	-1.285	-0.094
NHB	219113	-1.332	-0.010

Note that they suggest that a different model be used for different trip purposes. This is highly recommended, since the alternatives and the individual's willingness to travel vary by trip purpose.

Instead of using an impedance function to generate friction factors, you can also use a friction factor lookup table. In this case, the friction factors are usually partitioned into impedance ranges or cost bins, so that all trips belonging to a given impedance (e.g. cost or distance) range will have the same friction factor value. Note that this is essentially a discrete impedance function. The lookup table must have one field that contains the friction factors and another field that contains the lower bound of the impedance for which the friction factors apply.

As with the impedance functions, a friction factor table may also be calibrated for the study area; for more information, see Calibrating a Gravity/Entropy Model.

To generate a friction factor matrix you need:

- A zone-to-zone impedance matrix
- A zone-to-zone matrix that you wish to fill with friction factors
- Either an impedance function or a friction factor lookup table

The row and column IDs of the impedance matrix must contain all of the row and column IDs contained in the matrix to be filled. Friction factors will only be generated for those rows and columns in the current indices of the matrix to be filled.

You can apply the procedure to multiple matrices within the same matrix file at one time.

For more information, see:
To Create a Friction Factor Matrix from an Impedance Function

Top

⟩ To Create a Friction Factor Matrix from an Impedance Function

1. Open the matrix file you wish to fill with friction factors.

2. Open the matrix file containing impedances.

3. Choose **Planning-Trip Distribution-Synthetic Friction Factors** to open the Create Friction Factor Matrix dialog box.

4. Choose the matrix file that you wish to fill with friction factors from the Matrix Name drop-down

list. Only those cells contained in the current row and column indices will be filled. All matrices within the matrix file will be listed in the Matrices scroll list in the middle of the dialog box.

5. For each matrix that you wish to fill with friction factors, do the following:

    - Choose the matrix in the Matrices scroll list.
    - Check the **Use this matrix** box.
    - Make a choice from the Impedance Function radio list and enter values as described below:

For this function...	Do this...
Gamma	Type values for a, b, and c in the respective edit boxes
Inverse	Type a value for b in the b edit box
Exponential	Type a value for c in the c edit box
Discrete (F-Factor Lookup)	Choose the friction factor lookup table from the View drop-down list, choose the field that defines the impedance bins from the Impedance drop-down list, and choose the field that contains the values of the friction factors from the F-Factors drop-down list

    - Choose the matrix file and matrix containing the impedances from the Impedance Matrix File and Matrix drop-down lists.

6. Click OK. TransCAD applies the selected impedance function to the values in the impedance matrix, fills the selected matrices and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

The friction factor matrix file may now be used as an input to the gravity model.

Top

Applying the Gravity Model

Once you have the forecasted productions and attractions and the friction factor matrix for all of the defined trip purposes, you can apply the gravity model to generate the forecast production-attraction matrix.

To apply the gravity model, you need:

- A friction factor matrix or a lookup table
- A zone layer with estimated productions and attractions for each zone
- A selection set of the zones that you want included in the output matrix

The result is a zone-to-zone trip matrix.

A friction factor matrix is a zone-to-zone matrix that contains the friction factors associated with each pair of zones. To create a friction factor matrix from either an impedance function (e.g. gamma, exponential, or inverse power) or a friction factor lookup table, see "Generating a Friction Factor Matrix" in Preparing Data for the Gravity Model.

The productions and attractions must be stored in fields that are either contained in a zone layer or in a table that is joined to a zone layer. The input selection set is created from this zone layer. The input selection set determines the zones that are to be included in the resulting trip matrix. There will be a row and a column in the trip matrix for each zone in the selection set. The ID from the zone layer will be used as the row and column IDs in the output matrix. The IDs for all of the zones in the input selection set must be included in both the row and column IDs of the friction factor matrix. Note that the default is to include all of the zones in the layer in the output trip table. If that is what you want, then you do not have to create a selection set. Otherwise, you must choose a selection set of zones in the Gravity Evaluation dialog box.Note that the productions and attractions must be balanced for the set of zones on which the model is applied. This means that the sum of the productions and the sum of the attractions for the input selection set (or for all of the zones, if a selection set is not used) must be equal. If this is not the case, use the balancing procedure described in Chapter 4, *Trip Balancing*, to obtain balanced productions and attractions.

To use the Table method for generating friction factors, you will need a table containing fields with the friction factor and the time.If there are any missing entries for productions, then the corresponding row will be constrained to zero; that is, no trips will be produced by the zone. The same is true for missing entries for attractions.
You can apply the gravity model to several matrices within the same matrix file.

For more information, see:
To Apply a Gravity Model

Top

⟩ To Apply a Gravity Model

1. Open the zone layer or joined view that contains the production and attraction data. The data must be either contained in a zone layer or joined to a zone layer.

2. If you are using the Table method for generating friction factors, open a table containing fields with the friction factor and the time.

3. Choose **Planning-Trip Distribution-Gravity Evaluation** to display the Gravity Evaluation dialog box.

4. Choose the dataview containing the productions and attractions from the Dataview drop-down list.

5. Choose All Features or a selection set from the Records drop-down list.

6. Click the General tab to display the General page.

7. Add or edit the trip purposes in the scroll list. Make changes as follows:

To do this...	Do this...
Add a trip purpose	Click Add and type a trip purpose name in the Name edit box.
Remove a trip purpose	Highlight the row and click Drop.
To rearrange trip purposes	Highlight a row and click Move Up or Move Down.
Change the trip purpose	Highlight a row and choose the corresponding productions and attractions from the Productions and Attractions drop-down lists.
Choose a constraint type	Highlight a row and choose a type from the Constraint Type radio list. For

doubly-constrained models, enter the maximum number of iterations and the desired level of convergence in the Iterations and Convergence edit boxes.

8. Click the Friction Factors tab to display the Friction Factors page.

9. For each trip purpose, highlight it in the Purpose scroll list and choose a method for generating friction factors:

To use this method...	Do this...
Gamma	Click Gamma, enter values for a, b, and c, and choose the matrix containing the impedances from the Matrix File and Matrix drop-down lists.
Inverse	Click Inverse, enter values for b, and choose the matrix containing the impedances from the Matrix File and Matrix drop-down lists.
Exponential	Click Exponential, enter values for c, and choose the matrix containing the impedances from the Matrix File and Matrix drop-down lists.
Table	Click Table, choose the dataview from the Dataview drop-down list and the fields containing the friction factor and time from the F Factor and Time drop-down lists, then choose the matrix containing the impedances from the Matrix File and Matrix drop-down lists.
Matrix	Click Table and choose the matrix containing the friction factors from the Matrix File and Matrix drop-down lists.

10. Click OK to display the Save As dialog box.

11. Type a file name and click Save. TransCAD creates P-A flow matrices that match the production and/or attraction vectors based on the friction factor matrix and displays the Results dialog box.

12. Click Close. TransCAD displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the P-A flow matrices in a matrix view.

K-Factors

The gravity model may be modified slightly with the use of K-Factors. These are used to adjust the flows predicted by the gravity model. K-Factors are used when, for some reason, the flow between certain i, j zones are not forecasted accurately. Extensive use of K-Factors can improve the calibration immensely, by improving the fit of the model to the base year data. However, unless the K-Factors are based on behavioral assumptions that are likely to remain in the future, the forecasting power of the gravity model may be diminished.

With K-Factors, the gravity model is modified as follows:

$$T_{ij} = P_i \cdot \frac{K_{ij}A_j \cdot f(d_{ij})}{\sum\limits_{\text{all zones } z} K_{iz}A_z \cdot f(d_{iz})}$$

(constrained to productions)

$$T_{ij} = A_j \cdot \frac{K_{ij}P_i \cdot f(d_{ij})}{\sum\limits_{\text{all zones } z} K_{zj}P_z \cdot f(d_{zj})}$$

(constrained to attractions)

where: T_{ij} = the forecast flow produced by zone i and attracted to zone j

P_i = the forecast number of trips produced by zone i

A_j = the forecast number of trips attracted to zone j

K_{ij} = the K-Factor for flow between zone i and zone j

d_{ij} = the impedance between zone i and zone j

$f(d_{ij})$ = the friction factor between zone i and zone j

To use K-factors in the gravity model evaluation procedure, they must be stored in zone-to-zone matrices. These K-Factor matrices must include a row and a column for all zones included in the analysis, and the row and column IDs must match the zone IDs in the zone layer.

For more information, see:
To Apply a Gravity Model with K-Factors

Top

) To Apply a Gravity Model with K-Factors

1. Follow Steps 1 through 9 in the procedure To Apply a Gravity Model.

2. For each trip purpose for which you want to include K-Factors, do the following:

   - Highlight the trip purpose in the Purpose scroll list
   - Check the Include K-Factors box
   - Choose the matrix file and matrix that contains the K-Factors from the Matrix File and Matrix drop-down lists

3. Continue with Step 10 in the procedure To Apply a Gravity Model.

TransCAD includes the K-Factors in the gravity evaluation.

Top

Calibrating a Gravity/Entropy Model

Calibrating the gravity model consists of evaluating the parameters of the impedance function (or the values in the friction factor table) so that the gravity model reproduces, as closely as possible, the base year productions and/or attractions and the base year trip length distribution.

TransCAD provides a procedure that calibrates a friction factor lookup table, a K-Factor matrix, and exponential, inverse power, and gamma impedance functions. Regardless of the model being calibrated, the calibration procedure requires the same inputs:

- A base year P-A matrix
- An impedance matrix
- A zone layer
- A selection set of the zones that you want included

All of the calibration procedures use the base year P-A matrix and the impedance matrix to generate the Observed Trip Length Distribution (OTLD), and the aim is to calibrate the model such that this OTLD is reproduced as closely as possible.

The zone layer selection set defines the pairs of zones that are used in the calibration process. The ID of each zone in the selection set must be included in both the row and column IDs of the impedance matrix and the base year P-A matrix.

For more information, see:
Gravity Model Friction Factor Calibration
Gravity Model Exponential and Inverse Power Function Calibration
Gravity Model Gamma (Combined) Function Calibration
Gravity Model K-Factor Calibration

Top

Gravity Model Friction Factor Calibration

A friction factor table consists of a list of impedance bins/ranges with corresponding friction factor values. This calibration is done by first initializing all friction factors to "1" and then iteratively adjusting the friction factor for each range of impedances.

Each iteration *i* consists of the following steps:

1. Apply a gravity model using the latest friction factor lookup table and the base year productions and attractions. This produces a new production-attraction matrix.

2. Extract the TLD from this new trip matrix. Compare this TLD to the OTLD (range by range). If the convergence criterion is satisfied for each range, the procedure stops.

3. Update the friction factor value in each impedance range *r*:

$$F_i^r = F_{i-1}^r \cdot \frac{OTLD^r}{TLD_{i-1}^r}$$

where: F_i^r = the friction factor value for impedance range r for iteration i

           F_{i-1}^r = the friction factor value for impedance range r for iteration i-1

           $OTLD^r$ = the percentage of base year trips in impedance range r

           TLD^r = the percentage of forecast trips in impedance range r

4. Return to the first step.

Note that the calibrated friction factor matrix can be re-scaled without impacting the output of the gravity model.

Top

Gravity Model Exponential and Inverse Power Function Calibration

In the case of an exponential and inverse power function calibration, a single parameter is estimated such that the results of a gravity model using the functions $f(d_{ij}) = e^{-c(d_{ij})}$ and $f(d_{ij}) = d_{ij}^{-b}$, respectively, approximate the OTLD.

It has been shown in this case that a particularly robust and efficient calibration method is achieved by comparing, at each iteration, the mean impedance of the forecast to the observed mean cost, in which the mean impedance is defined as:

$$D = \frac{\sum_{ij} T_{ij} \cdot d_{ij}}{T}$$

where: T_{ij} = the number of trips between zone i and zone j

         d_{ij} = the travel impedance of going from zone i to j

         T = the total number of trips

Each iteration i of the calibration procedure consists of the following steps:

1. Compute the friction factor matrix based on the current estimate of the function parameter p_i.

   The initial parameter is taken as the inverse of the base year mean cost c^*.

2. Evaluate a gravity model constrained to the base year productions and/or attractions. This produces a new trip flow matrix.

3. Compute the mean impedance c_i and comparing it to c^*. If convergence has been reached, then the procedure stops.

4. Compute a new estimate of the parameter estimate based on p_{i-1}, c_{i-1}, c_i, and c^* using the following equation:

$$p_{i+1} = \frac{(c_i - c^*)p_{i-1} - (c^* - c_{i-1})p_i}{c_i - c_{i-1}}$$

unless it's the first iteration, in which case the following equation is used:

$$p_{i+1} = \frac{c_i p_i}{c^*}$$

5. Return to the first step.

Gravity Model Gamma (Combined) Function Calibration

Calibration of a gamma impedance function involves estimating the three parameters of the gamma function, a, b, and c, as shown in the following equation:

$$f(d_{ij}) = a \cdot d_{ij}^{-b} \cdot e^{-c \cdot (d_{ij})}$$

As with calibrating the friction factor table, the comparison step is based on the TLD. Each iteration *i* of the gamma calibration process consists of the following steps:

1. Apply a gravity model using the latest parameters and the base year productions and attractions. This produces a new production-attraction matrix.

2. Compute the TLD from this new trip matrix. Compare this TLD to the OTLD (range by range). If the convergence criterion is satisfied for each range, then the procedure stops.

3. Update the friction factor value in each impedance range r:

$$F_i^r = F_{i-1}^r \cdot \frac{OTLD^r}{TLD_{i-1}^r}$$

where: F_i^r = the friction factor value for impedance range r for iteration i

F_{i-1}^r = the friction factor value for impedance range r for iteration $i-1$

$OTLD^r$ = the percentage of base year trips in impedance range r

TLD^r = the percentage of forecast trips in impedance range r

4. Perform a linear regression using the rows of the friction factor table as observations to estimate new values of the gamma function parameters.

5. Return to the first step.

TransCAD also provides UTPS-like calibration of the gamma function (U.S. DOT, 1986). The primary modification is that the friction factors *fij* are weighted by the production *Pi* in the case of a production-constrained calibration or the attraction *Ai* in the case of attraction-constrained calibration. This has the effect of providing a better fit of the estimated equation for those zones with larger productions or attractions. The UTPS option should be used when the base matrix has productions (or attractions) of very different magnitudes and when a large number of zones is involved.

For more information, see:
To Calibrate a Gravity Model

Top

⟩ To Calibrate a Gravity Model

1. Open a dataview that contains the zone IDs in the ID field. The data must be either contained in a zone layer or joined to a geographic layer

2. Choose **Planning-Trip Distribution-Gravity Calibration** to display the Gravity Calibration dialog box.

3. Choose the matrix file containing the base-year P-A flows from the Matrix File drop-down list.

4. Choose the zone layer from the Layer drop-down list.

5. Choose whether to use all records or a selection set from the Using drop-down list.

6. Make choices as follows:

To do this...	Do this...
Choose the constrain type	Make a choice from the Constraint Type radio list
Set the maximum iterations	Type a value in the Iterations edit box
Set the level of convergence	Type a value in the Convergence edit box
Set the maximum trip length	Type a value in the TLD Maximum edit box

7. For each matrix in the base-year matrix file for which you wish to calibrate an impedance function or friction factor lookup table, do the following:

   - Highlight the matrix in the scroll list
   - Check the Use [matrix name] box
   - Choose the type of function to calibrate from the Function radio list

- Choose the impedance matrix from the Matrix File and Matrix drop-down lists

8. Click OK to display the Save Result Summary File As dialog box.

9. Type a file name for the output matrix and click Save. TransCAD calibrates the model and displays the Results dialog box.

10. Click Close. TransCAD displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the results in a matrix.

Top

Gravity Model K-Factor Calibration

K-Factors are zone-to-zone parameters that are calibrated in order to improve the fit of the model. K-Factors are calibrated after either the friction factor table or the impedance function parameters have been calibrated. They are computed as the ratio between observed values and values produced by the estimated friction factors or impedance parameters. This allows the calibrated gravity model to exactly replicate the base year P-A matrix.

To calibrate a gravity model with K-Factors, follow all steps listed in To Calibrate a Gravity Model, and check the Include K-Factor Calibration box.

For more information, see:
To Calibrate a Gravity Model with K-Factors

Top

⟩ To Calibrate a Gravity Model with K-Factors

1. Follow Steps 1 through 6 in the procedure To Calibrate a Gravity Model.

2. For each base matrix for which you want to include K-Factor calibration, do the following:

   - Highlight the base matrix in the Base Matrix scroll list
   - Check the Include K-Factor Calibration box

3. Continue with Step 7 in the procedure To Calibrate a Gravity Model.

Tri-Proportional Trip Distribution Models

The doubly-constrained trip distribution models discussed thus far require that the output flow matrix from trip distribution match the input productions and attractions. Tri-proportional models allow for another dimension of constraints. In tri-proportional models, groups of cells in the P-A flow matrix are required to sum to specified values.

TransCAD allows the additional dimension to be applied for both growth factor and gravity models. In either case, all steps described in the prior sections are followed. The only difference is that you have to define the grouping of cells that make up the third dimension, and the value to which each group of cells must sum. This is done by providing:

- A zone-to-zone matrix, called the matrix of classes, that contains an integer value indicating the class in which the cell belongs. This matrix must include a row and column for each zone included in the analysis, and the row and column IDs must match the zone IDs in the geographic layer.
- A lookup table in which the first field is an ID field containing the class IDs listed in the matrix of classes, and another field must contain the value to which the group of cells defined by the class must sum. Classes that have a missing total value in the lookup table are not constrained.

If there is a missing entry in the matrix of classes, then that P-A pair is not constrained. If there is an entry in the matrix of classes that is not found in the lookup table, then the P-A pair is not constrained. If there is a missing or negative sum value in the lookup table, then P-A pairs included in that class are not constrained.

For more information, see:
To Apply a Tri-Proportional Growth Factors Model
To Apply a Tri-Proportional Gravity Model

⟩ *To Apply a Tri-Proportional Growth Factors Model*

1. Open the zone layer or joined view that contains the production and attraction data. The data must be either contained in a zone layer or joined to a zone layer.

2. Open a matrix of classes and a lookup table.

3. If necessary, open a friction factor table or friction factor matrix to define your friction factors.

4. Choose **Planning-Trip Distribution-Tri-Proportional Growth Factor** to display the Tri-Proportional Growth Factor Balancing dialog box.

5. Choose the matrix that contains base year production-attraction flows from the Matrix File

drop-down list. The matrices contained in this matrix file will be shown in the Matrices scroll list in the middle of the dialog box.

6. If your study area zones are a subset of the zone layer, choose the selection set containing the study zones from the Records drop-down list.

7. Make choices as follows:

To do this...	Do this...
Choose the constraint type	Make a choice from the Constraint Type radio list
Set the maximum iterations	Type a value in the Iterations edit box
Set the level of convergence	Type a value in the Convergence edit box

8. For each matrix that you want to update, do the following:

   - Highlight the matrix in the Matrices scroll list
   - Check the Use [matrix name] box
   - Choose the fields containing the forecast productions and attractions from the Production and the Attraction drop-down lists
   - Choose the matrix of classes from the Matrix File and Matrix drop-down lists in the Matrix of Classes frame
   - Specify the table and field that contain the total trips per class from the drop-down lists in the Corresponding Totals frame

9. Click OK. TransCAD displays the Save As dialog box.

10. Type a file name and click Save. TransCAD generates P-A flow matrices that match the production and/or attraction vectors, and displays the Results dialog box.

11. Click Close. TransCAD displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the results in a matrix.

〉 *To Apply a Tri-Proportional Gravity Model*

1. Open the zone layer or joined view that contains the production and attraction data. The data must be either contained in a zone layer or joined to a zone layer.

2. Choose *Planning-Trip Distribution-Tri-Proportional Gravity* to display the Tri-Proportional Gravity Model dialog box.

3. Choose Friction Factors or Impedance Functions from the **Model Based on** drop-down list.

   If you chose Friction Factors, choose the friction-factor matrix file from the F-Factors drop-down

list. The matrices in the matrix file are listed in the scroll list in the middle of the dialog box.

If you chose Impedance Functions, click Define to display the Define Impedance Functions and Cost Matrices dialog box.

To do this...	Do this...
Add a matrix	Click Add and type a name in the Matrix Name edit box.
Remove a matrix	Highlight the row and click Drop.
To rearrange a matrix	Highlight a row and click Move Up or Move Down.
Set the impedance function	Highlight the matrix in the Names scroll list, click a button in the Function radio list, enter in a, b, and c values, and choose a cost matrix from the Matrix File and Matrix drop-down lists. If you want to use a friction factor table rather than a function, choose F-Factors, click the Undefined button, choose a friction factor table, then choose a friction factor field from the Field drop-down list.

Click OK when you are done to return to the Tri-Proportional Gravity Model dialog box. The matrices you defined are listed in the scroll list in the middle of the dialog box.

4. Make choices as follows:

To do this...	Do this...
Choose the records to use	Choose All Records or a selection set from the Records drop-down list
Choose the constraint type	Make a choice from the Constraint Type radio list
Set the maximum iterations	Type a value in the Iterations edit box
Set the level of convergence	Type a value in the Convergence edit box

5. For each matrix in the friction-factor matrix file for which you wish to apply the gravity model, do the following:

   - Highlight the matrix in the scroll list
   - Check the Use [matrix name] box
   - Choose the production field from the Production drop-down list
   - Choose the attraction field from the Attraction drop-down list
   - Choose the matrix of classes from the Matrix File and Matrix drop-down lists in the Matrix of Classes frame
   - Specify the table and field that contain the total trips per class from the drop-down lists in the Corresponding Totals frame
   - If K-Factors are to be included, check the Include K-Factors box, and choose the matrix file and matrix containing the K-Factors from the Matrix File and Matrix drop-down lists below the checkbox

6. Click OK. TransCAD displays the Save As dialog box.

7. Type a file name and click Save. TransCAD generates P-A flow matrices that match the production and/or attraction vectors based on the friction factor matrix, and displays the Results dialog box.

8. Click Close. TransCAD displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the results in a matrix.

Technical Notes on Trip Distribution

The Doubly-Constrained Model

The doubly constrained model can be written mathematically as:

$$T_{ij} = a_i \cdot P_i \cdot b_j \cdot A_j \cdot f(d_{ij}) \tag{1}$$

subject to:

$$\sum_j T_{ij} = P_i \tag{2}$$

$$\sum_i T_{ij} = A_j \tag{3}$$

where: T_{ij} = the forecast flow produced by zone i and attracted to zone j

P_i = the forecast number of trips produced by zone i

A_j = the forecast number of trips attracted to zone j

a_i = the balancing factor for row i

b_j = the balancing factor for column j

The Production- (Singly-) Constrained Model and Solution

The equation for the production- (singly-) constrained model is very similar to the doubly-constrained mathematical model, with two changes:

- Only constraint (2) from the doubly-constrained model is necessary
- $b_j = 1$ since the columns (or attractions) are not balanced

Therefore, the model becomes:

$$T_{ij} = a_i \cdot P_i \cdot A_j \cdot f(d_{ij}) \tag{4}$$

subject to:

$$\sum_j T_{ij} = P_i \tag{5}$$

And this model is easy to solve, as follows:

Substituting equation (4) into equation (5) yields:

$$a_i = \frac{1}{\sum_{\text{all zones } z} A_z \cdot f(d_{iz})}$$

(6)

Substituting equation (6) into equation (4) yields:

$$T_{ij} = P_i \cdot \frac{A_j \cdot f(d_{ij})}{\sum_{\text{all zones } z} A_z \cdot f(d_{iz})}$$

(7)

Equation (7) is probably the equation that you are used to seeing when the gravity model is discussed.

The Attraction- (Singly-) Constrained Model and Solution

The mathematical version of the attraction- (singly-) constrained model is analogous to the destination-constrained model. It differs from the doubly-constrained model in the following ways:

- Only constraint (3) from the doubly-constrained model is necessary
- $a_i = 1$ since the rows (or productions) are not balanced

Therefore, the model becomes:

$$T_{ij} = P_i \cdot b_j \cdot A_j \cdot f(d_{ij})$$

(8)

subject to:
$$\sum_i T_{ij} = A_j$$

(9)

Substituting equation (8) into equation (9) yields:

$$b_j = \frac{1}{\sum_{\text{all zones } z} P_z \cdot f(d_{zj})}$$

(10)

Substituting equation (10) into equation (8) yields:

$$T_{ij} = A_j \cdot \frac{P_i \cdot f(d_{ij})}{\sum_{\text{all zones } z} P_z \cdot f(d_{zj})}$$

(11)

Obtaining the Doubly-Constrained Solution

The doubly constrained problem reduces to determining the values of both of the balancing factors (a_i and b_j) such that the rows of the matrix are balanced to productions (equation (2)) and the columns are balanced to attractions (equation (3)), where the matrix cell entries are determined by equation (1). In the doubly-constrained problem, the balancing factors are interdependent as follows:

$$a_i = \frac{1}{\sum_{\text{all zones } z} b_z A_z f(d_{iz})}$$

(12)

$$b_j = \frac{1}{\sum_{\text{all zones } z} a_z P_z f(d_{zj})}$$

(13)

While there is no mathematically-derived solution for determining the balancing factors, the solution can be converged upon by iteratively calculating a_i given b_j (starting with $b_j = 1$) via equation (12) and then calculating b_j given a_i via equation (13) until equations (2) and (3) are satisfied within a given level of tolerance.

Top

Mode Split and Choice Analysis

Mode choice models are used to analyze and predict the choices that individuals or groups of individuals make in choosing the transportation modes that are used for particular types of trips. Typically, the goal is to predict the share or absolute number of trips made by mode.

An important objective in mode choice modeling is to predict the share of trips attracted to public transportation. The most commonly applied method to study mode choice is the logit model in one of its many forms. However, regression and cross-classification methods may also be encountered. With TransCAD you can also use mode choice analysis to predict market shares for products and services that do not involve transportation.

TransCAD provides procedures for estimating and applying mode choice models based on logit, regression, and cross-classification.

For more information, see:
About Mode Choice
An Example of Multinomial Logit
About the Multinomial Logit Model
Preparing Data for Multinomial Logit Estimation and Evaluation
Applying Multinomial Logit Models
Estimating Multinomial Logit Models
Estimating and Applying Binary Logit Using the MNL Procedures
Technical Notes on Mode Split and Choice Analysis

Top

About Mode Choice

Mode choice model estimation and application may be done at either a disaggregate or aggregate zonal level. Aggregate models seek to predict the zonal shares of trips by mode. Aggregate models are typically estimated using mode shares by origin-destination pair and average zonal demographics. Disaggregate models are based on individual-level data obtained from surveys. At the individual level, choice is discrete: a person picks one from a set of modal alternatives. Logit models are frequently estimated on individual-level data, and then forecasts are made based upon aggregate, explanatory variables.

The data for mode choice models usually include socio-economic characteristics of travelers (for example, income and auto ownership) and the service characteristics of the alternative modes (for example, travel time and cost). Good practice in model building includes identifying likely causal variables that explain mode choice and then testing the statistical significance of these variables empirically. For modeling the share of public transit trips, it is important to consider variables such as access to transit stops and any required transfers, as well as many other factors that research indicates are influencers of transit utilization.

As part of model building, TransCAD is often used to generate some or all of the service characteristics by O-D pair that are needed for model estimation and application. This is done by skimming modal network paths.

In many settings, there will be only two modes to consider: auto and transit. However, in large metropolitan areas with multiple public transportation modes, a mode choice model will normally include the major transit modes such as bus and rail. Where data permit, non-motorized modes (for example, walk and/or bicycle trips) may also be included. In areas with very low percentage utilization of public transit, mode choice models may appropriately be omitted from the forecasting process. Separate mode choice models are recommended by trip purpose, as mode choice determinants differ for different types of trips. Separate models may also be appropriate for different types of households or individuals.

Models do not need to be estimated with TransCAD in order to be applied in TransCAD. All of the model application methods are designed so that models estimated with other software can be easily implemented. This makes it easy to transfer models that already exist or to implement stated preference models that are based on choice experiments. The latter approach can be especially effective in alternatives analysis, in which predictions may be made for entirely new transit modes.

The primary methods used in mode split and choice analysis are regression, cross-classification, and discrete choice (for example, logit) models.

Regression Models
Regression models are sometimes used to predict aggregate mode shares. Regression models that are used for mode choice usually predict the proportion or number of trips made by a single mode. For example, a model may predict the proportion of automobile trips that are shared rides or the number of trips that are made by transit. Such models establish a statistical relationship between the proportion or number of trips and the socio-economic characteristics of the travelers and the characteristics of the alternatives.

In TransCAD, you can estimate linear regression equations and make forecasts using regression equations. When the zone shares are distributed between 0 and 1 and there are only two modes, regression may be appropriate. You can also import regression equations obtained from another source. Chapter 19, *Tabulations and Statistics*, in the *TransCAD User's Guide* provides information on how you can create, estimate, and apply linear regressions in TransCAD.

Cross-Classification Models

Cross-classification methods attempt to divide the population or analysis zones into relatively homogenous groups. The groups may be classified based on the characteristics of the decision makers (for example, income or auto-ownership) or on characteristics of the alternative modes (for example, travel times or relative travel times). They may also be based on derived utilities of the modes, which may include both socio-economic characteristics and attributes of the alternatives. In this way, cross-classification tables can also be used to implement diversion curves.

In cross-classification, average mode shares are typically derived for each homogeneous group. These average shares may be based on surveys or on estimations made from regression or discrete choice models. It is assumed in cross-classification that the mode share will remain relatively constant within each homogeneous group. Thus, once a table of classifications and mode shares is created, then it can be used to predict mode shares for groups of individuals or choice probabilities for individuals.

It is difficult to successfully apply cross-classification to mode choice. The primary obstacle is in creating homogenous classifications. There is usually more variance within each classification than between classifications, and the assumption that the mode share remains relatively constant within each classification is not valid.

TransCAD provides procedures that allow you to create cross-classification lookup tables and forecast mode share by cross-classification. Chapter 2, *Trip Generation - Production*, provides information on how you can perform cross-classification analysis in TransCAD.

Discrete Choice Models

The mode choice decision that an individual faces is discrete in nature: it is a choice from a set of available alternatives. Thus discrete choice models, which predict the choices made by decision units from a set of discrete alternatives, are often used for mode choice analysis.

Discrete choice models are in many respects a substitute for regression models when the dependent variable is qualitative or categorical rather than continuous. Regression models are ill suited for modeling discrete dependent variables due to violations of the assumptions of ordinary least squares (Aldrich and Nelson, 1984). Instead, discrete choice models are formulated as stochastic models, in which the probability that a particular response is observed is a function of a set of explanatory variables.

There is a variety of functional forms that can be proposed for the explanation of discrete choice. One that has proven advantageous, and is used extensively, is the Multinomial Logit (MNL) model.

Regression and cross-classification methods have been discussed in detail in Chapter 2, *Trip Generation - Production*, and Chapter 3, Trip Generation - Attraction. This chapter focuses on the multinomial logit model.

Top

An Example of Multinomial Logit

The best way to illustrate the use of a logit model for mode choice analysis is through an example. Imagine a town with 5 zones, a highway network and a bus network.

Each workday, people commute to work by either bus or auto. Each worker faces a binary choice problem, and such problems can be modeled using logit formulations.

As a town transportation planner, you want to forecast for a future year, such as the year 2005, the mode shares of bus and auto between each pair of zones. You believe that each individual mode choice is affected by the following factors:

- Parking cost
- Toll Cost
- Bus fare
- Travel time by auto
- Travel time by bus
- Auto ownership
- Household income
- Gender

These factors are called **explanatory variables**. They can be divided into two categories**:**

- Characteristics of the individual**,** such as income, auto ownership and gender.
- Characteristics or attributes of the **alternatives**, such as parking cost, toll cost, bus fare and travel time by mode. The alternatives are the choices available to the commuter. In this case, the alternatives are bus and auto.

If you have a **disaggregate** data set available that includes records of actual mode choice decisions made by individuals and values of the explanatory variables pertaining to each individual, you can estimate the **parameters** of the explanatory variables in the MNL model. The estimated parameters can be viewed as the weight or impact (either positive or negative) of the explanatory variables on the attractiveness (or **utility**) of the alternatives. TransCAD provides various tools for estimating the parameters of MNL models. Refer to Estimating Multinomial Logit Models for details.

Now suppose your MNL model is **estimated** (i.e., values of the parameters are available), and you want to use it for forecasting mode shares for each O-D pair for the year 2005. To do this, you need values of all explanatory variables for each O-D pair. To forecast for the year 2005, these value need to be what you expect them to be in the year 2005.

Some of the explanatory variables are based on both the origin and the destination of the trip, such as bus fare and travel time. O-D pair-based explanatory variables are best stored in matrices.

There are also some characteristics of the mode that are not based on the O-D pair. For example, parking cost in this example is based on the destination zone. In addition, the characteristics of the individuals making the work trips are based on the residence zone (i.e., the origin zone). Such data that are based on either the origin zone or the destination zone are best stored in zonal (or flat) databases.

You use a TransCAD MNL Model Table to store the model parameters, the structure of the model, and references to the locations of the above data. For a detailed explanation about the MNL model table, see About the MNL Model Table.

Now you are ready to use the MNL model evaluation tools provided by TransCAD to forecast mode shares for year 2005. The results of the evaluation are auto mode shares by O-D pair and bus mode shares by O-D pair.

In this example we showed that an MNL model can be used to forecast mode shares based on aggregate, zonal level data and O-D pair-based data. TransCAD provides a rich set of MNL modeling tools not only for this type of analysis, but also for MNL model evaluation based on disaggregate data, as well as based on aggregate data without O-D pair-based data. For more

information, see

About the Multinomial Logit Model

The Multinomial Logit (MNL) model relates the probability that a decision unit (for example, individual, household, firm, etc.) chooses a given alternative from a set of alternatives to the utility of these alternatives, according to the following formula:

$$P_n(i) = prob(Y_n = i) = \frac{e^{V_{ni}}}{\sum_{j \in C_n} e^{V_{nj}}}$$

where:

$P_n(i)$ = The probability with which person n will choose alternative i

Y_n = The value of the response variable for individual n

C_n = The set of alternatives in person n's choice set

V_{ni} = The measurable component of the utility of alternative i for individual n

The multinomial logit model (MNL) takes its name from the fact that the choice probabilities are distributed as the standardized multivariate logistic cumulative distribution (McFadden, 1974).

McFadden has shown how the MNL model can be derived from considerations of utility maximization, by employing the notion of a random utility function that is associated with each alternative. The decision unit evaluates the utility function for each alternative it faces and chooses the alternative with the highest utility value. Since actual utility functions are not known with certainty, they are specified with a random error term.

In particular, the multinomial logit model for the choice probabilities arises if it is assumed that the utility of an alternative is a function of the choice determinants, some unknown parameters, and an additive, Gumbel-distributed error term. It is the assumption that the error terms are IID Gumbel (similar to a normal distribution) that leads to the tractable MNL formulation.

The utility is expressed as:

$$U_{nj} = A'X_n + B'Z_j + C'W_{nj} + E_{nj}, j \in C_n$$

where:

U_{nj} = The utility of alternative j for individual n

X_n = A vector of characteristics of individual n

Z_j = A vector of attributes of alternative j

W_{nj} = A vector of interactions between characteristics of individual n with attributes of alternative j

E_{nj} = An error term that is independently and identically distributed (IID) Gumbel

C_n = The choice set facing individual n

A, B, C = Column vectors of model parameters

A', B', C' = Transposed column vectors of model parameters

and

$$V_{nj} = A'X_n + B'Z_j + C'W_{nj}, j \in C_n$$

where:

V_{nj} = The measurable component of the utility of alternative j for individual n

As reflected in the above equation, the utility functions are typically assumed to be linear in the parameter vectors A, B, and C for computational reasons.

It may be observed that the MNL choice probabilities are strictly greater than zero and less than one and that they sum to one across alternatives for each decision unit.

Note that multiplying both the numerator and denominator of the MNL logit equation by the quantity:

$$e^{(-V_{nm})}$$

where:

V_{nm} = The measurable utility of an arbitrary alternative m to individual n

yields the following expression:

$$P_n(i) = \frac{e^{(V_{ni}-V_{nm})}}{1 + \sum_{j \neq m} e^{(V_{nj}-V_{nm})}}, \quad \forall\ i, j \in C_n$$

As a result, the choice probabilities are affected only by the difference between the utilities of all but one of the alternatives and the utility of the other alternative. The choice of the omitted, reference alternative m is arbitrary, and different reference alternatives may be used for different variables.

This fact becomes important when specifying an MNL model.

MNL models are specified by defining the relative utility for each alternative. This means defining the explanatory variables that enter each relative utility and the relationship of the parameters among the relative utilities.

Explanatory variables that enter the utility functions may be of several types. The variables may be characteristics of the decision maker or attributes of the alternative. In addition, there may also be interaction variables that are the product of characteristics of the individual and attributes of the alternatives. For example, the following variable is an interaction variable:

$$\frac{TransitCost}{Household\_Income}$$

There may also be origin-destination-based explanatory variables, such as the auto travel time between every origin and every destination. Such O-D pair variables are best stored in matrices, and may be used with both MNL estimation and evaluation procedures in matrix form.

Another distinction is between generic and alternative-specific variables. Generic variables are those that have the same effect (i.e., the same value of the parameter) on the utility of different alternatives. Alternative-specific variables have different effects on the utility of different alternatives.

Top

Preparing Data for Multinomial Logit Estimation and Evaluation

There are three basic types of data for multinomial logit evaluation and estimation in TransCAD:

- A dataset on which you wish to estimate or evaluate a multinomial logit model. This is typically a dataset of decision makers or a dataset of zones on which you have some information (for example, income and auto ownership) that may be explanatory variables for the choice decision that is being studied.
- O-D pair-based explanatory variables that are stored in matrix form. This is particularly common in mode choice studies, in which characteristics of the alternatives are often based on the origin and destination of the trip.
- A specification of the multinomial logit model, called an MNL Model Table, which includes information on the alternatives available, the parameters of the model, and the explanatory variables necessary for the model.

For more information, see:
About the MNL Model Table
Creating and Modifying MNL Model Tables

Top

About the MNL Model Table

TransCAD uses a single table called an MNL Model Table to store information on an MNL model. This table holds information about:

- The model structure
- The sources of data to use for either estimation or evaluation
- Estimates of the parameters

There are two types of rows in an MNL Model Table:

- Utility rows, at the top, that define the relative utilities of the different alternatives and have references to the location of explanatory data
- Model rows, at the bottom, are that store estimated values of the parameters

The first column is used to store either the name of the alternatives (for the utility rows) or the name of the model (for the model rows). The number of remaining columns is the number of distinct parameters in the model. The headings of the columns provide the name of the parameters, which are used in display and reports.

The MNL Model Table may be in any of the forms that TransCAD recognizes, including dBASE, fixed-format binary, fixed-format text, and comma-delimited text. All of the fields in an MNL Model Table are string (character) fields.

Utility Rows - Specification of the Model

The utility rows in an MNL Model Table define the structure of the model and provide references to the location of the explanatory data. There is one utility row for each available alternative. The entry in the first column is the name of the alternative. The entries in the remaining columns of the utility row define the variables to include in each utility, whether or not the variables are generic or alternative-specific, and the number of parameters to be estimated.

Utility Rows - Sources of Explanatory Variables

The entries in the utility rows provide information on the location of the explanatory data. A null value or an entry of "ZERO" indicate that the parameter does not impact the relative utility of the row. An entry of "ONE" indicates that the parameter applies to an alternative-specific constant.

Any other entry is a reference to the location of values of each explanatory variable to be used for estimation and/or evaluation. There are three types of pointers to explanatory variables used in the MNL model table: fields, destination-based fields, and matrices.

All fields listed in an MNL Model Table must be in the same input dataview and have the same name as that in the dataview.

The field name may be preceded by a "D_", which means that the value of the explanatory variable is based on the destination of the trip. This is only an alternative when evaluating an MNL model on an aggregate dataset with explanatory variables provided in matrix form. For more information on destination-based fields, see MNL Application Using Aggregate Data with O-D Based Data.

The entry for a matrix data source contains both the name of the matrix file and the name of the matrix, in the format "matrix file name|matrix name." The appropriate cell in the matrices to be used for each decision maker is determined by the origin and destination of the trip that the decision maker takes. Any number of matrix files may be used in a single MNL Model Table. However, the

current row and column indices of all matrices used in a single MNL Model Table must be consistent. This means that the current view of all matrices must have the same number of rows, the same number of columns, and the same headings. For more information on matrix indices, see Chapter 16, *Working with Matrices*, in the *TransCAD User's Guide*.

In an example, the relative utility of Bus for decision maker n is:

$$V_{Bus_n} = \beta_{BUSCOST} * BUS \mid Fare_{ODn} + \beta_{TT} * TT \mid BUSTT_{ODn} + \beta_{INCOME} INCOME_n$$

INCOME is a field in the input dataview. The bus fare applicable to decision maker n is located in a matrix called Fare in a matrix file called BUS, and the bus travel time applicable to decision maker n is located in a matrix called BUSTT in a matrix file called TT. The appropriate cells in the matrices are determined by the origin and destination of the trip faced by the decision maker(s).

Model Rows - Estimated Values of the Parameters

In addition to the rows that specify the utilities, the MNL Model Table may also have rows that contain estimated values of the parameters. These rows follow the utility rows. Each row of parameters represents a separate estimated MNL model. You may have more than one estimated model if you estimate the model on different sets of decision makers (for example, higher income versus lower income). In the model rows, the first column stores the name of the model and the remaining columns store the estimated value of each parameter.

In an example model table that contains one set of estimates based on a survey done in Flintbury and one set of estimates based on a survey done in Springfield, the relative utility of Bus for a decision maker n who lives in Springfield is:

In this example

$$V_{Bus_n} = \beta_{TT} * TTB_n + \beta_{TC} * TCB_n + \beta_{INC} INC_n$$

and, using the estimated values of the parameters from the Springfield model,

$$V_{Bus_n} = -0.6 * TTB_n - 1.0 * TCB_n - 0.04 * INC_n$$

Where TTB, TCB, and INC are all fields from an input dataview.

According to the logit equation of probability and the model specified above, the probability that a person from Springfield will choose Bus is:

$$P_n(Bus) = \frac{e^{-0.6*TTB_n - 1.0*TCB_n - 0.04*INC_n}}{e^{-0.6*TTB_n - 1.0*TCB_n - 0.04*INC_n} + e^{-0.5 - 0.6*TTA_n - 1.0*TCA_n}}$$

Creating and Modifying MNL Model Tables

The MNL Model Table is used in TransCAD for both estimating and evaluating MNL models. Specifying an MNL Model Table consists of 3 steps:

- Creating the MNL Table
- Filling the MNL Table with sources of data
- Adding records of estimation results

You can use the standard commands such as **File-New** and **Dataview-Modify Table** to create and edit MNL Model Tables. See Chapter 8, *Creating and Modifying Data Tables*, in the *TransCAD User's Guide* for more information. In addition, TransCAD provides a tool specifically designed to create and modify MNL Model tables.

Creating the MNL Table

To create an MNL Model table, you choose the number and names of the alternatives, and the number and names of the parameters. TransCAD then creates a fixed-format binary file that meets the specifications of an MNL Model Table.

Filling the MNL Table with Sources of Data

The Fill MNL Model Table dialog box provides an efficient method for designating the variables to include in each utility equation and the sources of data to use in estimating or evaluating an MNL model. You can use this procedure to fill a new MNL Model Table or to modify an existing MNL Model Table.

A few things to remember when filling MNL Model Tables:

- All data sources specified in an MNL Table must be open in TransCAD before displaying the Fill MNL Model Table dialog box.
- If you modify an existing MNL Model Table, all prior data source entries that are not currently open in TransCAD will be deleted. However, you will be warned before this happens.
- All fields used as sources of data in an MNL Table must be contained in one dataview.
- Multiple matrix files may be used.
- All fields in an aggregate O-D based model are applied based on the origin of the trip, unless the entry of the field name is preceded by "D_". The "D_" is added to the field name if you check the Apply at Destination box in the Fill MNL Model Table dialog box.
- Keeping your field names, matrix file names, and matrix names short will make the MNL Model Table easier to read.

Adding Records of Estimation Results

The MNL Model Table may also include records that contain estimates of the parameter values. These records are listed below the utility/alternative records. To use an MNL Model Table to forecast mode choice, the table must contain at least one row of parameter values. The MNL Estimation procedure adds such a row automatically. However, you may already have estimates of parameters that you wish to use for evaluation. You can use the standard TransCAD interface tools to add parameter values.

For more information, see:
To Create an MNL Model Table
To Modify the Data Source Entries
To Add Model Estimation Records

⟩ To Create an MNL Model Table

1. Open the matrices and tables that contain the input data for the model.

2. Choose *Planning-Mode Split-Specify a Multinomial Logit Model*.

   If you already have a model table open, TransCAD displays the Fill MNL Model Table dialog box. Choose Create New from the Model Frame drop-down list.

   TransCAD displays the Create MNL Model Table dialog box.

3. For each alternative that you want to add, click Add under Specify Alternatives and type a name for the alternative in the Name edit box.

4. For each parameter that you want to add, click Add under Specify Parameters and type a name for the parameter in the Name edit box.

5. Click OK. TransCAD displays the Store Specification In dialog box.

6. Type a name for the table and click Save. TransCAD creates and saves a fixed-format binary file, with one row for each alternative and a column for each parameter, and displays it in a dataview. TransCAD then displays the Fill MNL Model Table dialog box.

7. Click Cancel.

⟩ To Modify the Data Source Entries

1. Open the matrices and tables that contain the input data for the model, and open the MNL Model Table.

2. Choose *Planning-Mode Split-Specify a Multinomial Logit Model* to display the Fill MNL Model Table dialog box.

3. Choose the dataview that contains the fields to be used as data sources from the Source Dataview drop-down list.

4. Choose the MNL Model Table that you wish to fill or modify from the Model Table drop-down list.

5. Choose the number of alternatives in the MNL Model Table from the Number of Alternatives drop-down list.

6. Choose the alternative for which you wish to create a relative utility function by highlighting it in the Specify Utility For scroll list.

7. Specify the data source for each parameter that is to be included in the utility function by clicking on the parameter in the scroll list and doing the following:

To do this...	Do this...
If the parameter is not applicable to the alternative	Click Not Applicable
Use a constant for the parameter	Click Constant
Use a data field for the parameter	Click Field and choose a field from the Field drop-down list; to apply the field based on the destination of the trip, check the Apply at Destination box
Use a matrix for the parameter	Click Matrix and choose a matrix file and matrix from the drop-down lists

8. Return to Step 6 to choose other alternatives.

9. If you want to use the same source of data with the same parameter in more than one utility equation, highlight the parameter, check the Generic Variable box, and choose the utilities from the scroll list.

    If you choose all of the utilities, TransCAD will display a message that the model will not be estimable if you include the variable in all of the utilities.

10. When you have specified all of the utilities for each alternative in your model, click OK.

TransCAD updates the MNL Table with the new data source information.

⟩ *To Add Model Estimation Records*

1. Open the MNL Model Table or, if it is already open, make it the current window by clicking on it or choosing it from the *Window* menu.

2. Choose *Edit-Add Records* to display the Add Records dialog box. Type a value for the number of records to add in the edit box and click OK. The chosen number of records is added to the bottom of the table.

    - OR -

    Click ➕ on the toolbar. An empty record is added to the bottom of the table.

TIP: You can show a grid in the table to see the empty records better. Choose *Dataview-Settings* and check the Grid box to add a grid to the table.

3. Type the name of the model in the first cell of the new record, and enter values for each parameter in the remainder of the cells in the row.

TransCAD updates your model table to contain the additional model you specified.

Applying Multinomial Logit Models

Application of logit models is done for forecasting purposes, and can only be performed once values of the parameters of an MNL model are known (i.e., estimated). The usual goal of application is to estimate the future shares of each alternative. The inputs to a logit model application are:

- The specification of the model, in the form of an MNL Model Table
- The values of the parameters, provided in an MNL Model Table
- The values of the explanatory variables, from either dataview fields or matrices

Application may be performed on either a disaggregate or an aggregate data set. The inputs and outputs vary, depending on whether it is an aggregate or disaggregate application and whether or not matrices (i.e., O-D based data) are used as sources for explanatory variables. Three main types of applications are:

- Application based on disaggregate data
- Application based on aggregate data, without O-D based data
- Application based on aggregate data, with O-D based data

For more information, see:
MNL Application Using Disaggregate Data
MNL Application Using Aggregate Data without O-D Based Data
MNL Application Using Aggregate Data with O-D Based Data
Summary of MNL Application
Incremental Logit Application
Missing Data in MNL Applications
Varying Choice Sets in MNL Application
Aggregation of Disaggregate Results from MNL Application
Aggregate Multinomial Logit Application
Applying Logit Models Using Utility Matrices (An Alternative)

Top

MNL Evaluation Using Disaggregate Data

A disaggregate data set is one that contains information at the level of the decision maker. To apply the MNL Application procedure to a disaggregate data set, the data must be arranged in a dataview as follows:

- A single record per decision maker
- A field containing a unique ID number for each record
- Fields of all explanatory data necessary for the model (for example, income and auto ownership), except those explanatory variables that are provided in matrix form
- Origin and destination fields, if O-D matrices are used as inputs

O-D based data, such as travel time and travel cost, are critical inputs to mode choice analysis. Often the travel time and travel cost data reported by the respondents of surveys are found to be inaccurate, due to numerous biases introduced in the survey process. Therefore, average O-D

travel characteristics derived from a transportation network are frequently used as the sources of the explanatory variables. If O-D based explanatory data are provided in matrix form, then the disaggregate dataset must also have fields containing the origin and destination ID numbers of the trip for each record. These ID fields provide information on the cell in the matrix that applies to the trip made by the decision maker. The entries in the origin and destination IDs must match the current headings in the matrix views of explanatory variables.

The results of application on disaggregate data sets are the probabilities with which each decision maker will select each alternative, according to the MNL logit formula:

$$P_n(i) = \frac{e^{V_{ni}}}{\sum_{j \in C_n} e^{V_{nj}}}$$

where:

$P_n(i)$ = The probability with which person n will choose alternative i

C_n = The set of alternatives in person n's choice set

V_{ni} = The systematic, measurable component of the utility of alternative i for person n

The results of the MNL Application procedure on disaggregate data is a fixed-format binary file that contains a field of IDs (identical to the ID field in the input disaggregate dataset) and a field for each alternative.

MNL Evaluation Using Aggregate Data without O-D Based Data

Application may also be performed on an aggregate data set. An aggregate data set is one that contains average information on a group of decision makers. In transportation planning, aggregate data sets at the level of the zone are often used for analysis. To apply the MNL Application procedure on an aggregate data set, the data must be arranged in a dataview as follows:

- A single record per zone
- A field containing a unique ID number for each zone
- Fields of all explanatory data necessary for the model (for example, income and auto ownership)

In the aggregate case, the explanatory variables used to apply the model are average values for each group of decision makers. For example, the average income for a zone will be used as the explanatory variable instead of the actual income for an individual. Thus, the utilities that are calculated in MNL Application using aggregate data sets are estimates of the average utilities for a group of decision makers. These average utilities are used in the MNL formula to obtain the predicted market share of each alternative for each aggregate group. The equation used to apply MNL models on aggregate data is the same as for disaggregate data, except for different

interpretations of the inputs and outputs:

$$S_g(i) = \frac{e^{V_{gi}}}{\sum_{j \in C_g} e^{V_{gj}}}$$

where:

$S_g(i)$ = The predicted market share of alternative i for group g

C_g = The set of alternatives available to members in group g

V_{gi} = The measurable component of the average utility of alternative i for members in group g

The output of MNL Application on aggregate data without O-D based explanatory variables is a fixed-format binary file that contains a field of IDs (identical to the ID field in the input aggregate dataset) and a field for each alternative.

Top

MNL Application Using Aggregate Data with O-D Based Data

Frequently in mode split analysis, what is desired are the mode shares for each origin-destination pair. There are several different types of explanatory variables used in such a model:

- Characteristics of the origin zone (for example, auto-ownership, income)
- Characteristics of the destination zone (for example, parking cost, employment)
- Characteristics of the O-D pair (for example, auto travel time)

You could create a dataview that contains a record for each O-D pair on which to apply the model. However, TransCAD has a more straightforward way to apply this kind of model. The inputs to the application are:

- A dataview with one record per zone that contains all explanatory variables that are either characteristics of the origin zone or characteristics of the destination zone
- Input matrices of explanatory variables that are characteristics of the O-D pair

The input dataview must have a unique ID for each zone that is consistent with the current origin zone (row) and destination zone (column) headings in the input matrices.

In MNL Application, a utility is calculated for each origin-destination-alternative combination. The MNL Model Table stores information on whether the explanatory variable should be obtained based on the origin, the destination, or the O-D pair. If the data source for the explanatory variable is a matrix, then it is used in the utility, based on the O-D pair. Otherwise, the source is a field from the zone dataview. If the name of the field is preceded by a "D_", then it is applied based on the

destination zone, otherwise it is applied based on the origin zone.

For example, the average parking cost for a zone would be stored in a field in the input dataview, and it would be applied to the utility based on the destination of the trip. Fields that contain information on auto ownership or transit access time should be included in utilities based on the origin zone, and should not be preceded by "D_" in the MNL Model Table.

For example, the average parking cost for a zone would be stored in a field in the input dataview, and it would be applied to the utility based on the destination of the trip. Fields that contain information on auto ownership or transit access time should be included in utilities based on the origin zone, and should not be preceded by "D_" in the MNL Model Table.

In an example model file with origin-based, destination-based, and O-D based entries, the MNL Model Table would require a dataview with the fields PARKCST and INC. PARKCST will be applied based on the destination of the trip, and INC will be applied based on the origin. The travel time for auto and bus are applied based on both the origin and destination, and they are stored in matrix file TT in matrices Auto and Bus, respectively.

The output of the aggregate, O-D based evaluation is a matrix file of market shares for each origin (rows) and destination (columns) pair, with one matrix for each alternative.

Top

Summary of MNL Application

The following table summarizes the different types of MNL Application:

Type of Model	D_ Allowed?	O-D Fields Required?	Output Format	Output Type	Output Units
Disaggregate-No Matrices	No	No	Fields	Probabilities	Individual
Disaggregate-With Matrices	No	Yes	Fields	Probabilities	Individual
Aggregate-No Matrices	No	No	Fields	Aggregate Shares	Zone
Aggregate-With Matrices	Yes	No	O-D Matrix	Aggregate Shares	O-D Pair

(Note also that you can use the Nested Logit procedures, which are described later in the chapter, to apply any of these MNL models. The Nested Logit procedures use a significantly different interface and method of storing the model specification.)

To apply an MNL model using the MNL interfaces, you need an MNL Model Table, a dataview containing either a disaggregate or aggregate data and, if desired, matrices containing explanatory data. The MNL Model Table must have at least one row of parameter estimates to be used for the application. All of the fields used as data sources in the MNL Model Table must be from the same dataview. The MNL Model Table, the dataview, and all matrices used as sources of data must be open in TransCAD before applying the model.

For more information, see:
To Apply an O-D Based Disaggregate MNL Model
To Apply an O-D-Based Aggregate MNL Model

⟩ *To Apply an O-D Based Disaggregate MNL Model*

1. Open the model table that specifies the model, the data file that contains the attributes of the decision makers, and any matrices that store origin-destination explanatory data.

2. Choose *Planning-Mode Split-Multinomial Logit Application* to display the Multinomial Logit Application dialog box.

3. Make choices as follows:

To do this...	Do this...
Choose the MNL Model Table	Choose a table from the Model Table Dataview drop-down list
Choose the number of alternatives	Choose a number from the Number of Alternatives drop-down list
Choose the model to apply	Choose a model from the Model scroll list
Choose the data sources dataview	Choose the dataview that contains all of the fields used as data sources from the Source Dataview drop-down list
Choose the records to use	Choose All Records or a selection set from the Records drop-down list

4. Choose Disaggregate from the Type of Data drop-down list.

5. Choose the unique ID field from the ID Field drop-down list.

6. Choose the fields that contain the origin zone of the trip and the destination zone of the trip from the Origin Field and Destination Field drop-down lists.

7. Click OK to display the Store Output Table In dialog box.

8. Type a name for the output file and click Save. TransCAD applies the model using the data from the data sources and the parameters from the specified model row, writes the results to the specified output file, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD joins the results to the source dataview. Scroll to the far right of the new dataview to see the results.

⟩ *To Apply an O-D-Based Aggregate MNL Model*

1. Open the model table that specifies the model, the data file that contains the zonal attributes, and any matrices that store origin-destination data.

2. Choose **Planning-Mode Split-Multinomial Logit Application** to display the Multinomial Logit Application dialog box.

3. Make choices as follows:

To do this...	Do this...
Choose the MNL Model Table	Choose a table from the Model Table Dataview drop-down list
Choose the number of alternatives	Choose a number from the Number of Alternatives drop-down list
Choose the model to apply	Choose a model from the Model scroll list
Choose the data sources dataview	Choose the dataview that contains all of the fields used as data sources from the Source Dataview drop-down list
Choose the records to use	Choose All Records or a selection set from the Records drop-down list

4. Choose Aggregate from the Type of Data drop-down list.

5. Choose the unique ID field from the ID Field drop-down list.

6. Click OK to display the Save As dialog box.

7. Type a name for the output matrix and click Save. TransCAD applies the model using the data from the data sources and the parameters from the specified model row, stores the results to the specified output matrix, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the resulting matrix.

Top

Incremental Logit Application

Incremental logit is an alternative method of applying logit models. Instead of forecasting based on a whole new set of explanatory variables, the incremental forecast is based on differences from an existing situation. This model is frequently used in transportation when improvements to an alternative are proposed. Incremental logit allows the study of the impacts of a transportation improvement without having to provide specifications of the entire transportation system (for example, specifications of all alternatives and demographics of riders).

The incremental logit equation used in TransCAD can be derived from the multinomial logit equation (see Technical Notes on Mode Split and Choice Analysis), and is as follows:

$$P_i' = \frac{P_i e^{\Delta U_i}}{\sum_{j=1}^{k} P_j e^{\Delta U_j}}$$

Where:

P_i = The existing probability (share) of using mode i

P_i' = The scenario probability (share) of using mode i

ΔU_i = $U_i' - U_i$

U_i = The existing utility for mode i

U_i' = The scenario utility for mode i

k = Number of choices (modes) available

Note that, in the above equation, any variables in the utility that do not change between the existing situation and the scenario to be forecasted are canceled out of the equation. Thus, only descriptions of the changes of level of service (for example, fare increased by 75 cents) are required. However, estimated parameters for these variables are also required. Ideally, these will be obtained from a locally estimated model. They may also be imported from other study areas.

Forecasting with an incremental logit model in TransCAD is very similar to forecasting a regular logit model. The inputs are:

- An MNL Model Table, which includes one row for each alternative and a column for those explanatory variables that change between the existing situation and the scenario situation
- A dataview containing values of the explanatory variables
- Matrices, if desired, containing values of the explanatory variables
- Input base shares (aggregate case) or base probabilities (disaggregate case)

The only new inputs are the base shares or probabilities. For O-D based aggregate MNL models, the input base shares will be matrices, in which each cell provides the base share for all trips between the respective origin and destination. One matrix of base shares is needed for each alternative.
For O-D based disaggregate MNL models, the base shares or probabilities will be fields in the dataview that contains the values of the explanatory variables. One field is necessary for each alternative.

For example, a city has a model of mode share that includes the alternatives of drive alone, carpool, and subway. The city is considering the introduction of a new technology that would make the subway trains run faster, but would also increase the fare. In an incremental logit model table for this situation, since no variables in the drive-alone and carpool utilities change, these rows are left blank. The sources of data listed are two fields TT_Dif and TC_Dif, which hold the difference in travel time and travel cost that each decision maker or group of decision makers will face. The Model row provides the values of the parameters necessary to evaluate the model. Note, however, that these rows must remain in the MNL Model Table

The existing probabilities or shares of Drive-Alone, Carpool, and Transit for each decision maker or group of decision makers is also necessary to evaluate the model. If we apply the above example model file on an aggregate (zonal) database, we would need to include three fields in the input zone database, the existing shares of driving alone, carpool, and transit.

For more information, see:
To Apply an Incremental Logit Model

⟩ *To Apply an Incremental Logit Model*

1. Follow Steps 1-9 of the procedure To Apply an O-D Based Disaggregate MNL Model or Steps 1-8 of the procedure To Apply an O-D-Based Aggregate MNL Model.

2. Check the Apply Incremental Logit box to display the Specify Base Shares for Incremental Logit dialog box.

3. For each alternative, highlight the alternative in the scroll list and choose the location of the base probability from the Base Share drop-down list. This will be a matrix file if it is an O-D-based aggregate model, or a field if it is an O-D-based disaggregate model.

4. When you have specified all base shares, click OK to return to the Multinomial Logit Application dialog box and continue with Steps 10 of the procedure To Apply an O-D Based Disaggregate MNL Model or Steps 9 of the procedure To Apply an O-D-Based Aggregate MNL Model.

When TransCAD runs the model, the base probabilities are included as specified in the Incremental Logit equation.

Missing Data in MNL Applications

Real data sets frequently have missing explanatory data for some of the records in the data set. There are two different ways that TransCAD can treat missing data in MNL Application:

- The default is to drop the alternative for the decision maker(s). For example, if a record does not have an entry for bus travel time, then it will be assumed that the probability of bus for the decision maker or group of decision makers defined by that record is zero. Note that missing values can be used to specify the choice sets available to each decision maker.
- The alternative is to drop the decision maker from the data set if there are any missing explanatory variables for any of the alternatives. This means that no probabilities or shares will be calculated for the record, and missing values will be output instead. To choose this option, click Options in the MNL Application dialog box to display the Options for MNL Application dialog box, and click the second radio button under Missing Data, and click OK.

Varying Choice Sets in MNL Application

Not all decision makers face the same choice set. There are many constraints on choices such as availability, accessibility, cost, and time that make some alternatives not feasible for certain decision makers. For example, people who do not have a car do not have the option of driving alone to work. Similarly, a person who lives 20 miles away from work does not have the option of walking to work. Frequently, simple rules are used to determine the subset of alternatives that are available to each decision maker.

In TransCAD, there are two ways of specifying the choice sets available to each decision maker:

- Use missing values to indicate when an alternative is not available, as discussed under the section on missing data. For example, if there is no entry for bus travel time for a particular decision maker, then TransCAD will assume that bus is not an option for that decision maker.
- Generate additional inputs that are dummy variables indicating whether or not each alternative is available to a decision maker or a group of decision makers.

These additional inputs are called **Choice Set Descriptors**. They are dummy variables that are equal to "1" for a decision maker(s) if the alternative is available and "0" if it is not. For an O-D based aggregate MNL model, a matrix of choice set descriptors is necessary for each alternative that is not available to all O-D pairs. For other models, a field of choice set descriptor must be specified for each alternative that is not available to all decision makers. Choice set descriptors are not necessary for any alternative that is available to all decision makers.

Once the choice set descriptors are created, application proceeds as usual, except that the choice set descriptors are an additional input specified in the dialog box.

For more information, see:
To Apply Choice Set Descriptors in MNL Application

Top

) *To Apply Choice Set Descriptors in MNL Application*

1. Begin the procedure To Apply an O-D Based Disaggregate MNL Model or the procedure To Apply an O-D Based Aggregate MNL Model.

2. Click Options to display the Options for MNL Application dialog box.

3. Check the **Apply varying choice sets** box.

4. For each alternative that is not available to all decision makers, highlight the alternative in the Alternative scroll list, and choose the matrix file (for O-D based aggregate models) or dataview field (for other models) that contains the choice set descriptor from the Choice Set Descriptor drop-down list. For matrix-based choice set descriptors, choose the matrix from the second drop-down list.

5. When you have specified all choice set descriptors, click OK to return to the MNL Application

dialog box, and continue with the procedure To Apply an O-D Based Disaggregate MNL Model or the procedure To Apply an O-D Based Aggregate MNL Model.

When TransCAD runs the model, the choice set descriptors are taken into account.

Aggregation of Disaggregate Results from MNL Application

In most cases, what is of interest for planning purposes is the aggregate forecast share of each mode. As discussed previously, aggregate shares may be produced by applying the MNL model using aggregate data (for example, data at the zonal level). This can be done to produce either zonal results or, more appropriately for mode-choice, O-D pair based results. When application is performed on disaggregate data, the outputs are the probabilities with which each decision maker will select each alternative. There are several relatively easy ways of aggregating results from disaggregate application to produce aggregate forecasts.

If it can be assumed that the disaggregate data set is a perfectly random sample, then the average of all output probabilities for a given alternative is the aggregate share for that alternative:

$$S(i) = \frac{\sum_{n=1}^{N_s} P(i)_n}{N_s}$$

where:

$S(i)$ = Aggregate forecast share of alternative i

$P(i)n$ = Probability of decision maker n choosing alternative i

NS = Number of decision makers in the sample

For example, the average of the probability with which each decision maker selects "auto" is the predicted mode share of auto.

If the sample is not drawn randomly such that different sampling rates are applied to different segments of the population, then the share of each forecast is the weighted sum of the forecasts of each segment of the population:

$$S(i) = \frac{\sum_{c=1}^{C} N_c \left[\frac{\sum_{n=1}^{N_{sc}} (P(i))_n}{N_{sc}} \right]}{N_T}$$

where:

$S(i)$ = Aggregate share of alternative i

$P(i)n$ = Probability of decision maker n (a member of classification c) choosing alternative i

NSC = Number of decision makers in classification c

NT = Number of decision makers in the population

NC = Number of decision makers in the population of classification c

C = Number of classifications

Alternatively, if weights have been generated for each record in the sample, then the following weighted average may be used:

$$S(i) = \frac{\sum_{n=1}^{N_s} (P(i))_n * w_n}{\sum_{n=1}^{N_s} w_n}$$

where:

$S(i)$ = Aggregate share of alternative i

$P(i)n$ = Probability of decision maker n choosing alternative i

wn = Weight of decision maker n

NS = Number of decision makers in the sample

The extension of any of these weighted averages may be performed on subsets of the population. For example, it may be of interest to know the aggregate forecast of mode share for a particular zone, for a particular O-D pair, or for people in a particular income level.

The calculation of the weighted averages can be performed using standard TransCAD capabilities, described in the *TransCAD User's Guide*, including formula fields (see Chapter 8, *Displaying and Editing Data*), the **Dataview-Statistics** command (see Chapter 19, *Tabulations and Statistics*), and one-to-many joins (see Chapter 11, *Joining Your Data to a Map*).

Top

Aggregate Multinomial Logit Application

The MNL Application procedure described above is a complete procedure that is intended to conform with most disaggregate and aggregate MNL model specifications. Most common practical applications, however, do not require all of the available features in the procedure.

Aggregate MNL Application is a more compact and speedier version of generalized MNL

Application. It is intended to support the more common aggregate logit models. This compact model:

- Cannot be used on disaggregate data
- Does not support varying choice sets
- Does not support incremental logit application

After these overhead features are taken out, what is left is a much faster MNL model. The inputs to the Aggregate MNL Application model are similar to the general MNL Application model. They are:

- An MNL Model Table, which includes a row for each alternative and a column for those explanatory variables that change between the existing situation and the scenario situation
- A dataview containing values of the explanatory variables
- Matrices, if desired, containing values of the explanatory variables
- An optional O-D matrix

For an explanation of these inputs, see Applying Multinomial Logit Models.

Like the generalized model, Aggregate MNL Application creates an output probability matrix file, with each matrix containing the probabilities for each model. Optionally, this procedure can also produce a matrix of calculated utilities by mode. Additionally, if your inputs contain an O-D matrix, the procedure can automatically multiply the probability matrices by the O-D matrix to produce separate O-D matrices by mode.

For more information, see:
To Run Aggregate Multinomial Logit Application

Top

⟩ *To Run Aggregate Multinomial Logit Application*

1. Open the model table that specifies the model, the data file that contains the zonal attributes, and any matrices that store O-D level of service data. Optionally, also open an input O-D matrix.

2. Choose *Planning-Mode Split-Aggregate Multinomial Logit Application* to display the Aggregate Multinomial Logit Application dialog box.

3. Make choices as follows:

To do this...	Do this...
Choose the MNL Model Table	Choose a table from the Model Table Dataview drop-down list
Choose the number of modes	Choose a number from the Number of Modes drop-down list
Choose the model to apply	Choose a model from the Model scroll list
Choose the data sources dataview	Choose the dataview that contains all of the fields used as data sources from the Data Source Dataview drop-down list
Choose the records to use	Choose All Records or a selection set from the Records drop-down list
Choose the ID field	Choose a field from the ID Field drop-down list
Choose how to deal with missing values	Choose to either drop the mode from consideration or drop the O-D cell from evaluation when encountering missing information from the For Missing Value radio list

4. Optionally, choose an input O-D matrix from the O-D Matrix File and Matrix drop-down lists. You

can choose to ignore O-D trips below a certain value by checking the Ignore trips below box and typing a value in the edit box.

5. Check which matrices to create in the Outputs frame.

6. Click OK to display the Save As dialog box.

7. Type a name for the output matrix and click Save. TransCAD runs the model using the data from the data sources and the parameters from the specified model row, stores the results to the specified output matrix, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

Applying Logit Models Using Utility Matrices (An Alternative)

TransCAD offers an alternative way of applying aggregate, O-D based mode choice using logit equations. This method should only be used if you already have matrices containing the utility of each alternative.

The inputs to this procedure are:

- An O-D matrix for each alternative that contains the utility of the alternative for each O-D pair
- An O-D Flow matrix that contains the total flow between each O-D pair

The current indices on the utility matrices must be consistent with the current index on the O-D Flow matrix. This means that all of the current row and column headings used in the O-D Flow matrix must be found in each of the utility matrices. The number of rows and columns in all of the matrix views must be the same.

Note that the procedure assumes that utilities and not disutilities are provided as inputs. This means that, if you have matrices of disutilities, you must first use the *Matrix-Fill* command and scale the matrices by -1 to translate them to utilities.

The logit probabilities (i.e., mode shares) are calculated from the utility matrices using the standard logit equation. These matrices of mode shares are then multiplied by the O-D Flow matrix, resulting in matrices of flow on each of the alternative modes. The output matrix file contains several matrices: one probability matrix for each alternative, and one flow matrix for each alternative.

For more information, see:
To Apply a Multinomial Logit Model with Utility Matrices

⟩ *To Apply a Multinomial Logit Model with Utility Matrices*

1. Make sure that the current indices on the utility matrices are consistent with the current index on the O-D Flow matrix.

2. Choose **Planning-Mode Split-Mode Split from Utility Matrices** to display the Logit Mode Split from Utility Matrices dialog box.

3. Choose the matrix that contains the total flows between each origin and destination from the Matrix File and Matrix drop-down lists.

4. Make choices as follows:

To do this...	Do this...
Add a mode	Click Add and type a name in the Mode Name edit box
Rename a mode	Highlight the row and edit the name in the Mode Name edit box
Remove a mode	Highlight the row and click Drop
Choose a utility matrix	Highlight the mode in the Names scroll list and choose a utility matrix from the Utility Matrix File and Utility Matrix drop-down lists

5. Once all of the modes are defined, click OK to display the Save Output Matrix As dialog box.

6. Type a file name for the output matrix and click Save. TransCAD computes the logit probability of each mode for each O-D pair, and writes the resulting probabilities and flows to the output matrix file, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the resulting matrix.

Top

Estimating Multinomial Logit Models

Estimating a multinomial logit (MNL) model means determining the best or most likely values of the parameters of the model. TransCAD supports estimation of the parameters based on disaggregate data; that is, data that are provided at the level of the decision maker.

The inputs to MNL Estimation are:

- An MNL Model Table
- A dataview containing disaggregate data
- Optional matrices containing explanatory variables

The MNL Model Table provides the structure of the model, including the number of alternatives, the number of parameters, the definition of each utility, and the location of the explanatory data. Destination-based fields (i.e., those MNL Model Table entries that were preceded by "D_" in evaluation) cannot be used in MNL Estimation.

The dataview of disaggregate data contains information on decision makers, the alternatives and explanatory data that apply to them and their trip, and the alternative that they chose. The dataview has the following characteristics:

- A single record per decision maker
- A field containing a unique ID number
- Fields of all explanatory data necessary for the model, except those explanatory variables that are provided in matrix form
- A choice field containing the alternative chosen by the decision maker

The entries in the choice field need to match the names of the alternatives in the MNL Model Table. For example, if the MNL Model Table lists the alternatives as "Auto" and "Bus," then this choice field in the disaggregate dataview should also have entries of "Auto" and "Bus." This field is case sensitive.

If any explanatory data are provided in matrix form, then the additional characteristics are required:

- Fields containing the origin and destination ID numbers of the trip for each record

These ID fields provide information on the cell in the matrix that describes the trip made by the decision maker. The entries in the Origin and Destination ID fields must match the current headings on the matrix views.

To estimate an MNL model, you provide the MNL Model Table and the dataview containing the disaggregate data. You then specify the choice field and, if necessary, the Origin and Destination ID fields. TransCAD then estimates the parameters based on the given dataset, and adds a record to the MNL Model Table that contains the estimated values of the parameters. If any columns in the MNL Model Table are hidden, they will be ignored by the estimation routine and the parameter will not be estimated.

For more information, see:
To Estimate a Multinomial Logit Model
Results of MNL Estimation
Missing Data in MNL Estimation
Guidelines for Specifying an MNL Model
MNL Model Error Messages
Varying Choice Sets in MNL Estimation
The MNL Estimation Algorithm

Top

⟩ *To Estimate a Multinomial Logit Model*

1. Open the model table that specifies the model, the data file that contains the disaggregate data, and any necessary matrices.

2. Choose *Planning-Mode Split-Multinomial Logit Estimation* to display the MNL Estimation dialog box.

3. Make choices as follows:

To do this...	To this...
Choose the MNL Model Table	Make a choice from the Model Table drop-down list
Choose the number of alternatives	Choose the number of alternatives listed in the MNL Model Table from the Number of Alternatives drop-down list
Name the new model	Type a name in the Model Name edit box
Choose the explanatory data dataview	Choose the dataview that contains all of the fields of necessary explanatory data for the model from the Source Dataview drop-down list
Choose the records to use	Choose All Records or a selection set from the Records drop-down list
Choose the ID field	Choose a field from the ID Field drop-down list
Choose the chosen alternative field	Choose the field from the Choice Field drop-down list
Close the dialog box	Click Close.

4. If your MNL Model Table includes matrices as data sources, choose the fields that contain the origin and destination of the trip made by each decision maker from the Origin and Destination drop-down lists.

5. Click OK. TransCAD estimates the model, adds a new record to the MNL Model Table that contains the name of the model and the estimated parameters, produces a report file of estimation results and statistics, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

Results of MNL Estimation

There are several results of the MNL Estimation procedure. One is the added row in the MNL Model Table that contains the estimated values of the coefficients. Another is a report file that provides information on:

- The number of valid cases
- The distribution of observed choices in the data set
- The estimated coefficient, standard error, and t-Statistic for each parameter
- The Rho-squared Statistic
- The Log-Likelihood

Two additional items may be included in the report file:

- The iteration log, which provides the estimate, standard error, and t-statistic for each iteration of the estimation process
- A parameter correlation table, which lists the correlation between all explanatory variables

The default is to not include either of these options. To include these additional items in the report file, click Options in the MNL Estimation dialog box and check the appropriate boxes in the Outputs frame.

Missing Data in MNL Estimation

Real data sets frequently have missing explanatory data for some of the records. There are two different ways that TransCAD can treat missing data in MNL estimation:

- The default is to drop the alternative for the decision maker. For example, if a record does not have an entry for bus travel time, then it will be assumed that bus is not an alternative for the decision maker. As long as the decision maker has at least two valid alternatives, one of which is chosen, the record will be included in the estimation. Note that this can be used to specify the choice sets available to each decision maker.
- The alternative is to drop the decision maker from the data set if there are any missing explanatory variables for any of the alternatives. To choose this option, click Options in the the MNL Estimation dialog box, and click the second radio button under Missing Data.

Guidelines for Specifying an MNL Model

Estimating good multinomial logit (MNL) models is an iterative process. Start by considering what explanatory variables you believe will impact the utilities of the alternatives. For example, auto travel time will impact the utility of auto. Also, consider whether each variable will positively or negatively impact the utility. You would expect that auto travel time would negatively impact the utility of auto; as the travel time of auto increases, the utility of taking auto decreases. Thus, the effect of travel time on auto should be negative.

Once you have an educated guess at the explanatory variables involved, specify the model by creating an MNL Model Table and run the estimation.
There are numerous statistics that can be used to check the model. A common test is that if the absolute value of the t-statistic is less than 2, then it is quite likely (95% confidence) that the variable is not significant, and thus should be dropped from the model. The Rho-squared Statistic indicates how much of the choice process is explained by the model: 1 means it explains all, 0 means it explains nothing.

Note that the fit of disaggregate models will always be significantly lower than the fit of aggregate models. This is because the disaggregate model is attempting to explain a much greater variance: there is more variance between individuals within a zone than between aggregate behavior between zones. This does not mean that disaggregate models will do a poor job of forecasting. In fact, because the disaggregate models capture more of the underlying behavior involved in the choices, a well-specified disaggregate model will have greater forecasting power than an aggregate model.

In addition to statistical tests, there are also intuitive tests that should be applied. For example, the signs of all the coefficients and their relative magnitudes must make intuitive sense. If the model does not pass these tests, then the specification of the model is suspect, and further refinement of the model is required.

Restrictions on the Model Specification

There are a number of restrictions on the specification of variables entering the utility functions that are necessary to identify the model parameters. First, if a variable does not vary across alternatives, then it cannot be included in all of the utilities. It is easy to see that such terms will cancel in the numerator and denominator of the choice function that was derived earlier:

$$P_n(i) = \frac{e^{(V_{ni} - V_{nm})}}{1 + \sum_{j \neq m} e^{(V_{nj} - V_{nm})}}, \quad \forall\ i, j \in C_n$$

Thus, these variables will have no effect upon the choice probabilities and their coefficients, and thus the model cannot be estimated. For example, you cannot include Income in all of the utilities.

Individual characteristics, which do not vary across alternatives, can be used in the utility functions. However, any such variable may be included in, at most, $j - 1$ of the utilities, where j is the number of alternatives. The utility in which the variable is not included is considered the base alternative for this variable. All interpretations of the coefficients for the variable are taken to be the effect of the variable on the non-base utility, compared with the effect of the variable on the base utility. Thus, only the relative impact of the variable is known, and not the absolute impact.

For example, you have estimated a model for the choice of automobile, bus, and bike. You include generic income variables in the bus and bike utilities, and the estimated coefficient is -0.1. This means that travelers with higher incomes will tend, all else being equal, to select automobile over bus or bike. Since income was included as a generic variable, we assume that income impacts the decision of whether to take bus or bike equally. We could have just as easily included income as an alternative specific variable, and obtained a different coefficient for both bike and bus. If the coefficient of income in the bus utility is -0.7 and the coefficient for the bike utility is -1.2, then we conclude that, all else being equal, higher income people will tend to take the bus over bike.

Similarly, there can be at most $j - 1$ alternative-specific constants, where an alternative specific constant is a variable that has the value 1 (one) for a given alternative and 0 (zero) for all other alternatives.

An attempt to include an independent variable that is perfectly correlated with the choice of a particular alternative results in a situation in which the variable and thus the model cannot be estimated. For example, a variable that has the value 1 (one) for a given alternative whenever it is chosen and 0 (zero) otherwise will be perfectly correlated with that choice.

Another important restriction on model specification is the need to avoid the inclusion of independent variables in the model that are highly collinear. As in the linear regression model, collinearity makes it impossible to identify the separate effects of the collinear variables on the choice probabilities. To use the option to report a parameter correlation table after an estimation run, click Options in the MNL Estimation dialog box and check the **Produce parameter correlation table** box.

MNL Model Error Messages

If you get an error message that says, "Not enough valid cases," check that:

- The entries in the choice field are consistent with the name of the alternative as written in the first column of the MNL Model Table
- There is no field in the MNL Model file that is null or "ZERO" for all utilities
- The entries in the Origin and Destination fields match the current headings on the matrices that contain explanatory variables

An error message that says "Some parameters are collinear" most likely means that there is an error in the specification of the model. An explanatory variable that does not vary across alternatives cannot be included in the utilities of all alternatives. The report file lists which variable is causing problems.

Varying Choice Sets in MNL Estimation

Because travelers do not all face the same choice set, more accurate models can be developed by appropriately specifying the choice sets relevant for each decision maker in the estimation data set. TransCAD handles varying choice sets in MNL Estimation the same way as in MNL Evaluation. In TransCAD, there are two ways of specifying the choice sets available to each decision maker:

- Use missing values to indicate when an alternative is not available. For example, if there is no entry for bus travel time for a particular decision maker, then TransCAD will assume that bus is not an option for that decision maker.
- Generate additional fields, called **Choice Set Descriptors**, in the disaggregate data set that contain dummy variables indicating whether or not alternatives are available.

Choice set descriptors are dummy variables that are equal to "1" for a decision maker if the alternative is available and "0" if it is not. They are necessary for each alternative that is not available to all decision makers, and are not necessary for any alternative that is available to all decision makers.

Once the choice set descriptors are created, MNL Estimation proceeds as usual, except that the choice set descriptors are an additional input specified in the dialog box.

For more information, see:
To Apply Choice Set Descriptors in MNL Estimation

⟩ *To Apply Choice Set Descriptors in MNL Estimation*

1. In the MNL Estimation dialog box, click the Options button to display the Options for MNL Estimation dialog box.

2. Check the Apply varying choice sets box.

3. For each alternative that is not available to all decision makers:
    - Choose the alternative in the scroll list
    - Choose the field that contains the choice set descriptor from the Choice Set Descriptor drop-down list

4. When you have specified all choice set descriptors, click OK to return to the MNL Estimation dialog box.

When TransCAD estimates the model, the choice set descriptors are taken into account.

Top

The MNL Estimation Algorithm

TransCAD performs estimation of the parameters in the MNL model by the method of maximum likelihood, which attempts to find the set of parameters that is most likely to have resulted in the choices observed in the data. More specifically, for MNL Estimation, TransCAD uses an enhanced version of the DFP (Davidon-Fletcher-Powell) method (Avriel, 1976) to obtain the maximum likelihood estimates of the model parameters. The parameter estimates are efficient and asymptotically multivariate normally distributed (McFadden, 1974) and thus provide the basis for the construction of tests of hypotheses concerning the model parameters. A maximum of 200 iterations are run.

Top

Estimating and Applying Binary Logit Using the MNL Procedures

Binary logit is a special case of multinomial logit (MNL) in which there are only two alternatives. In the case of 2 alternatives (i and j), the logit equation reduces to the more simple equation:

$$P_n(i) = \frac{1}{1+e^{(V_{nj}-V_{ni})}}$$

where:

Pn(*i*)	=	The probability with which person *n* will choose alternative i
Vni	=	The measurable component of the utility of alternative i for individual n
Vnj	=	The measurable component of the utility of alternative j for individual n

In addition to the binary logit method available with the **Statistics-Model Estimation** command, you can estimate and apply binary logit models using the same methods as is used for multinomial logit. The first two rows in the MNL Model Table will specify the relative utilities of each alternative, and the remaining rows will hold estimates of the model parameters.

As can be seen in the binary logit equation above, it is possible to fully specify the model by defining only one relative utility. You must include two rows of utilities in the MNL Model Table, although you do not have to include any data sources in one of the utilities.

Top

About the Nested Logit Model

When dealing with choice models that include several alternatives, there often exist natural groupings of alternatives and/or a natural hierarchy to the decision being made. For example, this occurs in mode choice analysis when:

- More than one transit alternative is available
- Access modes are considered
- Auto occupancy (for example, drive alone versus carpool) is considered

A fundamental assumption in a multinomial logit (MNL) model is that the disturbances of the alternatives are independent (the Independence from Irrelevant Alternatives or IIA assumption). When there are similarities among alternatives, such as those listed above, this fundamental assumption is violated and MNL cannot be used. A solution to this problem is the nested logit model, because it relaxes the assumption of independence. A nested logit model is often represented using a tree structure, which visually represents groupings or hierarchies of the choice alternatives. You can think of the decision process as occurring in two stages. First, the traveler decides whether to take transit or auto. If transit is chosen, then the traveler decides whether to take the bus or light rail. Similarly, if auto is chosen, then the traveler decides whether to drive alone or carpool.

Top

Nested Logit Probabilities

The attractive aspect of a nested logit model is that it relaxes a restriction of multinomial logit, and yet retains a straightforward (closed form) probability equation. In fact, the nested logit probability reduces to a function of multinomial logit probabilities. Each branch of the tree can be viewed as a multinomial logit model. Using the mode choice example above, there are three multinomial logit models. First, the upper level model is Transit (T) or Auto (A). From this upper-level model the so-called marginal probabilities of both transit and auto are derived, which are denoted as $P(T)$ and $P(A)$. There are two lower level multinomial logit models. If transit is chosen, then the traveler decides whether to take the Bus (B) or Light Rail (R). Similarly, if auto is chosen, then the traveler decides whether to Drive Alone (D) or Carpool (C).

From these lower-level models, the so-called conditional probabilities are derived, that is, the probability of choosing a particular lower level alternative, given that one of the alternatives in its associated nest has been selected. So, $P(B \mid T)$ is the probability of choosing Bus, given that Transit (either Bus or Light Rail) is chosen, and $P(R \mid T)$, $P(D \mid A)$, and $P(C \mid A)$ are similarly defined.

The unconditional probabilities (or joint probabilities) of the lower level alternatives, which are usually the probabilities of interest, are then the product of the marginal and conditional probabilities:

$$P(B) = P(B \mid T) * P(T) \quad \left[= \frac{P(B,T)}{P(T)} * P(T) = P(B,T) = P(B) \right]$$
$$P(R) = P(R \mid T) * P(T)$$
$$P(D) = P(D \mid A) * P(A)$$
$$P(C) = P(C \mid A) * P(A)$$

Probabilities can be similarly derived for a nested logit model with any number of levels simply by multiplying the multinomial logit probability of each node up to the root of the tree. For example, say we also want to predict the mode of access to light rail from among the choices of walk, bike, or drive. These three access alternatives would be nested below the light rail alternative. The probability of a traveler selecting to take the light rail and get to the station by walking (W) is then:

$$P(Light\ Rail\ with\ Walk\ Access) = P(W \mid R,T) * P(R \mid T) * P(T) ,$$

where $P(W \mid R,T)$ is the conditional probability from the logit model of light rail access, consisting of the walk, bike, and drive access alternatives.

Nested Logit Utility Specifications and the Logsum

Now that the nested logit probabilities have been defined as a function of multinomial logit probabilities, the issue is how to specify the utilities that enter the multinomial logit equations.

For the lower level models, these specifications are straightforward, in that the model is specified

as if it were an independent multinomial logit model. However, specifying the utility of a branch that has alternatives nested below it is not as straightforward, because its utility is a function of the alternatives below. For example, whether a traveler chooses transit over auto depends on the attractiveness (or utility) of transit, which is a function of the specific characteristics of both the bus and the light rail alternatives. Similarly, it also depends on the attractiveness of auto, which is a function of the specifics of the drive alone and carpool alternatives. How should the joint attractiveness of the lower level alternatives be included in an upper level alternative? The correct answer is a special variable called the logsum. This variable is simply the log of the denominator of the logit probability from the lower level decision. The logsum mathematically is equal to the expected maximum utility of the lower level nest, and therefore represents the attractiveness of the nest. This logsum is included as a variable in the upper level model just as any other explanatory variable, although the parameter (called the logsum parameter) has a special interpretation (related to the 'scale' of the model).

In the mode choice example, the utility of auto in the upper level model includes the logsum variable from the drive alone and carpool model as follows:

$$Utility\ of\ Auto = \begin{pmatrix} other\ explanatory \\ variables\ and \\ parameters \end{pmatrix} + \beta_{logsum} * \ln\left(e^{Utility\ of\ Drive\ Alone} + e^{Utility\ of\ Carpool}\right)$$

Similarly, the utility of transit includes the logsum variable from the bus and light rail model:

$$Utility\ of\ Transit = \begin{pmatrix} other\ explanatory \\ variables\ and \\ parameters \end{pmatrix} + \beta_{logsum} * \ln\left(e^{Utility\ of\ Bus} + e^{Utility\ of\ Light\ Rail}\right)$$

The marginal probabilities of transit and auto ($P(T)$ and $P(A)$) are calculated using the logit probability equation with the utilities as specified above.

Top

Applying Nested Logit

As with multinomial logit models, the nested logit model can be applied using either disaggregate data or aggregate data (and with or without matrices).

For more information, see:
Applying an Aggregate O-D-Based Nested Logit Model
Applying Nested Logit Using Segments
Applying Nested Logit Using Disaggregate Data

Top

Applying an Aggregate O-D-Based Nested Logit Model

A common application in transportation is to apply a nested logit model on an aggregate zonal level in order to get mode shares (and number of trips by mode) between each origin-destination pair. TransCAD has a special procedure for this application. The inputs to the procedure are:

- The nested logit model, including:
  - The structure of the tree,
  - The formulation of each utility equation, and
  - Values of the parameters in the nested logit model.
    This information is stored in TransCAD as a nested logit model file, which can be created from within the nested logit application procedure.

- The data necessary to run the model, including:
  - A zone database containing relevant data on the origins and destinations (for example, parking costs), and
  - Matrices containing relevant data on the origin-destination pairs (for example, travel times by each mode).

The outputs are origin destination matrices containing the probabilities (mode shares), number of trips (if a total trip matrix is supplied), and/or utilities for each of the lowest level modes and between each origin-destination pair.

For more information, see:
To Apply an Aggregate O-D-Based Nested Logit Model

Top

⟩ *To Apply an Aggregate O-D-Based Nested Logit Model*

1. Open the data file that contains the zonal attributes, and any matrices that contain origin-destination data. In the data file, the first field must contain the zone number, which must match the matrix row and column index.

2. Choose Planning-Mode Split-Nested Logit Application to display the Nested Logit Model dialog box. This dialog box is used to specify and display the structure of the nested logit model (including the alternatives, utility specifications, and data sources) as well as details about the output to be provided when the model is run.

3. If you have already created a nested logit TransCAD model file (.NLM) for your model, then you can load it by clicking the load model button (three dots) and selecting the nested logit model file. If you do not have a nested logit model file, you can create one with this dialog box.

4. The Modes box displays the alternative modes and the tree structure. View or modify the tree as follows:

To do this...	Do this...

Add a node to the tree	Highlight the parent of the node to be added, click the Add button to open the Add Mode dialog box, enter the name of the new node, and click OK.
Remove a node from the tree	Highlight the node and click Remove.
Expand a node on the tree	Click on the + next to the node.
Compress a node on the tree	Click on the – next to the node.
Rename a node	Highlight the node and enter the new name in the Current Mode text box.

5. The Variables box displays the utility equation for the alternative highlighted in the Modes box, including the parameters and the sources of the data. The first column displays the value of the parameter; the remaining two columns provide information on the source of the data. There are four types of utility entries:

Type...	Description...
Constant	Alternative specific constants.
Source Field	Explanatory variable associated with the origin.
Destination Field	Explanatory variable associated with the destination.
Matrix	Explanatory variable associated with the origin-destination pair.
Logsum	Parameter associated with the logsum from the children of the alternative. The logsum variable is automatically calculated in the procedure.

6. Modify the utility as presented in the Variables box as follows:

To do this...	Do this...
Add a parameter	Click Add to open the Edit a Utility Term dialog box, select the type of parameter to add, enter the value of the parameter and the location of the data, and click OK.
Remove a parameter	Highlight the parameter and click Remove.
Edit a parameter	Highlight the parameter and click Edit.
To view/edit a different utility	Highlight the mode in the Modes box, and its utility is displayed in the Variables box.

7. Use the features in the Options tab as follows:

To do this...	Do this...
Output a trip matrix by mode	Enter the Total Trip Matrix File and Matrix, and check the Trip Matrix checkbox in the Output Matrices frame.
Output a probability matrix	Check the Probability Matrix checkbox in the Output Matrices frame.
Output a utility matrix	Check the Utility Matrix checkbox in the Output Matrices frame.
Set rows/columns of output matrix	Select either PA Matrix, Data View (and selection set) or Skim Matrix in the Dimensions… frame.
Set treatment of missing data	Choose to either drop the mode (set probability of mode=0) or drop the O-D pair (do not calculate probabilities for any mode in the O-D pair) in the event missing values are encountered for a particular mode in an O-D pair.

8. Choose Run to enter the output file names to fill with probabilities, trips, and/or utilities by mode for each O-D pair.

Applying Nested Logit Using Segments

Often in Transportation planning, it is necessary to apply the nested logit model on segments of the

population. This occurs, for example, if the nested logit model includes person or household specific variables such as income level (low, medium, high) or number of autos in the household (for example, a dummy variable if there are fewer cars than workers). In this case, each segment will have a different set of mode choice probabilities. Therefore, the nested logit application procedure described above has to be run once for each segment that is specified by the model. To obtain the resulting trip matrices by mode, the total trip matrix must be separated into segment-specific total trip matrices.

Top

Applying Nested Logit Using Disaggregate Data

Just as with multinomial logit, nested logit can be applied using disaggregate data. As with multinomial logit, first the mode choice probabilities are calculated for each observation in the dataset, and then these probabilities are aggregated to generate population shares. Unlike the aggregate O-D application, disaggregate nested logit probabilities are not automatically generated in TransCAD. However, since the nested logit probabilities are simply a function of multinomial probabilities and logsum values, they can be calculated using formula fields and the MNL application procedure in the TransCAD interface.

For more information, see:
To Apply Nested Logit Models Using Disaggregate Data

Top

⟩ *To Apply Nested Logit Models Using Disaggregate Data*

1. Calculate the conditional probabilities for each of the lowest-level models as if they are independent from the rest of the decision tree. This is done by creating an MNL Model Table for each of the lowest-level models and choosing ***Planning-Mode Split-Multinomial Logit Application***.

2. Use formula fields to calculate the logsum variable for each of the lowest-level models.

3. Work your way up the tree by calculating conditional probabilities (feeding in the logsums for any branch that has altneratives nested beneath it) and logsums at each split in the tree.

4. Once the conditional probability at each node is calculated, calculate the joint probabilities of the lowest level alternatives (the bottom nodes on the tree) by multiplying the conditional logit probabilities from each node from the root to the base of the tree.

Top

Estimating Nested Logit

There are two ways to estimate the parameters in a nested logit model. One is called the full information estimator, in which the parameters of the entire nest structure are estimated at once. This results in efficient (that is, minimum variance) estimates of the unknown parameters. Numerous statistical software packages are available that perform such estimation. At this time, TransCAD does not support full information estimation of nested logit models, however such routines are being developed.

While full information estimation is not currently available in TransCAD, the second estimation approach, which is a sequential estimation method, can be performed in TransCAD. The sequential estimation method takes advantage of the fact that a nested logit model can be partitioned into distinct MNL models as shown above.

For more information, see:
To Estimate a Nested Logit Model Using the Multinomial Logit Estimation Procedure

Top

) *To Estimate a Nested Logit Model Using the Multinomial Logit Estimation Procedure*

1. Specify and estimate each of the lowest-level models as if they are independent from the rest of the decision tree, by creating an MNL Model Table for each of the lowest-level models and choosing **Planning-Mode Split-Multinomial Logit Estimation**.

2. Use formula fields to derive the logsum variable for each of the lowest-level models.

3. Work your way up the decision tree by specifying (i.e., creating an MNL Model Table) and estimating (i.e., choosing **Planning-Mode Split-Multinomial Logit Estimation**) each successive upper level model. Include the logsum variables in the utilities that have decisions nested beneath them.

In this manner, all of the parameters of the nested logit model can be estimated.

Top

Technical Notes on Mode Split and Choice Analysis

Logit analysis of mode choice behavior has a rich literature and has matured to the point where it is

codified in textbooks and planning manuals. Perhaps the single best reference on multinomial logit (MNL) analysis in transportation is Ben Akiva and Lerman (1985), which includes many references to the technical literature. Some users may find that Pindyk and Rubinfeld (1981) or Studenmund (1992) offer more approachable discussions of binary logit models from an econometric perspective.

Choice-based samples are efficient for many types of mode choice analysis. For a description of choice-based sampling and its treatment in logit analysis, consult Lerman and Manski (1979) or Ben Akiva and Lerman (1985).

Tests for logit models are very different from those for regression. Serious model builders should make an effort to become comfortable with suitable tests on alternative model specifications and parameter estimates.

Aggregation and prediction with logit models can be performed with a variety of methods. Koppelman (1976) is a key reference on these matters.

Nested logit models provide an attractive solution to the perennial problem of correlated mode choice alternatives. Sobel (1980) provides a good introduction to nested logit models.

There are improved estimation methods for nested logit that are attractive for use in mode choice models (Brownstone & Small, 1985; Daly, 1987). The FIML (full information maximum likelihood) estimator is efficient and superior to sequential estimators. Caliper has developed a version of this estimator that may be available at a later date.

There are instances in advanced practice or research in which users would like to implement alternative and more complex choice models. Normally these models will be estimated using specialized mathematical, statistical, or econometric software. However, evaluation of these models can easily be performed using the GISDK and Caliper Script to create add-ins for this purpose.

For more information, see:
Derivation of Incremental Logit

Top

Derivation of Incremental Logit

Incremental logit can be derived from the standard multinomial logit formulation in a few quick steps.

1. $$P'_i = \frac{e^{U_i}}{\sum_{j=1}^{k} e^{U_j}}$$ (standard multinomial logit equation)

2. Since $U'_i = U_i + \Delta U_i$,

$$P'_i = \frac{e^{(U_i + \Delta U_i)}}{\sum\limits_{j=1}^{k} e^{(U_j + \Delta U_j)}}$$

3. Dividing both sides by $\sum\limits_{m=1}^{k} e^{U_m}$,

$$P'_i = \frac{\left[\dfrac{e^{U_i} e^{\Delta U_i}}{\sum\limits_{m=1}^{k} e^{U_m}} \right]}{\sum\limits_{j=1}^{k} \left[\dfrac{e^{U_j} e^{\Delta U_j}}{\sum\limits_{m=1}^{k} e^{U_m}} \right]}$$

4. Since $P_i = \dfrac{e^{U_i}}{\sum\limits_{m=1}^{k} e^{U_m}}$,

$$P'_i = \frac{P_i e^{\Delta U_i}}{\sum\limits_{j=1}^{k} P_j e^{\Delta U_j}}$$

(incremental logit equation)

Where:

P_i = The existing probability (share) of using mode i

P'_i = The scenario probability (share) of using mode i

U_i = The existing utility for mode i

U'_i = The scenario utility for mode i

k = Number of choices (modes) available

Top

P-A to O-D and Time of Day Transformations

It is frequently necessary, at one or more stages in the transportation planning process, to convert a production-attraction matrix to a slightly different form. TransCAD has two procedures to help with such conversions, so that you can:

- Convert productions and attractions to origins and destinations
- Decompose a 24-hour trip table matrix into hourly trip tables
- Convert person trips to vehicle trips
- Apply peak hour factors

For more information, see:
About P-A to O-D and Time of Day Transformations
About the Hourly Lookup Table
Performing Time of Day Analysis
Converting 24-Hour P-A Matrices to 24-Hour O-D Matrices
Combining P-A to O-D and Time of Day Analysis
Converting Person Trips to Vehicle Trips
Applying Peak Hour Factors

Top

About P-A to O-D and Time of Day Transformations

There are several steps to the transportation planning process. The type of output from each stage depends on the input data and the structure of the model. The outputs from one stage of the transportation planning process often have to be converted before being used as inputs to the next stage. This is not a serious problem, as long as the definitions and requirements of the outputs and inputs are kept straight and conflicts are properly resolved.

Often these transformations can be completed easily, using TransCAD capabilities such as matrix manipulation and formula fields. However, there are a few transformations that are done frequently, so TransCAD has special procedures for them.

The output of the earlier stages of the modeling process is typically measured in productions and attractions instead of origins and destinations. Since the assignment algorithms require origins and destinations as inputs, productions and attractions must be converted. The definitions of productions and attractions are as follows:

- The zone that contains the home-end of home-based trips or the origin end of non-home-based trips is considered to have produced the trip
- The destination zone where an out-of-home activity will be undertaken is considered to have attracted the trip

There is a fairly straightforward method of translating productions and attractions to origins and destinations, which is based on information about when trips depart and return. You can do this with the P-A to O-D procedure.

Another data transformation done frequently is the decomposition of a 24-hour trip table matrix (either P-A or O-D) to hourly flow matrices. This transformation is based on information about the percent of flow that occurs in each hour throughout the day. The Time of Day procedure takes a 24-hour matrix, with information on the percent flow per hour, and produces hourly matrices. Peak hour factors can then be applied to the resulting matrices.

Both the P-A to O-D and the Time of Day procedures also provide means to convert person trips to vehicle trips. This conversion can be based on either an average vehicle occupancy factor, applied to the whole day, or hourly vehicle occupancy factors, specific to each hour in the day.

The procedures described in this chapter are particularly critical for assignment, in which O-D matrices of vehicle trips are required and for which analysis is usually done on certain hours of the day.

About the Hourly Lookup Table

The Time of Day procedure and many alternatives in the P-A to O-D procedure require an **Hourly Lookup Table**. This lookup table provides information on travel that occurs in each hour of the day. For the Time of Day procedure, the percentage of traffic that takes place in each hour is necessary. In the P-A to O-D procedure, if the desired output matrix is not a 24-hour O-D matrix, then information is needed on the percentage of traffic that departs during each hour, and the percentage of traffic that returns during each hour. These percentages typically vary by trip purpose, so information is needed for each trip purpose.

Another possible hourly input is one used to obtain the vehicle occupancy during each hour. This is used as an adjustment factor, in which the average vehicle occupancy throughout the day is modified for each hour according to the value in the hourly occupancy adjustment field. The vehicle occupancy for any hour is the 24-hour average vehicle occupancy plus the value in the occupancy adjustment field for that hour.

The Hourly Lookup Table must have the following form:

- Contain 24 records, one for each hour of the day.
- The first field contains sequential entries of 0 to 23, in which 0 indicates the hour from 12 AM to 1 AM, and 23 indicates the hour from 11 PM to 12 AM.
- The names of all of the fields are designated by the user
- The types of fields to include (e.g., percentage of trips, percentage of departures, percentage of returns, occupancy adjustment factor, types of trip purposes) are designated by the user based on the application.
- All hourly fields for any single application of P-A to O-D or time of day are contained in the same Hourly Lookup Table. However, additional fields for other applications may also be included.
- For each trip purpose, the total percent of daily trips equals 100.
- The occupancy adjustment factors are absolute adjustments from the average occupancy entered in the dialog box. The hourly occupancy is the average occupancy plus the value in the hourly occupancy adjustment field.

Ideally, the source for data on the travel occurring in each hour will be derived from locally initiated surveys or census data. However, in the absence of local data, there is a default Hourly Lookup Table, in the tab folder of the TransCAD program folder, which provides inputs of hourly data for the

time of day, P-A to O-D, and vehicle occupancy adjustments. Hourly data are provided in the default table for four trip purposes: home-based work, home-based non-work, home-based other, and non-home-based. The values in the default table are from NCHRP 187. These values are based on national averages and thus may not pertain to the study area.

The default table is a fixed-format binary file called hourly.bin, and the contents are as follows:

Field	Procedure	Description
HOUR	Both	Hour in the day for which the record applies: 0 is 12-1 AM
[% FLOW ALL]	Time of Day	The percent of daily O-D trips that occur during the hour
[% FLOW HBW]	Time of Day	The percent of daily HBW O-D trips that occur during the hour
[% FLOW HBNW]	Time of Day	The percent of daily HBNW O-D trips that occur during the hour
[% FLOW HBO]	Time of Day	The percent of daily HBO O-D trips that occur during the hour
[% FLOW NHB]	Time of Day	The percent of daily NHB O-D trips that occur during the hour
DEP_ALL	PA to OD	The percent of daily P-A trips that depart during the hour
RET_ALL	PA to OD	The percent of daily P-A trips that return during the hour
DEP_HBW	PA to OD	The percent of daily HBW P-A trips that depart during the hour
RET_HBW	PA to OD	The percent of daily HBW P-A trips that return during the hour
DEP_HBNW	PA to OD	The percent of daily HBNW P-A trips that depart during the hour
RET_HBNW	PA to OD	The percent of daily HBNW P-A trips that return during the hour
DEP_HBO	PA to OD	The percent of daily HBO P-A trips that depart during the hour
RET_HBO	PA to OD	The percent of daily HBO P-A trips that return during the hour
DEP_NHB	PA to OD	The percent of daily NHB P-A trips that depart during the hour
RET_NHB	PA to OD	The percent of daily NHB P-A trips that return during the hour
OCCADJ_HBW	Both	The absolute hourly vehicle adjustment factor for HBW trips
OCCADJ_HBNW	Both	The absolute hourly vehicle adjustment factor for HBNW trips
OCCADJ_HBO	Both	The absolute hourly vehicle adjustment factor for HBO trips
OCCADJ_NHB	Both	The absolute hourly vehicle adjustment factor for NHB trips
OCCADJ_ALL	Both	The absolute hourly vehicle adjustment factor for all types of trips

Performing Time of Day Analysis

Time of Day Analysis allows you to decompose a 24-hour flow O-D matrix into individual hourly flow O-D matrices. To perform Time of Day Analysis, you need to specify the initial 24-hour flow O-D matrix file and a lookup table containing the percent of flow that occurs in each hour (or a chosen group of hours) of the day. TransCAD divides the matrix into matrices of hourly flow. You can run this procedure on several purposes (i.e., matrices) within a single matrix file at the same time.

Once you have hourly trip table matrices, you can generate multi-hour trip table matrices by using the **Matrix-QuickSum** or **Matrix-Fill** command. You will want to do this if, for example, you want to run assignment on a peak period consisting of several hours. For more information on these commands, see Chapter 18, *Working with Matrices*, in the *TransCAD User's Guide*.

For more information, see:
To Perform Time of Day Analysis

Top

⟩ *To Perform Time of Day Analysis*

1. Open the 24-hour flow O-D matrix file you wish to analyze, along with the lookup table containing time of day information as described above.

2. Choose **Planning-Time of Day Analysis** to display the Time of Day Decomposition dialog box.

3. Choose the matrix file that contains the 24-hour flow values from the Flow Matrix File drop-down list.

4. Choose the dataview that contains the hourly flow percentages from the Lookup Dataview drop-down list.

5. Enter the time range to report by typing the beginning hour (0-23) in the Report Hours edit box and the ending hour (0-23) in the Through edit box.

6. For each matrix that you want to decompose into hourly flows, do the following:

    - Highlight the matrix in the Matrices scroll list
    - Check the Use Matrix [matrix name] box
    - Choose the field that contains the hourly flow percentage for the matrix from the Percent Hourly Flow drop-down list

7. Click OK to display the Save As dialog box.

8. Type a name for the output file and click Save. TransCAD separates each 24-hour flow matrix into multiple matrices containing hourly flows, saves all of the hourly matrices in a single matrix file, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program

	when you are done.
Close the dialog box	Click Close.

TransCAD displays the output matrix.

Converting 24-Hour P-A Matrices to 24-Hour O-D Matrices

The conversion of productions and attractions to origins and destinations is based on an estimation of when the P-A trips depart and return. In a translation from a 24-hour P-A matrix to a 24-hour O-D matrix, it is easy to estimate the time of departure and return: it is assumed that all trips depart and return during the same day. Thus, the only input necessary to do a 24-hour to 24-hour translation is the P-A matrix. Combining P-A to O-D and Time of Day Analysis describes how to convert a 24-hour P-A matrix to hourly or partial day O-D matrices, in which departure and return information for each hour throughout the day is necessary.

For more information, see:
To Convert a 24-Hour P-A Matrix to a 24-Hour O-D Matrix

) To Convert a 24-Hour P-A Matrix to a 24-Hour O-D Matrix

1. Open the 24-hour O-D matrix file to be converted.

2. Choose **Planning-PA to OD** to display the Convert P-A Matrix to O-D Matrix dialog box.

3. Choose the matrix file that contains the 24-hour production-attraction flows from the PA Matrix File drop-down list.

4. Make sure the Report each hour separately box is not checked. To report hours separately, see the procedure To Convert a 24-Hour P-A Matrix to Hourly O-D Matrices.

5. Make sure that the value "0" is in the Report Hours edit box and the value "23" is in the Through edit box.

6. For each P-A matrix that you want to convert to origins and destinations, do the following:

    - Highlight the matrix in the Matrices scroll list
    - Check the Use Matrix [matrix name] box

7. Click OK to display the Save As dialog box.

8. Type a name for the output file matrix and click Save. TransCAD converts each P-A matrix to

an O-D matrix, saves all of the O-D matrices in a single matrix file, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the resulting matrix. There will be one matrix for each input matrix.

Top

Combining P-A to O-D and Time of Day Analysis

With TransCAD you can perform Time of Day Analysis while converting from a P-A matrix to an O-D matrix. With the procedure described in Converting 24-Hour P-A Matrices to 24-Hour O-D Matrices, you have the additional options to translate a 24-hour P-A matrix to either:

- Hourly O-D matrices for the whole day or a certain part of a day
- A partial-day O-D matrix (e.g., a matrix containing the total O-D flow from 6-10 AM)

To obtain hourly or partial-day output matrices, information is necessary about the departures and returns for every hour in the day. Therefore, an Hourly Lookup Table, as described in About the Hourly Lookup Table, needs to be specified for the procedure.

To apply this procedure, you provide a 24-hour flow P-A matrix and an Hourly Lookup Table. You also state what hours you want reported and whether or not you want each hour reported in a separate matrix or whether you want the reported hours aggregated into a single matrix. TransCAD then translates the P-As to O-Ds and the does Time of Day Analysis necessary to provide the requested hourly or partial-day O-D matrices.

For more information, see:
To Convert a 24-Hour P-A Matrix to Hourly O-D Matrices or a Partial-Day O-D Matrix

Top

) To Convert a 24-Hour P-A Matrix to Hourly O-D Matrices or a Partial-Day O-D Matrix

1. Open the 24-hour flow P-A matrix file you wish to convert, along with the Hourly Lookup Table containing time of day information.

2. Choose **Planning-PA to OD** to display the Convert P-A Matrix to O-D Matrix dialog box.

3. Choose the type of O-D Matrix to create as follows:

To do this...	Do this...
Create Hourly O-D Matrices	Check the Report Each Hour Separately box
Create a Partial Day O-D Matrix	Remove the check from the Report Each Hour Separately box

4. Enter the time range to report by typing the beginning hour (0-23) in the Report Hours edit box and the ending hour (0-23) in the Through edit box.

5. Choose the matrix file that contains the 24-hour production-attraction flows from the PA Matrix File drop-down list.

6. Choose the view that contains the hourly percent departure and hourly percent return for the P-A matrix from the Lookup Dataview drop-down list.

7. For each P-A matrix that you want to convert to origins and destinations, do the following:

    - Highlight the matrix in the Matrices scroll list
    - Check the Use Matrix [matrix name] box
    - Choose the field that contains the hourly percentage departure for the matrix from the Hourly Percent Departure drop-down list
    - Choose the field that contains the hourly percentage return for the matrix from the Hourly Percent Return drop-down list

8. Click OK to display the Save As dialog box.

9. Type a name for the output file and click Save. TransCAD converts each P-A matrix to an O-D matrix, performs the required Time of Day Analysis, saves all of the O-D matrices in a single matrix file, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the resulting matrix file.

Converting Person Trips to Vehicle Trips

Another formulation that is often applied to flow matrices is the conversion of person trips to vehicle trips. You can do this by scaling any matrix using the *Matrix-Fill* command; see Chapter 18, *Working with Matrices*, in the TransCAD User's Guide for more information.

You can also apply vehicle occupancy factors when running either the P-A to O-D or Time of Day procedure. In both dialog boxes, it works exactly the same way:

- Enter a 24-hour average occupancy for each matrix
- Optionally, choose a field of adjustment factors, with an adjustment factor for each hour

The adjustment factor is an absolute adjustment; the occupancy applied to any hour is the 24-hour average occupancy for the whole matrix plus the adjustment factor pertaining to that hour. In this way, you can apply a different auto-occupancy rate for each hour throughout the day. Note that you

cannot apply hourly occupancy rates for the 24-hour P-A to 24-hour O-D conversion, but it is available for all other permutations of the P-A to O-D and Time of Day procedures.

For more information, see:
To Convert to Vehicle Trips in the P-A to O-D or Time of Day Procedures

Top

⟩ *To Convert to Vehicle Trips in the P-A to O-D or Time of Day Procedures*

1. Follow Steps 1-6 of the procedure To Perform Time of Day Analysis or the procedure To Convert a 24-Hour P-A Matrix to a 24-Hour O-D Matrix, or Steps 1-7 of the procedure To Convert a 24-Hour P-A Matrix to Hourly O-D Matrices or a Partial-Day O-D Matrix.

2. For each input matrix that you want to convert to vehicle trips, do the following:

    - Highlight the matrix in the Matrices scroll list
    - Check the **Convert person trips to vehicle trips** box
    - Type the value for the average occupancy for all trips in the matrix in the Average Occupancy edit box
    - If you want to apply a different occupancy to each hour, choose a field from the Hourly Adjustment drop-down list

3. Continue with Step 7 of the procedure To Perform Time of Day Analysis or the procedure To Convert a 24-Hour P-A Matrix to a 24-Hour O-D Matrix, or Step 8 of the procedure To Convert a 24-Hour P-A Matrix to Hourly O-D Matrices or a Partial-Day O-D Matrix.

TransCAD will now produce matrices of vehicle trips.

Top

Applying Peak Hour Factors

Peak hour factors are simply scale factors that are applied to flow matrices. You can apply them by using the standard matrix manipulation tools in the matrix menu. Using the *Matrix-Fill* command, you can apply a peak hour factor to a single matrix, to all matrices, or to certain matrices in a matrix file.

For more information, see:
To Apply Peak Hour Factors to a Trip Table Matrix

Top

⟩ To Apply Peak Hour Factors to a Trip Table Matrix

1. Choose the matrix view that you want to apply a peak hour factor to by clicking on the window or choosing it from the **Windows** menu.

2. Choose **Matrix-Fill** to display the Fill Matrix dialog box.

3. Click the Single Value tab to display the Single Value page.

4. Click the Multiply Cells By Value radio button.

5. Type the value of the peak hour factor in the Value edit box.

6. Choose the matrices to fill, using the Matrices to Fill radio list:

To do this...	Do this...
Fill the current matrix	Click This Matrix
Fill some matrices in the matrix file	Click Some Matrices and choose the matrices in the scroll list
Fill all matrices in the matrix file	Click All Matrices

7. Click OK.

TransCAD applies the peak hour factor to the chosen matrices. See To Fill Cells with a Single Value.

Top

Traffic Assignment

Traffic assignment models are used to estimate the flow of traffic on a network. These models take as input a matrix of flows that indicate the volume of traffic between origin and destination (O-D) pairs. The flows for each O-D pair are loaded onto the network based on the travel time or impedance of the alternative paths that could carry this traffic. TransCAD provides a full complement of traffic assignment procedures that are used for modeling urban traffic. These procedures include numerous variants that can be used for modeling transit, as well as intercity passenger and freight traffic. Transit assignment methods are described in Chapter 12, *Transit Assignment*. This chapter covers the core set of road traffic assignment methods. More advanced road traffic assignment procedures are documented in Chapter 10, *Advanced Traffic Assignment Methods*.

For more information, see:
About Traffic Assignment
Required Data for Traffic Assignment
Optional Data for Traffic Assignment
Standard Results of Traffic Assignment
Optional Results of Traffic Assignment
Performing Traffic Assignment
Technical Notes on Traffic Assignment

About Traffic Assignment

Given a network and a demand matrix, traffic assignment allows you to establish the traffic flow patterns and analyze congestion points. Traffic assignment is a key element in the urban travel demand forecasting process. The traffic assignment model predicts the network flows that are associated with future planning scenarios, and generates estimates of the link travel times and related attributes that are the basis for benefits estimation and air quality impacts. The traffic assignment model is also used to generate the estimates of network performance that are used in the mode choice and trip distribution stages of many models.

Historically, a wide variety of traffic assignment models have been developed and applied. Many of the older, ad hoc traffic assignment methods that have been used have undesirable properties and should be replaced in future work. Nevertheless, some of these methods are included in TransCAD so that older models can be transferred without modification to the TransCAD environment or because they may be of some academic interest. Note that, with minimal additional effort, TransCAD allows you to apply more sophisticated traffic assignment methods such as User Equilibrium.

Some methods, such as All-or-Nothing Assignment, ignore the fact that link travel times are flow dependent (i.e., that they are a function of link volumes) when there is congestion, or that multiple paths are used to carry traffic for each specific O-D pair.

Equilibrium methods take account of the volume dependence of travel times, and result in the calculation of link flows and travel times that are mutually consistent. Equilibrium flow algorithms require iteration between assigning flows and calculating loaded travel times. Despite the additional computational burden, equilibrium methods will almost always be preferable to other assignment models.

In many urban areas, there are many alternate routes that could be and are used to travel from a single origin zone to a single destination zone. Often trips from various points within an origin zone to various points in a destination zone will use entirely different major roads to make the trip. In some instances, reasonable alternate routes may be so numerous that they cannot be easily counted. For the traffic assignment model to be valid, it must correctly assign car volumes to these alternative paths.

From a behavioral perspective, traffic assignment is the result of aggregating the individual route choices of travelers. Assignment models, not surprisingly, also differ in the assumptions made about how and which routes are chosen for travel.

The key behavioral assumptions underlying the User Equilibrium assignment model are that every traveler has perfect information concerning the attributes of network alternatives, all travelers choose routes that minimizes their travel time or travel costs, and all travelers have the same valuations of network attributes. First proposed by Wardrop, at user equilibrium (UE), no individual travelers can unilaterally reduce their travel time by changing paths (Sheffi, 1985). A consequence of the UE principle is that all used paths for an O-D pair have the same minimum cost. Unfortunately, this is not a realistic description of loaded traffic networks (Slavin, 1996).

An alternative and more realistic equilibrium model was proposed by Daganzo and Sheffi (1977). Known as Stochastic User Equilibrium or SUE, this model is premised on the assumption that travelers have imperfect information about network paths and/or vary in their perceptions of

network attributes. At stochastic user equilibrium, no travelers believes that they can increase their expected utility by choosing a different path. Because of variations in traveler perceptions and also in the level of service experienced, utilized paths do not necessarily have identical generalized costs. The SUE model is consistent with the concept of applying discrete choice models for the choice of route, but with the necessary aggregation and equilibrium solution.

Another, but not mutually exclusive, approach to making assignment models more realistic entails multi-class and/or multi-criteria models in which different groups of travelers value network attributes such as travel time or reliability differently (Dial, 1996). These models can also be profitably employed in performing multi-modal traffic assignments.

In the remainder of this section is a description of the core traffic assignment models for road traffic and a discussion of the primary advantages and disadvantages of each method. More advanced methods of assignment are covered in Chapter 10, *Advanced Traffic Assignment Methods*, and in supplemental documentation.

For more information, see:
Traffic Assignment Methods
Link Performance Functions

Top

Traffic Assignment Methods

The following are traffic assignment methods encountered in transportation planning practice, all of which are available in TransCAD:

All-or-Nothing Assignment (AON)
Under All-or-Nothing Assignment, all traffic flows between O-D pairs are assigned to the shortest paths connecting the origins and destinations. This model is unrealistic in that only one path between every O-D pair is used, even if there is another path with the same or nearly the same travel time or cost. Also, traffic on links is assigned without considering whether or not there is adequate capacity or heavy congestion; travel time is a fixed input and does not vary depending on the congestion on a link.

STOCH Assignment
STOCH Assignment distributes trips between O-D pairs among multiple alternative paths that connect the O-D pairs. The proportion of trips that is assigned to a particular path equals the choice probability for that path, which is calculated by a logit route choice model. Generally speaking, the smaller the travel time of a path, compared with the travel times of the other paths, the higher its choice probability would be. STOCH Assignment, however, does not assign trips to all the alternative paths, but only to paths containing links that are considered "reasonable." A reasonable link is one that takes the traveler farther away from the origin and/or closer to the destination. The link travel time in STOCH Assignment is a fixed input and is not dependent on link volume. Consequently, the method is not an equilibrium method.

Incremental Assignment
Incremental Assignment is a process in which fractions of traffic volumes are assigned in steps. In each step, a fixed proportion of total demand is assigned, based on All-or-Nothing Assignment. After each step, link travel times are recalculated based on link volumes. When there are many increments used, the flows may resemble an equilibrium assignment; however, this method does not yield an equilibrium solution. Consequently, there will be inconsistencies between link volumes

and travel times that can lead to errors in evaluation measures. Also, Incremental Assignment is influenced by the order in which volumes for O-D pairs are assigned, raising the possibility of additional bias in the results.

Capacity Restraint

Capacity Restraint attempts to approximate an equilibrium solution by iterating between all-or-nothing traffic loadings and recalculating link travel times based on a congestion function that reflects link capacity. Unfortunately, this method does not converge and can flip-flop back and forth in the loadings on some links (Sheffi, 1985, p. 113). The capacity restraint method as implemented in some software packages attempts to lessen this problem by smoothing the travel times and by averaging the flows over a set of the last iterations. This method does not converge to an equilibrium solution and has the additional problem that the results are highly dependent on the specific number of iterations run. Performing one more or one less iteration usually changes the results substantially.

User Equilibrium (UE)

User Equilibrium uses an iterative process to achieve a convergent solution, in which no travelers can improve their travel times by shifting routes. In each iteration, network link flows are computed, which incorporate link capacity restraint effects and flow-dependent travel times. The formulation of the UE problem as a mathematical program, and the Frank-Wolf solution method employed in TransCAD, are described in Technical Notes on Traffic Assignment.

Stochastic User Equilibrium (SUE)

Stochastic User Equilibrium is a generalization of user equilibrium that assumes travelers do not have perfect information concerning network attributes and/or they perceive travel costs in different ways. SUE assignments produce more realistic results than the deterministic UE model, because SUE permits use of less attractive as well as the most-attractive routes. Less-attractive routes will have lower utilization, but will not have zero flow as they do under UE. SUE is computed in TransCAD using the Method of Successive Averages (MSA), the only known convergent method (Sheffi and Powell, 1982; Sheffi, 1985). Due to the nature of this method, a large number of iterations should be used.

System Optimum Assignment (SO)

System Optimum Assignment computes an assignment that minimizes total travel time on the network. Under SO Assignment, no users can change routes without increasing their total travel time on the system, although it is possible that travelers could reduce their own travel times. SO Assignment can be thought of as a model in which congestion is minimized when travelers are told which routes to use. Obviously not a behaviorally realistic model, SO assignment can be useful in analyzing Intelligent Transportation System (ITS) scenarios.

Top

Link Performance Functions

All of the traffic assignment procedures in TransCAD, except for All-or-Nothing and STOCH Assignment, update travel times iteratively based on **link performance functions**, which are mathematical descriptions of the relationships between travel time and link volume. The BPR (Bureau of Public Roads) formulation is one of the most-commonly used link performance functions. The BPR function relates link travel times as a function of the volume/capacity ratio according to:

$$t = t_f \left[1 + \alpha \left(\frac{v}{c} \right)^{\beta} \right]$$

where: t = Congested link travel time

t_f = Link free-flow travel time

v = Link volume

c = Link capacity

α, β = Calibration parameters

While different formulations of such functions have been suggested over the years (Branston, 1976; Davidson, 1966), the BPR function (Traffic Assignment Manual, BPR, 1964) is very well suited for use in conjunction with traffic assignment models. With a suitable choice of parameters, this function can represent a wide variety of flow-delay relationships (including those of many other flow-delay models) and is therefore used by the traffic assignment models in TransCAD.

Historically, values for α and β have been set as 0.15 and 4.0, respectively. However, different values can and should be used in many circumstances. These parameters can be modified to include the approximate effect of intersection delay associated with a link. NCHRP 365 can be consulted for a further discussion of BPR model parameters for different settings.

In TransCAD, you can set the BPR function parameters globally, by link type, or for each specific link. See Optional Network Attributes for more information.

TransCAD supports the use of link performance functions other than the BPR. These assignment techniques are described in Chapter 10, *Advanced Traffic Assignment Methods*, and permit the use of a library of pre-defined and user-defined Volume Delay Functions (VDFs).

Top

Required Data for Traffic Assignment

Required data for traffic assignment include an O-D matrix, a network with the appropriate attribute fields, and the line layer from which the network was derived. In addition, there are many optional inputs, which are described in Optional Data for Traffic Assignment.

For more information, see:
O-D Matrix
Network
Required Network Attributes and Model Settings

Top

O-D Matrix

The O-D matrix contains the vehicle volumes to be assigned for each O-D pair. The IDs contained in the row and column headings of the matrix view must match the node IDs in the network. Cells in the matrix whose IDs are not in the network are not assigned, and the row and column IDs not found in the network are reported in the report file. See Chapter 18, *Working with Matrices*, of the *TransCAD User's Guide* for detailed information on matrices.

Top

Network

All traffic assignment methods require a TransCAD Network. A network is a special TransCAD data structure that stores important characteristics of transportation systems and facilities. TransCAD networks are defined, derived, and used in conjunction with a line layer and its associated endpoint layer. The network is created and used for analysis in TransCAD because of its extremely efficient and compact format.

To create a network, you choose the line layer you want to use, decide which nodes and links to include, and choose the fields that contain link and node costs and other attributes. The resulting network will include information on all nodes, links, and attribute fields that you chose from the line layer. The network must contain all the origin and destination nodes that are in the O-D flow matrix, as well as all links that may be used by the O-D trips. The following sections describe the required and optional link attributes used in traffic assignment. All of the link attributes you wish to use must be included when you create the network.

Choose **Networks/Paths-Create** to build a network. For detailed information on creating and using networks, see Chapter 13, *Networks and Shortest Paths*, and Chapter 14, *Network Settings*, in the *TransCAD User's Guide*.

Top

Required Network Attributes and Model Settings

The required network attributes and assignment settings vary, depending on the assignment method used. The following table summarizes the requirements for each assignment method:

Assignment Method	Required Attributes	Required Settings
All or Nothing	Time	none
Capacity Restraint	Time	Iterations
	Capacity	Convergence
		Alpha
		Beta
Incremental	Time	Iterations
	Capacity	Convergence

Method	Attributes	Settings
User Equilibrium	Time Capacity	Alpha Beta Iterations Convergence
Stochastic User Equilibrium	Time Capacity	Alpha Beta Iterations Convergence Alpha Beta Function Error
System Optimum	Time Capacity	Iterations Convergence Alpha Beta

Required Attributes

The required link attributes must be included as fields in the input network. The attributes are defined as:

Attributes	Type	Contents
Time*	Numeric	Free-flow travel time
Capacity*	Integer	Maximum flow that a link can carry

The values of both time and capacity can vary by direction along each link. These fields are noted with an asterisk (*) and should be replaced by pairs of fields representing the relevant data in each direction. For example, the field Time* should read as a pair of fields named [Time AB] and [Time BA]. If you do not provide directional fields in the network, then it is assumed that the value in the field provided applies to both directions on the link. For more information on bi-directional network fields, see Chapter 13, *Networks and Shortest Paths*, in the *TransCAD User's Guide*.

Note that the only required network attribute for All-or-Nothing Assignment is a Time field. All the other assignment methods require both Time and Capacity fields in the network file.

Any field can be designated as the Time field. For example, you could calculate a specialized or generalized cost function based on a formula you believe to be appropriate. Keep in mind, however, that the Time field will be used in the link performance function in the same manner as free-flow travel time is used.

There are many optional link fields that you can also use in assignment. These are described under Optional Network Attributes.

Required Settings

In addition to the network fields required, different assignment methods require different parameter settings. Unlike the required link attributes, the required settings in assignment are not fields in the network, but are specified in the Traffic Assignment dialog box. The settings are defined as follows:

Settings	Contents
Iterations	Maximum number of iterations to be performed
Convergence	Convergence criterion value; if the maximum absolute change in all the link flows between consecutive iterations is less than this value, convergence is achieved and the assignment procedure stops
Alpha	The global default value of the α parameter in the BPR function

Beta	The global default value of β parameter in the BPR function
Function	Error term distribution function for stochastic user equilibrium
Error	Percentage error for the error term used in stochastic user equilibrium assignment

All-or-Nothing Assignment does not require any settings. All of the other assignments require the first four settings: Iterations, Convergence, Alpha, And Beta. The Function and Error settings are only used for Stochastic User Equilibrium. The Function setting refers to the distribution of the error term. There are three options for the Error function: the normal distribution (i.e., for probit assignment), the Gumbel distribution (i.e., for logit assignment), and the uniform distribution. The magnitude of the error term is specified as a percentage of the link cost function.

While the global default values for the Alpha and Beta settings are required, different values of Alpha and Beta can be provided for each link type or for each link. This is described in Optional Data for Traffic Assignment.

Top

Optional Data for Traffic Assignment

TransCAD provides a wide variety of options for the traffic assignment procedures. You can control link performance function parameters, treatment of transfer and turning penalties, preloading of network links, and calculation of additional output measures. You can use system defaults and then code exceptions for specific links and intersections.

For more information, see:
Optional Network Attributes
Turning Prohibitions, Turn Penalties, and Transition Penalties

Top

Optional Network Attributes

In addition to the required link attributes of time and capacity, there are several optional link attributes:

Attributes	Contents
Link type	Codes representing the type of link
Alpha*	Link-specific α parameter in the BPR function
Beta*	Link-specific β parameter in the BPR function
Preload*	Fixed background link flow

As described earlier, the asterisk (*) following the attribute name indicates that the attribute may be bi-directional and thus two fields (one for each direction) can be provided for each attribute.

Link Type
Transportation networks usually include many different classifications of links, such as highways,

arterials, streets, and centroid connectors. You can assign a classification to each link in a geographic file, and include this information in your networks.

To classify links by type, use one field in the geographic file to store a numeric code that identifies the type of each link. Once you create this field, you must include the field in your network, and use the Network Settings dialog box to identify the field containing the link types and the code you have used for centroid connectors. For more information about defining and using link types, see Chapter 14, *Network Settings*, in the *TransCAD User's Guide*.

The link type attribute field can serve many purposes, such as:

- Denoting centroid connectors
- Providing link type-specific default values for parameters, attributes, and turning movements
- Tabulating results by link type

Centroid connectors are not physical links, so they should only be traversed once at the beginning of the trip to access the road network and once at the end of the trip. They should never be used in the middle of a trip. By designating the centroid nodes in a selection set and specifying this set in the Network Settings dialog box, the assignment procedures in TransCAD will not allow the use of centroid connectors except at the beginning and the end of a trip. *This method is strongly recommended for planning networks with centroid connectors where paths might use centroid connectors improperly in a path*. If you do not have centroid connectors in your network, but you would like to add them, see "Connecting Features to a Network" in Chapter 22, *Geographic Analysis Tools*, in the *TransCAD User's Guide*.

Link type distinctions are also useful when a set of default link attributes such as speeds, capacities, or BPR curve parameters are desired for each type of link (e.g., highways, arterials, streets, and connectors). The default values to be used for each link type are stored in a lookup table. When the attribute value of a link is missing from the input network field, TransCAD finds the link type, consults the lookup table, and uses the default value. Defaults can be provided for such parameters as alpha and beta of the BPR function, speed, capacity, and number of lanes.

To use defaults for network link attributes you must create a special table, called a Link Type Lookup Table, containing the following fields:

Field	Type	Contents
Linkname	String	Name of the link type
Code	Integer	A code for the link type category
BPRA	Real	The α parameter in the BPR function
BPRB	Real	The β parameter in the BPR function
Speed	Real	The default link speed in miles per hour for the link type
CAP	Real	The capacity per lane in vehicles per hour
LANES	Integer	The number of lanes
ERROR	Real	The percentage error term for SUE
Function	NA	Not used in this version
K	Real	Constant for generalized cost assignment

The Link Type Lookup Table must have the fields as listed above, in terms of field name, type, and ordering. You choose the Link Type Lookup Table to be used in the Network Settings dialog box.

Alpha and Beta of the BPR Function

The parameters alpha (α) and beta (β) of the BPR function can be defined in many ways:

- Global default values for all links in the network are entered under Default Settings in the Traffic Assignment dialog box

- The default values of alpha and beta can be defined using a Link Type Lookup Table
- Different values of alpha and beta can be provided for each link in the network, using fields in the network containing values of alpha and beta for each link

If entries of alpha and beta are missing for any link, then the default values for the link type will be used. If the link type value is also missing, then the global value will be used.

Preloads

Another traffic assignment option is to preload traffic on the network. Preloads are fixed background volumes on links. These volumes are associated with vehicle trips that are on the network but are not contained in the O-D matrix to be assigned. Highway traffic assignment usually only allocates passenger car trips onto the network. By using preloads, vehicular traffic such as bus and truck traffic can be incorporated in to the assignment process. Preloading is especially appropriate for bus traffic that follows a fixed route. Contributions to preload volumes can also come from a separate assignment model, but when preloaded these flows are treated as fixed. Inclusion of preloaded traffic can increase the accuracy of the computed link loadings and congested travel times. Preloading may also be useful in analyzing the effects of incremental increases in traffic.

Preloads are specified in TransCAD by including extra fields in the network that contain the preload to assign to each link. The preloads may be bi-directional, in that a preload field is provided for the forward topological direction (AB) and the reverse topological direction (BA). If only one field of preloads is provided, then the value will be preloaded on both directions of the link. The field(s) containing the preloads are specified in the Traffic Assignment dialog box.

Top

Turning Prohibitions, Turn Penalties, and Transition Penalties

For some traffic assignment applications, it may be important to restrict or impede turning movements at intersections. You can specify turn prohibitions, turn penalties, and transition or transfer penalties globally or by link type through the Network Settings dialog box, and for specific link-to-link pairs through lookup tables.

A turning penalty is added to the travel time of a path when the path turns at a node. The penalty value can depend on the turning direction (left turn, right turn, or U-turn) as well as on the types of links between which the turn is made.

There are three methods for defining turn penalties/prohibitions:

- Global turning penalties, which are defined for different turning directions and are independent of link type
- Turning penalties defined for different turning directions and for different pairs of link types
- Turning penalties defined between pairs of specific links, without using turning direction or link type information

When multiple turn penalties/prohibitions are defined for a set of links, TransCAD applies specific penalties first, followed by default penalties defined by link type, and lastly, global penalties/prohibitions.

A transition (or transfer) penalty independent of turn direction can be added to the travel time of a path when the path includes changes from one link type to another. For instance, a penalty can be applied for transferring from a highway link to a rail link, to simulate delays at mode transfer points. Transition penalties can be useful in modeling multi-modal commodity flows over a line layer.

Chapter 14, *Network Settings*, in the *TransCAD User's Guide* contains a complete description of how to define and modify the relevant network settings and lookup tables for turn prohibitions, turn penalties, and transition penalties. Once these are included in the network, the specified prohibitions and penalties are automatically applied when the traffic assignment model is run.

Standard Results of Traffic Assignment

Upon successful completion, the traffic assignment procedure produces the following output files:

- A table file containing the estimated link volumes and link costs
- A text file containing a summary of user inputs and model outputs

The purpose of traffic assignment is to forecast the traffic conditions for the given network and demand volumes. The assigned link volumes are the primary output of the assignment model; TransCAD provides these measures in the form of a solution file, which is a fixed format binary file that is automatically joined to the line layer on which the network is based. The solution file also includes loaded travel times and the volume-to-capacity ratios, which reflect the degree of congestion on each link. The link outputs included in the output table file are as follows:

Link Output Fields	Contents
AB_flow, BA_Flow	Volume on link from A to B/from B to A (A and B are end nodes of a link)
Total_Flow	Total volume on links in both directions
AB_Time, BA_Time	Travel time (or cost) for link from A to B/from B to A
Max_Time	Maximum travel time (or cost) for links in both directions
AB_voc, BA_voc	Volume to capacity (V/C) ratio for link from A to B/from B to A
Max_voc	Maximum V/C ratio for links in both directions
AB_speed, BA_speed	Speed on link from A to B/from B to A at last iteration of assignment

TransCAD also produces a report, which is appended to the master report file. This report file includes general information about the assignment, such as date, time, options, input files, and output files. In addition, the report includes the following system-wide summary variables:

System-wide Outputs	Contents
Total VHT	Total vehicle hours of traffic from the assignment
Total VMT	Total vehicle miles of travel from the assignment

If there are any discrepancies in the data, a log report will be generated and appended to the master log file listing the problematic data.

Optional Results of Traffic Assignment

TransCAD provides the following options when performing traffic assignment:

Option	What it does
Report Cold Start	Reports Cold Start Vehicle Distance Traveled, used in air-quality analysis, for a specified cold start period.
Produce Tabulation	Creates frequency tables on link flow range and link V/C range, and saves the tables with the given file names.
Create Themes	Creates a Scaled Symbol Theme over the line database using the field AB_Flow (and BA_Flow) output from Traffic Assignment. For most assignments, a Color Theme is applied to the line database using the field AB_VOC (and BA_VOC) output from the Traffic Assignment.
Skip Small Values	Will not assign small values present in the O-D matrix below the specified threshold.
Save Link Flow	Updates a network field with the assigned flow at the last iteration of assignment.
Warm Start	Specifies the starting flows for an assignment, which are generally based upon a saved link flow.
Loading Multiplier	Specifies the proportion of demand to load from the O-D matrix.
Preload PCE	Specifies the Passenger Car Equivalent (PCE) to apply to the preloaded vehicles.

To set these options, click Options in the Traffic Assignment dialog box.

Report Cold Start Data

You can generate data on cold start traffic. When you choose the Report Cold Start option, TransCAD keeps track of the location and volume of traffic that is in the cold start mode. This quantity is required for air quality impact estimation.

The duration of the cold start mode is user defined and specified in the Assignment Options dialog box. This time period represents how long a vehicle is in cold start mode. To report the cold start total vehicle miles (VMT), the free-flow travel times in the network must be in minutes, and the cold start period in seconds.

The cold start option produces these additional fields in the standard output table:

Link Output Fields	Contents
AB_cold_flow, BA_cold_flow	Cold start volume on link from A to B/from B to A
Total_cold_flow	Total cold start volume on links in both directions
AB_cold_length, BA_cold_length	Proportion of link length used by cold-start trips for link from A to B/from B to A
AB_cold_VMT, BA_cold_VMT	Total vehicle mileage for cold-start volumes on link from A to B/from B to A

If you are interested in further information about emissions, there is a separate procedure available for interfacing the MOBILE5 program with TransCAD. Contact Caliper for further information.

Critical Link Analysis

The Critical Link Analysis option allows you to output unique flow fields and O-D matrices for specified sets of links. Under this option, you specify critical sets of links in a data table. For each set of links, TransCAD reports the estimated volume between every O-D pair that has been assigned to each critical set. This output is in the form of a matrix file where the entry in the matrix indicates the number of trips from the row ID node to the column ID node that go through the critical link set.

In addition, TransCAD can report the flow on all links that use the critical link sets. This output is in the form of additional AB and BA flow fields in the assignment output table for each link set. For

example, if a link set were called "Crit_set", the flow fields would be named 'AB_Flow_Crit_set' and 'BA_Flow_Crit_set' respectively.

The required fields for the critical link table are:

Field	Type	Contents
ID	Integer	Unique ID for the record
LINK	Integer	Line ID of the link
FROM_NODE	Integer	Beginning node of the link
TO_NODE	Integer	Ending node of the link
SET	Character	Critical link set the link belongs to

In an example of a critical link table, SET1 could be a critical link set consisting of links with IDs 1 and 2 and the flow to be tracked goes from node 1 to 2 and then from 2 to 3. SET2 could track flow on link ID 4 in the direction from node 5 to 6.

Produce Tabulations of Flows and Volume-to-Capacity Ratios

TransCAD also provides a Do Tabulation option to display flow ranges for all the links. When you choose this option, TransCAD creates two frequency tables. One contains individual and cumulative frequencies of different link volume ranges, in both absolute and percentage terms. The other contains the same information, but for volume-to-capacity ratios. The tabulations will be saved to the default file names ASN_VOC.MTX and ASN_FLOW.MTX unless you specify otherwise in the Output File Settings dialog box.

Results from the Do Tabulation option are provided in matrix form. This option is used to assess the reasonableness of an assignment or network scenario, based on link flow ranges and the distribution of link volume-to-capacity ratios.

Skip Small Values

TransCAD provides an option to skip small values in the O-D matrix. When this option is checked, TransCAD will not assign values in the O-D matrix below a given threshold. This threshold is specified in the edit box next to the option.

Save Link Flow

This option lets you update a network field with the flow values from the last iteration of assignment. The updated field can then be used in an assignment that uses the warm start option (described below).

Report Turns

With this option, you can report exact turning movement flows on a selected set of nodes. Before you run assignment, you need to create a selection set on the node layer indicating the node intersections on which you want to calculate exact movements. Then you choose this selection set with the Report Movement option. You can also display the output graphically using the turning movement tool after this table is generated; for more information, see Displaying Intersection Flows for Traffic Assignment.

Warm Start

This option lets you specify a network field that contains the flow values already present on the links, based on values obtained in an Equilibrium Assignment (UE, SUE). The assignment will then continue for the next n iterations specified in the dialog box. For this to be effective, you should update the network travel times with those output from the last iteration of the previous assignment.

Create Themes over Flows and Volume-to-Capacity Ratios

You can display the assignment results as a combination of thematic maps over the line layer. The Create Themes will generate a scaled-symbol theme using the field AB_Flow (and consequently BA_Flow) that will scale each side of the link with the volume assigned to the link. This option will

also generate a color theme using the field AB_VOC (and BA_VOC) that will apply a color to each side of the link indicating the level of congestion of the link in terms of volume-to-capacity ratios (V/C). The color theme is not available for All-or-Nothing Assignment, since this technique does not utilize link capacities.

You can also create themes using directional flows and volume-to-capacity ratios from assignment results with the **Planning-Planning Utilities-Create Flow Map** command. For more information, see Adding Flow and V/C Ratio Themes.

Loading Multiplier
This option lets you specify a proportion of the demand to load from the O-D matrix. This effectively scales the matrix for assignment without updating the values stored in the matrix.

Preload PCE
This option lets you specify a Passenger Car Equivalent (PCE) for the preload volume. For more information regarding preload volumes, see "Preloads" in Optional Network Attributes. The following are suggested values from HCM 1995:

PCE	Level	Type of Terrain Rolling	Mountainous
Trucks	1.7	4.0	8.0
Buses	1.5	3.0	5

In addition to the Do Tabulation and Cold Start Analysis options, the Critical Link Analysis option also produces additional output files.

Top

Performing Traffic Assignment

TransCAD can perform traffic assignment with all of the methods described previously as well as with a number of more specialized or advanced models that are described later in this manual.

For more information, see:
To Perform Traffic Assignment
To Identify Centroid Connectors (Nodes)
Applying Turn and Transition Penalties

Top

⟩ *To Perform Traffic Assignment*

1. Open or create a map containing the line layer on which to perform traffic assignment, open the corresponding network, open the flow matrix, and make the line layer the working layer.

2. Choose **Planning-Traffic Assignment** to display the Traffic Assignment dialog box.

3. Choose a traffic assignment method from the Method drop-down list.

4. Choose the travel demand matrix file from the Matrix File drop-down list, and the demand matrix to be assigned from the Matrix drop-down list.

5. Depending on the method chosen, choose the network fields for time, capacity, and/or preload.

6. To use link-specific values for alpha and beta, choose the corresponding network fields from the Alpha and Beta drop-down lists.

7. Depending on the method chosen, make globals settings by typing values for iterations, convergence, alpha, beta, and/or error in the respective edit boxes, and choose a function from the Function drop-down list.

8. Click Options to display the Options dialog box.

   Choose options as follows:

To do this...	Do this...
Report cold start data	Check the Report Cold Start box and type a value for the cold start period (in seconds) in the edit box.
Perform critical (select) link analysis	Choose a table from the Table drop-down list and choose sets from the scroll list. Sets that are not chosen will only output O-D matrices. Sets that are chosen will output O-D matrices and additional flow vectors.
Report tabulations of link flows and V/C ratios	Check the Do Tabulation box.
Skip small values in the assignment	Check the Skip Small Values box and type a minimum value in the edit box.
Save link flows in the network	Check the Save Link Flow box and choose a field in which to store the results from the drop-down list.
Report turning movements	Check the Report Turns checkbox and choose a selection set to report turning movements.
Specify flow values already present on the links	Check the Warm Start box and choose a network field that contains the flow values already present on the links.
Create V/C and flow themes of the results	Check the Create Themes box, type a maximum V/C value in the Max Vac edit box, type an interval value in the Interval Size edit box, and choose start, end, and intermediate colors from the drop-down lists.
Specify a loading multiplier	Type a value in the Loading Multiplier edit box.
Specify a preload PCE factor	Type a value in the Preload PCE edit box.

   Click OK to return to the Traffic Assignment dialog box.

9. Click OK. TransCAD displays the Store Flow Table In dialog box. Type a file name and click Save.

   If you chose to report valuations of link flows and V/C ratios, perform critical link analysis, or report movements on nodes, TransCAD instead displays the Output File Settings dialog box. Choose to use, rename, or overwrite each file as described below, and click OK.

If the status is...	Do this...
In Use or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

10. TransCAD assigns traffic flow to the links in the network, creates a link flow table and displays a Result Summary dialog box:

To do this...	Click...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

Depending on the options you chose, TransCAD may create a matrix file containing zone-to-zone O-D flow passing over critical links, create a movement table on selected nodes, create tabulations of flow and V/C ratios, or display a color theme of V/C ratios and a scaled-symbol theme of vehicle flows.

) To Identify Centroid Connectors (Nodes)

1. Create a selection set of nodes representing the centroid nodes.

2. Do Steps 1-7 of the procedure To Perform Traffic Assignment.

3. Click Network to display the Network Settings dialog box.

4. Check the Centroids box.

5. Click the Other Settings tab to display the Other Settings page.

6. Click the In Selection radio button, and choose the selection set of nodes from the drop-down list.

7. Click OK to return to the Traffic Assignment dialog box and continue with Steps 8 of the procedure To Perform Traffic Assignment.

When this network is used in the future, TransCAD keeps track of the centroid nodes and makes sure that centroid connectors are only used at the beginning and end of any trip.

Applying Turn and Transition Penalties

To use turn and transition penalties, you must have a network file that contains turn information. For more information, see "Turn Penalties" in Chapter 14, *Network Settings*, in the *TransCAD User's Guide*.

Adding Flow and V/C Ratio Themes

If you did not choose to make themes in the Options dialog box when performing traffic assignment, you can still add flow and V/C themes after you run the assignment procedure.

For more information, see:
To Add Flow and V/C Themes

Top

) To Add Flow and V/C Themes

1. Do the procedure To Perform Traffic Assignment, and make sure the joined view with the flow and V/C ratio is open.

2. Choose **Planning-Planning Utilities-Create Flow Map** to display the Create a Traffic Flow Map dialog box.

3. Choose the line layer that contains the traffic assignment results from the Line Layer drop-down list.

4. Choose a field that contains flow data from the Flow drop-down list. If the flow data are contained in directional fields, you can choose either the AB or BA flow field.

5. Choose a field that contains V/C data from the V/C drop-down list. If the V/C data are contained in directional fields, you can choose either the AB or BA V/C field.

6. Type a maximum value for V/C in the Max. V/C edit box and an incremental value in the Size of Intervals edit box.

7. Choose the start, end, and intermediate colors for the V/C theme from the From, To, and Via drop-down lists.

8. Click OK.

TransCAD adds a scaled-symbol theme of flow and a color theme of the V/C ratio to the map.

Top

Displaying Intersection Flows for Traffic Assignment

If you chose to report movements in your traffic assignment options, you can use the Display

Intersection Flows tool to graphically display the reported turning movements. You need to have the output table of the Report Turns option and the base network geographic file open to use this tool.

For more information, see:
To Display Intersection Flows for Traffic Assignment

Top

) *To Display Intersection Flows for Traffic Assignment*

1. Open the movement table and the base geographic file.

2. Choose *Planning-Planning Utilities-Display Intersection Flows* to display the Display Intersection Flows dialog box.

3. Choose the movement dataview from the Table Name drop-down list.

4. Choose the field that contains movement volumes from the Movement Field drop-down list.

5. Type a title and footnote, if desired, in the Title and Footnote edit boxes.

6. If you want to display road labels in the intersection diagram, choose a line layer field that contains road names or road labels from the Link Labels drop-down list.

7. If you want to label the legs of the intersection with the value of flow, check the Display Flow Labels box.

8. Click OK to display the Intersection toolbox.

9. Choose the intersection node ID you wish to display from the drop-down list.

10. Click to display an intersection diagram for the chosen node ID.

11. Click and click on a node on the map to display an intersection diagram for that node.

12. Click to display the Display Intersection Flows dialog box and reconfigure the settings.

13. Click the close box in the upper right corner of the toolbox.

TransCAD closes the Intersection toolbox.

Top

Technical Notes on Traffic Assignment

A key reference for the traffic assignment models in TransCAD is Sheffi (1985) and Patriksson (1994), which contains an excellent overview of methods and technical details on Stochastic User Equilibrium methods. Mathematical Formulation and Solution Algorithm for Deterministic Traffic Assignment is based upon Regueros (1992).

For more information, see:
Using Network Assignment Models
Memory Requirements
Mathematical Formulation and Solution Algorithm for Deterministic Traffic Assignment
Solution Method for SUE Assignment

Top

Using Network Assignment Models

Traffic assignment models should be carefully matched to the data at hand and the analysis purpose. For long-range planning, less detail is typically warranted than for short-range analysis. For short-range analysis, a higher degree of accuracy is desirable and can be achieved through careful data collection and model calibration. Users should not use more elaborate or detailed networks or options unless they are important in the analysis. Some of these options slow down assignment runs, but may not add accuracy to the results.

Application of traffic assignment models should preferably be by time-of-day and not for 24-hour periods. Probably the minimum requirement is for peak period models, but a peak-hour assignment or a series of hourly assignments may be a better approach. A good case can be made for dynamic models in which traffic is assigned by small time intervals, but these methods are still experimental (Janson, 1991; Slavin, 1996).

TransCAD is set up to run a peak-hour assignment as a default when a link type lookup table is used for relevant input parameters. The reason is that the capacity field in this table is expressed in terms of the capacity per lane per hour. If you wish to perform a 3-hour peak period assignment, the hourly capacity should be multiplied by 3 and saved in the lookup table.

In running an assignment model for the base case scenario, it is desirable to obtain flows that are consistent with traffic counts and with measured speeds. Key links in the network should be examined to establish the validity of the assignment model. Improvements in the calibration of assignment models can come from refining the link cost parameters as suggested by Fricker and Moffett (1993) and Fricker (1989).

TransCAD provides numerous visualization, analysis, and reporting tools for examining traffic assignment output. Bandwidth displays (see "Scaled-Symbol Themes" in Chapter 7, *Using Themes to Present Information*, in the *TransCAD User's Guide*) and other thematic mapping options for line layers make it easier to comprehend traffic flows and to compare predicted and observed link volumes. Geographic selection and statistical analysis tools can be used to analyze traffic flows based upon link characteristics. A specialized tool is provided for screenline analysis; for more information, see Using Screenline Analysis in Chapter 15, *Data Preparation and Planning Utilities*.

Memory Requirements

If you are working with very large networks, please make sure that you have enough free RAM for the entire network to be in memory at once. If there is insufficient memory, an error message will appear.

Mathematical Formulation and Solution Algorithm for Deterministic Traffic Assignment

Wardrop presented the user equilibrium principle in 1952 and only 4 years later Beckman *et al.* (1956) proposed a rigorous mathematical framework to express this principle as a mathematical program; yet it took many years before suitable algorithms for practical implementation were proposed and tested (see LeBlanc (1973)).

Beckman *et al.* compared the equilibrium assignment problem to equilibria problems encountered in theoretical mechanics. One characteristic of such problems is that they may be expressed as extremum problems. He showed that by assuming that the cost, C_a, on any link a is a function of the flow, x_a1, on link a only, and that the link performance functions are increasing, then the flows x_a, satisfying Wardrop's First Principle, are unique and equal to those which minimize equation 1.

$$\min \quad z(\mathbf{x}) = \sum_a \int_0^{x_a} C_a(u)\,du$$

(1)

The method normally used to solve this problem is the convex combination algorithm, originally suggested by Frank and Wolfe in 1956 as a procedure for solving quadratic programming problems with linear constraints; it is also known as the FW method. LeBlanc (1973) applied the FW method, obtaining an efficient algorithm to solve this problem.

The travel time, C_a, can include numerous components, reflecting travel time, number of stops, safety, fuel consumption, etc. Many of these components can be expressed as a function of the travel time. Therefore, in the remainder of this work, travel time, t_a, will be used instead of travel cost.

$$\min \quad z(\mathbf{x}) = \sum_{ij} \int_0^{x_{ij}} t_{ij}(u)\,du$$

(2)

For the sake of completeness, LeBlanc's implementation of the User Equilibrium Assignment problem will be presented. The steady-state UE problem is formulated as follows:

$$st: D(j,s) + \sum_i x_{ij}^s = \sum_k x_{jk}^s \quad s = 1, \ldots, p$$
$$j = 1, \ldots n$$
$$j \neq s$$
$$x_{ij}^s > 0 \quad s = 1, \ldots p$$

(3)

Where : n = The number of nodes in the network

p = The number of origins and destinations

x_{ij} = The total flow along arc (i , j)

x_{ij}^s = The flow on arc (i , j) with destination s

$D(j,s)$ = The flow originating at node j with destination s

Equation 3 is the conservation of flow equation for node j and the non-negativity of flows constraint.

LeBlanc proved that this optimization problem is convex with respect to the link flows, x_{ij}. This problem is, however, not convex with respect to the path flows, x_{ij}^s, meaning that the equilibrium condition is not unique with respect to path flows.

Given a feasible flow vector, xn (a flow vector that satisfies the conservation of flow equation and the non-negativity of flow constraints), a first order expansion of $z(x)$ around xn can be written as:

$$z(y) = z(x^n) + \Delta z(x^n + \theta(y - x^n))(y - x^n) \quad \text{for } 0 \leq \theta \leq 1$$

(4)

A convenient linear approximation to $z(y)$ is to let θ equal 0 (this yields the following linear function in y):

$$z(y) = z(x^n) + \Delta z(x^n)(y - x^n)$$

(5)

In order to find a good direction in which to seek a decreased value of the original objective function, the following linear program must be solved:

$$LP: \quad \min z(y) = z(x^l) + \Delta z(x^l)(y - x^l)$$

(6)

Further manipulations of equation 6 and the removal of all constant terms yield the following objective function:

$$\text{LP:} \quad \min \quad \Delta z(\mathbf{x}^n)\mathbf{y} \tag{7}$$

$$\text{st:} \quad D(j,s) + \sum_i x_{ij}^s = \sum_k x_{jk}^s \qquad s = 1,\dots,p \tag{8}$$

$$j = 1,\dots n$$
$$j \neq s$$

$$x_{ij}^s \geq 0 \quad (i,j) \in A; \qquad s = 1,\dots,p \tag{9}$$

Solving the linear program of equation 7 yields a solution vector y^n that is also a feasible solution of the original non-linear problem of equation 6. The direction $d^n = y^n - x^n$ is a good descent direction in which to seek a decreased value of z (see Zangwill, 1969).

Since the feasible region is convex (it is generated by a set of linear flow conservation equations), each point on the line between x^n and y^n is also feasible.

The search for the descent direction $d^{\prime n}$ is determined by the solution of a linear problem (Equation 7), so that y^n lies at the boundary of the feasible region. According to this method, the solution vector for the next iteration, x^n, lies on the line between x^n and y^n. It can be observed, that the determination of the descent direction, automatically generates a bound for the line search.

In order to find the next point (the flow vector of the next iteration), $z(\mathbf{x})$ has to be minimized along $d^n = (y^n - x^n)$:

$$\min \quad z\left[\mathbf{x}^n + \alpha\left(\mathbf{y}^n - \mathbf{x}^n\right)\right] \tag{10}$$

subject to:

$$0 \leq \alpha \leq 1 \tag{11}$$

Since the search interval is bracketed, this minimization can be achieved with any interval reduction method.

Once the solution to equation 10 is found, the next point can be calculated as:

$$x^{n+1} = x^n + \alpha\left(y^n - x^n\right)$$

(12)

Further investigation of the LP objective function, equation 10, reveals that:

$$\Delta z(x^n)y = \min \sum_{ijs} \frac{\partial z(x^n)}{\partial x_{ij}^s} y_{ij}^s$$

(13)

The derivative can be decomposed by the chain rule in:

$$\frac{\partial z(x_{ij})}{\partial x_{ij}^s} = \frac{\partial z(x_{ij})}{\partial x_{ij}} \frac{\partial x_{ij}}{\partial x_{ij}^s}$$

(14)

It can be seen that:

$$\frac{\partial z(x_{ij})}{\partial x_{ij}} = t(x_{ij})$$

(15)

The vector x_{ij} can be written as:

$$x_{ij} = \sum_s x_{ij}^s = x_{ij}^1 + x_{ij}^2 + \ldots + x_{ij}^s + \ldots$$

(16)

So that:

$$\frac{\partial x_{ij}}{\partial x_{ij}^s} = 1$$

(17)

Defining c_{ij} as $t\left(x\big|_{x=x^n}\right)$, the linear program (LP) can be written as:

$$\min \sum_s \sum_{ij} c_{ij} y_{ij}^s$$

(18)

This last program is equivalent to minimizing the total travel time over a network with fixed (not flow dependent) travel times. This is solved by finding the shortest path connecting each OD pair, and assigning all the flow to it. The algorithm can be summarized as follows:

1. **Initialization**

    Perform an All-or-Nothing Assignment based on $t_{ij} = t_{ij}(0)$. This yields flow vector x^1.
    Set the iteration counter n to 1.

2. **Update Travel Times**

Update the link travel times $\left(t_{ij}^n = t_{ij}\left(x_{ij}^n\right) \quad \forall ij\right)$

3. **Direction Finding**

Perform an All-or-Nothing Assignment with t_{ij}^n. This yields the auxiliary flow vector y_{ij}^n.

4. **Line Search**

Find α that solves:

$$\min_{0 \leq \alpha \leq 1} \sum_{ij} \int_0^{x_{ij}^n + \alpha\left(y_{ij}^n - x_{ij}^n\right)} t_{ij}(u)\,du$$

5. **Move**
   Set:

$$x_{ij}^{n+1} = x_{ij}^n + \alpha\left(y_{ij}^n - x_{ij}^n\right)$$

6. **Convergence Test**
   If the convergence criterion is met, stop; otherwise go to step number 2.

Solution Method for SUE Assignment

The solution method utilized for SUE is the method of successive averages (MSA) (Powell and Sheffi, 1982). The MSA method utilizes a predetermined sequence of step sizes of the general form,

$$\alpha_n = \frac{K_1}{K_2 + n}$$

where:

α_n = Step size

n = Iteration counter

K_1, K_2 = Parameters

K_1, K_2 must be chosen so that the following two conditions are satisfied:

$$\sum_{n=1}^{\infty} \alpha_n \to \infty$$

$$\sum_{n=1}^{\infty} \alpha_n^2 < \infty$$

The first condition warrants that the sequence will reach the sought value, no matter how far it was started. The second condition guarantees that the variance of the random variable will diminish as the iterations proceed. One of the simplest step size sequences satisfies both conditions:

$$\alpha_n = \frac{1}{n} \quad (K_1 = 1, K_2 = 0)$$

For further details and proof of convergence, see Powell and Sheffi (1982).

Top

Advanced Traffic Assignment Methods

Many modeling problems call for more varied or specialized traffic assignment procedures. These assignment procedures may require use of alternative volume-delay relationships, treatment of multiple traffic modes and/or user classes, inclusion of complex road tolls, explicit consideration of turning delays at intersections, or simultaneous treatment of trip distribution. This chapter documents these more advanced traffic assignment options.

For more information, see:
Assignment with Alternative or User-Defined Volume Delay Functions
HOV Assignment
Multi-Modal Multi-Class Assignment (MMA)
Traffic Assignment with Volume-Dependent Turning Delays and Signal Optimization
Combined Trip Distribution - Assignment Model
Creating Volume Delay Function DLLs

Top

Assignment with Alternative or User-Defined Volume Delay Functions

This assignment procedure gives you the option of using one of several pre-programmed volume-delay functions (VDF) instead of the pre-defined BPR function described in Chapter 9, *Traffic Assignment*. In addition, you can program your own VDF, compile it using Microsoft C++, and use it with this procedure. The pre-programmed volume delay functions are:

- The BPR function
- A conical delay function used in EMME/2
- A logit delay function
- A generalized cost function based on the BPR curve

Instructions for creating your own volume-delay function are provided in Creating Volume Delay Function DLLs.

The specific pre-programmed functions are described below:

The Bureau of Public Roads (BPR) Function

This is the same function used in the basic traffic assignment described in the Chapter 9, *Traffic Assignment*:

$$t_i \cdot \left[1 + \alpha_i \left(\frac{x_i}{C_i} \right)^{\beta_i} \right]$$

where:

t_i = Free flow travel time on link i

C_i =   Capacity of link

x_i =   Flow on link i

α =   Constant

β = Constant

Conical Volume-Delay Function (Spiess, 1990)

In 1990 Spiess defined a set of equations as a replacement to the widely-used BPR functions:

$$f(x) = 2 + \sqrt{\alpha^2 \left(1 - \frac{x}{C} \right)^2 + \beta^2} - \alpha \left(1 - \frac{x}{C} \right) - \beta$$

where:

$$\beta = \frac{2\alpha - 1}{2\alpha - 2}, \quad x = v/C$$ and α is a constant larger than 1

Logit-Based Volume Delay Function

The Israel Institute of Transportation Planning and Research has calibrated a logit-based volume delay function. This function has the characteristic of including both link delay as well as delay caused at intersections. The total delay on a link is calculated as the sum of the link delay and an estimated intersection delay:

$$d = D_l + I_l$$

where:

$$D_l = t_0 \cdot c_1 \cdot \left[\cfrac{1}{1 - \cfrac{c_2}{1 + \exp\left(c_3 - c_4 \cfrac{x}{C}\right)}} \right]$$

D_l = Link delay

t_0 = Free-flow travel time

x = Traffic flow

C = Link capacity

c_1, c_2, c_3, c_4 = Parameters

$$I_l = d_0 p_1 \left[1 + \left(\cfrac{p_2}{1 + \exp\left(p_3 - p_4 \cdot \cfrac{x}{X}\right)} \right) \right]$$

where:

I_l = Intersection delay

d_0 = Free-flow travel time of intersection

x = Traffic flow

X = Intersection capacity

p_1, p_2, p_3, p_4 = Parameters

The intersection capacity can be calculated as a function of the link capacity and the expected percentage of green light for a signalized intersection.

A Generalized Cost Delay Function

This function is based on the BPR delay function, but also provides the ability to include a fixed cost on some of the links (tolls) and an operating cost per unit of distance ($/mile).

$$c_i(x) = k_i + \delta \cdot L_i + \varphi \cdot t_i \cdot \left[1 + \alpha_i \left(\frac{x_i}{C_i} \right)^{\beta_i} \right]$$

where:

c_i = Generalized cos

k_i = Dollar cost on lir

δ = Constant such as the operating cost per unit of length

L_i = Length of link i

φ = Constant representing the value of time

t_i = Free-flow travel time on link i

α = Constant

x_i = Flow on link i

C_i = Capacity of link

β = Constant

It is assumed that all the constants are greater or equal to zero.

For more information, see:
To Perform Assignment with an Alternative or User-Defined VDF

Top

) *To Perform Assignment with an Alternative or User-Defined VDF*

1. Open or create a map containing the line layer on which to perform traffic assignment, open the corresponding network, open the flow matrix, and make the line layer the working layer.

2. Choose **Planning-Advanced Assignment-Assignment with User VDF** to display the Assignment with User VDF dialog box.

3. Choose a delay function from the Delay Function drop-down list. To program your own VDF, see Creating Volume Delay Function DLLs.

4. Choose a traffic assignment method from the Method drop-down list.

5. Choose the travel demand matrix file from the Matrix File drop-down list, and the demand matrix to be assigned from the Matrix drop-down list.

6. Depending on the method and/or delay function chosen, choose the network fields for time, capacity, and/or preload and parameters specific to the delay function as follows:

To set this...	Do this...
Time	Highlight Time in the scroll list and choose a field from the Field drop-down list
Capacity	Highlight Capacity in the scroll list and choose a field from the Field drop-down list
Alpha	Highlight Alpha in the scroll list, choose a field from the Field drop-down list, and type a global default value in the Default Valued edit box
Beta	Highlight Beta in the scroll list, choose a field from the Field drop-down list, and type a global default value in the Default Valued edit box
Preload	Highlight Preload in the scroll list and choose a field from the Field drop-down list

7. Depending on the method chosen, choose settings by typing values for iterations, convergence, and/or error in the respective edit boxes, and choose a function from the Function drop-down list.

8. Click Options to display the Options dialog box. Choose options as described in the procedure To Perform Traffic Assignment, then click OK to return to the Assignment with User VDF dialog box.

9. Click OK. TransCAD displays the Store Flow Table In dialog box. Type a file name and click Save.

   If you chose to report values of link flows and V/C ratios in the Options dialog box, TransCAD displays the Output File Settings dialog box. Choose to use, rename, or overwrite each file as described below, and click OK.

If the status is...	Do this...
In Use or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

10. TransCAD assigns traffic flow to the links in the network, creates a link flow table and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

Depending on what options you chose, TransCAD may also create a matrix file containing zone-to-zone O-D flow passing over critical links, report tabulations of flow and V/C ratios, or display a color theme of V/C ratios.

Top

HOV Assignment

Many urban areas, in which traffic has overgrown the capacity of the existing road system, try to alleviate congestion by introducing lanes for high occupancy vehicles.

The model presented in this section helps to analyze the performance of High Occupancy Vehicle (HOV) lanes by assigning the HOV and non-HOV demand matrices simultaneously. Buses that use HOV lanes are assumed to be pre-loaded on the appropriate network links.

For more information, see:
Required Inputs for HOV Assignment
Technical Notes on HOV Assignment

Top

Required Inputs for HOV Assignment

Required inputs for the HOV assignment procedure include:

- An O-D matrix file with matrices for the non-HOV traffic, as well as for the HOV traffic: this procedure can handle more than one type of HOV traffic, i.e. HOV-2, HOV-3, etc.
- A network with the appropriate attribute fields
- The line layer from which the network was derived

The procedure also requires several selection sets, which should include the links that define each of the HOV modes and therefore should not be used by the non-HOV traffic.

O-D Matrix File
The O-D matrix file should include a matrix for each of the traffic modes to be assigned. Each matrix contains the vehicle volumes to be assigned for each O-D pair. The IDs contained in the row and column headings of the matrix must match the node IDs in the network. For more information, see Chapter 18, *Working with Matrices*, in the *TransCAD User's Guide*.

Network
As in all the traffic assignment models, this procedure requires a TransCAD network file. The attributes that should be included in this network depend on the assignment method chosen. For more information about the attribute required, see Chapter 9, *Traffic Assignment*.

Options
HOV assignment includes all of the assignment options available under the standard trip assignment procedure. For a full description of these options, see Chapter 9*, Traffic Assignment*. In addition, a Class Flows option is also available. When this option is checked, the output will include both the total assigned flow from all used O-D matrices and individual flow fields assigned for each separate O-D matrix used.

For more information, see:
To Perform HOV Assignment

Top

⟩ *To Perform HOV Assignment*

1. Open or create a map containing the line layer on which to perform HOV assignment, open the corresponding network, and open the O-D matrix.

2. Make the map the current window and choose the line layer from the drop-down list on the toolbar.

3. Choose *Planning-Advances Assignment-HOV* to display the HOV Assignment dialog box.

4. Choose a traffic assignment method from the Method drop-down list.

5. Choose the travel demand matrix file from the Matrix File drop-down list.

6. Under Mode Information, do the following for each matrix to be used for assignment:

    -   Highlight the matrix in the Matrices scroll list
    -   Check the Use <matrix name> box. TransCAD enables the Selection Set drop-down list
    -   Choose the selection set containing the links prohibited for the mode represented by <matrix name>, or choose None to include all links, from the Selection Set drop-down list

7. Choose the network fields for time, capacity, and/or pre-load and parameters for the BPR function as follows:

To set this...	Do this...
Time	Highlight Time in the scroll list and choose a field from the Field drop-down list
Capacity	Highlight Capacity in the scroll list and choose a field from the Field drop-down list
Alpha	Highlight Alpha in the scroll list and choose a field from the Field drop-down list and type a global default value in the Default Valued edit box
Beta	Highlight Beta in the scroll list and choose a field from the Field drop-down list and type a global default value in the Default Valued edit box
Preload	Highlight Preload in the scroll list and choose a field from the Field drop-down list

8. Depending on the method chosen, choose global settings by typing values for iterations, convergence, alpha, beta and/or error in the respective edit boxes, and choose a function from the Function drop-down list.

9. Click Options to display the Options dialog box. Choose options as described in the procedure To Perform Traffic Assignment, then click OK to return to the Assignment with User VDF dialog box.

10. Click OK. TransCAD displays the Store Flow Table In dialog box. Type a file name and click Save.

    If you chose to report values of link flows and V/C ratios in the Options dialog box, TransCAD displays the Output File Settings dialog box. Choose to use, rename, or overwrite each file as described below, and click OK.

If the status is...	Do this...
In Use or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

11. TransCAD simultaneously assigns all the demand matrices, taking into account the prohibited links permitted for each of the modes and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.

| Close the dialog box | Click Close. |

TransCAD displays a joined view with the resulting flow table. Depending on what options you chose, TransCAD may also create a matrix file containing zone-to-zone O-D flow passing over critical links, report tabulations of flow and V/C ratios, or display a color theme of V/C ratios.

Technical Notes on HOV Assignment

This procedure will simultaneously assign demand matrices representing Single Occupancy Vehicles (SOV) and one or more types of High Occupancy Vehicles (HOV). This procedure is intended for application to systems with separate HOV facilities; i.e., the HOV lanes should be represented as independent line segments in the database.

Upon successful completion, the HOV Assignment procedure produces the following results:

- A table containing the estimated combined segment volumes, the loaded travel times, and the volume to capacity ratios
- A report appended to the master report file containing summary of user inputs and model outputs

Multi-Modal Multi-Class Assignment (MMA)

Multi-Modal Multi-Class Assignment (MMA) is a flexible master assignment routine designed for use in major metropolitan areas, and is directly applicable in statewide or interregional models. Note that, while most MMA models are just multi-modal, the model in TransCAD is multi-modal and multi-class.

The MMA model is a generalized cost assignment that lets you assign trips by individual modes or user classes to the network simultaneously. Each mode or class can have different congestion impacts, different volume delay function parameters, and different values of time. You can also explicitly model the influence of toll facilities of all types using this assignment method.

For more information, see:
Preparing Data for MMA
Volume Delay Functions for MMA
Options for MMA
Results of MMA
To Perform Multi-Modal, Multi-Class Assignment
Assignment by Trip Purpose: An Application of MMA

Preparing Data for MMA

You can define for each mode or class:

- Passenger Car Equivalents, that determine the congestion effects of each vehicle class
- Exclusion sets, that specify selection sets of links that cannot be used by specific modes or user classes
- Fixed tolls, that are link based and added to the cost calculation by mode
- Entry-to-exit tolls, that are applied by mode
- A unique value of time for the mode and/or user class
- An O-D matrix of trips for the mode and/or user class

Passenger Car Equivalents

Passenger car equivalents (PCEs) are used to take account of the differential traffic impacts of larger vehicles, by treating them as having the same volume impact as some number of added cars. For example, larger, heavier vehicles occupy more physical roadway space than passenger cars and have poorer acceleration and deceleration. For each mode, you can specify the PCE factor of that mode. For further details about passenger car equivalents, refer to the Highway Capacity Manual.

Exclusion Sets

You can specify excluded links for each mode. For example, you may want to exclude links that do not meet bridge clearance requirements from the truck mode, or you may want to exclude HOV links for a single occupancy vehicle mode.

To specify an exclusion set, you need to create a selection set on your line layer that represent the links to be excluded for that mode. You need to create a separate selection set for each mode for which you want to exclude links.

Fixed Tolls and Entry-to-Exit Toll Calculations

You can consider both fixed tolls and node-to-node (or entry-to-exit) tolls in MMA path calculations:

- A fixed toll is a monetary cost assessed when passing through a single link in the network. Unlike travel time cost, this cost is the same regardless of the volume. Fixed tolls are coded in as an attribute in the line layer in a similar fashion as travel times, capacities and other link-based attributes. You can have a different fixed toll attribute field for each mode.
- Node-to-node tolls are costs that are dependent upon both the entering and exiting node of the path. This method of toll cost calculations is useful for toll facilities where the total cost depends upon the entry and exit tollbooth. You specify node-to-node tolls as a matrix, where the matrix row and column ID's represent the origin and destination node ID's and the cell values represent the origin-destination toll cost.

In an example toll matrix with an example toll facility, you would need to define the line segments that are used as fixed toll and entry-to-exit toll links. You do this by creating separate selection sets for fixed toll segments and entry-to-exit toll segments. You would then refer to these selection sets in a special section of the Network Settings dialog box.

Value of Time

Each mode or user class can have its own value of time (VOT). In an assignment based upon different income classes, each income class could be assigned with MMA and each could have a different value of time. Another example would be an assignment of commercial vehicles as well as personal vehicles. In this case, you might typically assign a higher value of time to the commercial vehicles mode.

Since MMA is a generalized cost assignment, you can take toll costs as well as travel times into consideration. You need to specify a value of time for each mode in order to perform a generalized cost assignment.

O-D Matrix File
You must define an origin-destination trip matrix for each mode or user class. All trip matrices must be defined in the same matrix file, but a separate matrix within the matrix file is defined for each mode.

Volume Delay Functions for MMA

There are three pre-programmed volume-delay functions you can use in this assignment model. They include the Bureau of Public Roads (BPR) function, the EMME/2 Conical Congestion Function, and the Israel Institute of Transportation Planning and Research (IITPR) function. Each function is described in a later section.

You can also create your own volume-delay function. For more information on programming a volume-delay function, see Creating Volume Delay Function DLLs.

The generalized cost function of the MMA model is:

$$ gc_{OD}^{m} = \sum_{i \in A_{OD}^{m}} \left\{ \text{VOT}^{m} \cdot VDF\left(t_{a}, c_{a}, x_{a}, \cdots\right) + \text{FT}_{a}^{m} \right\} + \sum_{me \in M_{OD}^{m}} MT_{m}^{i} $$

where:

gc_{OD}^{m} =   Generalized cost between origin and destination for mode m

m = Mode

a = Link

OD = Origin-Destination

A_{OD}^{m} = Set of links on the shortest path from O to D for mode m

VOT^{m} =   Value of time of mode m

t_{a} = Free flow travel time on link a

c_{a} = Capacity on link a

FT_{a}^{m} = Fixed toll on link a for mode m

M_{OD}^{m} = Set of node based toll sections between origin and destination for mode m

MT_{m}^{i} = Toll value for section i, mode m

VDF = Volume Delay Function

x_a = Total volume on link a, $\sum_{m}\left(PCE^{m} x_a^{m}\right)$

x_a^{m} = Flow of type m on link a

PCE^{m} = Passenger car equivalent for mode m

The equation assumes that you are using the Bureau of Public Roads (BPR) function.

Top

Options for MMA

The MMA procedure includes all of the assignment options available under the standard trip assignment procedure. For a full description of these options, see Chapter 9, *Traffic Assignment*. In addition, MMA also gives you the following options:

- Class Shares: The ability to report PCE equivalent volume flows by mode and/or class for each link.
- Toll volume: If a toll matrix is used, this option will output an origin-destination matrix from toll node ID to toll node ID.

Top

Results of MMA

The standard results of MMA is similar to the regular assignment:

- A report appended to the master report file, describing general details of the input files and fields and generic statistics such as total vehicle-distance and vehicle-time traveled
- A table of volume flow, volume/capacity (V/C) ratio, loaded travel times and loaded speeds by link

In addition, MMA can produce the following optional results:

- A loaded travel time matrix
- Tabulation tables of vehicle flow and V/C ratios by link
- A scaled-symbol theme of volume flow and a color theme of V/C ratio

- Passenger car equivalent (PCE) volume flows by mode and/or class for each link
- An O-D matrix between entry-to-exit toll nodes, if a toll matrix was used

For a more detailed description of trip assignment results, see Chapter 9, *Traffic Assignment*.

Top

⟩ *To Perform Multi-Modal, Multi-Class Assignment*

1. Open a map containing a line layer and corresponding network.

   If you want to include exclusion sets, create selection sets on your line layer that define exclusion links for each mode.

   If you want to include toll links, create selection sets on your line layer that define your fixed toll links and your entry-to-exit toll links.

2. Open the O-D flow matrix file. All vehicle modes must be in the same matrix file.

   If entry-exit tolls are to be used, open the node-to-node toll matrix.

3. Choose **Planning-Advanced Assignment-Multi-Modal Multi-Class Assignment** to display the Multi-Modal Multi-Class Assignment dialog box.

4. Choose a traffic assignment method from the Method drop-down list.

5. Choose the delay function to use from the Delay Function drop-down list.

6. If you want to use tolls, click the Network button to display the Network Settings dialog box, click the Toll tab, and do the following:

   - In the O-D Toll Links frame, choose In Selection Set and choose the selection set that contains the entry-to-exit toll links from the drop-down list, or choose In Network to use tolls defined in the network
   - In the Toll Links frame, chooe In Selection Set and choose the selection set that contains the fixed toll links from the drop-down list, or choose In Network to use tolls defined in the network
   - Click OK to return to the Multi-Modal Assignment dialog box.

7. If you want to include entry-to-exit tolls, choose the toll matrix file from the Toll Matrix drop-down list. Otherwise, choose None.

8. Do the following for each vehicle mode to be used in assignment:

   - Highlight a vehicle mode in the Class Information scroll list.
   - Check the Use Class box. The edit boxes and drop-down lists for PCE, VOT, Fixed Toll, and Exclusion Set are enabled. If you are using a toll matrix, the Road Toll drop-down list is also enabled.
   - Type values for the PCE and VOT that describe the vehicle mode.
   - If fixed tolls are to be used, choose the fixed toll field for the mode from the drop-down list under Fixed Toll.
   - If entry-to-exit tolls are to be used, choose the mode toll matrix from the drop-down list under Road Toll.

- If exclusion sets are to be used, choose the selection set for the mode from the drop-down list under Exclusion Set.

9. Make any changes under Delay Function Parameters as you would for Traffic Assignment. You may choose fields that describe the parameter for each link from the Field drop-down list or put in a default value that is used for all links in the edit box.

10. Click Options to display the Options dialog box. Choose options as described in the procedure To Perform Traffic Assignment, then click OK to return to the Assignment with User VDF dialog box.

11. Click OK. TransCAD displays the Store Flow Table In dialog box. Type a file name and click Save.

    If you chose to report values of link flows and V/C ratios, class shares, or toll volumes in the Options dialog box, TransCAD displays the Output File Settings dialog box. Choose to use, rename, or overwrite each file as described below, and click OK.

If the status is...	Do this...
In Use or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

12. TransCAD simultaneously assigns traffic flow, from all specified vehicle modes, to the links in the network, creates a link flow table and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays a joined view with the resulting flow table. Depending on what options you chose, TransCAD may also create a matrix file containing zone-to-zone O-D flow passing over critical links, report tabulations of flow and V/C ratios, or display a color theme of V/C ratios.

Assignment by Trip Purpose: An Application of MMA

The MMA procedure can be used to perform simultaneous assignment of trips by trip purpose. This provides an informative portrait of network utilization by purpose.

Traffic Assignment with Volume-Dependent Turning Delays and Signal Optimization

Traditionally, the traffic assignment models used by planners treat intersections simplistically, if at all. Turning movement penalties may be used that are fixed and not sensitive to flow. In reality, however, network flow patterns are strongly related to traffic signal settings. This is the result of users making path choices that vary with control strategies and their associated network performance characteristics (Cantarella et al. (1991)).

In contrast to planning models, the traffic engineering models used for signal optimization ignore the impacts of signal settings on path flows. This leads to sub-optimal and possibly poor signal settings. The Assignment with Volume-Dependent Turning Delays and Signal Optimization procedure breaks new ground by integrating traffic assignment procedures with detailed intersection models. This algorithm optimizes the signal timings, assuming that the intersections operate in isolated mode.

For more information, see:
Preparing Data for Assignment with Volume-Dependent Turning Delays
Displaying Intersection Flows for Assignment with Volume-Dependent Turning Delays
Optimizing Lights in Assignment with Volume-Dependent Turning Delays
Signalized Intersection Delay Models
Signal Optimization
Uncontrolled Intersections and Link Delays
SUE Assignment
The Movement File

Top

Preparing Data for Assignment with Volume-Dependent Turning Delays

The Assignment with Volume-Dependent Turning Delays and Signal Optimization procedure requires:

- A network file
- An O-D trip table
- An intersection movement and signal parameter file

This procedure performs a User Equilibrium or a Stochastic User Equilibrium Assignment over a network containing signalized and uncontrolled intersections, and provides a more realistic assignment for networks with congestion and intersection delay. Optionally, the procedure will re-time traffic signals to reduce delays and estimate link volumes for selected links by O-D pair.

Before using this procedure, you must do the following:

1. Prepare node and line layers that contains intersection and link data. The node layer (intersection data) requires the following fields:

   - Node type (required): a numeric field that defines the intersection type based on the

following values: 1 for Signalized, 2 for Controlled with a Yield or Stop Sign, 8 for Ignore Turning Delay, or 9 for Centroid.

- Cycle length (optional): if the cycle length for each signalized intersection is known, it will be used to estimate the turning delays; otherwise, the cycle length will be calculated from the effective green time, lost time, and phasing structure.

The line layer (link data) requires four fields:

- A field for the free flow travel time (Input)
- A field for the link's capacity (Input)
- A field for the α parameter of the BPR delay function (Input)
- A field for the β parameter of the BPR delay function (Input)

2. Construct a network from some or all of the segments in the line layer. Make sure that all the fields marked as Input in the previous step are included in the network file. Both the line layer and the node layer attributes are required in the network file.

3. Construct an O-D demand table from all or some of the centroid nodes. Flows from non-centroid nodes in the demand table will not be assigned and an appropriate error message will be appended to the master log file.

4. Construct the turning movements file. This file is the exact representation of each of the turning movements and control parameters of the network. See The Movement File for more information and an example.

For more information, see:
To Perform Traffic Assignment with Volume-Dependent Turning Delays and Signal Optimization

Top

) To Perform Traffic Assignment with Volume-Dependent Turning Delays and Signal Optimization

1. Open a map containing the line and node layers from which the network was built. Make sure either that the node or line layer shows in the drop-down list on the toolbar and that the correct network is active.

2. Open the travel demand matrix file and the movements and signal parameters file.

3. Choose **Planning-Advanced Assignment-Volume-Dependent Turning Delays** to display the Assignment with Volume-Dependent Turning Delays dialog box.

4. Choose the User Equilibrium (UE) or Stochastic User Equilibrium (SUE) assignment method from the Method drop-down list.

5. Choose the travel demand matrix file and the O-D demand matrix to be assigned from the Matrix File and Matrix drop-down lists, respectively.

6. Choose the movements and signal parameters file from the Movement Dataview drop-down

list.

7. Choose the delay model for the signalized intersections from the Delay Method drop-down list.

8. Under Fields, choose node and link variables as follows:

To change...	Do this...
The free-flow travel time link variable	Choose a field from the Time drop-down list
The intersection type node variable	Choose a field from the Node Type drop-down list
The capacity link variable	Choose a field from the Capacity drop-down list
The α parameter link variable	Choose a field from the Alpha drop-down list
The β parameter link variable	Choose a field from the Beta drop-down list

9. Under Default Settings make changes as follows:

To do this...	Do this...
Change the maximum iterations	Type a value in the Iterations text box.
Change the convergence criteria	Type a value in the Convergence text. box. If the maximum change in link flow and turning movement flow between two successive iterations is less than this value, the assignment for the current traffic signal program will terminate.
Change the BPR α parameter	Type a value in the Alpha text box.
Change the BPR β parameter	Type a value in the Beta text box.
Change the percentage error	If the SUE method is used, type a value for the error term in the Error text box. This value is used to estimate the standard deviation of the perceived travel time from the deterministic value.
Set the stochastic function	If the SUE method is used, set the stochastic function from the drop-down list.

10. If you want to optimize the traffic signals, do the following:

   - Check the Optimize Lights box
   - Type the maximum number of traffic light optimization iterations in the Iterations text box
   - Type the convergence value for traffic signal optimizations in the Convergence text box

11. If you want to use a fixed cycle time length, do the following:

   - Check the Fixed Cycle box
   - Type the value of the cycle time length in seconds that will be used for all the signals in the Fixed Cycle edit box
   - Type the minimum green time length in the Min Green Time text box
   - Type the lost time between phases in the Lost Time text box

12. Click OK to display the Store Results In dialog box. Type a file name and click Save.

13. TransCAD creates the solution tables and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD produces three files, each using the file name you chose in step 12 plus an appended letter, "l" for link flows, "n" for node information, and "m" for movement flows.

Top

Displaying Intersection Flows for Assignment with Volume-Dependent Turning Delays

You can use the Display Intersection Flows tool to graphically display the reported turning movements from the Assignment with Volume-Dependent Turning Delays procedure. You need to have the turning movements table and the base network geographic file open to use this tool.

For more information, see:
To Display Intersection Flows for Assignment with Volume-Dependent Turning Delays

Top

⟩ *To Display Intersection Flows for Assignment with Volume-Dependent Turning Delays*

1. Open the movement table and the base geographic file.

2. Choose *Planning-Planning Utilities-Display Intersection Flows* to display the Display Intersection Flows dialog box.

3. Choose the movement view from the Table Name drop-down list.

4. Choose the field that contains movement volumes Movement Field drop-down list.

5. Type a title and footnote, if desired, in the Title and Footnote edit boxes.

6. If you want to display road labels in the intersection diagram, choose a line layer field that contains road names or road labels from the Link Labels drop-down list.

7. If you want to label the legs of the intersection with the value of flow, check the Display Flow Labels box.

8. Click OK to display the Intersection toolbox.

9. Choose the intersection node ID you wish to display from the toolbox dropdown list.

10. Click to display an intersection diagram for the chosen node ID.

11. Click and click on a node on the map to display an intersection diagram for that node.

12. Click to display the Display Intersection Flows dialog box and reconfigure the settings.

13. Click the close box in the upper right corner of the toolbox.

TransCAD closes the Intersection toolbox.

Optimizing Lights in Assignment with Volume-Dependent Turning Delays

The Assignment with Volume-Dependent Turning Delays procedure performs User Equilibrium or Stochastic User Equilibrium assignment on a partially- or totally-signalized network. The procedure can be used in one of two modes:

- Evaluation/Prediction Mode: if you do not check the Optimize Lights box in the Volume-Dependent Turning Delays dialog box, the procedure will perform a traffic assignment run, taking the traffic signal parameters from the movement's input file.
- Optimization Mode: the procedure will perform a succession of traffic assignment runs and traffic signal optimizations. At each iteration, the procedure will re-optimize the traffic signal settings based on the flows obtained from the previous assignment run.

Evaluation/Prediction Mode

Conventional traffic assignment models offer the option to take turning penalties into account. These turning penalties are fixed, pre-determined values that depend only on the kind of movement involved (left turn, right turn, through movement, etc.) and in no way reflect the relation existing between traffic flow, signal setting (cycle length, green time length, etc.) and the delay caused to the traffic flow. When used in place of conventional assignment models as an evaluation tool, the Assignment with Volume-Dependent Turning Delays procedure has the advantage that the delay caused to traffic flow at intersections is explicitly modeled as a function of the incoming traffic flow and the settings of the traffic lights.

The formulation of the assignment problem in this mode is similar to the formulation of the standard User Equilibrium assignment problem of Beckman *et al.* (1956). At user equilibrium, the travel time on all routes actually used is less than or equal to that which would be experienced by a single vehicle on any unused route. Beckman *et al.* formulated the user equilibrium assignment problem as the following nonlinear optimization problem (for a detailed description, proof of convergence, and solution algorithm, refer to LeBlanc *et al.* (1975)):

$$\min \quad \sum_{ij} \int_0^{x_{ij}} t_{ij}(u)\,du$$

Subject to:

$$D(j,s) + \sum_i x_{ij}^s = \sum_k x_{ik}^s \qquad \begin{array}{l} j = 1,\ldots,n \\ s = 1,\ldots,p \\ j \neq s \end{array}$$

$$x_{ij}^s \geq 0$$

where:

n = Number of nodes in the network

p = Number of origins and destinations

x_{ij} = Represents the total flow on link ij

x_{ij}^{s} = Flow on link ij with destination s

$t_{ij}(\cdot)$ = Represents the relationship between flow and travel time for link ij

$D(j,s)$ =   Flow originating at node j with destination s

In the formulation above, the link performance function $t_{ij}(x)$ depends only on the value of flow. In the case of a signalized intersection, the delay is a function of the traffic flow, and the traffic signal parameters (cycle length, green time, etc.):

$$t(x, \mathbf{g})$$

where $\mathbf{g}$ represents the traffic signal setting parameters.

Therefore, in the Assignment with Volume-Dependent Turning Delays procedure, the objective function of Beckman's formulation is replaced by:

$$\min \quad \sum_{ij} \int_{0}^{x_{ij}} t_{ij}\left(u, \mathbf{g}\big|_{\text{fixed}}\right) du$$

A general requirement for convergence of the User Equilibrium assignment is that the flow-delay relationship be a convex, non-decreasing, and positive function. It can be shown that, for a fixed,

predetermined set of traffic control parameters, the delay function $t\left(\cdot, \mathbf{g}\big|_{\text{fixed}}\right)$ satisfies the same conditions required from the link performance function of the standard User Equilibrium assignment problem. Therefore, this problem is a convex optimization subject to linear constraints, meaning that the assignment method converges to a unique solution. A basic assumption of this formulation is that link interactions are not significant, meaning that the delay caused to one movement (or link) is caused by the flow on that link only. In a signalized network, this assumption is true only in the case where the traffic signals are pre-timed. In the case of traffic-actuated signals, the delay on one stream can be caused by traffic on other streams.

Optimization Mode

In current traffic management practice, it is customary to optimize traffic signal parameters (cycle time, green time splits, offsets, etc.) assuming that the traffic flow pattern is given and independent of the chosen control policy. This traffic flow pattern is usually obtained by direct measurement at some intersections or by running a standard traffic assignment problem with a fixed origin-destination (O-D) table. It is worth noting that standard traffic assignment models represent the delays at signalized intersections only approximately, if at all.

As early as 1974, Allsop (1974) reported the interdependence existing between traffic control parameters and the assignment (route choice):

"When all or part of the network is subject to traffic control, the relationships between travel cost and traffic flow on some or all of the links in the network depend on the control parameters, and these can therefore be used to influence the number of journeys made through the network and the routes taken."

The performance of the transportation system is the result of the interaction between the traffic management strategy (where the objective is an optimum performance from the system's point of view) and the individual network users (who wants to optimize their own travel time). This problem can be solved by a global optimization approach. This assumes a system performance index that depends on the flow pattern and the control parameters, subject to flow conservation constraints and an additional constraint expressing the Wardrop's User Equilibrium Principle:

$$\min \quad \sum_{\forall \text{ links } i} x_i t_i \left(x_i, \mathbf{g} \right)$$

st: Conservation of flow equations
     The flows satisfy the user equilibrium conditions

Global optimization is difficult to achieve because of the non-linear constraint present. An additional difficulty is the non-convex relationship existing between vehicle delay and the traffic signal controls. Some solution methods for this approach have been developed for extremely small and simple networks (Tan et al. (1979)). No practical global optimization method exists to solve real-size networks.

An alternative to the global optimization method is a heuristic iterative procedure originally suggested by Allsop (1974). The iterative optimization-assignment algorithm is a procedure consisting of successive alterations between a signal-optimization procedure and a traffic flow assignment program. During the assignment phase, the traffic control parameters are assumed to be fixed, and during the signal optimization phase the traffic flow pattern is assumed to be fixed. The iterative procedure does not necessarily converge to the optimal solution of the global optimization formulation (see Harker and Friesz (1984)). Dickinson (1981) showed that it can occur (see the numerical example) and that the network total cost can increase from one iteration to another, leading to a non-optimal solution.

However, as shown by Van Vuren et al. (1987), better traffic conditions may be identified by the iterative algorithm. They applied this iterative methodology with three different traffic management policies and obtained, after 20 iterations, a decrease in total travel time of around 28%. Applications of the iterative methodology have been mentioned by Harker and Friesz (1984), Luk (1978), Gartner et al. (1980) and others.

The iterative algorithm can be formulated as the following two-stage process:

Stage 1: User Equilibrium Assignment

$$\min z(x) = \sum \int_0^{x_i} t(u, \mathbf{g}) \big|_{g \text{ fixed}} du$$

st : flow conservation equations

Stage 2: Signal Optimization

$$\min J[x(\mathbf{g}), \mathbf{g}]\big\|_{x \text{ fixed}}$$

$$st: \text{ feasibility of control parameters}$$

The Assignment with Volume-Dependent Turning Delays procedure offers an iterative procedure for the User Equilibrium and Stochastic User Equilibrium assignment, which take account of traffic signal settings. An initial set of traffic signal parameters is assumed to be fixed. With this set of control parameters, a whole converged assignment is produced. The resulting flows are then used to produce optimal traffic signal settings based on Webster's method (Webster and Cobbe (1966)). This process is repeated until the change between two successive iterations is less than a specified convergence value. As previously mentioned, this approach might not converge to a global optimum. The procedure stores the best solution encountered. For further details of the iterative assignment-control problem refer to Tan et al. (1979), Allsop (1974) and Cantarella et al. (1991).

Signalized Intersection Delay Models

The traffic assignment model requires the definition of link performance functions. These link performance functions reflect the travel impedance associated with the link and intersections. In the case of a signalized network, the link performance functions depend obviously on the traffic control parameters.

The mathematical models used to estimate intersection delay are queuing models. The modeler views the traffic on each approach as a stream of customers seeking service from a server.

Assume that the vehicles arrive at a rate of q vehicles per time unit and can enter the intersection at a maximum rate of s vehicles (saturation flow) when the light is green. If the cycle length is c and the length of the green interval is g, it follows that the intersection can handle a maximum of $(g/c)s$ vehicles per unit time.

Definitions
- Phase: The portion of a signal cycle allocated to any single combination of one or more traffic movements simultaneously receiving the right-of-way.
- Cycle: A complete sequence of signal indications.
- Effective green time: Green time length plus yellow time.
- Lost Time: Time during which the intersection is not used by any movement. This time occurs during the change interval (when the intersection is cleared), and at the beginning of each phase.

g = Green time length
c = Cycle length
λ = Fraction of the time the signal is green (g/c)
s = Saturation flow

Q = Capacity of the approach $\left(\dfrac{g}{c}s\right)$

x = Degree of saturation; $\dfrac{q}{C}$ or $\dfrac{qc}{gs}$

The operation of a signalized intersection approach can be represented as graphically as follows. $A(t)$ represents the arrival rate by time t and $D(t)$ the departure rate. When the light is red, there are no departures (the curve is horizontal). When the light turns green, cars begin to move, and after an initial lost time, cars depart with a slope equal to the saturation flow.

If the system works approximately on a first-in first-out (FIFO) basis, the waiting time for vehicle i can be determined easily. The area between $A(t)$ and $D(t)$ is equal to the total delay suffered by all the vehicles who use the intersection approach. Dividing this area by the number of arrivals per cycle yields the average delay per vehicle. After some algebraic manipulations, the average uniform delay can be obtained as:

$$d_u = \frac{c\left(1 - g/c\right)^2}{2\left(1 - q/s\right)}$$

This delay was obtained under the assumption that vehicles arrive at a uniform rate q. Vehicles, however, arrive at intersections in a random manner. The best known of the delay models was given by Webster (1958). This model consists of three parts: the first part is the uniform delay model, the second part predicts the overflow delay caused by the stochastic (Poisson) arrival rate of the vehicles, and the third part is a correction term obtained by simulation results:

$$d = \frac{c\left(1 - g/c\right)^2}{2\left(1 - q/s\right)} + \frac{(q/Q)^2}{2q(1 - q/Q)} - 0.65\left(c/q^2\right)^{1/3}\left(c/q^2\right)^{(2+5g/c)}$$

This model has the disadvantage that it does not satisfy the conditions needed for the traffic assignment problem. This model is an asymptotic function, meaning that it generates infinite travel times when flow approaches capacity, and does not work at all in the over-saturation region. It usually happens, especially for considerably congested networks, that during some iterations of the assignment model more traffic is assigned to a link than its capacity.

Several delay models for over-saturated intersections have been developed. Akcelik (1988) developed a generalized delay formula that can replicate the values obtained by these models by means of the calibration parameters:

$$d(x) = \frac{0.5(1 - \lambda)^2}{1 - \lambda x} + 900Tx^n\left[(x - 1) + \sqrt{(x - 1)^2 + \frac{m(x - x_0)}{QT}}\right]$$

where:

d = Average overall delay (including stop-start delays) in seconds per vehicle

c = Signal cycle time length in seconds

g = Effective green time

λ = Ratio of effective green time to cycle time (g/c)

Q = Capacity in vehicles per hour

T = Flow period in hours

x = Degree of saturation (ratio of arrival flow to capacity)

m, n = Calibration parameters

x_0 = Degree of saturation below which the second term of the delay formula is zero

($x_0 = a + bsg$)

s = Saturation flow rate in vehicles per second

a, b = Calibration parameters

Here are calibration parameter values for various delay models:

	Parameter Values			
Delay Method	n	m	a	b
HCM	2	4	0	0
Australian	0	12	0.67	1/600
Canadian	0	4	0	0
TRANSYT 8	-1	4	0	0
Alternative to HCM	0	8	0.5	0

Signal Optimization

The optimization of the signals settings in the Assignment with Volume-Dependent Turning Delays procedure is done according to Webster's method (Webster 1958; Webster and Cobbe 1966). Webster developed an approximate formula for determining the optimum cycle length in terms of minimum delay:

$$c_{opt} = \frac{1.5L + 5}{1 - \sum_i y_i}$$

where:

c_{opt} = Optimum cycle length

L = Lost time per cycle

y_i = Flow divided by the saturation flow

i = Phase index

The cycle time is divided into the different phases proportional to the movement volume.

Uncontrolled Intersections and Link Delays

The formula used to analyze the delay at the links and unsignalized intersections is based on the equation developed by the U.S. Bureau of Public Roads, and known as the BPR function:

$$t(q) = t_0 \left[1 + \alpha \left(\frac{q}{C} \right)^{\beta} \right]$$

where:

q = Flow

t_0 = Free flow travel time

C = Link practical capacity

α, β = Calibration parameters

SUE Assignment

The Assignment with Volume-Dependent Turning Delays procedure provides the option of a Stochastic User Equilibrium (SUE) formulation for the traffic assignment. SUE gives more realistic results because all utilized paths need not have the same generalized costs. For a general description of the Stochastic User Equilibrium assignment, see Chapter 9, *Traffic Assignment*, or see Sheffi (1985) or Slavin (1995).

The Movement File

The movement file holds information about the turning movements and defines the delay function parameters that apply when moving through intersections. There is one record for each turning movement; an intersection can have one or more records for turning movements at that intersection. The movement file must contain the following fields:

- ID: the ID of the movement record
- NODE: the ID of the intersection
- FROMLINK: the ID of the "from" link
- TOLINK: the ID of the "to" link
- SATURATION: the saturation flow
- GREEN: the effective green time length
- PHASE: the phase number
- CONTROL: a code specifying the type of control at non-signalized intersections (0 for no sign, 1 for yield sign, or 2 for stop sign)
- DELAY: use this delay value for intersections marked with the "Ignore" code

The information for each turning movement depends on the type of the intersection:

- Centroids: each record contains NODE, FROMLINK, and TOLINK. One of the two links should have the ID -1 (indicating a dummy link).
- Signalized intersections: each line contains NODE, FROMLINK, TOLINK, SATURATION, GREEN, and PHASE.
- Unsignalized intersections: each line contains NODE, FROMLINK, TOLINK, and CONTROL.

Here is a movement file for a sample network:

```
  ID    Node   FromLink   ToLink   Saturation    Green    Phase   Control    Delay
 974    597     599600    599597         3000       25        1       --         0
 975    597     599600    588599         3000       25        1       --         0
 976    597     601599    599597         4200       25        2       --         0
 977    597     601599    588599         4200       25        2       --         0
 978    598     600598    599600           --       --       --       --        15
 979    598     600598    601600           --       --       --       --        15
```

Top

Combined Trip Distribution/Traffic Assignment Model

Combined trip distribution and traffic assignment models are used to find simultaneous solutions to trip distribution and traffic assignment problems. By joining these two steps in the traditional transportation planning process, these models can predict the spatial pattern of trips between O-D pairs as well as estimate the flow of traffic on network links. TransCAD provides a procedure to perform the combined modeling process.

For more information, see:
About the Combined Trip Distribution/Traffic Assignment Model
Inputs and Outputs of the Combined Trip Distribution/Traffic Assignment Model
Performing a Combined Trip Distribution/Traffic Assignment
Mathematical Formulation and Solution Algorithm for Combined Trip Distribution and Traffic Assignment

About the Combined Trip Distribution/Traffic Assignment Model

As mentioned in the previous chapters, the traditional urban transportation demand modeling process is composed of four steps, and each step simulates the traveler's decision making on one aspect of trip making:

- Trip generation predicts whether to make a trip
- Trip distribution finds where to go
- Modal split figures out which transportation mode to use
- Traffic assignment estimates which route to take for the trip

Typically, these steps are performed sequentially, with the outputs from one step used as inputs to the next step.

While in many cases the traditional transportation demand modeling process has provided forecast results sufficiently accurate for long-range transportation planning, it has been found that some outputs of the process are not always consistent with inputs to earlier steps. For instance, link speeds estimated in the final step of the process may differ from those used in earlier steps. This results from the inconsistency among the different models with regard to the definition of variables and coefficient values used for each model.

One way to solve the problem is to use "feedback", i.e., solving the sequential models iteratively by reintroducing output of the last step as input to the first step, until an overall equilibrium within the forecasting system is reached. The equilibrium is considered achieved when changes in certain system variables fall below a predetermined convergence criterion. Such methods, however, incur high computational cost, and frequently fail to converge. Moreover, solving the sequential models for different alternatives is a cumbersome task.

Another method to eliminate the inconsistency is to adopt simultaneous models, which combine several steps in the traditional modeling process. The most commonly encountered simultaneous models are those that solve combined trip distribution and traffic assignment problems, or combined trip distribution, modal split and traffic assignment problems. In the combined models, consistency in variables such as link time and link speed is constantly maintained, and an optimal equilibrium will always be reached. Combined models are well described in various papers by David Boyce (e.g., Boyce et al, 1992) and in Oppenheim (1995).

TransCAD provides a procedure to solve the combined trip distribution and traffic assignment problem. The solution to trip distribution is based on the gravity model, and the solution to traffic assignment satisfies the conditions of User Equilibrium (UE). The combined model, referred to hereafter as the TD-UE model, will be useful for travel forecasting in urban areas where highway travel plays a predominant role in the transportation system.

Inputs and Outputs of the Combined Trip Distribution/Traffic Assignment Model

The data required for the TD-UE model include a network, with the appropriate link and node fields, and the line layer from which the network was derived.

The required and optional network attributes and settings include all that are needed for running the UE assignment; for more information, see Chapter 9, *Traffic Assignment*. In addition, the TD-UE model requires three network node attributes:

Attribute	Type	Contents
Node Type	Integer	Code of node types
Production	Numeric	Number of trips produced by each zone (centroid node)
Attraction	Numeric	Number of trips attracted to each zone (centroid node)

The corresponding fields for these attributes must exist in the node layer associated with the line layer from which the network was derived. When the network is being created, these node attributes must be included. See Chapter 9, *Networks and Shortest Paths*, in the *TransCAD User's Guide* to learn how to incorporate node attributes in a network.

The TD-UE model also needs two variables:

Variable	Contents
Centroid Code	Node type code for a centroid node
Dispersion	A parameter that controls how flows from each origin distribute among all its destinations

In the node layer, the value of the Node Type field of all centroid nodes must be equal to the value of Centroid Code, and the value for all non-centroid nodes must be different from the value of Centroid Code.

If the Dispersion parameter is set to zero, then the overall O-D flow pattern will be such that system-wide total travel time will be minimized. If the Dispersion parameter is set to a very high value, then flows out of each origin tend to distribute evenly among all its destinations. As a rule, the value of this parameter should be set close to the observed system-wide average travel time in minutes.

The TD-UE model produces a flow table, similar to the standard UE assignment model output. In addition, it also creates an O-D matrix that contains the vehicle volumes assigned for each O-D pair, as calculated by the TD-UE model.

Top

Performing a Combined Trip Distribution/Traffic Assignment

Before conducting a combined trip distribution and traffic assignment in TransCAD, you must build

a network that contains all the required node and link attributes.

For more information, see:
To Perform Combined Trip Distribution/Traffic Assignment

Top

⟩ *To Perform Combined Trip Distribution/Traffic Assignment*

1. Open a map containing the line layer from which the network was built. Make sure that the line layer shows in the drop-down list on the toolbar and make sure that the correct network is active.

2. Choose *Planning-Advanced Assignment-Combined Distribution-Assignment* to display the Combined Trip Distribution/Assignment dialog box.

3. Choose a method from the O-D Method drop-down list.

4. Set node attributes as follows:

To do this...	Do this...
Specify the node type field and centroid code	Choose the field that contains the node types from the Node Type drop-down list and type the code used for centroids in the Centroid Code edit box
Specify the production and attraction fields	Choose fields from the Production and Attraction drop-down lists

5. Set link attributes by choosing the designated fields for time, capacity, pre-load volume, alpha, and beta from the corresponding drop-down lists.

6. If necessary, change any global variables for iterations, convergence, occupancy, alpha, beta, and dispersion by typing values in the corresponding edit boxes.

7. Click Options to display the Options dialog box.

    Choose options as follows:

Option	Description
Report Cold Start	Flow over the initial cold start period will be reported in the output table
Gravity Iterations	Number of iterations for the gravity portion of the model
Convergence	Convergence criteria for gravity portion
Beta	Model Beta parameter
Constraint	Production, Attraction, or Doubly constrained

    Click OK to return to the Combined Trip Distribution/Assignment dialog box.

8. Click OK to display the Output File Settings dialog box. Choose to use, rename, or overwrite each file as described below, and click OK.

If the status is...	Do this...
In Use or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you

9. TransCAD finds the O-D flows, assigns traffic flow to the links in the network, creates a link flow
    table, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the results in a joined view.

Mathematical Formulation and Solution Algorithm for Combined Trip Distribution and Traffic Assignment

In general, combined trip distribution/traffic assignment models are categorized into two groups:

*   Singly-constrained models, in which only the number of trips leaving each origin is controlled
*   Doubly-constrained models, in which both the numbers of trips leaving origins and the number of trips arriving at destinations are constrained to specified totals

Evans was among the first who studied the mathematical formulation of the combined distribution/assignment problem. She proposed the following formulation for the doubly-constrained combined model (Evans, 1976):

$$\min z(\mathbf{x}, \mathbf{q}) = \sum_a \int_0^{x_a} t_a(\omega) d\omega + \frac{1}{\zeta} \sum_{rs} \left(q_{rs} \ln q_{rs} - q_{rs} \right)$$

(1)

subject to:

$$\sum_k f_k^{rs} = q_{rs} \qquad \forall r, s \qquad (u_{rs})$$

$$\sum_s q_{rs} = O_r \qquad \forall r \qquad (\mu_r)$$

$$\sum_r q_{rs} = D_s \qquad \forall s \qquad (\lambda_s)$$

$$f_k^{rs} \geq 0 \qquad \forall k, r, s$$

where :

x_a = Flow on link a

x = The set of link flows

q_{rs} = Flow between origin r and destination s

q = The set of O-D flows

t_a = Travel time on link a

f_k^{rs} = Flow on path k between O-D pair r-s

ζ = A parameter

The first three constraints in the program are for flow conservation, and the variables in parentheses to the right of the constraint equations are associated dual variables. The last constraint is to maintain flow non-negativity. Evans proved that this optimization problem is convex, is equivalent to the combined trip distribution and traffic assignment problem, and has a unique

solution with respect to link flow x_a and O-D flow q_{rs}. The combined model that TransCAD uses is based on this formulation.

The first term in the objective function is the same as that for the User Equilibrium assignment model, and its minimization ensures that in the final solution, link flows satisfy the user equilibrium conditions.

The second term in the equation represents the entropy model, which was originally applied to urban and regional planning problems by Wilson (1970). Let each unique combination of travel decisions made by all the users in the system be a *state* of the system, then any set of O-D flow pattern **q** is an aggregation of such states which satisfy flow conservation constraints. It is assumed in the entropy model that all states are equally likely to occur, and thus the distribution pattern **q** that is most likely to occur is the one that contains the greatest number of states that satisfy the constraints. To maximize the number of states associated with a particular O-D distribution $N(\boldsymbol{q})$ is the same as to maximize its logarithm, given by:

$$\max \ln N(\mathbf{q}) = \ln \frac{Q!}{\prod_{rs} q_{rs}} = \ln Q! - \sum_{rs} \ln q_{rs}!$$

(2)

where Q is the total number of trips in the system (i.e., $Q = \sum rs\ qrs$). Since **ln** $Q!$ is a constant, after using Stirling's formula the objective function becomes

$$\min \sum_{rs} \left(q_{rs} \ln q_{rs} - q_{rs} \right)$$

(3)

which is the major component of the second term in equation (1). It can be shown (Sheffi, 1995) that the derivatives of the Lagrangian of program (1) with respect to the path flow variables f_k^{rs} result in the UE conditions, and that the derivatives of the Lagrangian with respect to the O-D flow

q_{rs} are given by

$$\frac{1}{\zeta}\ln q_{rs} + u_{rs} - \mu_r - \lambda_s = 0 \quad \forall r,s$$

(4)

The results can be converted to a more familiar form of gravity model equation:

$$q_{rs} = A_r B_s O_r D_s e^{-\zeta \mu_{rs}} \quad \forall r,s$$

(5)

where A_r and B_s are the balancing factors for origin r and destination s respectively; for more information, see Chapter 6, *Trip Distribution*. It is seen in (5) that the friction factor is composed of an exponential function.

Since travel costs are not considered in the entropy model, the entropy model tends to distribute trips from each origin evenly among all its destinations. The parameter ζ in equation (1) serves as weight. The smaller its value, the larger influence the entropy model will have on the final solution, and a greater trip dispersion in O-D flows will be observed.

Parameter ζ is negatively related to the influence of the friction factor and thus positively related to the level of dispersion in O-D flows. In other words, the larger the value of ζ, the greater the dispersion in O-D flows would be. In TransCAD, a parameter d, $d = 1/\zeta$, is used. d is called the dispersion parameter, since it is positively related to the level of O-D flow dispersion. ζ (or d) should be calibrated from data if observed O-D counts are available. Otherwise, d can be set close to the observed system-wide average travel length in minutes (Metaxatos and Boyce, 1995).

The solution algorithm adopted for the combined trip distribution and traffic assignment problem is given in Metaxatos and Boyce (1995).

Top

Creating Volume Delay Function DLLs

You can create a volume delay function DLL in TransCAD to solve traffic assignment problems. For the Volume Delay Function (VDF) to be valid, it must satisfy several requirements that guarantee convexity and therefore convergence of the traffic assignment problem:

- The function is non-decreasing and monotone
- The function should be continuous and differentiable
- The function must be defined for oversaturated regions (during the assignment process, some links will be loaded with more traffic than their capacity).

The DLL must be compiled with Microsoft Visual C version 6.0 or higher using the __**fastcall** argument-calling convention. If the target file name has a .VDF extension and is placed in the TransCAD program directory, TransCAD will find the file and offer it as an option to the User-Defined VDF Assignment procedure. If the DLL is not properly compiled or does not include all the necessary functions, TransCAD will return error messages. The definitions of some constants required by TransCAD are provided in the file vdfdll.h.

To initialize the DLL, the following procedure needs to be provided:

    void InitVDFDLL(int *ptc_status)

To get a descriptive string:

    short _export VDF_GetLabel(char *label)

To get the list of parameters and their default values, the following function should be included:

    long VDF_GetNParameters(void)
    short VDF_GetParameters(char **param_names)
    short VDF_GetDefaults(double *d)

The link values are passed in a matrix of 4-byte floating-point values. The matrix has two rows more than the number of parameters returned by VDF_GetNParameters (*n*). The number of columns will be the number of links. The first parameter is expected to be the free-flow cost of the link. The second parameter is expected to be the capacity of the link. The last variable (n+2) will be the current cost of the link as filled in by the DLL and the last but one parameter will be the link type.

After initializing the DLL and getting the parameter information the matrix values need to be initialized. Initialization of the matrix is done with the pre-process function:

    short VDF_Preprocess(float **Cost, long *links, void *defaults, short *types, short *n_types, short *LinkDisabled)

The pre-process function needs to be called even if the cost array has already been initialized, since this is where the DLL gets the number of links that is needed to access the cost matrix. The defaults array is either a one-dimensional array of default values for each parameter or a two-dimensional array where the links have default values that are dependent on their type.

The cost retrieval functions are:

    double   VDFValue(double *FlowVal, long *link, float **Cost)
    void   VDFValues(double *Flow, float **Cost, long *links)
    void   VDFTimeOnly(double *Flow, float **Cost, long *links)
    double   PreLoad_VDFValue(double FlowVal, long *link, float **Cost)
    void   PreLoad_VDFValues(double *Flow, float **Cost, long *links)
    void   PreLoad_VDFTimeOnly(double *Flow, float **Cost, long *links)

For more information, see:
Example of a Generalized Cost Volume Delay Function

Top

Example of a Generalized Cost Volume Delay Function

    #include <math.h>
    #include <string.h>
    #include <malloc.h>

```c
#include "vdfdll.h"

#ifndef NULL
#define NULL 0
#endif

typedef enum field_
{
   T0,
   CAPACITY,
   LENGTH,
   ALPHA,
   BETA,
   PRELOAD,
   K,
   OP_COST,
   VOT,
   TYPE,
   CURRENT,
   N_FIELDS
} FIELD;

static short    Required[N_FIELDS-2] = {1,1,1,1,1,0,1,1,1};

static int *_platform_tc_status;

static double BigReal = flt_max;
static double Threshold = 0.;


void DLLEXPORT InitVDFDLL(int *ptc_status)
{
   _platform_tc_status = ptc_status;

}

double DLLEXPORT VDFValue(double *FlowVal, long *link, float **Cost)
{
   double RetCost, ratio, ratio4, lambda;

   *_platform_tc_status = TC_OKAY;

   if (Cost[T0][*link] == flt_miss || Cost[CAPACITY][*link] == flt_miss)
      return ((double)Cost[T0][*link]);          // Uncapacitated link
   else
    {
    if (Cost[CAPACITY][*link] > 0.0)
      ratio = *FlowVal / Cost[CAPACITY][*link];
    else
      ratio = BigReal;

    if (ratio >= BigReal)
       ratio4 = ratio;
    else
       ratio4 = pow(ratio, Cost[BETA][*link]);

    lambda = 1.0 + Cost[ALPHA][*link] * ratio4;


    RetCost = Cost[K][*link] + Cost[OP_COST][*link] * Cost[LENGTH][*link] +
           Cost[VOT][*link] * Cost[T0][*link] * lambda;
    }
```

```
        return((double)RetCost);
}


void DLLEXPORT VDFValues(double *Flow, float **Cost, long *links)
{
    long    link;
    double  ratio, ratio4, lambda;

    *_platform_tc_status = TC_OKAY;
    Threshold  = 0.;

    for (link = 0; link < *links ; link++ )
      {
        if (Cost[T0][link] == flt_miss)
            {
            Cost[CURRENT][link] = flt_miss;
            continue;
            }

        if (Cost[CAPACITY][link] == flt_miss)
            {
            Cost[CURRENT][link] = Cost[T0][link];
            }
        else
          {
          if (Cost[CAPACITY][link] > 0.0)
            ratio = Flow[link] / Cost[CAPACITY][link];
          else
            ratio = BigReal;

            if (ratio >= BigReal)
                ratio4 = ratio;
            else
              {
              ratio4 = pow(ratio, Cost[BETA][link]);
              }

            lambda = 1.0 + Cost[ALPHA][link] * ratio4;

            Cost[CURRENT][link] = (float)(Cost[K][link] + Cost[OP_COST][link] * Cost[LENGTH][link] +
                        Cost[VOT][link] * Cost[T0][link] * lambda);

          }

        Threshold = max(Threshold, Cost[CURRENT][link]);
      }
}

void DLLEXPORT VDFTimeOnly(double *Flow, float **Cost, long *links)
{
    long    link;
    double  ratio, ratio4, lambda;

    *_platform_tc_status = TC_OKAY;
    Threshold  = 0.;

    for (link = 0; link < *links ; link++ )
      {
        if (Cost[T0][link] == flt_miss)
```

```c
        {
        Cost[CURRENT][link] = flt_miss;
        continue;
        }

    if (Cost[CAPACITY][link] == flt_miss)
        {
        Cost[CURRENT][link] = Cost[T0][link];
        }
    else
       {
       if (Cost[CAPACITY][link] > 0.0)
          ratio = Flow[link] / Cost[CAPACITY][link];
        else
          ratio = BigReal;

        if (ratio >= BigReal)
            ratio4 = ratio;
        else
          {
          ratio4 = pow(ratio, Cost[BETA][link]);
          }

        lambda = 1.0 + Cost[ALPHA][link] * ratio4;

        Cost[CURRENT][link] = Cost[T0][link] * (float)lambda;

       }

     Threshold = max(Threshold, Cost[CURRENT][link]);
    }
}


long DLLEXPORT VDF_GetNParameters( void )
{
   return N_FIELDS - 2;
}

//The dimentions of param_names should be (NParameters + 1)*VDF_LABELSIZE the extra one is for
type
short DLLEXPORT VDF_GetParameters(char **param_names)
{

   strncpy(&(param_names[T0][0]),       "Time",          VDF_LABELSIZE);
   strncpy(&(param_names[LENGTH][0]),   "Length",        VDF_LABELSIZE);
   strncpy(&(param_names[CAPACITY][0]), "Capacity",      VDF_LABELSIZE);
   strncpy(&(param_names[ALPHA][0]),    "Alpha",         VDF_LABELSIZE);
   strncpy(&(param_names[BETA][0]),     "Beta",          VDF_LABELSIZE);
   strncpy(&(param_names[PRELOAD][0]),  "Preload",       VDF_LABELSIZE);
   strncpy(&(param_names[K][0]),        "K",             VDF_LABELSIZE);
   strncpy(&(param_names[OP_COST][0]),  "Op. Cost",      VDF_LABELSIZE);
   strncpy(&(param_names[VOT][0]),      "Value of Time", VDF_LABELSIZE);

   return *_platform_tc_status = TC_OKAY;
}

short DLLEXPORT VDF_GetDefaults(double *d)
{
   d[K]       =  0;
   d[LENGTH]  =  flt_miss;
   d[T0]      =  flt_miss;
```

```c
       d[CAPACITY] =   flt_miss;
       d[ALPHA]    =   0.15;
       d[BETA]     =   4.0;
       d[PRELOAD]  =   flt_miss;
       d[OP_COST]  =   0.34;
       d[VOT]      =   0.5;

       return *_platform_tc_status = TC_OKAY;
}

short DLLEXPORT VDF_GetLabel(char *label)
{
       strncpy(label,  "Generalized Cost Function",   VDF_LABELSIZE);
       return *_platform_tc_status = TC_OKAY;
}


short DLLEXPORT VDF_Preprocess(float **Cost, long *links, void *defaults, short *types, short *n_types,
short *LinkDisabled)
{
       register long    i, j, k = 0;
       short   typed = (n_types && types != NULL);
       float   *v, *pDef;

       if ( typed )          // if link type is used
          {
          float   **Def = (float**) defaults;
          for (i = 0; i < *links; i++)
             {
             if (LinkDisabled[i])
                continue;

             for (k = 0; k < *n_types; k++)
                {
                if (Cost[TYPE][i] == types[k])
                   break;
                }
             if ( k >= *n_types )       // if link type not found
                return( *_platform_tc_status = TC_NOTFOUND );
                   // now link type found
             pDef = Def[k];                        // point to default vector of the type
             for (j = 0; j < N_FIELDS - 2; j++, pDef++)
                {
                v = &Cost[j][i];
                if ( *v <= flt_miss )          // if value missing
                   if ( *pDef > flt_miss )        // if default value valid
                      *v = *pDef;                 // use default
                   else if ( Required[j] )
                      return( *_platform_tc_status = TC_INVINPUT );
                }

             Cost[CURRENT][i] = Cost[T0][i];
             Threshold = max(Threshold, Cost[CURRENT][i]);
             }
          }

       else          // link type is not used
          {
          for (i = 0; i < *links; i++)
             {
             if (LinkDisabled[i])
                continue;
```

```c
            pDef = (float*) defaults;
            for (j = 0; j < N_FIELDS - 2; j++, pDef++)
               {
               v = &Cost[j][i];
               if ( *v <= flt_miss )          // if value missing
                  if ( *pDef > flt_miss )        // if default value valid
                     *v = *pDef;              // use default
                  else if ( Required[j] )
                     return( *_platform_tc_status = TC_INVINPUT );
               }

            Cost[CURRENT][i] = Cost[T0][i];
            Threshold = max(Threshold, Cost[CURRENT][i]);
            }
         }

    return( *_platform_tc_status = TC_OKAY );
}

void DLLEXPORT PreLoad_VDFValues(double *Flow, float **Cost, long *links)
{
    long    link;
    double  ratio, lambda, ratio4;
    float   PreloadFlow;

    *_platform_tc_status = TC_OKAY;
    Threshold  = 0.;


    for (link = 0; link < *links ; link++ )
     {
       PreloadFlow = max(0, Cost[PRELOAD][link]);

       if (Cost[T0][link] == flt_miss)
          {
          Cost[CURRENT][link] = flt_miss;
          continue;
          }

       if (Cost[CAPACITY][link] == flt_miss)
          {
          Cost[CURRENT][link] = Cost[K][link] + Cost[OP_COST][link] * Cost[LENGTH][link] +
                      Cost[VOT][link] * Cost[T0][link] ;
          }
       else
        {
        if (Cost[CAPACITY][link] > 0.0)
          ratio = (Flow[link] + Cost[PRELOAD][link]) / Cost[CAPACITY][link];
        else
          ratio = BigReal;

         if (ratio >= BigReal)
            ratio4 = ratio;
         else
          {
          ratio4 = pow(ratio, Cost[BETA][link]);
          }

         lambda = 1.0 + Cost[ALPHA][link] * ratio4;

         Cost[CURRENT][link] = (float)(Cost[K][link] + Cost[OP_COST][link] * Cost[LENGTH][link] +
                      Cost[VOT][link] * Cost[T0][link] * lambda);
```

```c
              }

          Threshold = max(Threshold, Cost[CURRENT][link]);
        }
}

double DLLEXPORT PreLoad_VDFValue(double FlowVal, long *link, float **Cost)
{
    double  ratio, ratio4, lambda, RetCost;
    float PreLoad = max(0, Cost[PRELOAD][*link]);

    if (Cost[CAPACITY][*link] == flt_miss)
        RetCost = Cost[K][*link] + Cost[OP_COST][*link] * Cost[LENGTH][*link] +
                    Cost[VOT][*link] * Cost[T0][*link] ;
    else
      {
       if (Cost[CAPACITY][*link] > 0.0)
        ratio = (FlowVal + PreLoad) / Cost[CAPACITY][*link];
       else
        ratio = BigReal;
        if (ratio >= BigReal)
           ratio4 = ratio;
        else
           ratio4 = pow(ratio, Cost[BETA][*link]);

       lambda = 1.0 + Cost[ALPHA][*link] * ratio4;

       RetCost = Cost[K][*link] + Cost[OP_COST][*link] * Cost[LENGTH][*link] +
                    Cost[VOT][*link] * Cost[T0][*link] * lambda;
      }
    return((double)RetCost);

}


void DLLEXPORT PreLoad_VDFTimeOnly(double *Flow, float **Cost, long *links)
{
    long    link;
    double  ratio, lambda, ratio4;
    float   PreloadFlow;

    *_platform_tc_status = TC_OKAY;
    Threshold  = 0.;


    for (link = 0; link < *links ; link++ )
      {
        PreloadFlow = max(0, Cost[PRELOAD][link]);

        if (Cost[T0][link] == flt_miss)
           {
           Cost[CURRENT][link] = flt_miss;
           continue;
           }

        if (Cost[CAPACITY][link] == flt_miss)
           {
           Cost[CURRENT][link] = Cost[T0][link] ;
           }
        else
           {
```

```
      if (Cost[CAPACITY][link] > 0.0)
        ratio = (Flow[link] + Cost[PRELOAD][link]) / Cost[CAPACITY][link];
      else
        ratio = BigReal;

      if (ratio >= BigReal)
          ratio4 = ratio;
      else
        {
        ratio4 = pow(ratio, Cost[BETA][link]);
        }

      lambda = 1.0 + Cost[ALPHA][link] * ratio4;

      Cost[CURRENT][link] = Cost[T0][link] * (float)lambda;

    }

      Threshold = max(Threshold, Cost[CURRENT][link]);
    }
  }
```

Transit Networks, Best Transit Paths, and Path Attributes

TransCAD has special tools and procedures for creating and working with transit networks. Transit networks are created from a route system layer, using information from the routes, the stops, and the underlying line geographic file (streets layer, rail layer, node layer, etc.). An important feature of transit network analysis in TransCAD is that fares are used to calculate the best transit paths and transit skims. Transit fares can be specified as flat, zonal, or mixed. Using transit networks, you can solve shortest path problems, calculate transit path attributes (i.e. skims) between stops in your route system or nodes on the underlying line layer, and perform transit assignment.

For more information, see:
About Transit Networks
Creating Transit Networks
Configuring Transit Networks
About Best Transit Paths
Best Transit Path Attributes (Transit Skims)

About Transit Networks

TransCAD creates transit networks from a route system and its associated stop and line layers. Transit networks are used for:

- Solving best path problems
- Calculating the attributes of the best paths (i.e., creating transit skims)
- Performing transit assignment

Transit networks are similar to other TransCAD networks in that they are graphs comprised of nodes and links that indicate allowable paths of travel, along with information on the costs of traversing each link (e.g., transit time). The links in the transit network represent actual transit segments (segments between two consecutive transit stops) and segments from the underlying line geographic file (e.g., access, egress and transfer links). The segments from the line layer provide connectivity to the network and represent zone-to-station access links, walking links, driving links, and transfer links.

For more information, see:
Attributes in a Transit Network
Routes in a Transit Network
Stops in a Transit Network
Merging Stops into a Single Node
Non-Transit Links in a Transit Network
Creating Centroid Connectors
Mode Table
Mode Transfer Table
Importing Transit Networks From Other Planning Packages

Top

Attributes in a Transit Network

The attributes in a transit network can come from the route layer, the stop layer, and the underlying line layer:

Source	Sample Attributes
Line layer on which the route system is based	Length, transit time, walk time, drive time, link-specific weighing factors
Route system layer	Headway, capacity, fare amount, route-specific weighing factors
Stop layer	Fare zone

When you create the network, you can choose any number of fields from any of these three sources. Typically, the fields to be included depend upon the type of analysis you want to perform.

During the network creation process each route segment, which is the segment between two stops on a route, will be converted into a directional link. Any attributes for this route segment link will come from the attributes of the underlying line layer. The attribute value of the route segment will be calculated as the fractional sum of the link attributes

The most important attribute to come from the underlying line layer will be the transit travel time by line segment, which is then transferred onto the route segments. This is a required field in the transit network.

Like highway networks, line layer attributes can be divided by direction. This is to handle the case

where the attribute value in one direction may be different than in the other direction. In this case, you would create pairs of fields in your line layer with "AB" and "BA" prefixes. This is similar to the method for defining highway network attributes. For a more detailed discussion of defining attributes by direction, see Chapter 13, *Networks and Shortest Paths*, in the *TransCAD User's Guide*.

Routes in a Transit Network

You can choose to include all the routes or just selected routes in a route system in a transit network. You can select routes using any of the TransCAD selection tools and commands. For more information, see "Selecting Routes to Edit" in Chapter 16, *Route Systems*, in the *TransCAD User's Guide.*

Since routes have directionality, you need to code routes in each direction that the transit system services. For example, if you create a route servicing an area from east to west, you should create separate route in the opposite direction, going from west to east, if service is provided in both directions.

In addition to route segment attributes, transit networks can also contain route attributes. Route attributes can be used to define transit network parameters such as waiting times, fares, capacities, etc. When creating a route system for transit network analysis, you might consider including some of the following fields in the route system layer:

Route Fare Fields	Type	Units	Contents
Fare	Real	Monetary	The flat fare that is paid to board the route
Fare Type	Integer	Constant	1-Flat Fare; 2-Zonal Fare
Mode	Integer		The mode ID of the route
# of Free Transfers	Integer		Number of free transfers
# of Discounted Transfers	Integer		Number of transfers with discounted fare
Fare Matrix	String		Fare matrix to use if route system is zonal
Transfer Penalty	Real	Time(min)	The time penalty for transferring to this route
Transfer Fare	Real	Monetary	The reduced fare (if any) that is paid when transferring to this route from another flat fare route

Weight Fields	Type	Units	Contents
Travel Time	Real	Constant	Weight on route's link impedance when calculating cost
Transfer Time	Real	Constant	Weight on transfer time to route
Waiting	Real	Constant	Weight on waiting time onto route
Dwell	Real	Constant	Weight on calculated route dwell times

Other Fields	Type	Units	Contents
Headway	Real	Time(min)	The average headway for this route
Capacity	Real	Veh/Time	Passenger capacity on this route

Alpha	Real	Constant	The first parameter of the congestion function, to be used in transit network assignment
Beta	Real	Constant	The second parameter of the congestion function, to be used in transit network assignment

Stochastic Assignment Fields	Type	Units	Contents
Link Time Error	Real	Percentage	Error in users' perception of link times
Headway Error	Real	Percentage	Error in users' perception of headways

Each of these fields can be used as an optional parameter when determining the settings of a transit network. None of these fields are required. Depending upon how you wish to define your route system and network, you can specify the fields that you need. Each of the parameters is described in Configuring Transit Networks.

Top

Stops in a Transit Network

When you create a transit network, TransCAD automatically includes all of the stops that exist along all the routes that are included in the network. No separate selection step is required.

Since stops are route dependent, and therefore disconnected from route to route, TransCAD will merge stops that are close together into a single node in the transit network. A field in the stop layer controls the way in which stops are merged together. Therefore, you should add a field like the following one to your stop layer:

Field	Type	Contents
NodeID	Integer	The ID of the underlying node layer that stops should merge to

If you want the fare structure to be zone based, you should consider adding another field like the following one to your stop layer:

Field	Type	Contents
Zone	Integer	The ID of the fare zone in which the stop is located, if there is a zone fare on the route

If these fields are not already in the route system, you can open the route table or stop table and use the **Dataview-Modify Table** command to add the missing fields, as described in "Customizing the Route System Tables," in Chapter 16, *Route Systems*, in the *TransCAD User's Guide*. Information on merging stops and using fare zones is presented in Configuring Transit Networks.

Top

Merging Stops into a Single Node

When you build a transit network, TransCAD merges nearby transit stops into a single node in the network. When stops are merged, there is no time penalty associated with traveling between any of the merged stops.

A field in the stops layer specifies how stops will be merged. The value in this field contains the ID of the underlying node into which the stop should be merged.

In the following example, stops 1, 2 and 3 will be merged to node 1001, and stop 4 and 5 will be merged to node ID 1004:

Stop ID	Stop Name	...	Node ID
1	Stop 1		1001
2	Stop 2		1001
3	Stop 3		1001
4	Stop 4		1004
5	Stop 5		1004

If you do not have a node ID field in your stops layer to specify the node ID values, you will need to add this field using the **Dataview-Modify Table** command. TransCAD can automatically fill in these values for you. You can also manually change some of the node ID values if you want to control how some stops are merged.

For more information, see:
To Fill in Node IDs in the Stops Layer

Top

⟩ To Fill in Node IDs in the Stops Layer

1. Choose the route or stop layer in a map that has a route system.

2. Choose **Transit-Tag Stops To Node** to display the Tag Stops to Node dialog box.

3. Choose All Routes or a selected set of routes in the network from the Routes drop-down list.

4. Choose the stops layer field in which to store the results from the Store In drop-down list.

5. Type a search distance in the Search Distance edit box to control how close stops should be in order for them to be merged.

6. Click OK.

TransCAD fills the stops layer field with a node ID that each stop will merge to given, the search distance constraint.

Top

Non-Transit Links in a Transit Network

In addition to your route system, you might also need to include additional links, from the underlying line layer, to provide reasonable connectivity. These additional links can represent either walking links or different types of station access or transfer links. These links need to be marked as a selection set in the underlying geographic layer. It is also important to prepare the numeric attributes for those links (walking time, drive access time, transit travel time on the links that routes traverse, etc.).

In creating the transit network, the nodes of the route system will be connected to the nodes of the underlying line layer selection, creating a combined network. The connections will be based on the node ID field you specified in the stop layer. For planning applications, it is good practice to have a node in the underlying geographic file at the location of every stop in the network. However, if this is not the case and the stop is located at a mid-block location, you will need to specify a node close to the stop. It is important to note that, in this case, the distance or time from the node to the station will be ignored.

You can also set the directionality of non-transit links. A non-transit line segment can be translated into the transit network either as a two one-way links or as a single one-way link going with or against the direction of the line segment's topology.

The purpose of non-transit links in a transit network is to provide access and egress between the centroid node and the stop, and to provide walk and transfer access between stops. There are two ways to code these links: the more traditional approach and an alternative GIS-based approach.

For more information, see:
The Traditional Approach for Adding Non-Transit Links
A GIS-Based Approach for Adding Non-Transit Links

Top

The Traditional Approach for Adding Non-Transit Links

In the traditional approach of coding non-transit links, single, straight links are added between centroids and the stops they have access to. These links are commonly identified as access and/or egress links. You would also code individual straight links between stops, identifying available transfers. These would be referred to as transfer or walk links.

There are several disadvantages to this approach:

- You need to manually estimate the stops that have reasonable access to/egress from particular centroid nodes
- You need to estimate each link's travel time and cost, bearing in mind that the actual distance traveled on the link may actually be longer than the computed GIS straight-line length
- You need to estimate which stops have reasonable transfer times

- The resulting "network" may be visually confusing

A GIS-Based Approach for Adding Non-Transit Links

In a GIS-based scheme for adding non-transit links, the transit route system and stops would be placed on an accurate GIS street layer, which would include most, if not all, major and minor streets. Portions of the street layer could then, in themselves, become the access, egress, and transfer walk links. In other words, the underlying street network provides the necessary connectivity for the route system. The only additional links that would need to be added would be centroid connector links, between the centroid node and nodes on the street network. A typical access path would go from the centroid to the street network using the centroid connector, and then to the stop using the street network links. Connectivity from stop to stop would be handled through the street network as well.

You do not need to include all of the street links as non-transit links for your transit network. You only need to include the links between the centroids and stops, and the links near stops, to allow for stop-to-stop transfers.

This approach has the following advantages over the traditional method:

- Real distances and travel times may be more accurately estimated from the centroid to the stops, and between stops
- You no longer need to estimate which centroids are accessible to which stops
- The "network" looks less visually confusing

The one disadvantage to this approach is that adding numerous street links will increase the overall network size.

Creating Centroid Connectors

There are various ways to create centroid connectors for transit network in both coding schemes. One is to use the centroid connection tool to create new links from the centroids of a TAZ point or area layer to the underlying line layer of the transit route system; for more information, see "Connecting Features to a Network" in Chapter 22, *Geographic Analysis Tools*, in the *TransCAD User's Guide*.

The centroid connection tool might be appropriate if you are using the GIS-based scheme, since all you want to do is to connect to your street network. The traditional scheme, however, requires many centroid connection links between centroids and stops, and this tool might not be the optimal one to use. An alternate strategy might be to write a program to create the access and egress links in a separate geographic file and then to merge this file into the underlying line layer, using either:

- The **Tools-Geographic Utilities-Merge Geography** command; for more information, see "Merging Geographic Files" in Chapter 25, *Managing Geographic Files*, in the *TransCAD User's Guide*.
- The **Tools-Advanced Line Editing-Copy and Paste** command; for more information, see "Copying and Pasting Segments" in Chapter 24, *Creating and Editing Geographic Files*, in the *TransCAD User's Guide*.

You can also create your connectors manually, using the Tools-Map Editing command; for more information, see "Editing Line Features" in Chapter 24, *Creating and Editing Geographic Files*, in the *TransCAD User's Guide.*

When creating centroid nodes, you must make sure that their IDs are consistent with the actual zone numbers. This means that either the centroid node IDs are the same as the zone number IDs, or that you have a correspondence between node IDs and zone IDs, so that you can create matrix indexes to go back and forth between the two; for more information, see "Displaying Portions of a Matrix" in Chapter 18, *Working With Matrices*, in the *TransCAD User's Guide*. It is also a good idea to create an additional field in your node layer to easily identify centroid nodes when necessary.

Mode Table

You can define transit service parameters for each route. If you create a mode table, however, transit service can also be classified by mode, such as local bus, express bus, subway, commuter rail, etc. The mode table can be used to define attributes that will be shared by all the routes that belong to that mode. The mode table may contain other information as well. By using mode information you can:

- Specify default service parameters, such as headway and transfer times by mode
- Specify different weighing factors to use for the service parameters by mode
- Specify some modes as flat fare based and other modes as zonal fare based
- Specify different impedance fields to use by mode, to model varying costs by mode in traversing the same links
- Specify different speeds to use for each mode
- Specify default speeds for non-transit link modes
- Control access and egress links for each non-transit link mode. For example, for all links in the drive-to-transit mode, you can enable access from zone to transit stop and disable egress from transit stop to zone
- Specify mode-to-mode transfer costs and fares

The mode table may contain the following fields:

Field	Type	Contents
Mode_Name	Character	Name of the mode
Mode_ID	Integer	ID of the mode, matching the mode field in the route table
Type	Character	T – Transit H – Highway W – Walking/Transfer
Impedance_Field	Character	Mode-specific link travel time field

Fare_Type	Integer	1 – Flat Fare
		2 – Zonal Fare
Fare Matrix	Character	Fare matrix to use for mode if zonal fare based
Speed	Real	Default Speed to use for mode in cases where travel times are missing
Headway	Real	Default headway value
Transfer Time	Real	The time cost for transferring to any route of this mode
Fare	Real	The flat fare that is paid to board any route of this mode
Transfer Fare	Real	The reduced fare (if any) that is paid when transferring to any route of this mode
IVTT_Weight	Real	Weight applied to in-vehicle impedance
Wait_ Weight	Real	Weight applied to waiting times
Transfer_ Weight	Real	Weight applied to the transfer times
Dwell_ Weight	Real	Weight applied to the dwelling times
On-Dwell Proportion	Real	Proportion of boarding time in total dwell time
Max_Wait	Real	Maximum wait time by mode
Min_Wait	Real	Minimum wait time at any stop of mode
Max_Access_Time	Real	Maximum total access time for mode
Max_Egress_Time	Real	Maximum total egress time for mode
Max_Travel_Time	Real	Maximum modal travel time
Link Error Term	Real	Error in users' perception on link times
Headway Error	Real	Error in users' perception headways

The first three fields are required, while the others are optional. If the field value for a route parameter, such as Fare, is missing from the input transit network, TransCAD consults the mode table for determine the value of the corresponding mode. If the value is missing from the mode table, or the parameter is not specified in the mode table, TransCAD uses the default value. The setting of the various default values will be discussed later.

The travel time field (Impedance_Field) in the mode table can be used to solve transit shortest path problems, using different in-vehicle travel time fields for different modes. For example, if you want to solve a problem involving both local subways and express subways, you can create a network that contains two different in-vehicle travel times. Each transit mode can then use the travel time field specified in the mode table.

The Fare Type and Fare Matrix fields may be used to specify mixed fare policies by mode. Some modes can be defined as flat fare based, while other modes may be defined as zonal fare based.

The Speed field can be used to define a default speed to calculate a default in- vehicle travel time if there are missing travel time values in the network.

The mode table can also be used to describe both transit modes and non-transit modes. For example, the walk mode can be represented as a record in the mode table with a description of its name, default travel speed and link time weight. You specify the type of the mode by codes in the Type field: "T" for a transit mode, "D" for a driving mode, or "W" for a walk/transfer mode.

When specifying the mode table, the user may choose to use only a subset of the records. That is useful when conducting a transit network analysis in which certain transit modes need to be excluded.

Top

Mode Transfer Table

TransCAD allows transfers among different transit lines, based on the topology of the network. In many situations, it is useful to control the characteristic of mode-to-mode transfers. If you want to solve a transit shortest path and have control over the possible inter-modal transfers, you have to define a table that lists the generalized costs (e.g., time) incurred when transferring from one mode to another mode at a given (or optionally at any) location in your network. The mode transfer table may contain the following fields:

Field	Type	Contents
From_Mode	Integer	Mode ID
To_Mode	Integer	Mode ID
At_Stop	Integer	Stop at which the transfer occurs
GeneralizedCost	Real (time)	Generalized transfer cost penalty
Fare	Real	Fare to be paid at this transfer

The transfer generalized cost and the fare will be applied at the next transit boarding point. Leaving a missing value in the At_Stop field means that this transfer will be applied at any stop where the transit lines of these modes intersect. The cost specified in this table has to be given in generalized cost units, as it will be added directly to the fare. For example, there might be free transfers between mode 1 and mode 1, and a 4- unit fare transferring between mode 1 and mode 3.

Top

Importing Transit Networks From Other Planning Packages

TransCAD can import transit networks from the TRANPLAN, MINUTP, and EMME/2 planning packages. The network files from these packages are normally converted into a TransCAD route system and the underlying line geographic file. Transit travel times are usually coded as an attribute field in the line layer and route IDs and headways are usually coded as an attribute field in the route layer. To import properly, all transit network data created from these packages need to be in their respective ASCII text formats. For more information about importing transit networks into TransCAD, see Importing Network Data.

Top

Creating Transit Networks

To create a transit network, you need to choose:

- The routes you want to include
- The route, stop, and line layer attributes to include

- The stops layer field you want to use to control stops merging
- Whether or not to add non-transit links for access, egress, transfers, and walking links

For more information, see:
To Create a Transit Network

Top

⟩ *To Create a Transit Network*

1. Choose the route or stop layer in a map that has a route system.

2. Choose *Transit-Create Network* to display the Create Transit Network dialog box.

3. Choose All Routes or a selection set of routes in the network from the Routes drop-down list.

4. Type a description for the network file in the Description edit box.

5. Choose one or more line layer fields to include in the network from the Line Layer Fields scroll list.

6. Choose any route layer fields to include in the network from the Route Fields scroll list.

7. Choose any stop layer fields to include in the network from the Stop Fields scroll list.

8. Choose a field in the stop layer containing the node IDs to merge stops to from the Using Node IDs In drop-down list.

   If the node ID field already has been tagged with the IDs of the nearest node, click the Use Existing Information radio button.

   Otherwise, click the Calculate New Values radio button and type a distance in the Distance edit box to have TransCAD fill this field with the IDs of the nearest nodes.

9. Choose the selection set that contains transfer, access/egress, walking and/or driving links in the Non-transit Links In drop-down list.

10. Click Attributes to display the Non-Transit Link Options dialog box.

    Choose the attribute field that corresponds to each line layer field added to the Transit Network, by highlighting a transit attribute in the scroll list and choosing a field in the Change Mapping drop-down list. For example, if the transit network includes a field for In-Vehicle travel time, the Non-Transit Links should map this field to a Walk-Time field.

    Click OK when you are done to return to the Create Transit Network dialog box.

11. If you want to set the directionality of non-transit links, uncheck the Ignore Link Directions box and then choose the field where TransCAD can read the link directions from the Read Info From drop-down list. The coding scheme used to define one-way links is similar to the scheme used for highway networks.

12. Click OK. TransCAD displays the Save Network As dialog box.

13. Type a name for the transit network file and click Save.

TransCAD creates the transit network file, and displays the Transit Network Settings dialog box, allowing you to set up fare structures and other network settings. See Configuring Transit Networks for a description of the Transit Network Settings dialog box.

Top

Configuring Transit Networks

TransCAD lets you configure your transit network to identify the location of key attribute information, such as headway and fares. Once you configure a transit network, the settings are saved with the network so that you can solve shortest paths, create skim matrices, or perform transit assignment without having to re-enter or modify these settings. The Transit Network Setting dialog box can also be used to view summary information about the contents of the network file, select a different transit network, update transit network links, or define the nodes in the network that represent centroids.

The settings include the following information:

- The travel time field to use to determine best paths, skim variables or perform assignments
- The network attributes containing route headways, transfer penalties, dwell times, layover times and maximum wait time
- Limits on the number of transfers, maximum and minimum wait time, total trip cost, maximum transfer times, maximum access and egress times, and maximum modal travel times
- Weights to assign to waiting times, travel times, dwell times, non-transit times, and transfer times
- Fare structure information
- Mode-specific information
- Route-stop-specific information
- Park-and-ride information
- Assignment parameter information for performing User Equilibrium and Stochastic User Equilibrium transit assignments (see Chapter 12, *Transit Assignment*)

TransCAD uses the transit network settings for all transit shortest paths, skims, and assignments. When finding paths, TransCAD minimizes a generalized cost value that is computed from the travel time variable along with the waiting time, the fare, dwelling and transfer times, and the conversion parameters.

There are seven types of settings in the Transit Network Settings dialog box:

Settings	Description
General	Sets the travel time field, path method and maximum trip cost, transfer time, maximum number of transfers, and centroids
Mode	Sets the mode table and mode transfer table, and some mode specific restrictions and defaults
Fare	Sets the fare settings to be flat, zonal-based, or mixed
Assignment	Sets the congestion, error term and dwelling parameter settings for transit assignment, if the assignment method is either User Equilibrium or Stochastic User Equilibrium (see Chapter 12, *Transit Assignment*)
Weights	Sets the weighing factors to be used for all components of the transit network when determining the best path
Park & Ride	Sets the park-and-ride settings
Other	Sets the headway, transfer, dwelling and layover time parameter, and sets minimum and maximum times for waiting, access, egress, and travel times

For more information, see:

Top

General Settings

The General settings let you choose the transit link travel time field, which is coded in the underlying line layer of the route system. If you define modes in your transit network, you can also set the link travel time field by mode. To set travel times by mode, your mode table must contain a character field that contains the link travel time field to be used for each mode. You can then choose the mode field to use from the Time by Mode drop-down list, which is only enabled if modes are defined. The mode tab settings are described in Mode Settings.

The General setting lets you choose the pathfinding method. A description of these pathfinding methods can be found in About Best Transit Paths.

The General settings let you indicate maximum trip costs, transfer times and number of transfers. These settings prevent unreasonable trip lengths and paths from being found.

The General settings also let you define zone centroids. To define centroids, you need to select them in the node layer of the underlying line geographic file first and then choose the selection set in this tab. Once centroids are defined, trips will be prevented from traversing centroid connectors in the middle of paths.
All of the transit path algorithms will minimize generalized cost. In order to calculate minimized cost, all time-based attributes will be converted into monetary units. The Value of Time (VOT) parameter is used as the conversion factor. All time units are multiplied by the VOT parameter to calculate the equivalent monetary cost. Both fare and time are used to calculate generalized cost. If you want to perform pathfinding using only travel time, you can set the VOT parameter to 1 and set all fare parameters to 0.

For more information, see:
To Change the Transit Network General Settings

Top

) *To Change the Transit Network General Settings*

1. Choose *Transit-Network Settings* to display the Transit Network Settings dialog box.

2. Click the General tab to display General page.

3. Make changes as follows:

To do this...	Do this...
Change the pathfinding method	Make a choice from the Path Method drop-down list
Change the maximum trip cost	Type value (in monetary units) in the Max. Trip Cost edit box
Change the maximum transfer time	Type a value (in time units) in the Max. Xfer Time edit box
Change the maximum number of transfers	Type a value in the Max. Xfers edit box
Change the conversion factors	Type the Value-of-Time (VOT) factor in the VOT edit box

4. If you want to use centroids and centroid connectors, click the appropriate radio button:

To do this...	Do this...
Use centroids in the network	Click the Centroids Are In Network radio button
Create centroids from a selection set	Click the Create Centroids From Selection Set radio button and choose the selection set that represents your centroid nodes from the drop-down list.

5. Click OK.

TransCAD closes the Transit Network Settings dialog box.

Top

Mode Settings

TransCAD supports mode-specific information and settings for both the transit and non-transit components of the network. To use modes in TransCAD, you need to create a mode table. The mode table only requires the following fields:

Field	Type	Contents
Mode_Name	Character	Name of the mode
Mode_ID	Integer	ID of the mode, matching the mode field in the route table
Type	Character	T – Transit H – Highway W – Walking/Transfer

Other fields can be added to further describe each mode. See Mode Table for a complete list of fields that the mode table can contain.

Additionally, you need to have a field in your route layer that indicates the mode ID of each route. If you want to have modes for non-transit links, you also need to have a field in your underlying line layer that indicates the mode ID of the non-transit link.

The mode table lets you define most parameters in the transit network settings by mode rather than by route or globally. For example, the local bus mode could have a travel time weight of 2.0 while the express bus mode could have a travel time weight of 1.0.

Mode settings also allow you to temporarily enable or disable selected modes. For example, you could disable the commuter rail mode to evaluate the costs and paths taken if commuter rail was not an option. Additionally, you could enable or disable access and/or egress links of each link mode. An example use of this feature would be the disabling of drive-egress links and walk-access links to skim an AM drive-access transit network.

You can also set mode-to-mode transfer costs by using a mode transfer table.
If you want to solve a transit shortest path problem and have control over the possible inter-modal transfers, you can define a table that lists the costs incurred when transferring from one mode to another mode at a given (or optionally at any) location in your network. The mode transfer table may contain the following fields:

Field	Type	Contents
From_Mode	Integer	Mode ID
To_Mode	Integer	Mode ID
At_Stop	Integer	Stop at which the transfer occurs
GeneralizedCost	Real (time)	Generalized transfer cost penalty
Fare	Real	Fare to be paid at this transfer

The transfer cost and the fare will be applied at the next transit boarding point. Leaving a missing value in the At_Stop field means that this transfer will be applied at any stop where the transit lines of those modes intersect. The cost specified in this table has to be given in generalized cost units, as it will be added directly to the cost function.

For more information, see:
To Change the Transit Network Mode Settings

Top

⟩ *To Change the Transit Network Mode Settings*

1. Choose **Transit-Network Settings** to display the Transit Network Settings dialog box.

2. Click the Mode tab to display the Mode page.

3. Click the Use Modes box and choose a mode table from the drop-down list. TransCAD opens the mode table, scans the contents, and then lists all the mode names, IDs, and types found in the table in the scroll list.

4. By default, all modes are used, or enabled. If you do not wish to use a mode, highlight the mode in the scroll list and then uncheck the Use Mode box below the scroll list.

5. Choose the field in the route layer that corresponds to the mode ID from the Route Mode drop-down list.

6. If non-transit modes are specified, highlight each non-transit mode in the scroll list and do the following:

To do this...	Do this...
Choose the line layer Mode ID	Choose the field in the line layer that corresponds to the mode ID from the Link Mode drop-down list
Enable access and/or egress	Check or uncheck the Access and Egress boxes

7. If you want to specify default speed, choose the speed field from the Speed drop-down list. These speeds are used to determine travel time only if values in the travel time field are missing.

8. If you want to use a mode transfer table, check the Use Costs box, choose the mode transfer table from the first drop-down list, and choose the fields in the mode transfer table from the From-Mode, To-Mode, Penalty, Fare, and At Stop drop-down lists.

9. Click OK.

TransCAD closes the Transit Network Settings dialog box.

Fare and Transfer Policy Settings

TransCAD supports powerful and flexible definition of transit fares. The fares used in a transit network can be of four different types:

- Flat fares, where the fare on each route is fixed regardless of the distance traveled
- Zonal fares, where the fare for a trip is based on the beginning and ending stops, and is independent of the number of routes that are used
- Zonal fares by mode, where the fare for each mode used on the trip is based on the beginning and ending stop for that particular mode
- Mixed fares, which are a combination of flat and zonal fares

You can specify flat fares at the route level, by mode, or globally for all the routes in the network. The route-level values are used first. However, the attribute may be missing, because:

- The corresponding field does not exist in the original table
- None was chosen from the drop-down list
- The value stored in the table is missing

In this case TransCAD will try to find the value in the mode table, if the mode option was checked in the Mode tab. If the value is also missing from the mode table, the global value will be used.

In a flat-fare system, you can specify regular fares and transfer fares by route, mode or globally. Regular fares are paid on the first route on the trip. Transfer fares are paid on subsequent routes. In the fare settings, you can also set the allowable number of free and reduced-fare transfers for the network. Free transfers allow travelers to ride for free on transfer routes, while reduced-fare transfers allow travelers to pay only the discount fare on subsequent routes. You can set the number of free and reduced-fare transfers allowed in the system.

If your transit system has free intra-modal transfers, specify it in the mode transfer table. Do not enter a large number in the free or discount transfer fields, since this will allow free or discount inter-modal transfers as well.

In a zonal fare system, the fare paid for a trip between origin and destination stations is based solely on the zones in which the origin and destination stations are located. The fares are specified in a fare matrix.

You also need to specify the fare zone for each stop. Therefore, to use zonal fares, you must

provide two pieces of information:

- The stop layer field in the network that contains the zone for each stop
- The name of the fare matrix in a matrix file

Since TransCAD merges common stops (i.e., stops which have the same node ID value) together into a single network node, the fare zone ID will be merged as well. Thus, it is important that common stops have the same fare zone ID's. If fare zones are different for common stops, an arbitrary stop's fare zone ID will be chosen to represent the merged node's fare zone.

In the previous example, the fare is applied globally, regardless of the modes used to go from origin to destination stop. You can apply zonal fares by mode, however. To do this, you must also provide:

- A mode table
- A fare matrix for each mode
- A character field in the mode table that identifies the matrix name in the fare matrix to use for each mode

For example, a mode table might contain a field called FARE_FIELD that describes the matrix name of each mode, while the matrix contains zone-to-zone fares for each mode. Thus a hypothetical trip going from zone 1 to zone 4 on bus, then transferring to subway and going from zone 4 to zone 2 on subway might cost $2.00 + $2.00 = $4.00 total for the trip.

If you do not have any stop layer fields in your network or if you do not have any matrices open, you will not be able to specify zonal fares.

If you have an area layer containing the boundaries of the fare zones, you can code each stop with the Zone ID it is located in by using the *Edit-Fill* command with the Tag option; for more information, see Chapter 8, *Displaying and Editing Data*, in the *TransCAD User's Guide*. You can also create the fare matrix by using the *File-New* command; for more information, see Chapter 18, *Working with Matrices*, in the *TransCAD User's Guide*.

If the zones are not easily represented as areas on a map, you can prepare the zonal fare information manually. To assign stops to zones, select the stops in each zone using any of the selection commands or tools, and then fill in the Zone ID using the *Edit-Fill* command. To create the zone fare matrix, first use the *File-New* command to create a three-column table that indicates the fares between every pair of zones in the system.

Then, use the *Matrix-Import* command to convert the fare table into a fare matrix. The same process can be used to create a zone fare matrix by mode. You just need to add additional fare fields for each mode. For more information on creating a table, see Chapter 9, *Managing Data Tables*, in the *TransCAD User's Guide*. For more information on importing the table into a fare matrix, see Chapter 18, *Working with Matrices*, in the *TransCAD User's Guide*.

To specify mixed fares, you need to provide the following information:

- A mode table
- A fare type field in the mode or route table that specifies if a mode or route is flat-fare based (1) or zone-based (2)
- A fare matrix field that contains the name of the fare matrix to use for the zone-based mode
- A fare matrix for each mode that is zone-based

Fare Priorities and Limitations

For all pathfinding methods where routes and headways are combined (Optimal Strategies and Pathfinder), not all fare types are considered when calculating the generalized cost function. This is due to the fact that these methods are destination based (path is determined from destination to

origin) and that fares are combined along with the paths. Once the best path is determined, however, all fare types are considered by traversing the path from origin to destination. Thus, the skimmed fare that is reported will be accurate. In addition, not all fare types are available for all pathfinding methods. Here are the availability of fare types for each method:

Fare Calculation Availability by Path Method

Method	Flat Fare			Zonal Fare
	Regular	Discount/Free	Mode Transfer Table Fare	
Shortest Path / UE / SUE	YES	YES	YES	YES
Optimal Strategies / Pathfinder	YES	Fare skimmed after path calculation	YES	Only if fare matrices by route

In fare systems that mix flat fares, zonal fares and mode transfer table fares, priority levels are given to each fare type in order to determine transfer fares:

Fare Priorities by Fare System

Fare System	Priority Level
Flat	1. Mode Transfer Table Fare 2. Regular/Discount/Free Fare
Zonal	Only fares from the fare zone matrix are used. Mode transfer table fares are ignored
	Mixed
Flat mode transfer to flat mode	1. Mode Transfer Table Fare 2. Regular/Discount/Free Fare
Zonal mode transfer to flat mode	1. Mode Transfer Table Fare 2. Regular/Discount/Free Fare
Zonal mode to zonal mode	Only fares from the fare zone matrix are used. Mode transfer table fares are ignored

One example of fare priority would be in a strict flat-fare system. If you transferred from a mode 1 route to a mode 2 route and:

1. A record exists in the mode transfer table defining the fare for a mode 1 to mode 2 transfer as $2.00 and

2. The mode 2 route is specified as a free transfer under the flat fare system

Then the mode transfer table would take priority and the calculated transfer fare would be $2.00.

For more information, see:
To Change Transit Network Fare and Transfer Policy Settings

⟩ To Change Transit Network Fare and Transfer Policy Settings

1. Choose **Transit-Network Settings** to display the Transit Network Settings dialog box.

2. Click the Fare tab to display the Fare page.

3. Click the Flat Fare, Zonal Fare or Mixed Fare radio button to choose the fare system.

4. If the fare system is flat fare, choose fields in the ROUTE column or enter values in the GLOBAL column that describe the fare system and transfer policies:

To do this...	Do this...
Choose the fare paid when taking a route	Choose a fare field from the Regular drop-down list, or choose None and type a value in the edit box in the GLOBAL column
Choose the fare paid when transferring	Choose a transfer fare field from the Transfer drop-down list, or choose None and type a value in the edit box in the GLOBAL column
Specify the number of free transfers	Choose a field from the Free Fares drop-down list, or choose None and choose a value from the drop-down list in the GLOBAL column
Specify the number of transfers before charging full fare	Choose a field from the Xfer Fares drop-down list, or choose None and choose a value from the drop-down list in the GLOBAL column

5. If your fare system is zonal, make choices in the Zone Fares frame as follows:

List item	Description
By	OD: One zonal system applies for the entire network
	Mode: One fare matrix applies for each mode
	Route: One fare matrix applies for each route
Matrix File	Fare matrix file
Zone ID	Network node field (from stops layer) to use as fare zone numbers
Matrix	Fare Matrix Name to use. This name field can be found in:
	Fare matrix file if by OD
	Mode table if by Mode
	Route tables if by Route

6. If your fare system is mixed-fare based, specify the flat-fare items in Step 4, specify the zonal fare items in Step 5, and then specify the fare type by route, by mode or globally.

7. Click OK.

TransCAD closes the Transit Network Settings dialog box.

Weights Settings for the Cost Function

In order to control the importance of individual components of the transit cost function, you can assign different weights to the in-vehicle time, transfer time, waiting time and dwelling time. You can also set the proportion of dwelling time that is spent on boarding vs. alighting. Additionally, you can set the weight used for non-transit link times, and non-transit drive link times if the Park and Ride option is enabled.

For more information, see:
To Change the Transit Network Weights Settings

Top

⟩ *To Change the Transit Network Weights Settings*

1. Choose **Transit-Network Settings** to display the Transit Network Settings dialog box.

2. Click the Weights tab to display the Weights page.

3. Set the weight values by choosing the Link Time, Transfer Penalty Time, Waiting Time, and Dwelling Time fields from the Route or Mode drop-down lists, or by choosing None and typing values for these weights in the GLOBAL column.

4. Set the On Dwelling Proportion ratio by choosing a field from the ROUTE or MODE drop-down list, or by choosing None and typing a value in the GLOBAL column.

5. Type a weight for the non-transit links in the Walking Link Time edit box. If Park & Ride is enabled, type a weight in the Driving Link Time edit box.

6. Click OK.

TransCAD closes the Transit Network Settings dialog box.

Top

Park-and-Ride Settings

The park-and-ride (PNR) option in the Transit Network Settings allows you to model the situation where travelers drive from an origin to a park-and-ride node, traverse a link to a transit station, traverse the transit links, and then walk to a destination.

The park-and-ride option is only available when computing transit shortest paths and creating transit skims. This option is not available for transit assignment. The auto trips from the origin to the park-and-ride lots can, however, be assigned as part of the road assignment process.

To enable the use of park-and-ride in TransCAD, you need to create a selection set of park-and-ride nodes in the node layer of the underlying line database. You also need to create a

selection set of driving links from the centroid nodes to the park-and-ride nodes. For these driving links, you need to code the driving times for each link.

You can also use a matrix that pre-defines travel times from centroid nodes to park-and-ride nodes.

When you define the selection set of non-transit links before creating the transit network, you must make sure that all the drive links are included in the selection set. You can define a drive time for each drive link as well. Drive times are coded as an additional field in the underlying line layer. You can also define a maximum drive time. If the path between a centroid and a park-and-ride node is greater than the maximum drive time, the path will be rejected.

Row IDs in the input matrix represent origin centroid node IDs, and the columns represent parking lot node IDs. Each cell represents the travel time cost from the origin centroid node to the parking node. This cost would override the impedance calculated from the drive links. If a centroid-to-PNR matrix is used, you will not need to define the park-and-ride nodes, since they will already be defined in the row IDs. In fact, the Parking Nodes option will be disabled if an input matrix is defined. Here are the park-and-ride settings:

Name	Type	Value
Origin-to-Parking Time Matrix	Matrix	Travel time matrix from origins to parking nodes
Parking Node Selection Set	Selection Set	Selection set of Parking Nodes in underlying node layer
Drive Link Selection Set	Selection Set	Selection set of drive links in underlying line layer
Drive Link Time	String	Name of drive time field in line layer
Max. Drive Time	Real	Maximum drive-access travel time

In one example of a park-and-ride situation, trips are forced to go from the centroid node to the park-and-ride node using only the driving links. For each centroid, you can go to either park-and-ride station. The driving link network is used to determine the minimum path travel time cost from centroid to park-and-ride. Once at the park-and-ride node, the trip traverses the single link to the station using the link walk time.

In a second, more traditional example, drive links are coded explicitly as one and only one link from the centroid to the park-and-ride node. This one link represents a composite of all drive paths to the PNR nodes, and drive links are only added when it trips from a given centroid to a PNR node are feasible. From the PNR node, a link is traversed to the station and then to the rest of the transit network.

The second example has the advantage of using fewer driving links. However, in the second example, care must be given to estimate the correct driving time for each link. Also, consideration must be given in determining which centroid-to-PNR node connections are feasible. In the first example, the underlying line layer helps determine the best driving time from centroid to PNR node and the maximum drive time setting can help determine the proper centroid-to-PNR node connections.

In both examples, only the drive links are used going out of the origin centroid node to the parking lot node. The travel times on these links are defined by their drive link times. Non-driving links cannot be used going out of the origin centroid. From the destination stop to the destination centroid, all non-transit links can be used, including the driving links. However, the travel times on these links are the regular non-transit times and not the driving times.

For more information, see:
To Change the Transit Network Park-and-Ride Settings

⟩ To Change the Transit Network Park-and-Ride Settings

1. Choose **Transit-Network Settings** to display the Transit Network Settings dialog box.

2. Click the Park & Ride tab to display the Park & Ride page.

3. Check the Enable Park-and-Ride Mode box.

4. If an origin-to-parking time matrix is to be used, choose a matrix file and matrix from the Matrix File and Matrix drop-down lists.

5. Choose the parking nodes as follows:

If...	Then...
The parking nodes are in the network	Click the Parking nodes are in network radio button
The parking nodes are in a selection set	Click the Create parking nodes from selection set radio button and choose a selection set from the drop-down list

6. Choose the driving links as follows:

If...	Then...
The driving links are in the network	Click the Driving links are in network radio button
The driving links are in a selection set	Click the Create driving links from selection set radio button and choose a selection set from the drop-down list

7. Choose the drive link time field in the line layer from the Driving Link Time drop-down list.

8. Type a maximum drive impedance in the Max. Driving Time edit box.

9. Click OK.

TransCAD closes the Transit Network Settings dialog box.

Other Settings

The Others tab in the Transit Network Settings dialog box sets other time-based costs in the network. These time costs are waiting times (based on headways), transfer times, dwell times and layover times. This tab is also used to set minimum and maximum waiting times and maximum access, egress and travel times. You can set these parameters by route, by mode or globally.

To determine the relationship between the waiting time and the route headway, specify an

interarrival parameter. If you want the wait time to be half of the headway value, specify a value of 0.5. A value of 0.5 means a uniform distribution of passenger arrival, while a value of 1 means exponential distribution.

The interarrival parameter is used to derive waiting time from vehicle service frequency in the following way:

$$w_i = \frac{\alpha}{f_i}$$

where:

w_i	=	The waiting time for vehicles of route i
f_i	=	The service frequency of route i
α	=	The interarrival parameter

The case $\alpha = 1$ corresponds to an exponential distribution of interarrival times of the vehicles with a mean of $1/f$ and a uniform passenger arrival rate at a stop, and the case $\alpha = 1/2$ is an approximation of a constant vehicle interarrival time $1/f$ given a uniform passenger arrival rate. In the case where $\alpha = 0.5$, the waiting time would be considered to be half the headway time.

For more information, see:
To Change the Transit Network Others Settings

⏵ *To Change the Transit Network Others Settings*

1. Choose **Transit-Network Settings** to display the Transit Network Settings dialog box.

2. Click the Others tab to display the Others page.

3. Set the time values by choosing fields from the Headway, Transfer, Max. Wait, Min. Wait, Dwelling, Layover, Max. Access, Max. Egress and Max. Travel drop-down lists in the ROUTE or MODE columns, or by choosing None and typing values for these times in the GLOBAL column.

4. Type a value for the interarrival parameter in the Interarrival Para. edit box.

5. If you chose the PathFinder or the UTPS method on the General tab, type a threshold value, which is used to determine whether a path segment with a different cost value will be combined into a trunk link or not, in the Cost Threshold % edit box. The maximum difference allowed for this combination process to take place is 25%.

6. Click OK.

TransCAD closes the Transit Network Settings dialog box.

Other Transit Network Settings Options

You can get information on or change the active transit network from within the Transit Network Settings dialog box.

For more information, see:
To Get Information on a Transit Network
To Choose the Active Transit Network from the Transit Network Settings Dialog Box

) To Get Information on a Transit Network

1. Choose **Transit-Network Settings** to display the Transit Network Settings dialog box.

2. Click Info. TransCAD displays the Transit Network Information dialog box.

3. Click Close when you are done viewing the information. TransCAD closes the Transit Network Information dialog box.

4. Click OK.

TransCAD closes the Transit Network Settings dialog box.

) To Choose the Active Transit Network from the Transit Network Settings Dialog Box

1. Choose **Transit-Network Settings** to display the Transit Network Settings dialog box.

2. Click Network. TransCAD displays the Transit Network File dialog box.

3. Choose the transit network you want and click Open. TransCAD displays the name of the network in the Transit Network Settings dialog box.

4. Click OK.

TransCAD closes the Transit Network Settings dialog box, loads the transit network you chose, and uses that network for subsequent analysis.

Updating Transit Network Links

Links in transit networks are created from information in the route system layer and its underlying geographic files. The attributes associated with each transit network link are calculated by aggregating attributes from the underlying geographic line layer. Therefore, all the routes sharing common infrastructure will have the same attribute values. In some cases, however, different routes will have different operational characteristics even when they share common infrastructure, such as express subways and local service subways sharing common tracks.

To update the attributes associated with individual transit segments, prepare a table with the desired and updated attribute values. Each entry in this table needs to have the stop ID for which you are providing the data update and the updated value or values. Here is an example:

Stop ID	IVTT_AM	IVTT_PM
12	10	15
14	11	17
…	…	…

In this example, the transit link following Stop ID 12 will be updated with the IVTT_AM value of 10 and the IVTT_PM value of 15.

For more information, see:
To Update Transit Network Links

⟩ To Update Transit Network Links

1. Choose *Transit-Network Settings* to display the Transit Network Settings dialog box.

2. Make sure the correct network is displayed in the Active Transit Network box. If not, click Network and choose the correct network file.

3. Click Update to display the Update Transit Network dialog box.

4. Choose the table that contains the updated information from the Table drop-down list.

5. Choose the field that contains the stop ID from the Stop ID drop-down list.

6. For each field stored in the transit network:

- Highlight the field in the scroll list
- Choose the corresponding update field in the table from the Field drop-down list

7. Click OK.

TransCAD updates the attributes in the network. Any subsequent analysis will use the updated network information.

Tips for Using Transit Network Settings

- It is possible for a path to include only non-transit links. If you would like to minimize the possibility of choosing non-transit links in the path, set the non-transit link weight (on the Weight tab) to a higher number.
- If you would like fare to be less involved as a factor in the generalized cost calculations, set the Value of Time (VOT) parameter (on the General Tab) to a high number.
- Set the maximum access and egress times (on the Others tab) to values that would prevent unreasonable trips from the centroid to the transit system.
- You can set the maximum and minimum wait times by route (on the Others tab) to simulate routes with low frequencies but also low waiting times. An example would be commuter routes with one-hour headways where passengers realistically would only wait a maximum of 10-15 minutes, since they would time their arrivals to the schedule.
- You can vary the link time weights (on the Weights tab) by route to simulate bias for one mode over the other.
- You can vary the waiting time weight (on the Weights tab) by route to simulate the situation where passengers are willing to wait more for one mode versus another. You can also vary the wait time weight globally to affect how willing passengers are to wait in general.
- Use a mode table if you want to skim link variables by mode.
- Set the maximum transfer time (on the General tab) to values that would prevent unreasonable transfer time walking between routes.

About Best Transit Paths

Attributes of the best transit paths are used in transit planning and for developing inputs for mode choice models. Historically, a number of transit network route choice models have been proposed. The main differences among these models are the hypotheses made on the traveler's route choice. TransCAD provides three route choice models for finding the best paths and path attributes (skimming): the shortest path method, the method of optimal strategies, and a more general and flexible Pathfinder method. The Pathfinder method was developed at Caliper Corporation, based on specifications from some leading consultants.

The Shortest Path Method
This is method assumes that all passengers traveling from an origin to a destination choose one itinerary that minimizes the total generalized travel cost. On any path segment only one transit line will be chosen, even when the segment is served by several transit lines with similar travel times.

The Method of Optimal Strategies

The concept of an **optimal strategy** may be considered as a generalization of the concept of a single path. Based on the assumption that passengers only have the information of which transit line arrives next at a given stop, a strategy is defined as a set of rules that allow the passenger to travel from origin to destination. A line segment going out of a stop will be used only if its addition to the optimal strategy will reduce the total expected travel cost from that stop to the destination. Unlike the paths created by the shortest path method, paths corresponding to optimal strategies have branches, and sometimes are referred to as "hyper-paths." Spiess (1989) presents a detailed description of the model. This method returns only a matrix of skimmed values and not a specific path.

The Pathfinder Method

This method is a generalization of the old UTPS and other methods, in which multiple paths are utilized between a single O-D pair. Similar service characteristics are combined into common trunk links, even in hard cases characterized by:

- Different transit travel times for route segments
- Different stopping patterns
- Different route layouts
- Paths over transfer points

The Pathfinder method computes the reduced first wait associated with the fact that different routes could be used to reach a destination because of overlapping service. The algorithm preprocesses the transit network and builds trunk links (links shared by one or more common routes). In order for transit links to be combined into a common trunk link, their impedance (where the impedance is made up of in-vehicle travel times, fares, etc.) has to be similar (but not identical) and less than a user-defined threshold, which cannot exceed 25% of the best path impedance. Once it has preprocessed the network, Pathfinder builds vines on the combined network.

For more information, see:
Solving Best Path Problems

Solving Best Path Problems

For long-range planning models, TransCAD solves shortest path problems on a transit network in two ways:

- Between nodes of the underlying line layer
- Between stops on a route system

There are other modules available for transit applications that provide transit shortest paths from point-to-point, address-to-address, and based upon schedules.

When you solve a transit shortest path problem, TransCAD uses the current transit network, settings, and fare structure. These can be changed with the *Transit-Network Settings* command; for more information, see Configuring Transit Networks.

The first time you solve a transit shortest path problem, TransCAD asks for the name of a table in which to store the results. TransCAD then creates the table and attaches it to the route system as a

milepost layer named Transit Paths. If you solve a series of shortest paths, the results are all stored in the same table and displayed as part of the layer. The records that identify the most recently created path are selected, so that the most recently created path is highlighted on the map.

TransCAD produces a series of directions for each transit shortest path, indicating the place to board each route, the number of stops to ride, and the place to get off each route. To produce these directions, TransCAD needs a description of the location of each stop. This information can be stored as part of the stop table in the route system, or TransCAD can figure out the location based on information in a street layer. The first time you solve a transit shortest path problem, TransCAD asks you where to find the stop locations.

In the Transit Shortest Path toolbox, you can change the method to use when determining best paths. You can also choose the origin and destination, either based on a specific node or stop or based on multiple nodes or stops close to the points you picked.

The transit shortest path results are displayed in a dialog box that includes the following information:

- The total generalized cost of travel between each origin and destination
- The cash fare paid for the trip
- The in-vehicle travel time
- The initial wait time
- The transfer wait time
- The access time, if the path is from node to node
- The egress time, if the path is from node to node
- The total dwell time
- In-vehicle, initial wait, transfer wait, transfer, access, egress, and dwell costs
- The total number of transfers
- The transfer penalty
- Skimmed values for each link network attribute for the entire path; if a mode table is included in the transit network settings, skimmed values are divided into the modal components
- Directions for making the transit trip; the Pathfinder and Optimal strategies produce a solution based on combined routes, so that the directions may have different branches

The results are presented in the Transit Path Results dialog box.

When either the Pathfinder or Optimal Strategies method is chosen, sometimes the best path will contain branches. When this occurs, attributes such as first wait times are combined by branch. Some other attributes, such as Fare and in-vehicle travel time, are averages weighted by route frequency.

For example, after the access link walk of 0.108 miles, you could either board the Green or the Yellow Line routes (2 and 3). From either route, you could transfer either to the Orange or Blue line routes (4 and 5). All paths take you to the same destination of I St. NW and 17th St. NW where you walk 0.230 miles to your destination.

For more information, see:
To Find the Shortest Transit Path

Top

⟩ To Find the Shortest Transit Path

1. Choose the layer on which you want to route from the drop-down list on the toolbar. You can choose either the route stops layer or the underlying endpoints layer.

2. Choose **Transit-Shortest Path** to display the Transit Shortest Path toolbox.

3. If you have not already chosen and configured a transit network, click [icon] to display the Transit Network Settings dialog box, choose a network, and set the fare and other settings. Click OK when you are done to close the Transit Network Settings dialog box.

4. Choose a method from the Method drop-down list.

   If you want your origin and destination stops or nodes to contain all stops or nodes close to the locations you click, check the Multiple Nodes box.

5. Click [icon] to activate the stop tool, and then click on the map at the desired origin and destination locations.

   If your current layer is the endpoint layer and you click on a location that contains more than one endpoint, TransCAD displays the Choose a Feature dialog box. Choose the node that you want to use and click OK.

6. Click [icon] to find the shortest transit path.

7. If this is the first transit shortest path you have solved, TransCAD displays the Save Paths dialog box. Type a name for the file in which paths are stored and click Save.

   TransCAD may display the Stop Location Information dialog box.

   Indicate where stop location information can be found and click OK. This information is used to create path directions, using the names provided in the stop location field. This field can be the stop name as stored in the stop layer or the nearest intersection to the stop in the line layer, if the line layer has street name information.

8. TransCAD solves the shortest path problem and displays the results both on the map and in the Transit Path Results dialog box.

   If you want to save the path and results in a text file, click Save Path, type an output file name, and click Save.

   When you close the Transit Path Results dialog box, TransCAD displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

9. Return to Step 5 to solve another transit shortest path problem, or close the Transit Shortest Path toolbox.

Best Transit Path Attributes (Transit Skims)

You can also solve multiple transit shortest path problems, and store the resulting values (transit skims) in a matrix file that indicates the characteristics of the transit shortest path between pairs of traffic analysis zones or stops.

A transit skim matrix file may contain one or more of the following matrices:

- The total generalized cost of travel between each origin and destination
- The cash fare paid for the trip
- The in-vehicle travel time
- The initial wait time
- The transfer wait time
- The total transfer time
- The total access time
- The total egress time
- The total dwell time
- The total in-vehicle, initial wait, transfer wait, transfer, access, egress, and dwell costs
- The transfer penalty
- The number of transfers required to make the trip

In addition, you can skim any link variable, other than the one used for minimization.

You can also report the skims by mode. If you include a mode table in your transit network settings, all the link attributes can be categorized by mode.

If you set up your transit network with the Park and Ride option, you can choose to output a parking lot matrix and a drive time matrix in addition to the output skim matrix. The parking lot matrix contains the parking lot node ID chosen for each O-D pair. The dimensions and matrix IDs of the parking lot matrix is similar to the skim matrix. The drive time matrix is a matrix of shortest path drive times between origin TAZ nodes and parking lot node IDs. To set up your transit network with the Park and Ride option, see Park-and-Ride Settings.

You can create transit skims for all nodes or stops, or select the nodes or stops you want to appear in the rows and columns of the matrix. You can use the same selection set for both origins and destinations (in which case the resulting matrix is square), or use separate selection sets for the origins and destinations. You cannot create transit skims from zones to stops or vice versa.

You can create the origin and destination selection sets using any selection tool or command. TransCAD finds the best transit path between each origin and destination, and stores the results in the skims matrix file.

You can also designate the method with which TransCAD finds the best paths between O-D pairs. Currently three methods are available: Shortest Path, Optimal Strategies, and Pathfinder.

You can also create transit skims when performing transit assignment. When you create transit skims this way, you have two additional methods you can use: User Equilibrium and Stochastic User Equilibrium. To learn how to create transit skims within transit assignment, see Chapter 12, Transit Assignment.

For more information, see:

) *To Create a Transit Skim Matrix*

1. Choose the node or stop layer from the drop-down list on the toolbar.

2. Choose the *Transit-Multiple Paths* command to display the Transit Skims dialog box.

3. If you have not already chosen and configured a transit network, click Network to display the Transit Network Settings dialog box, choose a network, and set the fare and other settings. Click OK when you are done to close the Transit Network Settings dialog box.

4. Choose All Features or a selection set of origins from the Origins drop-down list.

5. Choose All Features or a selection set of destinations from the Destinations drop-down list.

6. Choose a pathfinding method from the Skim Method drop-down list.

7. Highlight in the Skim Variables scroll list all the attributes that you want to include in the skims matrix file. Notice that the general cost attribute is automatically selected initially. The number in parentheses indicates how many attributes are currently chosen.

8. If you want to skim by mode and you have included a mode table in your network settings, check the Skimming on Modes box and highlight the modes you want to skim by in the Skim Modes scroll list. The number in parentheses indicates how many modes are currently chosen.

9. If you have the Park-and-Ride settings and you wish to create the parking lot node matrix and the drive time to parking lot matrix, check the Create Parking Matrix box.

10. Click OK to display the Save As dialog box.

11. Type a file name and click Save. TransCAD creates the transit skim matrix and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the generalized cost matrix in a matrix view. To see other matrices, choose them from the drop-down list on the toolbar. If you checked the parking lot box, the other matrices are shown in additional matrix views.

Transit Assignment

Transit assignment models are used to estimate the number of passengers that use links and routes in a transit network as a function of transit level of service and fare. These models need an O-D matrix of passenger demand and a transit network, and produce link level and aggregate ridership statistics. TransCAD includes an array of sophisticated transit network assignment procedures.

For more information, see:
About Transit Assignment
Transit Assignment Settings
Performing Transit Assignment
Summarizing and Aggregating Transit Assignment Results
Technical Notes on Transit Assignment

Top

About Transit Assignment

The transit assignment procedure lets you choose among five different assignment methods:

- Shortest Path (All-or-Nothing Assignment)
- Method of Optimal Strategies
- Pathfinder
- User Equilibrium
- Stochastic User Equilibrium

The first three are non-equilibrium methods that do not take transit capacity into account. They use the path choice models described in Chapter 11, *Transit Networks, Best Transit Paths, and Path Attributes*. All-or-Nothing Assignment assigns all travelers, between a particular origin and destination, to the shortest path through the network. The Method of Optimal Strategies, at each stop in a hyper-path, splits all the trips arriving at the stop to all the used downstream links, in proportion to their service frequencies. Interestingly, this method ignores the relative travel times of competing service links. The Pathfinder method is another multi-path assignment method that assigns trips to overlapping routes with similar service characteristics, and takes into account the reduced first wait times by creating a combined trunk network. Within a trunk-line link, trips are distributed among component links in proportion to their frequencies.

The last two models are equilibrium assignment methods, which take into account the capacity of the transit service and the effect of crowding and dwelling times on ridership. These methods distribute the flow between a particular origin and destination to multiple paths, based on their relative attractiveness.

In practice, stochastic user equilibrium (SUE) transit assignment produces assignment results that appear to be the most reasonable. This method results in an assignment in which many reasonable paths may be used for each O-D pair, even when capacity is not an issue.

All of the assignments, except the Method of Optimal Strategies, are based on a generalized cost function that includes travel time components and fare. For many applications, some of the components such as dwell time can be given zero weights. The cost function is described in

For more information, see:
Link Generalized Cost Penalty Functions

Link Generalized Cost Penalty Functions

The User Equilibrium and Stochastic User Equilibrium assignment methods allow you to specify a **link generalized cost penalty function**, which increases the generalized cost of links in a transit network as the route becomes more and more congested. The link cost penalty function represents three types of effects:

- The degradation in rider comfort which results from increased crowding
- The increased dwell time that results from congestion on board the vehicle
- The possibility that a rider will be unable to board a vehicle because it is loaded to capacity

The link cost penalty function has a generic formulation whose parameters can be used to adjust the level and severity of the cost penalty. The equation is:

$$c = c_f \left[1 + \alpha \left(\frac{p}{cap} \right)^{\beta} \right]$$

where:

c = Adjusted link cost

c_f = Link cost with zero passengers

p = Passengers on the link

cap = Route capacity (number of seats)

α, β = Parameters

Note that the route capacity must be in the same units as the O-D demand matrix. For example, if the trip table to be assigned is a peak-hour table, the capacity should be expressed in seats per hour. The values of α and β are calibration constants that may vary from location to location, or from route to route.

You can specify default system-wide values for the α and β parameters, or use values that vary by route. To use route-specific values, the route table must include fields for the α and β values, and these two fields must be included in the transit network. For information on setting up the route table, see Chapter 16, *Route Systems*, in the *TransCAD User's Guide*. For information on choosing the fields to include in a transit network, see Chapter 11, *Transit Networks, Best Transit Paths, and Path Attributes*.

The transit link cost penalty function is not intended to represent the congestion effect of transit vehicles on a roadway network. It is used to represent delays due to passenger crowding. If these effects are significant, the travel time on the underlying street network layer should be adjusted as necessary, and these estimates of congested travel times should be included as attributes of the transit network.

Transit Assignment Settings

The Assignment tab of the Transit Network Settings dialog box is used to define transit assignment parameters if the pathfinding method is either User Equilibrium (UE) or Stochastic User Equilibrium (SUE). If any other path method is chosen, this tab will be hidden.

This tab lets you specify congestion parameters and error terms by route, by mode, or globally. TransCAD always looks first at the route-level values. If TransCAD finds the attribute there, it will be used. If the attribute is missing, for any of these reasons:

- The corresponding field does not exist in the original table
- None, rather than a field, was chosen from the drop-down list
- The value stored in the table is missing

Then TransCAD will try to find the value in the mode table, if the mode option was checked on the Modes tab. If the value is also missing from the mode table, the global value will be used.

Both the UE and SUE methods make use of the congestion and dwelling parameters. Only the SUE method makes use of the error terms parameter. You can define an error term both on the transit link travel time and on the route headways. You can also define the error distribution function to use on either error term.

For more information, see:
To Set Impedance Parameters for Transit Assignment

⟩ To Set Impedance Parameters for Transit Assignment

1. Choose **Transit-Transit Assignment** to display the Transit Assignment dialog box.

2. Choose User Equilibrium or Stochastic User Equilibrium from the Method drop-down list.

3. Click Network to display the Transit Network Settings dialog box.

4. Click the Assignment tab to display the Assignment page.

5. Set the congestion parameters by choosing fields from the Alpha, Beta, and Capacity drop-down lists in the ROUTE or MODE column, or by choosing None and typing values for these congestion parameters in the GLOBAL column.

6. If you are using Stochastic User Equilibrium assignment, set the error terms by choosing fields from the Link Time and Headway drop-down lists in the ROUTE or MODE column, and by choosing None and typing values for these error terms parameters in the GLOBAL column. Also choose fields from the Link Function and Headway Function drop-down lists.

7. Set the dwelling parameters, used to estimate the time spent at a transit stop, which is a function of the number of passengers that board and alight at that particular stop, by typing values in the On Volume, and Off Volume edit boxes.

8. Click OK. TransCAD closes the Transit Network Settings dialog box.

9. Click Cancel to close the Transit Assignment dialog box, or continue using the procedure To Perform a Shortest Path, Optimal Strategies, or Pathfinder Transit Assignment or To Perform User or Stochastic User Equilibrium Transit Assignment.

Performing Transit Assignment

To perform a transit assignment, you need to provide:

- A transit route system that defines the routes and stops
- A transit network built from the route system, with complete settings and fare structure information
- An O-D passenger demand matrix, with stop-to-stop or node-to-node demand

The O-D matrix indicates the number of passengers traveling between each origin and destination. The matrix row and column IDs must match the node IDs in the network or the stop IDs in the stops layer. Cells in the matrix whose IDs are not in the network are not assigned.

For more information, see:
Results of Transit Assignment

Results of Transit Assignment

The Transit Assignment procedure produces a table of ridership at every stop along each route in the transit network. The table contains one record for each route segment, indicating the ridership on that segment. The segments are identified by the ID of the stop at the beginning and end of each segment.

The assignment table also indicates the milepost at the beginning and end of each route segment. This information is used to add the ridership data to the map as a milepost layer. You can display transit ridership data using scaled-symbol or color themes on this layer, or use the data to add labels to a map indicating transit ridership.

If the transit network includes non-transit links, TransCAD produces a table of flows on the non-transit links, which contains one record for each non-transit link, indicating the forward and reverse flow on that link. The segments are identified by the IDs of the links.

The Transit Assignment procedure has six optional results:

- A matrix of critical (select) link analysis results, indicating the O-D pairs that use a particular portion of a transit route
- A table of boarding and alighting counts, indicating the number of riders boarding and alighting at every transit stop
- Aggregate ridership data for each transit corridor, with combined information for all routes sharing a single right-of-way
- Matrices of skimmed loaded network attributes, which make it possible to estimate the number of transfers, the loaded generalized costs, and any of the additional transit network attributes between each OD pair; transit link attributes can also be skimmed by mode
- A table of origin stop to destination stop trips for selected routes
- A table of transfer movements between routes or at stops

Critical (Select) Link Analysis

The traffic assignment model can determine the set of O-D pairs whose riders use any portion of a transit route. To produce critical link analysis reports, you create a selection set on the stop layer containing the stops that are of interest.

Critical link analysis results are stored in a matrix file, with one matrix for each stop in the stop selection set. Each matrix indicates the number of riders from each O-D pair that are riding the route as it departs from the stop.

Boarding and Alighting Counts

The Transit Assignment procedure can produce a detailed table of boarding and alighting at transit stops. This table can be joined to the transit stops layer in a joined view, and used to create thematic maps illustrating boarding and alighting at stops.

Aggregate Ridership Counts

Often several transit routes operate along a single right-of-way. This output option produces aggregate ridership results that indicate the total transit ridership for all routes that share a common right-of-way.

The aggregate ridership data are stored in a table similar to the route-level ridership results. This table aggregates all of the transit riders along a portion of a corridor onto a single route that operates in the corridor. This layer is automatically attached to the route system to produce a milepost layer. You can use scaled-symbol or color themes on this layer to illustrate aggregate ridership in each transit corridor, or use the data to add labels to the map indicating transit ridership. In addition, the aggregate table contains ridership both in the aggregate and by direction, so you can use dual bandwidths to illustrate directional flows.

Note that the route listed in the table is arbitrary. For example, if four routes operate between two stops, the aggregate ridership table will list the total flow for all four routes on just one of the four route numbers. Therefore, care needs to be taken when analyzing results from this table.

Skimming a Loaded Transit Network During Assignment

Loaded transit networks can be skimmed by using the procedures discussed in Chapter 11, *Transit Networks, Best Transit Paths, and Path Attributes*. Alternatively, the Transit Assignment procedure

can keep track of transit network attributes and report the result in a matrix file. This option permits estimation of same variables described in the previous chapter. However, it should be noted that this option provides different estimates for skims than the procedures in Chapter 11 for the transit assignment methods that are multi-path, equilibrium, or both.

For Stochastic User Equilibrium assignment, skimming provides estimates of the expected values of the attributes. This is computed in the course of the assignment and increases the computation burden significantly.

Line O-D Routes

The Transit Assignment procedure can produce a table that shows stop-to-stop O-D trips within a route. To enable this option, you need to first create a selection set on your route layer that contains the route you want to analyze in this report.

The line O-D routes option is not available for the methods that use combined headways (i.e. the Method of Optimal Strategies and Pathfinder).

Movement Table

The Transit Assignment procedure can produce a table that shows trip movements between designated routes and/or trip movements between all routes connected to a designated stop. To specify the routes and stops for this option you create a movement table, which has three integer fields: FROM_LINE, TO_LINE and AT_STOP.

For example, all routes connected to stops merged with stop 95 might be included in the analysis. In addition, all transfers from route 16 to 17 would be calculated in the report.

For more information, see:
To Prepare for Performing Transit Assignment
To Perform a Shortest Path, Optimal Strategies, or Pathfinder Transit Assignment
To Perform User or Stochastic User Equilibrium Transit Assignment

Top

⟩ *To Prepare for Performing Transit Assignment*

1. Open or create a map containing the transit route and stop layers.

2. If you plan to use the options to create table or matrix output, open the necessary input tables and create selection sets on the route and stop layers as necessary.

3. Open or create an O-D demand matrix indicating the node-to-node or station-to-station flow.

4. Open or create a transit network, and use the procedures in Configuring Transit Networks, to use the Transit Network Settings dialog box to set up the network and define the fare structure.

Top

〉 *To Perform a Shortest Path, Optimal Strategies, or Pathfinder Transit Assignment*

1. Make the map the current window, and choose the route system layer from the drop-down list on the toolbar.

2. Choose **Planning-Transit Assignment** to display the Transit Assignment dialog box.

3. Choose Shortest Path, Optimal Strategies, or Pathfinder from the Method drop-down list.

4. Choose the O-D matrix file and matrix from the Matrix File and Matrix drop-down lists.

5. Choose the type of O-D matrix by clicking the Based on Stop Layer or Based on Node Layer radio button.

6. Click Options to display the Transit Option Settings dialog box.

    Choose one or more output options:

To do this...	Do this...
Compute critical link flows	Choose a selection set of stops from the Critical Link Analysis drop-down list.
Use a movement table	Choose a movement table to use to calculate route transfer movements from the Movement Table drop-down list.
Calculate O-Ds on routes	Choose a selection set of routes to calculate in-route O-Ds from the Line O-D Routes drop-down list. This method is disabled for Optimal Strategies and Pathfinder assignment.
Compute boardings and alightings	Check the Compute Boarding Counts box.
Display transit and walk flow outputs	Check the Create Flow Themes box.
Aggregate segment counts	Check the Aggregate Segment Counts box.
Build skims	Check the Variables box and choose from the Variables scroll list all of the attributes that you want to be included in the Skims matrix file. If you included a mode table in your network settings, you can also choose skimming by mode by checking the Modes box and choosing the modes to skim from the Modes scroll list.

    Click OK to return to the Transit Assignment dialog box.

7. Click OK. TransCAD displays the Output File Setting dialog box. Choose to use, rename, or overwrite each file as follows:

If the status is...	Do this...
In Use or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

8. Click OK. TransCAD performs the transit assignment, creates a table of flows for the transit links, creates a table of flows for non-transit links, creates a new map layer named Transit Flows, creates optional output tables and matrices, displays the transit flows in a dataview, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

If the Create Flow Themes option was checked, TransCAD will also create a scaled-symbol theme on both the transit and non-transit flows

) *To Perform User or Stochastic User Equilibrium Transit Assignment*

1. Make the map the current window, and choose the route system layer from the drop-down list on the toolbar.

2. Choose **Planning-Transit Assignment** to display the Transit Assignment dialog box.

3. Choose the desired User Equilibrium or Stochastic User Equilibrium from the Method drop-down list.

4. Choose the O-D matrix file and matrix from the Matrix File and Matrix drop-down lists.

5. Choose the type of O-D matrix by clicking the Based on Stop Layer or Based on Node Layer radio button.

6. Type the maximum number of iterations in the Iterations edit box.

7. Type the convergence value in the Convergence edit box.

8. Click Network to display the Transit Network Settings dialog box, click the Assignment tab, and set the congestion function parameters as follows:

To do this...	Do this...
Use default values	In the ROUTE and MODE column, choose None from both the Alpha and Beta drop-down lists. In the GLOBAL column, type the desired values in the Alpha and Beta edit boxes.
Use values that vary by route	In the ROUTE column, choose the network attributes containing the alpha and beta parameter values from the drop-down lists. In the GLOBAL column, type default values to use when route-specific data are unavailable.

Click OK to return to the Transit Assignment dialog box. For more information, see Transit Assignment Settings.

9. Click Options to display the Transit Option Settings dialog box, and choose one or more output options:

To do this...	Do this...
Compute critical link flows	Choose a selection set of stops from the Critical Link Analysis drop-down list.
Use a movement table	Choose a movement table to use to calculate route transfer movements from the Movement Table drop-down list.
Calculate O-Ds on routes	Choose a selection set of routes to calculate in-route O-Ds from the Line O-D Routes drop-down list. This method is disabled for Optimal Strategies and Pathfinder assignment.
Display transit and walk flow outputs	Check the Create Flow Themes box.
Aggregate segment counts	Check the Aggregate Segment Counts box.
Build skims	Check the Variables box and choose from the Variables scroll list

all of the attributes that you want to be included in the Skims matrix file. If you included a mode table in your network settings, you can also choose skimming by mode by checking the Modes box and choosing the modes to skim from the Modes scroll list.

Note: For both the UE and SUE methods, boarding counts are automatically created.

Click OK to return to the Transit Assignment dialog box.

10. Click OK to display the Output File Setting dialog box. Choose to use, rename, or overwrite each file as follows:

If the status is...	Do this...
In Use or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

11. Click OK. TransCAD performs the transit assignment, creates a table of flows, creates a new map layer named Transit Flows, creates optional output tables and matrices, displays the transit flows in a dataview, and displays a Results Summary dialog box:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

Displaying Transit Assignment Results

The Transit Assignment procedure can automatically attach the assignment flow table to the route system and display the results. You can also manually display results by using the ***Route System-Linear Referencing-Attach*** command; for more information, see "Creating Milepost Layers" in Chapter 17, *Linear Referencing Systems*, in the *TransCAD User's Guide*.

For more information, see:
To Display Transit Assignment Results

⟩ *To Display Transit Assignment Results*

1. Open your route system and transit assignment results flow table.

2. Choose the route system layer from the drop-down list on the toolbar.

3. Choose **Route System-Linear Referencing-Attach** to open the Attach Milepost Table dialog box:

4. Click the Line Layer radio button.

5. Choose the dataview that contains your flow results from the Dataview drop-down list.

6. Choose the route system layer from the To Layer drop-down list.

7. Choose ROUTE from the Routes drop-down list.

8. Choose FROM_MP from the Start drop-down list.

9. Choose TO_MP from the End drop-down list.

10. Click OK.

TransCAD attaches the flow table to the route system and creates a new layer. You can now display the flow results in any TransCAD theme.

Summarizing and Aggregating Transit Assignment Results

TransCAD provides several ways to summarize and aggregate transit assignment results. You can:

- Compute route attributes, by using the **Route Systems-Utilities-Compute Route Attributes** command; for more information, see "Computing Route Attributes" in Chapter 16, *Route Systems*, of the *TransCAD User's Guide*
- Fill a line layer field with a route attribute, by using an attribute from the route layer and filling this attribute into extra numeric fields in the line layer; you can also use headway and Passenger Car Equivalent (PCE) information on the route layer to calculate hourly vehicle flow on the line layer
- Aggregate on/off counts to nodes, by using the boarding counts table to aggregate the on/off counts in the underlying line database's node layer, producing total boardings and alightings at intersections
- Aggregate on/off counts to routes, by using the boarding counts table to aggregate the on/off counts in the route table, producing total boardings and alightings by route
- Using both the boarding counts and transit flow tables, you can calculate boardings, alightings, passenger miles, passenger hours, and accumulated passengers by route, by mode and by stop field
- Create transit reports, by using the transit flow table and the route system to create an aggregate flow table similar to the aggregate flow table for the Transit Assignment procedure
- Aggregate transit assignment results for corridors and right-of-ways, by using the route system and the transit assignment flow table to create an aggregate flow table

For more information, see:
Filling a Line Layer Field with a Route Attribute
Aggregating On/Off Counts to Nodes
Aggregating On/Off Counts to Routes

Filling a Line Layer Field with a Route Attribute

You can choose an attribute from the route layer and fill this attribute into extra numeric fields in the line layer. Every line segment that makes up the route will get this route attribute. You can use the results to answer questions such as:

- What is the total route ridership on the line segments?
- What is the number of buses on the line segments?

For line segments that are part of more than one route, the results will be additive by route. For example, if a line segment is part of routes 1, 2 and 3, and if the ridership on these routes is 30, 50 and 80 riders respectively, the resulting total would be 160 riders on the line segment.

Since routes are directional, the attributes are filled in based on direction. You do this by specifying two numeric fields, one for the results in the "AB" direction (the same as the topological direction of the line segment) and another for results in the "BA" direction (opposite to the topological direction of the line segment).

You can also calculate hourly vehicle flow on the line layer, given headway and Passenger Car Equivalent (PCE) information on the route layer. This is useful if you wish to preload buses on your road network. The estimate of vehicle flow is governed by the following equation:

$$Flow = PCE * TimeUnits / Headway$$

where:

$$Time\,Unit = \quad \begin{array}{l} \text{1 for Hours} \\ \text{60 for Minutes} \\ \text{3600 for Seconds} \end{array}$$

For each route, you would need to specify the average PCE of the vehicles serving the route and the route headway, in the appropriate time units (hours, minutes or seconds).

For more information, see:
To Fill a Line Layer Field with a Route Attribute

⟩ *To Fill a Line Layer Field with a Route Attribute*

1. Make sure that your working layer is a route system layer, and that there are at least two extra

numeric fields in the underlying line layer.

2. Choose *Transit-Fill Line Layer Field with Route Attribute* to display the Fill Line Layer Field with Route Attribute dialog box.

3. Choose All Routes or a selection set of the routes whose fields you wish to place in the line layer from the Selection drop-down list.

4. Choose the type of loading to do as follows:

To do this...	Do this...
Load a route field	Click the Load a route field to the line layer radio button choose the field to load from the Route Feld drop-down list
Calculate flow	Click the Calculate flow from route headways and PCE radio button, choose the fields representing headway and PCE by route from the route layer and choose whether the units of headway are in seconds, minutes or hours, from the respective drop-down lists

5. Click the Output tab to display the Output page.

6. Choose the fields in the line layer to fill with the results in both the AB and BA direction from the AB Fill Field and BA Fill Field drop-down lists.

7. If you want the fields cleared before filling them, check the **Clear values before filling** box.

8. Click OK. TransCAD displays a Confirm dialog box to make sure that you want to overwrite the chosen fields.

9. Click Yes.

TransCAD fills the two fields in the line layer with the information from the route layer.

Top

Aggregating On/Off Counts to Nodes

You can aggregate the on/off counts calculated in the boarding table and put the results in the node layer of the underlying line database. The result will be total boardings and alightings at intersections, as fields in the node layer. The boarding counts table is an optional output of the Transit Assignment procedure.

Before you can run this procedure, you need to prepare both your node layer and your stops layer. For the node layer, you need modify the table to add two empty real fields. These fields will contain the boarding and alighting results.

For the stops layer, you need to assign a node ID to each stop. This field should already exist, as it is a required field during the transit network creation process.

For more information, see:
To Aggregate On/Off Counts to Nodes

Top

⟩ *To Aggregate On/Off Counts to Nodes*

1. Open your route system and boarding counts table.

2. Make the map the current window, and choose the route system layer from the drop-down list on the toolbar.

3. Choose **Transit-Aggregate On/Off Counts** to display the Aggregate On/Off Boarding for Nodes dialog box.

4. Choose the boarding counts table from the Boarding Table drop-down list.

5. Choose the stop layer from the Stop Layer drop-down list and the field that contains the node ID from the Node ID drop-down list.

6. Choose the node layer from the Node Layer drop-down list and the fields that will contain the resulting aggregated boardings and alightings from the Boarding and Alighting drop-down lists.

7. Click OK.

TransCAD fills the two fields in the node layer with the boardings and alightings.

Top

Aggregating On/Off Counts to Routes

You can aggregate on/off counts and put the results into the route table. The results are total boardings by route. The boarding counts table is an optional output of the Transit Assignment procedure.

Before you can run this procedure, you need to prepare your route layer, by modifying the table to add an empty real field. This field will contain the resulting counts.

For more information, see:
To Aggregate On/Off Counts to Routes

Top

⟩ *To Aggregate On/Off Counts to Routes*

1. Open your route system and boarding counts table.

2. Make the map the current window, and choose the route system layer from the drop-down list on the toolbar.

3.   Choose *Transit-Route Utilization* to open the Aggregate Number of Passengers dialog box:

4.   Choose the boarding counts table from the Boarding Table drop-down list.

5.   Choose ROUTE from the Route ID drop-down list and ON from the Boarding Counts drop-down list.

6.   Choose the route table from the Route Table drop-down list, the route ID field from the route ID drop-down list, and the field that will store the results from the Aggregation Field drop-down list.

7.   Click OK.

TransCAD fills the aggregation field with the total boardings by route.

Top

Creating Transit Reports

You can create transit reports of total boardings, alightings, passenger miles, passenger hours, and accumulated passengers using three different summary levels:

- The route level
- The route group level (e.g., statistics for each mode)
- The transit link group level (i.e., statistics for commonly-identified groups of transit links)

The To Create Transit Reports procedure uses both the boarding counts table and the flow report table created by the Transit Assignment procedure. The flow report table also needs to be attached to the route system as a linear-referenced layer. If you run the To Create Transit Reports procedure immediately after the Transit Assignment procedure, the Transit Assignment procedure will have automatically created the linear-referenced layer for you. Otherwise, you will need to open and attach the flow report table manually. The procedure To Attach a Flow Table to the Route Layer and Create A Linear-Referenced Layer shows you how to attach a flow report table to a route system. For more information on Linear Referencing, please see Chapter 17, *Linear Referencing Systems*, in the *TransCAD User's Guide*.

To calculate route group level statistics, you need to you need to assign a route group to each route. This means having an existing or new field in the routes layer that has an assigned group name or ID for each route. An example route group would be the mode field that groups routes into their respective modes.

To calculate transit link group statistics you need identify common groups of transit links in the stops layer. This means having an existing or new field in the stops layer that has the group to which the stop is assigned. The transit link outbound from the stop will belong to that group.

For example, the links outbound from stops 1, 2 and 3 might belong to group "PENN STA" and the links outbound from stops 6 and 7 might belong to group "RONKONKOMA". The To Create Transit Reports procedure will produce summary statistics using those groups of links.

For more information, see:
To Attach a Flow Table to the Route Layer and Create A Linear-Referenced Layer
To Create Transit Reports

⟩ *To Attach a Flow Table to the Route Layer and Create A Linear-Referenced Layer*

1. Open your route system and transit assignment results flow table.

2. Make the map the current window, and choose the route system layer from the drop-down list on the toolbar.

3. Choose *Route Systems-Linear Referencing-Attach* to display the Attach Milepost Table dialog box.

4. Click the Line Layer radio button.

5. Choose the dataview that contains your flow results from the Dataview drop-down list.

6. Choose the route system layer from the To Layer drop-down list.

7. Choose ROUTE from the Routes drop-down list.

8. Choose FROM_MP from the Start drop-down list.

9. Choose TO_MP from the End drop-down list.

10. Click OK.

TransCAD attaches the flow table to the route system and creates a new layer. You are now ready to run Transit Reports.

⟩ *To Create Transit Reports*

1. Open your route system, boarding counts table and transit assignment results flow table. Attach the flow table to the route system.

2. Make the map the current window, and choose the route system layer from the drop-down list on the toolbar.

3. Choose *Transit-Reports* to display the Create Transit Reports dialog box.

4. Choose the appropriate tables from the Boardings/Alightings and Transit Flows drop-down lists.

5. Check the reports you wish to produce in the Report frame.

6. Choose how to aggregate statistics as follows:

To aggregate statistics by...	Do this...
Route	Check the By Route box
Route group	Check the By Route Field box and choose the route group field in the route layer from the drop-down list
Link group	Check the By Stop Field box and choose the link group field in the stop layer from the drop-down list

7. Click OK. TransCAD displays the Output Report Table dialog box.

8. Type a name for the output file and click Save.

TransCAD calculates the summary statistics by the chosen group levels and displays the results.

Top

Aggregating Transit Assignment Results for Corridors and Right-of-Ways

You can create an aggregate flow table using the route system and the transit assignment flow table. Often several transit routes operate along a single right-of-way. This procedure calculates aggregate ridership results that indicate the total transit ridership for all routes that share a common right-of-way.

The aggregate ridership data are stored in a table similar to the route-level ridership results. This table aggregates all of the transit riders along a portion of a corridor onto a single route that operates in the corridor. This table is automatically attached to the route system to produce a milepost layer. You can use scaled-symbol or color themes on this layer to illustrate aggregate ridership in each transit corridor, or use the data to add labels to the map indicating transit ridership. In addition, the aggregate table contains ridership both in the aggregate and by direction, so you can use dual bandwidths to illustrate directional flows.

Note that the route listed in the table is arbitrary. For example, if four routes operate between two stops, the aggregate ridership table will list the total flow for all four routes on just one of the four route numbers. Therefore, care needs to be taken when analyzing results from this table.

For more information, see:
To Aggregate Transit Assignment Results for Corridors and Right-of-Ways

Top

)To Aggregate Transit Assignment Results for Corridors and Right-of-Ways

1. Open your route system and transit assignment results flow table.

2. Make the map the current window, and choose the route system layer from the drop-down list on the toolbar.

3. Choose **Transit-Aggregate Transit Assignment** to display the Aggregate Transit Flows dialog box.

4. Choose the transit flows dataview from the Transit Flows drop-down list.

5. Click OK. TransCAD displays the Aggregate Table dialog box.

6. Type a name for the output file and click Save.

TransCAD aggregates the transit flows, creates the table, and attaches the table to the route system. You can now produce a flow theme using ABFLOW and BAFLOW.

Technical Notes on Transit Assignment

For non-equilibrium route choice models except the Method of Optimal Strategies, TransCAD calculates the generalized cost of path k as:

$$c_k = \sum_{i \in J}[r_j + VOT * (\gamma_x x_j + \gamma_w w_j)] + \sum_{i \in I}[VOT * (\gamma_d d_i + \gamma_v t_i)] \tag{1}$$

For equilibrium methods, the cost function is:

$$c_k = \sum_{i \in J} r_j + VOT * (\gamma_x x_i + \gamma_w w_I)] + \sum_{i \in I}[VOT * (\gamma_d d_i + \gamma_v t_i(1 + \alpha(v_i / C_i)^\beta))] \tag{2}$$

where:

c_k = Total cost for path k, in monetary term

C_i = Hourly capacity of vehicles serving link i

d_i = Dwelling time at stops associated with link i

i = Index of a link on which path k goes through

I = Set of links used in path k

j = Index of a transit line used in path k

J = Set of transit lines used in path k

r_j = Fare for line j

t_i = In-vehicle time or non-transit time on link i

v_i = Volume on link i

VOT = Monetary value of time unit

w_j = Waiting time for transit line j

x_j = Transfer penalty time for transit line j

α, β = Crowding effect parameters

γ_d = Dwelling time weight

γ_v = In-vehicle time weight

γ_w = Waiting time weight

γ_x = Transfer penalty time weight

If j is the first transit line boarded, then x_j equals zero.

The variables associated with VOT represent time, and the variables associated with VOI represent impedance, which are then converted to monetary value. In (2) discomfort effects due to on-board and boarding/alighting congestion are accounted. By using proper positive value of the corresponding parameters, the discomfort efforts can be expressed in time measure. Parameters

VOT, VOI, γ_d, γ_v, γ_w, γ_x, α, β, and those used in calculating dwelling time (see below) are all determined by the user.

It should be noted that in a stochastic transit assignment, t_i and w_j are random variables. The user must specify the types of the random distribution functions for vehicle headway and for user cost perception, as well as their variances. The headway variances for transit lines should be contained in a field in the route table, while variance in user cost perception is defined as a global value.

The delay in boarding/alighting is captured in dwelling time. Along a path, dwelling time is calculated for each stop, given by:

$$d = c_0 + c_1 * v_{on} + c_2 * v_{off} \qquad (3)$$

for equilibrium models, where:

d = Dwelling time

c_0 = Constant

c_1 = Weight for boarding volume

c_2 = Weight for alighting volume

v_{on} = Boarding volume

v_{off} = Alighting volume

For non-equilibrium models,

$$d = c_0$$

(4)

Both c_1 and c_2 have positive values for equilibrium models, and equal zero for non-equilibrium models. The weights for dwell time can be set to zero when dwell is presumed to be incorporated in the link travel time.

Waiting time is calculated at each stop where the initial boarding or a transfer occurs, given as:

$$w = \alpha * h \qquad \text{or} \qquad w = \alpha / f$$

(5)

where:

f = Line service frequency

h = Vehicle headway

w = Waiting time

α = Interarrival parameter

For a discussion on the interarrival parameter, please see Other Settings in Chapter 11, *Transit Networks, Best Transit Paths, and Path Attributes*.

In the Method of Optimal Strategies, for a particular destination, travel cost is calculated for each link. Given a destination, cost for link j is calculated as:

$$c_j = \sum_{i \in I} \omega_i [c_i + r_i + VOT * (\gamma_x x_i + \gamma_w w_i + \gamma_d d_a + VOI * \gamma_v t_i]$$

(6)

$$\omega_k = f_k / \sum_{i \in I} f_i$$

(7)

where:

a = Index of stop at which link j ends

c_j = Travel cost for link j, in monetary term

d_a = Dwelling time at stop a

i = Index of a link leaving stop a, which belongs to the optimal strategy

I = Set of links leaving stop a, which belong to the optimal strategy

r_i = Fare for line on link i

t_i = In-vehicle time on link i

w_i = Waiting time for transit line on link i

x_i = Transfer time for transit line on link i

ω_i = Weight for link i

Notice that r_i, x_i, w_i all equal zero if the transit line on link i is the same as on link j, or when i is a walk link or a centroid connector. Also note that $x_i = 0$ when i is the first link of the first transit line boarded.

If origin o is a stop, then travel cost from o to the given destination is calculated as:

$$c_o = \sum_{i \in I} \omega_i [c_i + r_i + VOT * (\gamma_w w_i + \gamma_d d_o) + VOI * \gamma_v t_i]$$

(8)

where I is the optimal strategy link set from o, and ω_i is calculated by (7). If o is a zone centroid, then:

$$c_o = \sum_{i \in I} 1/n_o (c_i + t_i]$$

(9)

where I is the optimal strategy access link set from o, and n_o is the number of links in the set.

Top

O-D Matrix Estimation

Accurate and up-to-date trip tables are critical inputs for transportation planning models. The principal method of collecting information on the spatial pattern of trips within urban areas traditionally has been the large-scale home interview survey. When there are sufficient observations gathered by zone for statistical reliability, home interview surveys can be factored up to compute the flows among traffic zones. Unfortunately, home interview surveys of the necessary sample size are prohibitively expensive and difficult to implement, and are therefore rarely

attempted.

In contrast, traffic counts on highway links are inexpensive to obtain and are routinely collected in many areas. It is thus extremely attractive to have a method to create or update trip tables based on traffic counts.

TransCAD provides a very flexible and effective procedure for estimating and/or updating an origin-destination (O-D) matrix based on a sample of network link traffic counts and an optional, initial or base trip table.

For more information, see:

About O-D Matrix Estimation

An origin-destination (O-D) matrix contains traffic flows (most frequently, vehicle flows) from every origin to every destination. Such tables are often necessary inputs to transportation analysis procedures, such as trip distribution or traffic assignment.

The problem of calculating an O-D matrix that is consistent with a set of traffic counts has been of methodological interest for at least twenty years. As described in the references in Technical Notes on O-D Matrix Estimation, various methods have been proposed that treat important aspects of the problem.

Consistency with route choice behavior is sought, so that predicted traffic counts can be estimated as the result of an assignment process in which a predicted O-D matrix is flowed over the network. Some methods assume fixed link use proportions by O-D pair, but this is not desirable (Yang et al, 1992). Link utilization is arguably flow dependent, and should be calculated with equilibrium flows.

A second consideration is that there is often a prior estimate of the trip table to be predicted. It is generally considered appropriate to find a new matrix that is close to the prior matrix, as well as achieving consistency with counts.

Traffic counts themselves are stochastic variables that are measured with error, and may be inconsistent with flow conservation. Methods that treat counts as deterministic may give unstable or unrealistic results.

Counts are usually available for only a small subset of links. This presents no insurmountable difficulties, but an effective sample should be comprised of measurements from widely dispersed parts of the network.

The O-D Matrix Estimation procedure in TransCAD is based on the work of Nielsen (1993), who independently developed it as a procedure for TransCAD 2.1. The method was re-implemented by Caliper Corporation. This method has the advantages of treating counts as stochastic variables, as well as working with any traffic assignment method. It therefore is attractive for use with the

Stochastic User Equilibrium Assignment method, as well as with User Equilibrium Assignment.

Nielsen's method is an iterative (or bi-level) process that switches back and forth between a traffic assignment stage and a matrix estimation stage. The procedure requires an initial estimate of the O-D matrix. This can be a default, be a prior estimate based upon survey measurements, or be synthetically generated (e.g., from a doubly-constrained trip distribution model).

The success of this method is based upon use of a realistic traffic assignment model. Otherwise, a biased trip table will be produced. In practice, Nielsen's method appears to work quite well, and many users have reported good results with its use.

O-D matrix estimation has many uses in model development and calibration. An important application of this technique is to update trip tables based on journey-to-work data provided by the US Census. O-D matrices derived from this source only have work trip traffic included and therefore should be updated to account for other trips, as well as for changes in trip-making patterns since the 1990 reference year for Census data. This technique may also be used in small-area analysis where there is no prior estimate of the O-D matrix. The O-D Matrix Estimation procedure provided by TransCAD allows both types of applications.

Top

O-D Matrix Estimation Inputs and Outputs

The O-D Matrix Estimation procedure requires a substantial number of inputs, including observed link counts, a base O-D matrix, and the inputs required for the chosen traffic assignment method. This section also discusses the results of the procedure.

For more information, see:
Observed Link Counts
Base O-D Matrix
Traffic Assignment Methods
Results of O-D Matrix Estimation

Top

Observed Link Counts

The O-D Matrix Estimation procedure is aimed at producing an O-D matrix that is consistent with observed link counts. Therefore, a set of observed link counts is required for the procedure. This is frequently a subset of the road network, since counts are not taken on all links of the network.

It is assumed that these link counts contain none or a very small portion of local trips, i.e., trips that start and end within the same zone. This is because the O-D Matrix Estimation procedure only takes into account trips between zones, and the diagonal in the O-D flow matrix is ignored. If a significant number of local trips are counted, then the counts need to be adjusted to remove the local trips.

The link counts should be directional counts because the traffic flows on two sides of a street are most likely different. To handle directional flows, the line layer must include two fields for the link counts: one containing the value in the forward topological direction along each link, and the other containing the value in the reverse topological direction along each link. The two fields should have the same name, plus the prefix "AB" to represent the forward topological direction or "BA" to represent the reverse topological direction. If the link count field you specify does not have such a prefix, or the two field names could not be found, the procedure will assign the value in the count field to both directions of the link.

This procedure requires a reasonable number of counts in order to give good results. If there are too few counts, you can enrich the counts by using the output of a traffic assignment for other links.

Another thing to remember is that the inputs should all be for the same time period: the link capacities, counts, and O-D flow matrix will all represent traffic for a given time period in the day.

Top

Base O-D Matrix

Another required input is a base O-D matrix, which serves two purposes: to set the dimensions for the output matrix, and to provide initial values for the estimated trip table.

The matrix rows represent the origins, and the matrix columns represent the destinations. When you create the base O-D matrix, make sure it contains the correct origins and destinations. The estimated O-D matrix will have exactly the same origins and destinations as the base O-D matrix. The current row and column headings of the base O-D matrix must match the node IDs in the line layer.

The O-D Matrix Estimation procedure only accounts for trips between zones. If the base O-D matrix contains local flows, i.e., if the diagonal cells in the matrix have positive values, they will be ignored by the procedure. This means that the input values in the diagonal will be copied to the output O-D matrix diagonal, but the values will have no impact on the flows in the rest of the matrix.

If there is no prior information on flows, the base O-D matrix should be constructed to have a small positive value (e.g., 0.1) for every cell that is expected to have positive flow in the estimated matrix. If there has been a previously measured or estimated trip table, this should be used as a base matrix.

For more information on creating and editing matrices, see Chapter 18, *Working with Matrices*, in the *TransCAD User's Guide.*

Top

Traffic Assignment Methods

Many different types of traffic assignment methods may be used in the O-D matrix estimation procedure, including:

- User Equilibrium
- Stochastic User Equilibrium
- System Optimization Assignment
- Capacity Restraint
- Incremental Assignment
- All-or-Nothing Assignment

If you are not sure which method to use, the first two methods are recommended. All of the inputs required for the chosen traffic assignment method are also required for the O-D Matrix Estimation procedure. For more details about traffic assignment methods and required inputs, see Chapter 9, *Traffic Assignment*. The inputs to the O-D Matrix Estimation procedure are, in part, based on the assignment method selected.

Top

Results of O-D Matrix Estimation

The O-D Matrix Estimation procedure produces the following files upon a successful completion:

- A matrix file containing the estimated O-D flows. This estimated O-D matrix has the same dimension as the input O-D matrix.
- A table file containing estimated link flow volume and link cost data. This table is automatically joined to the input line layer. This table is the same output produced by traffic assignment. See Chapter 9, *Traffic Assignment*, for a description of this table.

Depending on your settings, the procedure may also add to the master report file a summary of user inputs and model outputs, and add to the master log file a list of any discrepancies in the input data.

Top

Preparing Data for O-D Matrix Estimation

To use the O-D Matrix Estimation procedure, you must:

- Prepare the base O-D matrix
- Prepare a geographic file containing both a node and a line layer
- Prepare the required link data
- Create a network from the line layer, including all the relevant attributes

Certain data fields are required for the line layer. The fields do not need to have the exact names shown in the following tables, although using these names will make it easier for you to use the O-D Matrix Estimation procedure.

If you already have a line geographic file but some of the required fields are missing, you can add them using the **Dataview-Modify Table** command; for more information, see Chapter 9, *Managing*

Data Tables, in the *TransCAD User's Guide*. You can also create a joined view, using the **Dataview-Join** command; for more information, see Chapter 11, *Joining Your Data to a Map*, in the *TransCAD User's Guide*.

For more information, see:
Fields in the Line Layer
Network File for O-D Matrix Estimation

Top

Fields in the Line Layer

The line layer must have the following fields:

Field	Type	Contents
ID	integer	A number that uniquely identifies the line feature
Dir	integer	A number that indicates whether the feature is one-way or two-way
Time*	numeric	The free-flow travel time on a link
Count*	numeric	The observed link flow

Depending upon the assignment method you choose for O-D matrix estimation, several additional fields may be required:

Field	Type	Contents
Capacity*	numeric	Link capacity
Alpha*	real	Link specific α parameter in the BPR function
Beta*	real	Link specific β parameter in the BPR function
Preload*	numeric	Fixed background link flow

As described earlier, the values for many of these fields can vary by direction along each link. As a result, the fields noted with an asterisk (*) in the above tables should be replaced by pairs of fields representing the relevant data in the two directions. For example, the field "Time*" should read as a pair of fields named "AB Time" and "BA Time" or "Time AB" and "Time BA." For a more detailed explanation about these link fields, see Chapter 9, *Traffic Assignment*.

Top

Network File for O-D Matrix Estimation

The network must contain all the origin and destination nodes that are in the base O-D matrix, as well as all links that may be used by the O-D trips.

When you create the network, choose to include as link fields the Time* and Count* fields. If you choose any traffic assignment method other than All-or-Nothing Assignment, include the Capacity*

field. If you have link specific α or β parameters, include the Alpha* or Beta* fields. If you need to load fixed background link flow, include the Preload* field. For more information on how to create networks, see Chapter 13, *Networks and Shortest Paths*, in the *TransCAD Users' Guide*.

The O-D estimation procedure, like most other network analysis procedures, takes into account any turn and transition penalties that are part of the network. For more information on turn and transition penalties, see Chapter 14, *Network Settings*, in the *TransCAD User's Guide*.

Performing O-D Matrix Estimation

Once the input files are prepared, it is easy to use the O-D Matrix Estimation procedure.

For more information, see:
To Perform O-D Matrix Estimation

⟩ *To Perform O-D Matrix Estimation*

1. Open the map that contains a line layer from which the network was built, and load the network.

2. Open the base O-D matrix.

3. Choose **Planning-OD Matrix Estimation** to display the O-D Matrix Estimation dialog box.

4. Choose a method from the Method drop-down list.

5. Choose the O-D matrix file from the Matrix File drop-down list and the matrix from the Matrix drop-down list.

6. Depending on the method chosen, choose the fields for time, capacity, and/or count.

7. To use link-specific values for alpha and beta, choose the corresponding network fields from the Alpha and Beta drop-down lists.

8. Depending on the method chosen, make global settings by typing values for iterations, convergence, alpha, beta, and/or error in the respective edit boxes, and choose a function from the Function drop-down list.

9. Click Options to display the Options dialog box.

   Choose options as follows:

To do this...	Do this...
Report cold start data	Check the Report Cold Start box and type a value for the cold start period (in seconds) in

	the edit box
Report tabulations of link flows	Check the Produce Tabulation box
Create a scaled-symbol theme of the results	Check the Create Themes box
Log the total flow in the estimated matrix for each iteration	Check the Report All Iterations box

Click OK to return to the O-D Matrix Estimation dialog box.

10. In the O-D Matrix Estimation Settings frame, enter the maximum number of iterations for the estimation procedure and the convergence criteria, the value that specifies the desired maximum difference between observed and predicted traffic counts in terms of the number of trips. Suggested values for the maximum number of iterations are between 10 and 20. A possible default value for the difference between predicted and observed counts would be a number of trips that is within 5 percent of counts.

11. Click OK to display the Output File Settings dialog box. Choose to use, rename, or overwrite each file as described below:

If the status is...	Do this...
In Use, or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists, and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

12. Click OK. TransCAD generates an O-D matrix to best fit the observed network data, and displays a Results Summary dialog box:

To do this...	Click...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the resulting O-D matrix and a joined view showing the link flows associated with the estimated O-D matrix. Depending on the options you chose, TransCAD may also report tabulations of flow and display a scaled-symbol theme of flow.

Top

Technical Notes on O-D Matrix Estimation

There is a substantial literature on methods for estimating O-D flows from traffic counts. The key references to consult are Turnquist and Gur (1979), Van Zuylen, J.H. and L.G. Willumsen (1980), McNeil, S. and C. Hendrickson (1985), Yang and Pang (1992), and Nielsen (1993). A good discussion of methods based on entropy maximization is found in the text by Ortuzar and Willumsen. List and Turnquist (1994) have a model applied to truck traffic with multiple user-classes (i.e., types of trucks). Other O-D estimation methods can also be used with TransCAD either by running them externally or by creating add-ins.

Top

Transit O-D Matrix Estimation

TransCAD provides a very flexible and effective procedure for estimating and/or updating a transit passenger origin-destination (O-D) matrix. This procedure is based on sample counts on the transit network, and an optional, initial, or base transit trip table.

For more information, see:
About Transit O-D Matrix Estimation
Transit O-D Matrix Estimation Inputs and Outputs
Preparing Data for Transit O-D Matrix Estimation
Performing Transit O-D Matrix Estimation

Top

About Transit O-D Matrix Estimation

An origin-destination (O-D) matrix contains transit passenger flows from every origin to every destination. Such tables are often necessary inputs to transportation analysis procedures, such as trip distribution or transit assignment.

The problem of calculating an O-D matrix that is consistent with a set of passenger counts has been of methodological interest for at least twenty years. Various methods have been proposed that treat important aspects of the problem. Like the highway O-D matrix estimation technique, transit O-D matrix estimation in TransCAD is based upon Nielsen's method. For a more detailed description of generic O-D matrix estimation techniques and Nielsen's method, see About O-D Matrix Estimation in Chapter 13, *O-D Matrix Estimation*.

Top

Transit O-D Matrix Estimation Inputs and Outputs

The Transit O-D Matrix Estimation procedure requires a substantial number of inputs, including observed passenger counts, a base transit trip O-D matrix, and the inputs required for the chosen transit assignment method. This section also discusses the results of the procedure.

For more information, see:
Observed Passenger Counts
Base Transit O-D Matrix
Transit Assignment Methods
Results of Transit O-D Matrix Estimation

Top

Observed Passenger Counts

The Transit O-D Matrix Estimation procedure is aimed at producing an O-D matrix that is consistent with observed passenger counts. Therefore, a set of observed passenger counts is required for the procedure. This is frequently for a subset of the transit network, since counts are not taken on all links of the network.

Passenger counts can be of three formats:

- On and off counts at stops
- Ridership counts on route segments
- Counts on access, egress and other non-transit links that are part of the underlying line layer

For the first two formats, the counts are referred to by stop ID. You need to prepare a database that contains the stop ID, on (boarding) count, off (alighting) count, and/or route segment ridership count. For the ridership count, the count is applied to the route segment coming out of the stop ID. Here is an example table of on, off, and route segment counts:

In an example table of on, off, and route segment counts, 8 people might board at stop ID 4 while 6 people alight, and on the transit link going out of stop ID 6, there could be a count of 23 passengers.

In the case where you have both route segment counts and on and off counts, you can set the priority level of the count type in cases of conflicts. If a route contains both segment and on and off counts, only the count type that is given priority will be used. As an example, if stops on route 1 contain both types of counts, and priority is given to the on and off counts, then all ridership counts for the route will be ignored.

For the non-transit link format, you need to prepare a database that contains the non-transit link ID, the count flow in the AB direction, and the count flow in the BA direction. In an example table, if link 1001 is an access/egress link, then there are 305 passengers accessing transit and 112 passengers egressing transit.

It is important that these link counts be directional, since the flows on both sides of the non-transit link segment are most likely different. To handle the directional issue, the line layer must include two fields for the link counts, one containing the value in the forward topological direction along each link, and the other containing the value in the reverse topological direction along each link. The two fields should have the same name, plus the prefix "AB" to represent the forward topological direction or "BA" to represent the reverse topological direction. If the link count field you specify does not have such a prefix, or the two field names could not be found, the procedure will assign the value in the count field to both directions of the link.

It is assumed that these link counts contain none or a very small portion of local, or intrazonal trips, i.e., trips that start and end within the same zone. This is because the Transit O-D Matrix Estimation procedure only takes into account trips between zones, and the diagonal in the O-D flow matrix is ignored. If a significant number of local trips are counted, then the counts need to be adjusted to remove the local trips.

This procedure requires a reasonable number of counts in order to give good results. If there are too few counts, you can enrich them by using the output of a transit assignment.

Please keep in mind that the inputs need to be consistent: the capacities (if the method chosen is User Equilibrium or Stochastic User Equilibrium), counts, and O-D flow matrix should all reflect ridership for the same time period in the day.

Base Transit O-D Matrix

Another required input is a base O-D matrix, which serves two purposes: to set the dimensions for the output matrix, and to provide initial values for the estimated transit trip table.

The matrix rows represent the origins, and the matrix columns represent the destinations. When you create the base O-D matrix, make sure that it contains the correct origins and destinations. The estimated O-D matrix will have exactly the same origins and destinations as the base O-D matrix. The current row and column headings of the base O-D matrix must match the node IDs in the underlying line database, if the assignment is based on nodes. If the assignment is based on stops, then the O-D matrix must match the stop IDs.

The Transit O-D Matrix Estimation procedure only accounts for trips between zones. If the base O-D matrix contains local flows, i.e., if the diagonal cells in the matrix have positive values, they will be ignored by the procedure. This means that the input values in the diagonal will be copied to the output O-D matrix diagonal, but the values will have no impact on the flows in the rest of the matrix.

If there is no prior information on flows, the base O-D matrix should be constructed to have a small positive value (e.g., 0.1) for every cell that is expected to have positive flow in the estimated matrix. If there has been a previously measured or estimated trip table, this should be used as a base matrix.

For more information on creating and editing matrices, see Chapter 18, *Working with Matrices*, in the *TransCAD User's Guide*.

Transit Assignment Methods

Several different transit assignment methods may be used in the O-D matrix estimation procedure, including:

- Shortest Path
- User Equilibrium
- Stochastic User Equilibrium

All of the inputs required for the chosen traffic assignment method are also required for the Transit O-D Matrix Estimation procedure. For more details about traffic assignment methods and required inputs, see Chapter 12, *Transit Assignment*. The inputs to the O-D Matrix Estimation procedure are, in part, based on the assignment method chosen.

Results of Transit O-D Matrix Estimation

The Transit O-D Matrix Estimation procedure produces the following files upon a successful completion:

- A matrix file containing the estimated O-D flows. This estimated O-D matrix has the same dimensions as the input O-D matrix.
- A table file containing estimated link flow volume and link cost data. This table is automatically joined to the input line layer. This table is the same output produced by traffic assignment. See Chapter 12, *Transit Assignment*, for a description of this table.

Depending on your settings, the procedure may also add to the master report file a summary of user inputs and model outputs, and add to the master log file a list of any discrepancies in the input data.

Preparing Data for Transit O-D Matrix Estimation

To use the Transit O-D Matrix Estimation procedure, you must:

- Prepare the base transit O-D matrix
- Prepare a route system with route stops
- Prepare a geographic file that underlies the route system, containing both a node and a line layer
- Prepare the required link data
- Prepare the require route and stop data
- Create a transit network from the route system and line layer, including all the relevant attributes

For more information, see:
Transit Network File for Transit O-D Matrix Estimation

Transit Network File for Transit O-D Matrix Estimation

The transit network must contain all the origin and destination nodes that are in the base O-D matrix, as well as all the transit and non-transit links that may be used by the O-D trips.

When you create the transit network, choose to include all of the fields in the routes, stops, and underlying line layer field that you would need for transit assignment. For more information on

creating transit networks, see Chapter 11, *Transit Networks, Best Transit Paths, and Path Attributes*.

Performing Transit O-D Matrix Estimation

Once the input files are prepared, it is easy to use the Transit O-D Matrix Estimation procedure.

For more information, see:
To Perform Transit O-D Matrix Estimation

⟩ To Perform Transit O-D Matrix Estimation

1. Open the map that contains a route system from which the transit network was built, and load the transit network.

2. Open the base O-D matrix.

3. Open the stop-based boarding/alighting/ridership database and/or the link-based non-transit count database.

4. Choose **Transit-OD Matrix Estimation** to display the Transit O-D Matrix Estimation dialog box.

5. Choose a method from the Method drop-down list.

6. Choose the O-D matrix file from the Matrix File drop-down list and the matrix from the Matrix drop-down list.

7. Choose whether the matrix is based on the stop or node layer by clicking the Based on Stop Layer or Based on Node Layer radio button.

8. Make choices from the Stop Counts Settings frame as follows:

To do this...	Do this...
Choose the stop dataview	Choose the dataview containing boardings, alightings, and ridership from the Dataview drop-list
Choose the records to use	Choose All or a selection set from the Selection drop-down list
Choose the field with the on volume	Choose a field from the On Volume drop-down list
Choose the field with the off volume	Choose a field from the Off Volume drop-down list
Choose the field with the ridership	Choose a field from the Ridership drop-down list
Choose which counts have priority	Choose either On/Off or Ridership from the Priority radio list

9. Make choices from the Link Counts Settings frame as follows:

To do this...	Do this...

Choose the link dataview	Choose the dataview containing non-transit counts from the Dataview drop-list
Choose the records to use	Choose All or a selection set from the Selection drop-down list
Choose the field with the AB link volume	Choose a field from the Link Volume AB drop-down list
Choose the field with the BA link volume	Choose a field from the Link Volume BA drop-down list

10. If the assignment method is either User Equilibrium or Stochastic User Equilibrium, in the Equilibrium Settings frame type the number of iterations in the Iterations edit box and the convergence values in the Convergence edit box.

11. Click Options to display the Transit Option Settings dialog box, and choose one or more output options:

To do this...	Do this...
Compute critical link flows	Choose a selection set of stops from the Critical Link Analysis drop-down list.
Use a movement table	Choose a movement table to use to calculate route transfer movements from the Movement Table drop-down list.
Aggregate segment counts	Check the Aggregate Segment Counts box.
Build skims	Check the Variables box and choose from the Variables scroll list all of the attributes that you want to be included in the Skims matrix file. If you included a mode table in your network settings, you can also choose skimming by mode by checking the Modes box and choosing the modes to skim from the Modes scroll list.

Note: For all methods, boarding counts are automatically created.

Click OK when you are done to return to the Transit O-D Matrix Estimation dialog box.

12. In the O-D Matrix Estimation Settings frame, enter the maximum number of iterations for the estimation procedure in the Iterations edit box and the convergence criteria, the value that specifies the desired maximum difference between observed and predicted traffic counts in terms of the number of trips, in the Convergence edit box. Suggested values for the maximum number of iterations are between 10 and 20. A possible default value for the difference between predicted and observed counts would be a number of trips that is within 5 percent of counts.

13. Click OK to display the Output File Settings dialog box. Choose to use, rename, or overwrite each file as described below:

If the status is...	Do this...
In Use, or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists, and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

14. Click OK. TransCAD generates an O-D matrix to best fit the observed transit counts, and displays a Results Summary dialog box:

To do this...	Click...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the Notepad program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the Notepad program when you are done.
Close the dialog box	Click Close.

TransCAD displays the resulting O-D matrix and all of the normal outputs associated with transit assignment.

Top

Data Preparation and Planning Utilities

This chapter provides background information for building planning models in TransCAD and documents the operation of many utilities that model builders will find useful for data preparation and analysis of model results. The first section in this chapter describes considerations in preparing planning model input data. This is followed by a discussion of generating centroid connectors for a planning network and building cross-classification tables from survey data for trip generation models.

Two advanced shortest path procedures are described that are useful in testing networks prior to performing traffic assignments. These are the k-shortest path procedure, which finds alternative routes for traveling from an origin to a destination on the road network, and a toll shortest path procedure, which is useful in testing paths prior to performing a traffic assignment on a network with toll roads. Used interactively on a loaded network, these procedures also help you understand traffic assignment results.

The next set of utilities makes it easy to generate trip length distributions from trip distribution models and to display intersection flows resulting from traffic assignments. Other utilities perform screenline analysis and generate an O-D matrix for a subarea of a region.

Two new assignment utilities make it easy to compare traffic assignments and calculate speeds and delays on selected links.

Also documented in this chapter are instructions for saving and restoring procedure settings and for viewing the report and log files that TransCAD creates when a procedure is run.

The final set of utilities described in this chapter deal with importing planning and related data from other planning packages and U.S. Census files. TransCAD can import data from TRANPLAN, MINUTP, EMME/2, TRIPS, and QRSII. TransCAD has extensive capabilities for importing and making use of Census data directly. These include support for files from the Census Transportation Planning Package (CTPP) and the Public Use Microdata Sample (PUMS). These procedures are augmented and updated on an ongoing basis. New import procedures will be documented in the readme files that come with TransCAD.

For more information, see:
Preparing Planning Model Input Data
Creating Centroids and Centroid Connectors
Building Cross-Classification Tables
Solving a K-Shortest Path Problem
Solving a Toll Shortest Path Problem
Analyzing Trip Length Distribution
Displaying Intersection Flows
Using Screenline Analysis
Creating a Subarea O-D Matrix
Computing Assignment Differences
Using the Link Calculator
Saving and Using Procedure Settings
Working with the Log File and Report File
Importing Network Data
Importing Other Planning Data
Importing U.S. Census Data

Top

Preparing Planning Model Input Data

A substantial portion of the work in any modeling project is data preparation. Appropriate use of GIS technology can greatly reduce this burden and increase the accuracy of your work.

You first need to identify and obtain the necessary data sets. Often the only data available are out-of-date and will need to be updated. There may also be more than one source for some of the input data. In either case, it is important to assess the quality of the data prior to embarking upon model estimation.

Modeling is more than a little like cooking; it's hard to produce a first rate result without good raw materials. Data of good quality and pertinence are thus prerequisites for good models.

You should start out by inspecting the data sets in tabular and graphic forms. Use the conditional selection tools to identify out of range values for different variables. Produce some thematic maps on the input data. Before beginning the model application, estimation, or transfer process, check to see that you have all of the inputs required.

For more information, see:
Planning Model Inputs
Traffic Analysis Zones
Survey Data
Zonal Attributes-Trips, Demographics, and Economic Variables
Trip Tables
Transportation Networks
Transit Networks
Traffic Counts

Top

Planning Model Inputs

Typical inputs required for travel demand model development include the following:

- A set of traffic analysis zones (TAZs)
- Survey data
- Zonal demographics and economic variables
- Trip tables
- Zone centroids
- Road line layer and network file

- Transit route system and network file
- Traffic counts

For forecasting, you will also need future values of demographics and scenarios reflecting network changes. The discussion that follows will address each of these data items and provide suggestions for how the data might be stored in TransCAD.

Top

Traffic Analysis Zones

For most urban areas in the U.S., traffic analysis zones (TAZs) have already been defined. To use the zones defined for tabulation of the Census Journey-to-Work data, you can use the appropriate TransCAD procedures to import the zonal boundaries and corresponding attributes. This should be done through creation of an area layer for zones.

You will probably wish to put both origin and destination characteristics of the zones in the same layer, although this is not required.

If TAZs have not already been defined, or if they need to be modified, TransCAD provides many tools for defining and refining them for travel demand modeling. This section describes some of the criteria that are important in defining zones, and the methods that are available in TransCAD for supporting this activity. It is difficult to provide definitive guidance for defining TAZs, but you should consider the important principles outlined in this section.

The function of analysis zones arose in aggregate analysis as the basic real unit for data measurement (i.e., sampling) and analysis. With respect to disaggregate models, the zone is often the basis for aggregating from individual level models. In this respect, the zoning scheme is a key part of the aggregation method employed.

In general, zones should be as small as possible and of roughly the same size, where size is not necessarily measured solely by geographic area but could be measured by population or some other variable related to the volume of transportation activity. Zones of equal size are desirable for aggregate models, to avoid problems of heteroscedasticity in zonal-level models.

Small zones are good because they provide the greatest accuracy, all other things being equal. However, if survey data are to be used, larger zones may be preferred to meet the goal of having a sufficient sample size for statistical significance for each zone. Using the smallest level geography may be inadvisable if key data are not provided by the U.S. Census Bureau for reasons of non-disclosure. There is a tradeoff between the number of zones and the processing time required in analysis, but with modern computers (with ample memory) this should not be an issue, except in the very largest metro areas.

Zones should be compact in shape and relatively homogeneous in terms of characteristics. Because so many models are based on factors related to the spatial separation of zones, it is important that distance or travel times between zone centroids reflect actual average distances and times, regardless of the direction of travel. Compactness reduces the bias that results from the assumption that travel begins and ends at zone centroids. The property of homogeneity, minimizing the within zone variance as opposed to the between zone variance of key measures, is very important for aggregate models, because they can only explain the effects of the between-zone variance in travel determinants.

Zones should be mutually exclusive, cover the area of interest, and not be contained within other zones. It is also good practice to respect key natural boundaries in defining or refining a zoning system.

Many analysts feel that the zones for planning models should be defined with reference to the transportation network to be analyzed. This is especially important in forecasting demand for specific road improvements and other localized facility changes. There is no restriction in TransCAD with respect to the number of different zoning systems that can be utilized, so you may wish to use different sets of zones for different analyses.

With the advent of geographic information systems and digital spatial data from the U.S. Census Bureau, it has become recommended practice in the U.S. to build analysis zones from Census geographic units. This provides a strategic advantage for planning, because it provides a wealth of data on socio-economic characteristics that could not otherwise be obtained or could only be obtained at great cost. Even with an unlimited budget, surveys do not have response rates that are competitive with the Census. Perhaps of even greater importance is that, surveys have substantial non-response problems with questions concerning sensitive personal matters such as household income. For urban passenger travel demand forecasting, Census blocks, block groups, and tracts are thus the natural building blocks for TAZs.

The splitting of Census geography may occasionally be warranted, either because Census blocks can be very large in rural areas or because it can be necessary to have zones that bear a particular geographic relationship to major transportation facilities or network connections.

If Census geography is to be used for defining zones, it can be read directly from the various CDs that are provided by Caliper Corporation. Census geography can be aggregated, split, or reshaped using the geographic editing and districting tools described in the *TransCAD User's Guide.*

Zones defined in other GIS, CAD, and mapping software can also be imported using the appropriate TransCAD facilities. Zones can also be digitized from paper maps if one so desires.

For freight transportation analysis, ZIP Codes, counties, and BEA areas are zones for which data are typically reported. Boundary files for these areas are all available from Caliper Corporation.

External Zones
External zones can be created through geographic editing of the zone layer. External zones and special generators and attractors are designated through selection sets in some procedures, such as trip balancing, so that the correct treatment is applied.

Alternatives to Zones
For some analyses there is no need for using zones. For example, if you are building a disaggregate model from survey data and locating trip origins and destinations, zones will not be required for generating model inputs. Moreover, if sample enumeration is used for forecasting, predictions for the region will not require use of zones.

Survey Data

With TransCAD you can analyze virtually all forms of survey data. For most modeling purposes, each survey will be located by the respondent's primary address. For traveler surveys, each survey

will most commonly be located by their residence.

There are special utilities for importing the Census Public Use Microdata Sample (PUMS) data and for building cross-classification tables for trip generation and other purposes from disaggregate survey records.

Formulas can be used to scale the field values of interest based on sample weights. Survey data can be aggregated to the zonal level by joining the zonal dataview to the survey dataview (a one-to-many join). Remember to use the appropriate sample weights when performing this operation.

Another common operation is using TransCAD to compute network variables that can be appended to survey records prior to analysis and model building. This is done by exporting a relevant matrix to a table and joining the survey dataview to a dataview of the table.

Various analytical procedures have their own data format requirements, so some data may need to be transformed prior to running the procedure. Be sure to check the data formats for the procedures that you are planning to use.

Top

Zonal Attributes—Trips, Demographics, and Economic Variables

Characteristics of zones will typically be stored as fields in the area database that characterizes the zones. If these data are in other databases, a relational join can be used, based on a common zonal ID.

If you have a large number of variables and wish to keep them in separate tables, you can save all of the maps, tables, matrices, and related joins in a single workspace.

If you want to import attribute data from the CTPP data sets, there is a utility for this process; for more information, see Opening CTPP Tables.

Top

Trip Tables

Trip tables contain information on the origin-destination flows associated with the various trip purposes and modes. In TransCAD, this information is stored in matrix files. You will probably find it convenient to store related trip tables (e.g., those for different purposes) as matrices in the same matrix file.

Information for how to import data into matrices is provided in Chapter 18, *Working with Matrices*, in the *TransCAD User's Guide*.

Special tools are provided for reading the journey-to-work data from the Census Transportation Planning Package; for more information, see Creating Matrices of Journey-to-Work Data.

Top

Transportation Networks

In urban transportation analysis, the analysis network is of critical importance. The network determines the modal characteristics that underlie trip distribution and mode choice behavior. Furthermore, network utilization and performance is often a major, if not the major, focus of an analysis. Basic concepts about TransCAD networks are introduced in the *TransCAD User's Guide*. You may find it helpful to review Chapters 13, *Networks and Shortest Paths*, and 14, *Network Settings*, before undertaking a major network development task. This section describes how to develop and use networks in urban travel demand forecasting.

In TransCAD, a network is a separate data object that is derived from and intimately related to the geographic line layer from which it is created. The network file contains the data you specified as desired for the network links and nodes. If it is not already present, data must be added to the line layer that characterize network links sufficiently for the analysis you intend to perform. Key variables suggested for urban networks are:

- Direction (one-way or two-way)
- Link type (e.g., a classification of roads)
- Free-flow travel speed
- Capacity

The length of each link is always a line layer attribute, and is automatically recalculated when the line layer geography is edited.

Network Coding

A network for urban transportation analysis should include all facilities that might carry a measurable level of traffic among zones. This would include highways, arterials, and some other streets.

For example, if the aim is to replicate current conditions on the road system, you cannot expect to do so if you use an analysis network that only carries 60 percent of the traffic. Similarly, predicted speeds for a future scenario will be lower than if the full capacity of the network is represented. Harvey and Deakin (1993) recommend coding facilities of one functional class below that for which reliable traffic loadings are required. If available, existing traffic counts can be used to identify road segments that must be included, and may also help in identifying those which do not carry significant traffic.

You should anticipate your analysis and reporting requirements and make sure that road facilities are appropriately coded by type. For example, you can assign an additional type code to a new facility simply for the purpose of greater ease in reporting results. Similarly, it is good practice to explicitly code major transportation facilities, such as HOV lanes.

Typically you will prepare a base case network and one or more scenario-based networks. If the changes associated with a future scenario are small in terms of network structure, you can use the Network Settings dialog box to enable and disable links and to update network attribute data. For

most work, however, you should prepare separate network files for each scenario. You can have different networks for different time periods. If you are doing time-of-day based assignments, it may be important to capture differences between the AM and PM networks.

Connections to Zone Centroids

Centroid connectors connect TAZ zones to the rest of the transportation network. These additional links are necessary to connect trips from zones onto the highway line layer. Inherently, they represent the local roads used to access the "network."

Centroid connectors should be coded such that they accurately represent proper access from centroids to the line layer used for the network. In areas where the network is sparse, you may only need to code one centroid connector from the TAZ to the network. In areas where the network is dense, you may need to code several centroid connectors, in order to fully represent all access opportunities from the TAZ to the adjoining network.

TransCAD provides a centroid connection tool that lets you automatically create centroid connectors. Using the **Tools-Map Editing-Connect** command, you can create new links from the geographic centroids of the TAZs to nearby nodes or links in the network. For more information on this tool, see Creating Centroids and Centroid Connectors.

In TransCAD, the originating node of the centroid connectors represents a centroid node. When creating centroid nodes, you must make sure that the node IDs are consistent with the actual zone numbers. This means that either the centroid node IDs are the same as the zone number IDs, or that you have a correspondence between node IDs and zone IDs, so that you can create matrix indexes to go back and forth between the two; for more information, see "Displaying Portions of a Matrix" in Chapter 18, *Working With Matrices*, in the *TransCAD User's Guide*. It is also a good idea to create an additional field in your node layer that identifies centroid nodes.

Data for Urban Road Network Development

There are many possible sources of data for urban network development. Among the alternatives are public and private GIS files, preexisting coded networks, and maps that are suitable for digitizing.

There are many sources of GIS files on highways and streets that can be used in network development. For example, the street files based on TIGER/Line files and the highway networks supplied with TransCAD could be used as a point of departure for network development. Alternatively, GIS files that have good accuracy with respect to urban roads can be purchased from some commercial vendors, such as Etak or NavTech.

You should recognize, however, that much of the information about the link attributes will not be present in GIS files. For example, these files may not necessarily have information about one-way streets, prohibited turning movements, speed limits, or the number of lanes.

In some metropolitan areas, there has already been effort expended in developing a GIS-based representation of the network. This file can usually be imported without difficulty into TransCAD.

When importing data from CAD systems and some GIS files, it is imperative to check for network connectivity. Often the networks have been prepared for graphic purposes only, and there are many undershoots and overshoots where the network is disconnected. These links will need to be edited so that they are connected at the appropriate nodes.

Another common operation is to import, as a line layer, an existing network that was prepared for another transportation planning package; for more information, see Importing Network Data. If you do this, you should be prepared to see a stick network. The geography of this stick network can be edited so that the links have a more appropriate shape, but this can be a very tedious operation. Typically, there are also errors in node locations that can be corrected through extensive

geographic editing. However, you can use the imported network as is, unless you feel that it has attribute errors.

After importing a network, you should perform some basic checks on connectivity. This can be done by computing zone-to-zone and node-to-node shortest paths and/or creating shortest path matrices. You should also check for extraneous links, dangling links, links without nodes at the endpoints, and duplicate links. As the performance of shortest path and traffic assignment routines depends upon the number of links and nodes, it is a good idea to remove extraneous links and nodes as part of the network development process.

Top

Transit Networks

As with highway networks, transit networks can be developed from scratch or imported from other sources, including from earlier versions of TransCAD and from other planning packages. As described in Chapter 11, *Transit Networks, Best Transit Paths, and Path Attributes*, a new alternative is to develop the analysis network from the transit route system.

Separate networks can be created for each transit mode, or a multi-modal network can be used. If you want a multi-modal network, you must begin with a geographic line layer that includes the links and nodes of the various modes. Alternatively, if you are an advanced user, you could use GISDK to construct a special network builder that might be more efficient for your purposes.

The issues that arise when coding centroid connectors for highway networks are the same when it comes to transit networks. The only difference for transit networks is that the connectors represent access and egress from the centroid to nearby stops. You can use the ***Tools-Map Editing-Connect*** command to create centroid connectors for transit networks. For a more detailed discussion on some of the unique issues surrounding centroid connectors for transit, see Creating Centroid Connectors in Chapter 11, *Transit Networks, Best Transit Paths, and Path Attributes*.

Top

Traffic Counts

Traffic counts are important for validating demand model results, and can be a crucial data for estimating or refining O-D tables. Traffic counts should be stored with the geographic line layer that corresponds to the transportation network that is used in the analysis.

Top

Creating Centroids and Centroid Connectors

TransCAD provides a centroid connection tool that lets you automatically create centroid connectors. Using the **Tools-Map Editing-Connect** command, you can create new links from the geographic centroids of the TAZ zones to nearby nodes or links in the network. When centroid connectors are created, new nodes that represent the centroid nodes are added at the location of each TAZ zone centroid, and new links are added that connect each of these new nodes to the nearest existing nodes or links. You can also specify the number of centroid connectors to create for each TAZ.

To use the **Tools-Map Editing-Connect** command, the line (network) layer and the TAZ zone layer must both appear in the same map, and the line layer must be stored in a standard format (editable) geographic file.

The **Tools-Map Editing-Connect** command allows you to place a limit on the maximum length of a connection between the zone and the line layer. When you set a maximum length, features that are further away are left unconnected. You can choose to connect all of the zones to the line layer, or only those in a selection set. You can also limit the nodes at which connections can be made, by creating a selection set. These selection sets can be created using any of the TransCAD selection tools and commands.

When you connect to nodes, you can set the number of connector links to create from each TAZ zone to the nearest nodes. If more than 1 connection is set, TransCAD makes sure that all the links are regularly spaced. For example, if you set three connections per TAZ, TransCAD will create three links from the centroid node to three existing nodes on the network. The links would be created in a way such that the angular distances among the three would be more or less equal.

You can also choose to fill in one of the node or link data fields for each of the added links and nodes. You can fill the field(s) with a constant value, making it easy to select the links or nodes that were added automatically, or you can code each added node or link with the ID of the TAZ zone. To use the fill options, you need to add an empty integer field to both your line and node layer. You can add fields by choosing the **Dataview-Modify Table** command.

For more information, see:
To Create Centroid Connectors Using the Connect Tool

Top

⊃ *To Create Centroid Connectors Using the Connect Tool*

1. Choose the point or area layer containing the TAZ zone features from the drop-down list on the toolbar.

2. Choose **Tools-Map Editing-Connect** to display the Connect dialog box.

3. Choose whether to connect all external features or only those in a selection set from the Using drop-down list.

4. Choose the line layer to which the connections are added from the To Line Layer drop-down list.

5. If you want to limit the maximum connection length, type a value in the Connect Features Within edit box. Leave the edit box blank to allow any connection length. The length is in the current map units, which are shown after the edit box.

6. Choose how to connect the external features as follows:

To do this...	Do this...
Connect to nodes	Click the Nodes radio button, choose from the drop-down list whether connection can be to all nodes or only those in a selection set, and type the maximum number of connections in the Maximum Connections edit box.
Connect to lines	Click the Links radio button. TransCAD will display the Update tab.

7. If you want to fill node and line fields, click the Fill tab to display the Fill page.

8. Choose which fields to fill and how to fill them as follows:

To do this...	Do this...
Fill a node or line field	Choose the field from the appropriate drop-down list
Not fill a node or line field	Choose None from the appropriate drop-down list
Fill with a single value	Click the Single Value radio button and type the value in the edit box
Fill with the external feature IDs	Click the IDs from Layer radio button

9. If you are connecting to lines and you want to change the way that fields are updated when lines are split, click the Update tab to display the Update page.

10. Change the splitting method as follows:

To do this...	Do this...
Change the method for a field	Highlight the field in the Fields list and click the desired option in the When Splitting radio list
Undo your changes	Click Reset

11. Click OK.

TransCAD adds the new nodes and lines to the line layer, filling in values for the new nodes and lines and updating fields for split lines as requested.

Building Cross-Classification Tables

You can create a cross-classification table from disaggregate data. Cross-classification methods separate the population in an urban area (or any universe that is being studied) into relatively homogenous groups, based on certain socio-economic characteristics. This procedure empirically derives the average values of characteristics of the population (e.g., the number of home-based work trips per household) for each classification, and creates a table containing the classifications and the average values. The cross-classification table built by this procedure may be used in the Trip Generation Cross-Classification procedure with minor modifications; for more information, see To Build a Cross-Classification Table.

With this procedure, you specify the characteristics by which you want to classify the population, the cut-off values between classifications, and the variables that you want averaged for each classification, and TransCAD builds a cross-classification table from your disaggregate database.

The Format of Cross-Classification Tables

Cross-classification tables have a particular format. If you use n classification variables to define your classifications and you request averages of m variables for each classification, the cross-classification table has one column for each of the n characteristics. These n columns in the trip rate table are used to create one record for each possible classification. The entries in the columns are real values (or integers), and they represent the upper bound of the range included in the classification. The lower bound in the range is the next lowest value entered in the column. These n columns are the first columns in the table.

After the columns that define the classification comes a set of $2m$ columns. These contain two columns for each averaged variable: one for the average of the variable for respondents in the given classification, and one for the standard deviation of the variable within the classification. These columns are the right-most columns of the trip rate table. The fields with averages have "R_" before the original field name, and the fields with standard deviations have "S_" before the original field name.

Here is a sample cross-classification table that was created by this procedure:

Pers/HH	Inc/HH	R_WorkTrip/HH	S_WorkTrip/HH
1	1000	0.19	0.59
1	25000	1.00	1.00
1	55000	1.49	0.87
1	55000	1.48	0.88
2	1000	0.58	1.07
2	25000	1.10	1.38
2	55000	2.44	1.56
2	55000	2.95	1.41
3	1000	0.89	1.39
3	25000	2.05	1.49
3	55000	3.26	1.55
3	55000	3.93	1.56
4	1000	1.14	1.63
4	25000	2.13	1.58
4	55000	3.47	1.61
4	55000	4.55	1.96
9999	1000	0.78	1.42
9999	25000	2.30	1.76
9999	55000	3.59	1.89
9999	55000	5.52	2.64

In choosing the classifications variables, the number of ranges for each variable, and the cut-off values for the ranges, the goal is to make the classification groups as homogeneous as possible. In particular, you want homogeneity within the zones, and heterogeneity between the zones. Use the intrazonal standard deviations that are reported as the "S_" fields in the output cross-classification table to gauge the homogeneity of the classifications.

For more information, see:
To Build a Cross-Classification Table

Top

⁾ To Build a Cross-Classification Table

1. Choose *File-Open* and open the table containing disaggregate data.

2. Choose *Planning-Planning Utilities-Build Cross Classification Table* to display the Build Cross-Classification Table dialog box.

3. Choose the table containing the disaggregate data from the Data File drop-down list.

4. Highlight the variables for which you want to obtain averages for each classification in the Fields to Average scroll list.

5. Click Add to display the Add New Classification dialog box.

   Highlight all the variables by which you want to classify the population in the New Classification scroll list and click OK. The chosen variables will appear in the Classification Variables list.

6. For each variable:

   - Highlight the field in the Classification Variables scroll list
   - Choose the number of ranges that you want the classification variable to have from the # Ranges drop-down list
   - Highlight each range in the Ranges scroll list and type a value for the upper bound in the Upper Bound edit box

7. Click OK. TransCAD displays the Store Results In dialog box.

8. Type a file name for the output table and click Save.

TransCAD creates the cross-classification table and displays it in a dataview. The resulting table can be used as input to the regular cross-classification model with a couple of minor changes:

1. The S_ field that reports the standard deviation of each class needs to be deleted.
2. The resulting maximum values are very high numbers. You should replace these values with arbitrarily high numbers that will be larger than the largest input data value.

Top

Solving a K-Shortest Path Problem

The K-Shortest Path toolbox is used to compute a user-specified number of shortest paths between one origin and one destination. Each k-shortest path will have a cost greater than or equal to the true shortest path. These k-shortest paths are then displayed graphically in the map window.

To use the K-Shortest Path toolbox, you will need a line layer that includes the cost field to be minimized (e.g. Travel Time) and a network created from this line layer that includes this cost field.

To solve a shortest path problem, you mark the origin and destination by using the Add a Stop tool and clicking on the map. TransCAD places the stops at the endpoints of line features, such as the nearest intersection or the nearest point where a road or highway feature begins or ends. You

cannot use intermediate points when finding k-shortest paths.

The ![icon] button takes you to the Network Settings dialog box, where you can change the active network and the way the network is going to be used (turn penalties, transfer penalties, etc.).

You can choose the number of shortest paths to find and how to display the results. You can output the paths either as selection sets on the line layer or as a route system, with each route representing a path.

For more information, see:
To Solve a K-Shortest Path Problem

Top

⟩ *To Solve a K-Shortest Path Problem*

1. Open or create a map that contains a line layer and network file.

2. Choose the node or line layer from the drop-down list on the toolbar.

3. Choose **Networks/Paths-K-Shortest Path** to display the K-Shortest Path toolbox.

4. Click ![icon] to activate the Add a Stop tool, and then click on the map at the origin and destination nodes.

5. Enter the number of paths you want to generate in the # of Paths edit box.

6. Choose the cost variable you want to minimize from the Based On drop-down list.

7. Choose the method to display the paths from the Display As radio buttons according to the following table:

Option	What it Does
Route System	Each path becomes a route in the route system
Selection Sets	Each path is stored as a selection set of links

8. Click ![icon] in the K-Shortest Path toolbox.

TransCAD solves the k-shortest path problem and displays the results using the options you chose.

To clear the stops, click ![icon] in the K-Shortest Path toolbox.

Top

Solving a Toll Shortest Path Problem

You can find the best path between one node and another over a network, taking toll costs into account. The shortest path is the one that minimizes the total cost of a particular network cost attribute, such as distance, time, or dollar cost. In the case where toll facilities are present in the network, a generalized cost is calculated and minimized. Generalized cost is computed based on a user-specified value of time. Using the Toll Shortest Path toolbox, you can generate different shortest paths based on mode-specific properties, such as differences in toll cost between vehicle classes and the value of time (impedance) between modes.

When using a generalized cost approach, it is important to consider the value of time, which is the cost value assigned to each unit of impedance. In many cases, each mode or user class can have it's own value of time. For example, commercial vehicles tend to have a higher value of time than personal vehicles.

When you solve a toll shortest path with intermediate destinations problem with TransCAD, the order in which you visit the points is the order in which you click the destinations to be visited.

There are two types of toll facilities that can be considered:

- Fixed link tolls, which are the monetary costs assessed when passing through single links in the network. Unlike travel time cost, this cost is the same regardless of the volume. Fixed tolls are stored as attributes in the line layer, similar to travel times, capacities, and other link-based attributes. You can have a different fixed toll attribute field for each mode.
- Entry-to-exit tolls, which are node-to-node tolls that are dependent upon both the entering and exiting node of the path. This method of toll cost calculation is necessary for toll facilities where the toll on a link is not constant, but depends upon the entry and exit tollbooth. You specify node-to-node tolls as a matrix, where the matrix row and column IDs represent the origin and destination node IDs and the cell values represent the O-D toll cost.

You need to define the line segments that are used as fixed toll and entry-to-exit toll links, by creating separate selection sets for each. You can then choose these selection sets in the Network Settings dialog box.

For more information, see:
Using the Toll Shortest Path Toolbox

Top

Using the Toll Shortest Path Toolbox

You find a toll shortest path by using tools in the Toll Shortest Path toolbox to specify the origin, destination, and intermediate points of your route. You can also choose the toll matrix to use and set the impedance.

You can specify your stops by:

- Using the Add a Stop tool and clicking on the map. TransCAD places the stops at the endpoints of line features, such as the nearest intersection or the nearest point where a road or highway feature begins or ends.

- Using the Add Stops Base on a Selection Set tool and choosing a point layer and selection

set. TransCAD adds one stop for each selected feature, with stops located at the nearest line feature endpoint. If two or more features are located near the same line feature endpoint, TransCAD adds only a single stop at that location. TransCAD adds annotations to the map so you can see all of the stops.

The ![icon] button displays the Network Settings dialog box, where you can change the active network and the way the network is going to be used, such as by using turn penalties and transfer penalties.

The Options button displays the Shortest Path dialog box, where you can choose attributes to skim, set the output display options, set the value of time (impedance), and choose the toll matrix settings.

When you find the shortest path, TransCAD will display the results on the map, using a freehand annotation. If you choose, TransCAD will also display skim results for the path and/or driving directions.

When you solve shortest path problems, TransCAD uses the active network and any settings that you have specified using the Network Settings dialog box. For more information on network settings, see Chapter 14, *Network Settings*, in the *TransCAD User's Guide*.

For more information, see:
To Solve a Toll Shortest Path Problem
To Clear the Toll Shortest Path Routes and Stops

Top

⟩ To Solve a Toll Shortest Path Problem

1. Choose the node or line layer from the drop-down list on the toolbar, and make sure the correct network is active. If entry-to-exit tolls or fixed tools are to be used, open the node-to-node toll matrix file and create selection sets containing the fixed toll links and the entry-to-exit toll links.

2. Choose **Networks/Paths-Toll Shortest Path** to display the Toll Shortest Path toolbox.

3. Click ![icon] to display the Network Settings dialog box and click the Toll tab to display the Toll page.

    Make choices as follows:

To do this...	Do this...
Not use entry-to-exit tolls	Click the Not in Use button in the O-D Toll Links radio list
Use entry-to-exit tolls in the network	Click the In Network button in the O-D Toll Links radio list
Use entry-to-exit tolls in a selection set	Click the In Selection Set button in the O-D Toll Links radio list and choose the selection set that contains the entry-to-exit toll links from the drop-down list
Not use fixed tolls	Click the Not in Use button in the Toll Links radio list
Use fixed tolls in the network	Click the In Network button in the Toll Links radio list
Use fixed tolls in a selection set	Click the In Selection Set button in the Toll Links radio list and choose the selection set that contains the entry-to-exit toll links from the drop-down list

Click OK to return to the Toll Shortest Path toolbox.

4.   Add stops as follows:

To mark stops...	Do this...
By clicking on them	Click to activate the Add a Stop tool, and then click on the map at each desired stop location
Based on a point layer	Click to display the Add Stops dialog box, choose a layer and a selection set from the drop-down lists, and click OK

5.   Choose the cost variable you want to minimize from the Minimize drop-down list.

6.   To generate driving directions, choose the field containing the route name or street name from the Directions drop-down list. TransCAD uses this name when it generates the directions.

7.   Click Options and choose one or more options as follows:

To do this...	Do this...
Save the shortest path to a selection set	Choose a selection set from, or type the name of a new selection set in, the Selection Set editable drop-down list, and choose a method from the Selection Method drop-down list.
Show the shortest path on the map	Check the Show Path box.
Show the total cost for the path	Check the Report Costs box.
Report toll costs and other skims for the path	Check the Skimming box and choose the fields to report from the scroll list.
Enable entry-to-exit type tolls	Choose the node-to-node toll matrix file from the Toll Matrix drop-down list. If the matrix file has more than one matrix, choose the matrix you wish to use from the Matrix drop-down list. To report toll costs, be sure to choose the toll field from the Skimming scroll list.
Enable fixed tolls	Specify the network field that contains the fixed toll for the link from the Link Toll drop-down list. To report toll costs, be sure to choose the toll field from the Skimming scroll list.
Set the value of time (impedance)	Type the new impedance value in the VOI edit box. The impedance value represents the dollar cost per unit of impedance. The default value of 1 indicates one dollar per unit of impedance. If impedance is computed in minutes, the impedance would be one dollar per minute or 60 dollars per hour.

Click OK to return to the Toll Shortest Path toolbox.

8.   To show the path on the map, choose a color to use from the Color drop-down list.

9.   Click .

TransCAD solves the shortest path and displays the result, using the options you chose.

) To Clear the Toll Shortest Path Routes and Stops

1. Click in the Toll Shortest Path toolbox.

TransCAD clears the stops and routes from the map.
  - OR -

1. Close the Toll Shortest Path toolbox by clicking the close button in the upper right corner of the toolbox.

TransCAD clears the stops and routes from the map and closes the toolbox.

Analyzing Trip Length Distribution

In transportation analysis, it is sometimes helpful to view an existing or forecasted trip length distribution. For example, calibration of the gravity model is accomplished by reproducing, within a tolerance value, a known trip length distribution.

You can easily generate a trip length distribution from a flow matrix and an impedance matrix (e.g., travel time or travel distance), to visualize the trip length distribution. The current indices on the two matrices must be consistent. That is, the current editor of both matrices must have a matching:

- Number of rows
- Number of columns
- Headings on the rows and columns

The output of the trip length distribution procedure is a matrix. Each row of the matrix corresponds to a range of trip lengths, and there is a column each for count, percent, cumulative count, and cumulative percent.

You can control the format of the trip length distribution output by clicking Options in the Trip Length Distribution dialog box and choosing options. All of the options involve formatting of the **bins**. Each bin (i.e., a row in the output matrix) is a range of travel times.

You can indicate the number of bins to include, or the size of the bins. You can also control the starting and ending values for the bins that are reported. If you choose not to ignore values below a certain value, then any values that are below the starting bin are grouped in with the starting bin. Similarly, you can choose not to ignore values above a certain ending value.

TransCAD also generates a report file is that records the date of the run, inputs to the run, and statistics (minimum, maximum, average, and standard deviation) of the trip lengths.

For more information, see:
To Generate a Trip Length Distribution Matrix
Generating Trip Length Distribution Charts

⟩ To Generate a Trip Length Distribution Matrix

1. Choose **File-Open** and open the input flow matrix.

2. Choose **File-Open** and open the impedance matrix.

3. Choose **Planning-Planning Utilities-Trip Length Distribution** to display the Trip Length Distribution dialog box.

4. Choose the O-D flow matrix from the Base Matrix File and Matrix drop-down lists.

5. Choose the impedance matrix from the Impedance Matrix File and Matrix drop-down lists.

6. Click Options to display the Trip Length Distribution Options dialog box.

   Specify the trip length ranges as follows:

To do this...	Do this...
Specify where the bins start	Click the first radio button in the Bins Start At frame, and type the minimum value for the ranges
Start the bins at the minimum impedance	Click Minimum Impedance
Specify where the bins end	Choose the first radio button in the Bins End At frame, and type the maximum value for the ranges
End the bins at the maximum impedance	Click Maximum Impedance
Specify the number of bins	Click Number of Bins Is and type the number of bins in the edit box; the bin size will be determined by the start and end values
Specify the size of the bins	Click Bin Size Is and type the size of the bins in the edit box; the number of bins will be determined by the start and end values
Ignore some values	If you specified the start or end values, you can check one or both of the Ignore boxes to ignore values that are outside of the range you specified; otherwise values outside of the range you specified will be grouped into the first and/or last bins

   Click OK to return to the Trip Length Distribution dialog box.

7. Click OK to display the Save As dialog box.

8. Type the file name for the output matrix and click Save.

TransCAD generates the trip length distribution matrix and displays it in a new matrix view.

Top

Generating Trip Length Distribution Charts

After generating the trip length distribution matrix, you can easily create a chart of the trip length distribution.

For more information, see:
To Generate a Trip Length Distribution Chart

⟩ *To Generate a Trip Length Distribution Chart*

1. Generate a Trip Length Distribution matrix by following the steps in the procedure To Generate a Trip Length Distribution Matrix.

2. Highlight the Percent column heading in the trip length distribution matrix.

3. Choose **File-New** to display the New File dialog box.

4. Choose Chart from the scroll list and click OK. TransCAD displays the Matrix Chart Data dialog box.

5. Click the Selected Cells radio button and click OK. TransCAD displays the Chart Properties dialog box.

6. Choose a chart type and other options and click OK.

TransCAD creates and displays a chart of the trip length distribution. To learn more about creating and modifying charts, see Chapter 20*, Creating Charts*, in the *TransCAD User's Guide*.

Computing Intrazonal Travel Times

The **Network/Paths-Multiple Paths** command, which uses the shortest path matrix procedure, typically creates a matrix containing the minimum impedance, or travel time, between each O-D pair. This matrix is commonly used as an input file for trip distribution procedures such as the gravity model.

Because of the design of the network and its centroid connectors, the shortest path matrix procedure computes zero travel times along the diagonal of the matrix, where the origin is the same as the destination. In reality, these intrazonal travel times are greater than zero and represent local travel beginning and ending in the same zone. Trip distribution procedures, such as the gravity model, require a good estimate of these travel times for the outputs to be accurate.

Using the **Planning-Planning Utilities-Intrazonal Travel Times** command, you can automatically calculate the intrazonal travel times along the diagonal of a matrix, by averaging the travel times between the origin zone and its closest neighbor zones. The only required input is a matrix created by the shortest path matrix procedure. You can choose how many neighbor zones you wish to include in the averaging calculation and whether to apply a final factor to the end result.

For more information, see:
To Compute Intrazonal Travel Times

To Compute Intrazonal Travel Times

1. Choose **File-Open** and open the shortest path matrix.

2. Choose **Planning-Planning Utilities-Intrazonal Travel Times** to display the Intrazonal Impedance Calculation dialog box.

3. Choose the shortest path matrix from the Matrix drop-down list.

4. Make choices as follows:

To do this…	Do this…
Apply a factor to the final time	Type a value in the Factor Values By edit box. The final time will be multiplied by this value.
Choose the number of adjacent zones	Type a value in the Adjacent Zones edit box. This number of adjacent zones will be considered when calculating the average travel time.
Replace the values on the diagonal	Click the Replace radio button.
Add to the values on the diagonal	Click the Add radio button.
Treat missing values as zero	Click the As Zero radio button.
Treat missing values as missing	Click the As Missing radio button.

5. Click OK.

TransCAD calculates the intrazonal travel times and puts them in the diagonal of the matrix.

Displaying Intersection Flows

If one of your traffic assignment options was to choose to report turning movements, you can use the Display Intersection Flows toolbox to graphically display reported turning movements.

To see how to run traffic assignments and report movements, please see Optional Data for Traffic Assignment in Chapter 9, *Traffic Assignment*.

You can also use this toolbox to display turning movements that are created from any source. To use this toolbox, you need to prepare a database with the fields shown above. The link and node IDs refer to the geographic line database for which you wish to display intersection flows.

For more information, see:
To Display Intersection Flows

⟩ *To Display Intersection Flows*

1. Choose *File-Open* and open the movement table.

2. Choose *File-Open* and open the base geographic file.

3. Choose *Planning-Planning Utilities-Display Intersection Flows* to display the Display Intersection Flows dialog box.

4. Make choices as follows:

To do this...	Do this...
Choose the movement table	Choose a table from the Table Name drop-down list
Choose the movement volume field	Choose a field from Movement Field drop-down list
Add a title to the intersection diagram	Type a title in the Title edit box
Add a footnote to the intersection diagram	Type a footnote in the Footnote edit box
Display road labels in the intersection diagram	Choose a line layer field that contains road names or road labels from the Link Labels drop-down list
Label intersection legs with the flow value	Check the Display Flow Labels box

5. Click OK. TransCAD displays the Intersection toolbox.

6. Make choices as follows:

To display an intersection diagram...	Do this...
Based on a node ID	Choose the intersection node ID you wish to display from the drop-down list and click
By clicking on the node on the map	Click and click on a node on the map

TransCAD creates an intersection diagram for the chosen node.

7. To change the settings, click to display the Display Intersection Flows dialog box, make the changes, and OK. Return to Step 6 to display intersection diagrams for other nodes

8. When you are done, click the close box in the upper right corner of the toolbox.

TransCAD closes the Intersection toolbox.

Using Screenline Analysis

Screenline analysis compares the results of trip assignment with the traffic counts on roads. More precisely, it is a process of comparing the directional sum of ground count traffic volumes across a screenline or a cordon line with the directional sum of the assigned traffic volumes across the same screenline or cordon line. Screenline analysis is a useful tool for the calibration of trip assignment models, and it can also be used for the more general purpose of calculating flows that cross a screenline.

A **screenline** is an imaginary line on a map, composed of one or more straight line segments. A screenline can run across a number of network links. When two ends of a screenline meet, it is called a **cordon line**.

In screenline analysis, all the links crossed by each screenline form a group for which the total directional ground traffic counts and the total directional assigned volumes are calculated. The ratio between the two sums is then used as an indicator for the accuracy of the assignment results at the screenline location. The average of the ratios over all the screenlines can be used as a measure of the overall accuracy of the trip assignment.

For more information, see:
About Screenline Analysis
Results of Screenline Analysis
Using the Screenline Editor Toolbox

Top

About Screenline Analysis

Performing screenline analysis in TransCAD consists of three primary steps:

- Preparing the line layer
- Defining screenlines
- Calculating flows over screenlines

Preparing the Line Layer

The purpose of screenline analysis is to compare ground traffic counts with assignment results. Therefore a critical input is a line layer than contains both traffic counts and assignment results. The data can either be included in or joined to the line layer.

In most instances, traffic counts will not be available for all links in the network. Traffic counts and assignment results are only necessary for those links that are crossed by a screenline. For best results, the traffic counts and assigned flows on the link should be directional, by having two fields each for counts and assigned flows. Each field would contain data for only one topological direction along each link.

If directional counts or assigned flows are not available, then non-directional (total link flow) data should be used for both. In addition, the units for the counts and for the assigned flows must be consistent; that is, they both must measure traffic for the same period in the day.

Defining Screenlines

A screenline is an imaginary line on a map, which crosses one or more network links. To run screenline analysis, you need to specify each screenline that you want analyzed. Any number of screenlines can be analyzed at the same time.

You can draw and edit screenlines on the map using the tools in the Screenline Editor toolbox.

The screenlines are drawn as freehand lines on the map; they are not features in a map layer. The tools on the toolbox allow you to add, select, delete, and rename screenlines, and view the links that any screenline intersects.

The specifications of screenlines are stored in a **screenline definition table**. This table contains all

of the information needed to create screenlines on a map and to run screenline analysis. The screenline definition table is automatically updated when changes are made to the screenlines using the Screenline Editor.

The screenline definition table contains one or more records for each screenline. Each record includes the name of the screenline and a longitude and latitude of one of the points that defines the screenline. The fields are as follows:

Field	Contents
ID	A unique ID for each record
SCREENLINE	TransCAD internal ID for the screenline
NAME	Your name for the screenline
LONGITUDE	The longitude of a point that defines the screenline
LATITUDE	The latitude of a point that defines the screenline

The screenline definition table is automatically created, formatted, and updated as you modify screenlines using the Screenline Editor toolbox. In fact, you never have to directly look at or modify the screenline definition table to do screenline analysis, since everything is displayed as freehand lines and can be directly modified on the map using the Screenline Editor toolbox.

Note: you should not use the regular freehand tools for modifying screenlines. All manipulation of screenlines should be done from the Screenline Editor toolbox.

When running screenline analysis, you can create a new screenline definition table, or edit and use an old screenline definition table. You can have any number of screenline definition tables.

Calculating Flows over Screenlines

Once the line layer with traffic counts and assignment flows is open and the screenlines are defined, screenline analysis results are produced by TransCAD with the push of a button from the Screenline Analysis Editor toolbox.

Top

Results of Screenline Analysis

The screenline analysis procedure creates a table that includes the sum of ground counts and the sum of assigned flows across each screenline, and the ratio of counts to assigned flows. The table has one record for each screenline and has the following fields:

Field	Contents
SCREENLINE	TransCAD internal ID number for the screenline
NAME	Your name for the screenline
IN_FLOW	The sum of the assigned flow over the "in" direction of the screenline
IN_COUNT	The sum of the traffic counts over the "in" direction of the screenline
IN_RATIO	The ratio IN_FLOW/IN_COUNT
OUT_FLOW	The sum of the assigned flow over the "out" direction of the screenline
OUT_COUNT	The sum of the traffic counts over the "out" direction of the screenline
OUT_RATIO	The ratio OUT_FLOW/OUT_COUNT
TOT_FLOW	The sum of the assigned flow over the screenline in both directions
TOT_COUNT	The sum of the traffic counts over the screenline in both directions
TOT_RATIO	The ratio TOT_FLOW/TOT_COUNT

The definition of the "in" and "out" directions is dependent on the way in which the screenline is drawn. The "in" direction always flows from the left of the screenline to the right of the screenline, where "left" is defined as the left side of the screenline in the direction of its topology.

Top

Using the Screenline Editor Toolbox

The Screenline Editor toolbox has tools and buttons to:

- Create and modify screenlines
- View the links that a screenline intersects
- Do the screenline analysis calculation
- Enter settings for the line layer

Tool	Name	How to use it...
	Add	Click on the tool to activate it, then click on the map to add a new screenline
	Select	Click on the tool to activate it, then click on the map to select a screenline
	Delete	Click to delete the selected screenline
	Rename	Click to rename the selected screenline
	Show	Click to display a table of links that the selected screenline intersects
	Calculate	Click to compute the analysis results for all screenlines
	Settings	Click to choose the line layer and the fields containing the count and the assigned flow

Do not attempt to edit a screenline by moving the endpoints and shape points with the Pointer tool in the main toolbox. That will corrupt the screenline definition table. To make changes to a screenline, delete the original screenline and add a new one, using the Screenline Editor toolbox.

After you select a screenline, you should never try to delete it by pressing the Delete key on the keyboard. That also will corrupt the screenline definition table. Instead, use the Delete tool in the Screenline Editor toolbox.

Each screenline can pass through one or more links in the network. You can view the links that a particular screenline intersects by clicking . The resulting dataview also displays all of the attribute data associated with the link in the line layer.

For more information, see:
To Perform Screenline Analysis

Top

) To Perform Screenline Analysis

1. If necessary, make a line layer that has ground counts and assigned flows the working layer, by choosing it from the drop-down list on the toolbar.

2. Choose *Planning-Planning Utilities-Screenline Analysis* to display the Screenline Dataview dialog box.

3. Choose the screenline definition table that you wish to use as follows:

To do this...	Do this...
Create a new table	Click New Table and click OK to display the Store Table In dialog box. Type a file name and click Save.
Open an existing table	Click Open Table and click OK to display the Table Stored In dialog box. Choose the table and click Open.
Use an existing dataview	Choose the dataview from the drop-down list and click OK.

TransCAD displays the Screenline Analysis Settings dialog box.

4. Make choices as follows.

To do this...	Do this...
Choose the line dataview	Choose the dataview that contains the ground counts and assigned flows from the Line View drop-down list
Choose the ground count fields	Choose the fields from the Forward and Reverse Count drop-down lists
Choose the assigned flow fields	Choose the fields from the Forward and Reverse Flow drop-down lists

Click OK. TransCAD displays the Screenline Editor toolbox.

5. Use the tools and buttons in the toolbox as follows:

To do this...	Do this...
Create a new screenline	Click the Add tool to activate it, click on the starting point of the screenline, and click on additional points as needed. Press Esc if you want to cancel a partially-drawn screenline. While you are editing the screenline it will be shown as a thin, black dotted line. Press Enter or double-click at the endpoint to end the screenline. It will be shown as a thick, red dotted line.
Select an existing screenline	Click the Selection tool to activate it and click on a screenline. TransCAD displays handles at the endpoints and shape points of the screenline.
Delete the selected screenline	Click . TransCAD displays a Confirm dialog box. Click Yes to delete the selected screenline or No to keep it.
Rename the selected screenline	Click . TransCAD displays the Rename Screenline dialog box. Type a new name and click OK.
Display a screenline link dataview	Click . TransCAD displays a dataview that contains all the network links that are intersected by the selected screenline.
Change the settings	Click . TransCAD displays the Screenline Analysis Settings dialog box. Make changes to the settings and click OK. TransCAD will use these settings for all future screenline analysis calculations until you change them or exit the Screenline Editor toolbox.

Perform screenline calculations	Click Σ. TransCAD displays the Store Summary In dialog box. Type a file name and click Save. TransCAD computes the flows, counts, and ratios over each screenline, writes the results to the file, and displays the results in a dataview.

6. Return to Step 5 to modify the screenlines, choose new settings, and run the screenline analysis again. When you are done, click the close box in the upper right corner of the toolbox.

TransCAD closes the Screenline Editor toolbox.

Creating a Subarea O-D Matrix

When forecasting transportation demand for a region, you may want to perform a more detailed investigation of traffic patterns within a subarea, such as the downtown area. To facilitate subarea analysis, TransCAD has a procedure for creating an O-D trip table for that subarea. The reduced O-D matrix may be used as the demand table for performing a traffic assignment on a subarea network, which may be more detailed than the regional network.

For more information, see:
Defining a Subarea
Preparing Data for and Results of Subarea O-D Matrix Creation
Technical Notes on Subarea O-D Matrix Creation

Defining a Subarea

To define a subarea, you specify a cordon line that circumscribes the subarea by either:

- Selecting one or more areas in an area layer and use the outer boundary of the area set as the cordon
- Drawing the cordon line directly on the screen as a freehand polygon annotation, or loading a previously-saved freehand polygon annotation

The subarea O-D matrix is defined by **cross links** and **internal centroids**. Cross links are links that cross the cordon line, and internal centroids are centroid nodes that are inside the cordon. An endnode of a cross link, whether it is a centroid or a regular node, is called an **external station** if it is located outside of the cordon. A subarea O-D matrix is a square matrix, which means that within the matrix there is a row and a column for each of the internal centroids and the external stations.

A trip will be assigned to the subarea O-D matrix if any part of the trip is inside the subarea. There are four ways that a trip can be at least partially inside the subarea:

1. The trip originates at or passes through an external station, passes through the subarea, and

ends at or passes through an external station.

2. The trip originates at or passes through an external station, enters the subarea, and ends at an internal centroid.

3. The trip originates at an internal centroid, exits the subarea, and ends at or passes through an external station.

4. The trip originates at an internal centroid and ends at another internal centroid.

After a subarea is specified, TransCAD asks for a name for the subarea, and attaches that name as a prefix to the following node and link selection sets:

Node Layer Set Name	Contents
Centroids	Internal centroids
External	External stations

Link Layer Set Name	Contents
Crossing	Cross links
Links	Links insides a subarea, including cross links

For instance, if the name of the subarea is "CBD" then TransCAD creates four selection sets: CBD_Centroids, CBD_External, CBD_Crossing, and CBD_Links.

In addition to creating these selection sets, TransCAD does the following:

- Displays information for the subarea, including the numbers of internal centroids, external stations, and subarea links
- Highlights internal centroids, external stations, and subarea links
- Zooms in to the defined subarea

All the node and link selection sets for a subarea will be kept even after the current subarea O-D matrix creation is completed, so that you can use them again in a later analysis.

Top

Preparing Data for and Results of Subarea O-D Matrix Creation

Subarea O-D matrix creation requires all the inputs for a regular traffic assignment. In addition, for the definition of a subarea, TransCAD needs the subarea name and a name for storing the subarea O-D matrix file. You must also provide the following settings, depending on the subarea definition method that is chosen:

Definition Method	Settings
Area Set	Name of Area Layer; Name of Area Set
Polygon Annotation	A selected polygon annotation, or name of a file which contains a previously-saved freehand polygon annotation

In additional to the standard traffic assignment outputs, subarea O-D matrix creation also produces a subarea O-D matrix.

For more information, see:
To Create a Subarea O-D Matrix

) *To Create a Subarea O-D Matrix*

1. Open a map containing the line layer from which the network was built. Make sure that the line layer shows in the drop-down list on the toolbar and that the correct network is active.

2. Prepare to define the subarea as follows:

To do this...	Do this...
Define by an area set	Make sure that the map contains an area layer and a selection set corresponding to the subarea has been created
Define by polygon annotation	Make sure that a polygon annotation is selected or a subarea polygon annotation file exists

3. Choose **File-Open** and open the regional O-D matrix.

4. Choose **Planning-Planning Utilities-Subarea Analysis** to display the Subarea Assignment dialog box.

5. Choose how to define the subarea as follows:

To do this...	Do this...
Define by an area set	Click the Area Layer radio button, choose an area layer from the drop-down list, and choose an selection set from the Selection drop-down list
Define by polygon annotation	Click the Polygon radio button

6. Make changes to the settings in the Fields and Globals frames as described in the procedure To Perform Traffic Assignment in Chapter 9, *Traffic Assignment*.

7. Click OK to display the Output File Settings dialog box. Choose to use, rename, or overwrite each file as described below, and click OK.

If the status is...	Do this...
In Use, or Exists and the file should be kept	Click Save As, choose a folder, type a file name and click Save. The status will change to New.
Exists, and the file name can be reused	Check Overwrite. The status will change to Overwrite. If you want to overwrite all files whose status is Exists, click Overwrite All.

TransCAD assigns traffic flow to the links in the network, creates a link flow table and a sub-area O-D matrix, and displays the results.

Technical Notes on Subarea O-D Matrix Creation

Subarea analysis is attractive especially when dealing with extremely large regions. One of the important uses of subarea analysis is for generating reports that are based on the traffic assignment from a statewide or large regional model. In this circumstance, the cordon crossing volumes from the subarea analysis can assist in judging the validity of the overall model.

You should be cautious, however, in using subarea analysis in place of large models. While it can be attractive to reduce the dimensions of the traffic assignment problem significantly, the model results will differ even if the subnetwork is a straight subset of the original network.

Computing Assignment Differences

You can compare two flow tables to find assignment differences. The Assignment Differences procedure reports various statistics regarding the differences in the assignments. These statistics are computed in both the forward and reverse directions of each link and include:

- Assigned flow difference
- Absolute value of the flow difference
- An indication of whether or not this difference is positive or negative

The procedure also creates a theme on the line layer to graphically illustrate the locations and magnitude of these differences. The Assignment Differences procedure is especially useful in analyzing the effects of changing network attributes (e.g., capacity, alpha, beta, etc.) or employing different assignment techniques.

To compute assignment differences, you will need a line layer and two tables that include the assigned flows on the forward and reverse directions of the links. The flow table output from any TransCAD assignment routine can be used. Also, it is desirable that the line layer include all records in both flow tables.

The Assignment Differences procedure creates an output table with a record for each link. Once the table has been created and joined to the line layer, a theme is created illustrating the locations of the differences and their respective magnitudes. The output table includes the following fields:

Field	Contents
ID	Link ID (used for joining to link database)
AB_FLOW1, BA_FLOW1	Assigned Flow from base assignment
AB_FLOW2, BA_FLOW2	Assigned Flow from most recent assignment
AB_DIFF, BA_DIFF	AB_FLOW 1 minus AB_FLOW2 (BA_FLOW 1 minus BA_FLOW2)
AB_ABSDIFF, BA_ABSDIFF	Absolute value of the AB_DIFF (BA_DIFF)
AB_POSNEG, BA_POSNEG	+, if AB_DIFF is positive, - if AB_DIFF is negative (+, if BA_DIFF is positive, - if BA_DIFF is negative)

This table is joined to the line layer using the ID field and displayed in a dataview.

For more information, see:

) *To Compute Assignment Differences*

1. Open a map with the line layer used for traffic assignment.

2. Open the two assignment tables you wish to compare.

3. Choose **Planning-Planning Utilities-Assignment Differences** to display the Assignment Differences Dialog Box.

4. Choose the dataview that contains the base assignment flow from the Base Assignment drop-down list.

5. Choose the dataview that you wish to compare to the base assignment flow from the New Assignment drop-down list

6. Choose the color you wish to use to represent the links with positive differences in flow from the Positive Color drop-down list

7. Choose the color you wish to use to represent the links with negative differences in flow from the Negative Color drop-down list.

8. Click OK. TransCAD displays the Store Results In dialog box.

9. Type a file name and click Save.

TransCAD computes the assignment differences, creates the output table, joins it to the line layer, and displays the joined view. TransCAD also creates a scaled-symbol theme on the line layer illustrating the magnitude of the difference, and a color theme indicating whether this difference is positive or negative.

Using the Link Calculator

With the Link Calculator you can compute vehicle miles of travel (VMT), Vehicle Hours of Travel (VHT), delay, and percent delay for one or more links using the results of a traffic assignment. The Link Calculator has several options for output and can be run in either an interactive or batch mode. The Link Calculator is very useful for analyzing Level of Service (LOS) over a set of links.

To use the Link Calculator, you will need a line layer that includes the free-flow travel time, the assigned flows, and congested travel times on each link. It is desirable if these fields are directional; that is, a pair of fields define these values in both the forward and reverse directions of each link. You can obtain all of the necessary fields by joining the line database to the results of a Traffic

Assignment procedure, or by using the Link Calculator immediately following a traffic assignment. Flow and congested travel times are standard outputs of the Traffic Assignment procedures, while free-flow times are generally a standard input to Traffic Assignment procedures.

For more information, see:
Results of Using the Link Calculator
About the Link Calculator Toolbox
Setting Up the Link Calculator
Technical Notes on the Link Calculator

Top

Results of Using the Link Calculator

The Link Calculator can be run in either interactive mode or batch mode. When run in interactive mode, the computations are displayed within the Link Calculator toolbox and are updated as different link selections are made on the map. Using the output from a traffic assignment, the Link Calculator will compute the congested speed (single link only), VMT, VHT, Delay, and Percent Delay for one or more links at a time. You can also weight any of the computations over a set of links any field (e.g., flow) in the line layer.

When run in batch mode, the output of the Link Calculator is a table that includes the following fields:

Field	Contents
ID	Link ID (used for joining to link database)
AB_CSP, BA_CSP	Congested speed on link
AB_VMT, BA_VMT	Vehicle Miles of Travel on link. computed as Link Length * Flow
AB_VHT, BA_VHT	Vehicle Hours of Travel on link. computed as Flow * Time
AB_DELAY, BA_DELAY	Delay on link
AB_PDELAY, BA_PDELAY	Percent delay on link

This table is joined to the line layer using the ID field and displayed in a dataview.

Top

About the Link Calculator Toolbox

When you run the link calculator in interactive mode, you use the Interactive Link Calculator toolbox. The tools in the Link Calculator toolbox allow you to perform the following functions:

- Analyze one or more links by selecting them on a map by pointing.
- Analyze one or more links by selecting them on a map by drawing a shape.
- Return to the Link Calculator - Set Up Parameters dialog box

The link calculator tools are:

Tool	Name	How to use it...
	Select links by pointing	Click on one or more links to compute the congestion parameters
	Select links by shape	Click a polygon to create a selection of links to compute congestion parameters for.
	Return to setup	Click to return to the Link Calculator - Set Up Parameters dialog box

Top

Setting Up the Link Calculator

Setting up the link calculator requires certain data to be stored with the line layer. The data are generally output from the Traffic Assignment procedure. The following parameters must be available for setup:

- A measure of the link length (e.g., distance)
- Map units of length (miles, feet, kilometers, meters)
- Units of time (hours, minutes, seconds)
- Free-flow travel time on link *
- Assigned flow on link *
- Congested travel time on link *

A * denotes a directional attribute (AB and BA)

Before opening the Link Calculator toolbox, you use the Link Calculator - Set Up Parameters dialog box to choose the settings. In this dialog box, you first choose the dataview that contains the assignment results. Settings such as link length and units of time and length can also be made in this dialog box.

For more information, see:
To Set Up the Link Calculator
To Perform Computations Using the Link Calculator in Interactive Mode
To Perform Computations Using the Link Calculator in Batch Mode

Top

⟩ *To Set Up the Link Calculator*

1. Open or create a map that contains a line layer joined to the output table from traffic assignment.

2. Choose **Planning-Planning Utilities-Link Calculator** to display the Link Calculator - Set Up Parameters dialog box.

3. Make choices as follows:

To do this...	Do this...
Choose the assignment results dataview	Choose a dataview that contains the line layer joined to the assignment results from the Assignment View drop-down list
Choose the link length field	Choose a field from the Read Length From drop-down list
Choose the units of length field	Choose a field from the Units of Length drop-down list
Choose the units of time field	Choose a field from the Units of Time drop-down list
Choose the free-flow time fields	Choose the fields from the AB and BA Free-Flow Time drop-down lists
Choose the assigned flows fields	Choose the fields from the AB and BA Assigned Flow drop-down lists
Choose the congested travel time fields	Choose the fields from the AB and BA Congested Time drop-down lists
Choose the weight fields	Choose the fields that contain the forward and reverse fields to weight the computations by from the Weight Field drop-down lists

4. Choose a mode for using the link calculator from the Mode radio list:

To do this...	Do this...
Use the Link Calculator tools to click links on the map	Click Interactive
Analyze a selection set of links	Click Batch and choose a selection set from the Selection drop-down list

5. Click OK. TransCAD saves the settings and closes the Link Calculator - Set Up Parameters dialog box. TransCAD will use these settings for all future Link Calculator computations until you change them or exit the Link Calculator toolbox.

6. Continue with one of the following procedures:

If you chose ...	Use the procedure...
The interactive mode	To Perform Computations Using the Link Calculator in Interactive Mode
The batch mode	To Perform Computations Using the Link Calculator in Batch Mode

Top

) To Perform Computations Using the Link Calculator in Interactive Mode

1. Do the procedure To Set Up the Link Calculator, making sure to choose Interactive from the Mode radio list.

2. Choose the links to analyze as follows:

To do this...	Do this...
Analyze a single link segment	Click ⬚ in the Link Calculator toolbox and click on a link. The Link Calculator toolbox shows the computed AB and BA values for the selected link.
Analyze several links by pointing	Click ⬚ in the Link Calculator toolbox and hold down the Shift key while clicking on several links. The Link Calculator toolbox shows total and average computed values for the selected links.
Analyze several links by shape	Click ⬚ in the Link Calculator toolbox, then click on each corner of the shape, and double-click to close it. The Link Calculator toolbox

shows the total and average computed values for all link segments within the shape.

3. To change the settings, click [icon] to return to the Link Calculator - Set Up Parameters dialog box, make the changes, click OK, and return to Step 2.

4. When have finished your analysis, close the toolbox by clicking the close box in the upper right corner of the toolbox.

TransCAD closes the Link Calculator toolbox.

Top

⟩ *To Perform Computations Using the Link Calculator in Batch Mode*

1. Do the procedure To Set Up the Link Calculator, making sure to choose Batch from the Mode radio list and a selection set from the Selection drop-down list.

2. Click OK to display the Save As dialog box.

3. Type a name for the table and click Save.

TransCAD performs the computations, builds a table of results, and joins the Assignment View to it. The resulting joined view is displayed in a dataview. TransCAD also launches the Windows Notepad program and displays the total and average computed values for all of the links in the selection set.

Top

Technical Notes on the Link Calculator

The following equations are used in Link Calculator computations for a single link.

1. Speed = Length/Congested Travel Time * (Conversion Factor)

2. Vehicle Miles of Travel (VMT) = Length * Flow * (Conversion Factor)

3. Vehicle Hours of Travel (VHT) = Congested Travel Time * Flow * (Conversion Factor)

4. Delay = (VMT/Free Flow Speed - VMT/Congested Speed) * (Conversion Factor)

5. Percent Delay = Delay/VHT * 100

Note: the Conversion Factor is a dimensionless constant that is calculated based on the units of length and time specified. This allows TransCAD to report Vehicle Miles of Travel (VMT) and

Vehicle Hours of Travel (VHT).

Saving and Using Procedure Settings

Many TransCAD procedures require a number of input settings. Often you may want to run a procedure several times after making changes to the settings, or you may want to vary the settings slightly. Rather than reentering all of the settings every time you run the procedure, you can save them to a settings file. You can have any number of sets of settings for each procedure.

Later, when you run the procedure again, you can quickly restore the settings from any of the scenarios that you have previously saved. All of the settings are then automatically restored for you.

For more information, see:
To Save the Settings for a Procedure
To Apply Saved Settings to a Procedure
To Arrange and Delete Saved Settings

〉 To Save the Settings for a Procedure

1.   Make all of the settings that you want to have saved in the procedure's dialog box.

2.   Click Settings. If this is the first time that you have saved the settings for a procedure, TransCAD will display a Confirm dialog box. Click Yes to display the Settings dialog box.

3.   Click Add. TransCAD adds a new set to the scroll list.

4.   Type a name for the set in the Name edit box and type a description in the Description edit box.

5.   Click OK to return to the procedure's dialog box.

TransCAD saves the set of settings. Click OK to run the procedure or click Cancel.

〉 To Apply Saved Settings to a Procedure

1. Click Settings in the procedure's dialog box to display the Settings dialog box.

    All saved sets for the chosen procedure are displayed in the scroll list.

2. Highlight a set in the scroll list.

3. To see the input settings associated with the chosen set, click Contents. TransCAD displays the Show Options dialog box.

    Click OK to return to the Settings dialog box.

4. Click OK.

TransCAD applies all of the settings from the chosen set and returns to the procedure's dialog box. The dialog box shows all of the chosen settings. Change any settings you wish to modify and click OK to run the procedure.

Top

⟩ *To Arrange and Delete Saved Settings*

1. Click Settings in a procedure's dialog box to display the Settings dialog box.

2. Make choices as follows:

To do this...	Do this...
Sort the sets by date	Click Sort by Date
Sort the sets by name	Click Sort by Name
Rearrange the sets manually	Highlight one or more sets in the scroll list and click Move Up or Move Down
Delete a set	Highlight one or more sets in the scroll list, click Delete, and click Yes in the Confirm dialog box

3. Click OK.

TransCAD returns to the procedure's dialog box.

Top

Working with the Log File and Report File

Every time that you run a procedure, TransCAD saves information on the procedure in two text files. These files are stored on your computer and can be accessed either from the Results Summary dialog box that is displayed after a procedure is completed, or from the Logging tab in the User Preferences dialog box. When you choose to display either of these files, TransCAD launches an editing program (the default is Windows Notepad) to display the file.

The log file lists every procedure that you run and any warnings that were encountered. The default log file is called tcw_log.txt.

Like the log file, the report file lists every procedure that you run. It also lists all of the input data that was used for the procedure. The default report file is called tcw_rep.txt.

The Logging tab in the User Preferences dialog box lets you set options for the log and report files. You can change the name and location of both files, and you can specify a default editing program other than Windows Notepad to use when viewing the files.

Every time you run a procedure, information on the procedure are appended to both the log file and the report file. In the User Preferences dialog box you can set a maximum size limit for these files or delete all of the contents of either file. If either file exceeds the file size limit, TransCAD will prompt you on startup as to whether you want to delete the contents of the file.

For more information, see:
To Choose the Default Editor for Viewing the Log File and Report File
To View the Contents of the Log File or Report File
To Change Log File and Report File Options

Top

⟩ *To Choose the Default Editor for Viewing the Log File and Report File*

1. Choose *Edit-Preferences* to display the User Preferences dialog box.

2. Click the Logging tab to display the Logging page.

3. The File text box in the Editor frame lists the default editor. Click next to the text box to display the Choose a Text Editor dialog box.

4. Choose an editor program and click Open. TransCAD updates the default editor program.

5. Click OK.

TransCAD closes the User Preferences dialog box.

Top

⟩ *To View the Contents of the Log File or Report File*

1. Choose *Edit-Preferences* to display the User Preferences dialog box.

2. Click the Logging tab to display the Logging page.

3. The Log text box lists the name and location of the log file and the Report text box lists the name and location of the report file.

To view...	Do this...
The log file	Click Display under the Log text box
The report file	Click Display under the Report text box

4. TransCAD launches the editor program and displays the file. Close the editor program when you are done viewing the file and return to TransCAD.

5. Click OK.

TransCAD closes the User Preferences dialog box.

   - OR -

1. Run a planning procedure. When the procedure is complete, TransCAD displays the Results Summary dialog box.

2. Make choices as follows:

To do this...	Do this...
View any warnings	Click Show Warnings and scroll to the bottom of the file. Close the editor program when you are done.
View the report	Click Show Report and scroll to the bottom of the file. Close the editor program when you are done.
Close the dialog box	Click Close.

Top

⟩ *To Change Log File and Report File Options*

1. Choose *Edit-Preferences* to display the User Preferences dialog box.

2. Click the Logging tab to display the Logging page.

3. Make choices as follows:

To do this...	Do this...
Change the log file name or location	Click ⸱⸱⸱ next to the Log text box to display the Enter Log File Name dialog box. Choose a folder from the scroll list to change the location, type a new file name in the File Name edit box, and click Save.
Change the report file name or location	Click ⸱⸱⸱ next to the Log text box to display the Enter Log File Name dialog box. Choose a folder from the scroll list to change the location, type a new file name in the File Name edit box, and click Save.
Change the file limit size	Type a value in the File Limit edit box.

4. Many procedures also create output files such as tables and matrices. To change the default location of procedure output files, click ⸱⸱⸱ next to the Path edit box to display the Browse for Folder dialog box, choose a folder, and click OK.

5. Click OK.

TransCAD saves the log file and report file options, and closes the User Preferences dialog box.

Importing Network Data

TransCAD provides tools for importing networks and network data from a variety of stand-alone transportation planning packages. These networks are converted into full-fledged GIS databases that can be used for all types of planning, modeling, and mapping applications.

Stand-alone transportation planning packages such as UTPS, MINUTP, EMME/2, TRIPS, and TRANPLAN store transportation network data in rigidly-defined data files. These files define a transportation planning network as a collection of nodes and links. Each link has a starting node and an ending node, and a set of rigidly-defined attribute data.

TransCAD stores transportation network information in a more flexible format that is different in three significant ways:

- Each link can be defined by a series of geographic coordinates that indicate its true location and shape
- Any number of attributes can be defined and stored for each link
- Attribute data can be defined and stored for each network node (e.g., turning penalties, type of signalization, and number of accidents)

TransCAD provides a seamless import capability for transportation planning network files in MINUTP, EMME/2, TRIPS, and TRANPLAN ASCII format. TransCAD can also import MINUTP network files that are in binary format. Usually no preprocessing of the original files is required.

When you import a highway network from TRANPLAN, EMME/2, TRIPS, and MINUTP, TransCAD creates a geographic file containing the highway network nodes, links, and all associated attribute data. When you import a transit network from TRANPLAN, MINUTP or EMME/2, TransCAD creates three different files:

- A geographic file containing the nodes, links, and associated attribute data for the highway or underlying network geography
- A TransCAD network file corresponding to this geographic file
- A route system containing each defined transit route, with associated stop locations

When loading transit routes from a TRANPLAN or EMME/2 file, a stop is added at every node along each route. When loading transit routes from a MINUTP file, stops are added only at designated stations.

Link Direction
TRANPLAN files can include link information that varies by direction. TransCAD imports this data automatically into matching pairs of data fields with an AB or BA designation. If the TRANPLAN file indicates that a link has different attribute values in each direction, TransCAD stores the two sets of values in the appropriate fields. If the TRANPLAN file indicates that a link has identical attribute values in the two directions, TransCAD stores these values in both the AB and BA fields. If a link is one-way, the AB fields are filled in, the BA fields are left blank, and the direction flag for the link is set to 1.

For MINUTP ASCII file networks, only a single set of attributes can be stored for each link. When a MINUTP network is imported, the resulting attribute table contains only a single set of attribute fields, without any AB or BA designation. If a link is one- way, the direction flag in the TransCAD geographic file is set accordingly. If the MINUTP file contains pairs of link records, one defining a link in the AB direction and another defining an identical link in the BA direction, the resulting TransCAD geographic file contains links with identical geography but different attribute values. For MINUTP binary file networks, TransCAD will create the appropriate AB and BA designations of fields.

Coordinates

Transportation planning packages typically store network coordinates in an arbitrary X-Y coordinate system, where the coordinates do not have any true geographic meaning. Occasionally, planning package network files use a defined coordinate system such as State Plane or UTM coordinates.

When you import data from planning package network files, you can use the coordinate conversion capabilities of TransCAD to place these networks in their true geographic location. If the files used a defined coordinate system, TransCAD can automatically convert these data into longitude and latitude coordinates. If the files use an arbitrary coordinate system, you can define a custom coordinate system that enables TransCAD to do the conversion, or you can convert using an N-Point transformation. To perform an N-Point transformation, you need to locate three points on the network and note the local coordinates. For each of these points, you would locate its real-world longitude-latitude coordinate in degree and decimal-degree format (e.g., longitude = -71.33432, latitude = 43.22322). Then you would enter in both the local and world coordinates when defining the N-Point transformation in the Coordinate System dialog box.

For information on coordinate systems and performing coordinate system conversions, see Chapter 28, *Projections and Coordinate Systems*, in the *TransCAD User's Guide.*

ASCII File Issues

Before you begin importing an ASCII file, you should inspect it to make sure that it is a clean file. The import procedures can fail if the ASCII file does not meet standard format requirements. Some causes of import failure are:

- The end-of-line characters are not uniformly located at the same column in the nodes or links section of the file
- The end-of-file character is not present in the file
- Empty lines exist within line or node records
- Garbage values are found in the ASCII file
- Both the beginning and end node of a link have the exact same x and y coordinate
- Column spacings are not completely uniform for all link or node records

You should check your file for any of these possible causes if the import procedure fails.

For more information, see:
Importing MINUTP ASCII Network Files
Importing MINUTP Binary Network Files
Importing TRANPLAN Network Files
Importing TRIPS Network Files
Importing QRSII Network Files
Importing and Exporting EMME/2 Network Files

Top

Importing MINUTP ASCII Network Files

MINUTP ASCII highway networks are defined by two text format files, one containing node data and the other containing link data. A third, optional file defines transit link and line data. This third file contains several different types of records that define transit routes, plus access, egress, and transfer links, which are used by MINUTP in transit network analysis.

When you import MINUTP networks into TransCAD, the access, egress, and transfer links are stored as physical links in the resulting geographic file. These links can be distinguished from other links because they have a different value for the link type field.

The fields in MINUTP ASCII link and node files can also vary in both spacing and definition. Link files can have many different attribute fields and their spacing can be defined arbitrarily. TransCAD lets you define all of the field and spacing definitions of both the links and node files. Using the Field Specification dialog box, you can add and delete fields in the specification and change their positions.

To import data from MINUTP ASCII networks, you must provide:

- Two input files (for a highway network) or three input files (for a transit network)
- Field definitions for both the links and nodes
- The file names for the resulting geographic files

For more information, see:
To Import a MINUTP ASCII Highway Network
To Import MINUTP Highway and Transit Networks

〉 *To Import a MINUTP ASCII Highway Network*

1. Choose **Planning-Import Planning Data-Import Planning Networks** to display the Import Network File dialog box.

2. Choose MINUTP from the Import File Type drop-down list.

3. Click Highway Nodes to display the File Open dialog box, choose the file containing the node definitions, and click Open.

4. Click Highway Links to display the File Open dialog box, choose the file containing the link definitions, and click Open.

5. Type a file name for the new highway layer In the Layer to Create edit box.

6. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

7. To define the fields for either the nodes or the links file, click the appropriate Fields button to

display the Field Specification dialog box:

Make choices as follows:

To do this...	Do this...
Add a new field to the specification	Click on the column where you wish to add the new field, at the top of the scroll list, and click Add Field
Move the location of an existing field	Click the button under the field, at the bottom of the scroll list, and click Move Left or Move Right
Save your field definitions	Click Save, type the file name for the.fdf file, and click Save
Load previously created field definitions	Click Load, choose the the.fdf file, and click Open

Click OK when you are done to return to the Import Network File dialog box.

To change field names or types or manually change the end location of existing fields, click Field Info to display the Field Information dialog box:

Highlight a field in the scroll list and make choices as follows:

To do this...	Do this...
No longer use the field	Remove the check from the **Use this field** box
Change the end column number	Type a value in the To edit box
Change the field name	Type a new name in the Name edit box
Change the field type	Choose a Type from the Type drop-down list
Change the number of decimal places	Type a value in the Decimal edit box; this is only enabled for fields of type Real

Click OK when you are done to return to the Field Specification dialog box.

Click OK when you are done defining fields to return to the Import Network File dialog box.

8. Click OK. TransCAD displays the Save As dialog box.

9. Type a file name for the new geographic file and click Save.

TransCAD reads the input files, builds the geographic file, and displays it as a layer in a new map window.

Top

⟩ To Import MINUTP Highway and Transit Networks

1. Choose *Planning-Import Planning Data-Import Planning Networks* to display the Import Network File dialog box.

2. Choose MINUTP from the Import File Type drop-down list.

3. Check the Import Transit Data box.

4. Click Highway Nodes to display the File Open dialog box, choose the file containing the node definitions, and click Open.

5. Click Highway Links to display the File Open dialog box, choose the file containing the link definitions, and click Open.

6. Click Transit File to display the File Open dialog box, choose the file containing the transit route definitions, and click Open.

7. To define the fields for the nodes, links, or transit file, click the appropriate Fields button to display the Field Specification dialog box and make choices as follows:

To do this...	Do this...
Add a new field to the specification	Click on the column where you wish to add the new field, at the top of the scroll list, and click Add Field
Move the location of an existing field	Click the button under the field, at the bottom of the scroll list, and click Move Left or Move Right
Save your field definitions	Click Save, type the file name for the.fdf file, and click Save
Load previously created field definitions	Click Load, choose the the.fdf file, and click Open

Click OK when you are done to return to the Import Network File dialog box.

To change field names or types or manually change the end location of existing fields, click Field Info to display the Field Information dialog box, highlight a field in the scroll list, then make choices as follows:

To do this...	Do this...
No longer use the field	Remove the check from the **Use this field** box
Change the end column number	Type a value in the To edit box
Change the field name	Type a new name in the Name edit box
Change the field type	Choose a Type from the Type drop-down list
Change the number of decimal places	Type a value in the Decimal edit box; this is only enabled for fields of type Real

Click OK when you are done to return to the Field Specification dialog box.

Click OK when you are done defining fields to return to the Import Network File dialog box.

8. In the Layer to Create frame, type names for the new layers in the Highways, Transit Routes, and Transit Stops edit boxes.

9. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

10. Click OK. TransCAD displays the Save As dialog box.

11. Type a file name for the highway geographic file and click Save. TransCAD displays the Save Network As dialog box.

12. Type a file name for the TransCAD network file and click Save. TransCAD displays the Save Route System As dialog box.

13. Type a file name for the route system and click Save.

TransCAD reads the input files, builds the geographic file, network, and route system, and displays them as layers in a new map window.

Importing MINUTP Binary Network Files

Since the MINUTP binary network format already contains all the field specifications, and since both nodes and links are already defined in the file, it is easy to import a MINUTP binary network file. The file will need to have a .dat extension.

For more information, see:
To Import a MINUTP Binary Highway Network

⟩ *To Import a MINUTP Binary Highway Network*

1. Choose *Planning-Import Planning Data-Import MINUTP Binary Highway Networks* to display the Open MINUTP Network File dialog box.

2. Choose a MINUTP binary file (with a .dat extension), and click Open. TransCAD displays the Import MINUTP Network File dialog box.

3. Type a name for the highway layer in the Layer Name edit box.

4. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

5. Click OK. TransCAD displays the Save As dialog box.

6. Type a file name for the highway geographic file and click Save.

TransCAD reads the binary network file, builds the geographic file, and displays it as a layer in a new map window.

Importing TRANPLAN Network Files

A TRANPLAN highway network is stored in a single ASCII file, which contains both node and link data. TRANPLAN transit networks are defined in a single, stand-alone file that defines the nodes, links, and routes (which in TRANPLAN are referred to as lines). Transit route definitions do not rely on the definition of any highway network nodes and links.

There are several formatting options that apply to TRANPLAN network files. You must know which of these options are used in a TRANPLAN file in order to import it successfully.

Node records can be stored in either a standard format (with up to four nodes defined in each line of the input file) or in a large coordinate format (with only a single node defined per input line). Check the Large Coordinates box in the Import Network File dialog box if that is the node format.

The transit file can identify modes using either a one-digit or a two-digit field. The format of the transit file varies based on the width of the mode field. You identify the width of the mode field by indicating the maximum mode number (between 1 and 99). TransCAD assumes that the mode field is two digits if the maximum mode number is 10 or above, and interprets the file accordingly.

Finally, there are two formats for storing node data in a TRANPLAN transit file:

- UTPS, the default format, can have a maximum of nine nodes per line
- HUD format can have up to ten nodes per line, and requires that the maximum mode number be 9 or less

Click the appropriate radio button in the Import Network File dialog box to choose the correct format.

TRANPLAN ASCII line networks come in either one-way or two-way format. The TRANPLAN NETCARD program can export binary TRANPLAN networks into either format. You should use the two-way format to import TRANPLAN files into TransCAD. Importing from a two-way format file will eliminate all duplicate link geography, while all links that have both an AB and BA direction will be duplicated if you import from a one-way format file.

For more information, see:
To Import a TRANPLAN Highway Network
To Import a TRANPLAN Transit Network

Top

) *To Import a TRANPLAN Highway Network*

1. Choose *Planning-Import Planning Data-Import Planning Networks* to display the Import Network File dialog box.

2. Choose TRANPLAN from the Import File Type drop-down list.

3. Click Highway Links to display the File Open dialog box, choose the file containing the highway network data, and click Open.

4. Type a name for the highway layer in the Highways edit box.

5. Make a choice for the number of nodes per line in the network file as follows:

If the network file has...	Do this...
One node per line	Check the Large Coordinates box
Four nodes per line	Remove the check from the Large Coordinates box

6. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

7. Click OK. TransCAD displays the Save As dialog box.

8. Type a file name for the new geographic file and click Save.

TransCAD reads the input file, builds the geographic file, and displays it as a layer in a new map

window.

⟩ *To Import a TRANPLAN Transit Network*

1. Choose *Planning-Import Planning Data-Import Planning Networks* to display the Import Network File dialog box.

2. Choose TRANPLAN from the Import File Type drop-down list.

3. Check the Import Transit Data box.

4. Click Transit File to display the File Open dialog box, choose the file containing the transit line definitions, and click Open.

5. In the Layer to Create frame, type names for the new layers in the Highways, Transit Routes, and Transit Stops edit boxes.

6. Make a choice for the number of nodes per line in the transit file as follows:

If the transit file has...	Do this...
Nine nodes per line	Click the UTPS Format radio button
Ten nodes per line	Click the HUD Format radio button

7. Type the maximum mode number in the transit file in the Max. Mode # edit box. Any value over 9 will define the mode field as having two digits.

8. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

9. Click OK. TransCAD displays the Save As dialog box.

10. Type a file name for the highway geographic file and click Save. TransCAD displays the Save Network As dialog box.

11. Type a file name for the TransCAD network file and click Save. TransCAD displays the Save Route System As dialog box.

12. Type a file name for the route system and click Save.

TransCAD reads the input files, builds the geographic file, network, and route system, and displays them as layers in a new map window.

Importing TRIPS Network Files

TRIPS highway networks are defined by two text format files, one containing node data and the other containing link data.

For more information, see:
To Import a TRIPS Highway Network

Top

⟩ *To Import a TRIPS Highway Network*

1. Choose *Planning-Import Planning Data-Import Planning Networks* to display the Import Network File dialog box.

2. Choose TRIPS from the Import File Type drop-down list.

3. Click Highway Nodes to display the File Open dialog box, choose the file containing the node definitions, and click Open.

4. Click Highway Links to display the File Open dialog box, choose the file containing the link definitions, and click Open.

5. Type a name for the highway layer in the Highways edit box.

6. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

7. Click OK. TransCAD displays the Save As dialog box.

8. Type a file name for the new geographic file and click Save.

TransCAD reads the input files, builds the geographic file, and displays it as a layer in a new map window.

Top

Importing QRSII Network Files

A QRSII highway network is stored in a single ASCII file, which contains both node and link data.

For more information, see:
To Import a QRSII Highway Network

Top

) *To Import a QRSII Highway Network*

1. Choose **Planning-Import Planning Data-Import Planning Networks** to display the Import Network File dialog box.

2. Choose QRSII from the Import File Type drop-down list.

3. Click Highway Links to display the File Open dialog box, choose the file containing the link definitions, and click Open.

4. Type a name for the highway layer in the Highways edit box.

5. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

6. Click OK. TransCAD displays the Save As dialog box.

7. Type a file name for the new geographic file and click Save.

TransCAD reads the input files, builds the geographic file, and displays it as a layer in a new map window.

Importing TMODEL Network Files

TMODEL highway networks are defined by two text format files, one containing node data and the other containing link data. Commonly, the TMODEL nodes file has a .NDE extension and the TMODEL links file will have a .LNX or .LVX extension.

For more information, see:
To Import a TMODEL Highway Network

) *To Import a TMODEL Highway Network*

1. Choose **Planning-Import Planning Data-Import Planning Networks** to display the Import Network File dialog box.

2. Choose TMODEL from the Import File Type drop-down list.

3. Click Highway Nodes to display the File Open dialog box, choose the file containing the node definitions, and click Open.

4. Click Highway Links to display the File Open dialog box, choose the file containing the link definitions, and click Open.

5. Type a name for the highway layer in the Highways edit box.

6. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

7. Click OK. TransCAD displays the Save As dialog box.

8. Type a file name for the new geographic file and click Save.

TransCAD reads the input files, builds the geographic file, and displays it as a layer in a new map window.

Importing and Exporting EMME/2 Network Files

An EMME/2 highway network is stored in a single ASCII file, which contains both node and link data. EMME/2 transit networks are stored in two files, one that defines the nodes and links and another that defines the routes. Both highway and transit files are created in EMME/2 "batchout" files using "punch" commands. These ASCII files need to have an .in extension for TransCAD to recognize them as EMME/2 ASCII files. In addition, you should not have more than one EMME/2 .in network file in the same folder.

You can also export TransCAD line geographic files and route systems into EMME/2 batchout node, link and routes files. Since the EMME/2 batchout files contain standard attribute fields for each link, node, and route, you will need to have these attributes in the TransCAD line, node and route layers and you will need to specify these fields when you run the export procedure.

In addition, the nodes batchout file contains a special symbol for each node that is a centroid. If you want the exported node file to contain the special symbol, first create a selection set of nodes that are centroids and then specify the selection set in the export dialog box.

For more information, see:
To Import an EMME/2 Highway Network
To Import an EMME/2 Transit Network
To Export an EMME/2 Highway Network
To Export an EMME/2 Transit Network

⟩ *To Import an EMME/2 Highway Network*

1. Choose **Planning-Import Planning Data-Import EMME/2 Files** to display the Open EMME/2 Files dialog box.

2. Choose an EMME/2 file (with an .in extension), and click Open. TransCAD displays the Import EMME/2 Files dialog box, lists all of the .in files in the folder, reads their headers and determines the types of .in files from the headers.

3. Click the Network radio button.

4. Type names for the line and node layers in the Layer Name and Node Layer Name edit boxes.

5. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

6. Click OK. TransCAD displays the Save As dialog box.

7. Type a file name for the new geographic file and click Save.

TransCAD reads the input files, builds the geographic file, and displays it as a layer in a new map window.

) *To Import an EMME/2 Transit Network*

1. Choose **Planning-Import Planning Data-Import EMME/2 Files** to display the Open EMME/2 Files dialog box.

2. Choose an EMME/2 file (with an .in extension), and click Open. TransCAD displays the Import EMME/2 Files dialog box, lists all of the .in files in the folder, reads their headers and determines the types of .in files from the headers. Make sure that both the highway and transit files are in the same directory.

3. Click the Route System radio button.

4. Type names for the new layers in the Layer Name, Node Layer Name, Route System Name, and Stops Layer Name edit boxes.

5. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import Network File dialog box.

6. Click OK. TransCAD displays the Save As dialog box.

7. Type a file name for the highway geographic file and click Save. TransCAD displays the Save Network As dialog box.

8. Type a file name for the TransCAD network file and click Save. TransCAD displays the Save Route System As dialog box.

9. Type a file name for the route system and click Save.

TransCAD reads the input files, builds the geographic file, network, and route system, and displays them as layers in a new map window.

) *To Export an EMME/2 Highway Network*

1. Choose *File-Open* and open the line geographic file that you wish to export.

2. Choose *Planning-Import Planning Data-Export to EMME/2 Batchout* to display the EMME/2 Exporter dialog box

3. Choose the line layer to use from the Line Layer drop-down list.

4. Choose the fields for the highway link attributes from the Modes, Type, Lanes, VDF, UL1, UL2, and UL3 drop-down lists in the Highway Links frame.

5. If there is selection set on the node layer that represents the centroids, choose it from the Centroids drop-down list, then choose the fields for the highway node attributes from the UL1, UL2, and UL3 drop-down lists in the Highway Nodes frame.

6. To export to a coordinate system other than longitude and latitude, click Coordinates to display the Export Coordinates dialog box, choose the appropriate coordinate system, and click OK.

7. Click OK. TransCAD displays the Save Highway Network As dialog box.

8. Type an output highway file name and click Save.

TransCAD creates the highway links and nodes EMME/2 batchout file.

) *To Export an EMME/2 Transit Network*

1. Choose *File-Open* and open the route system that you wish to export.

2. Choose *Planning-Import Planning Data-Export to EMME/2 Batchout* to display the EMME/2 Exporter dialog box.

3. Choose the line layer to use from the Line Layer drop-down list.

4. Choose the fields for the highway link attributes from the Modes, Type, Lanes, VDF, UL1, UL2, and UL3 drop-down lists in the Highway Links frame.

5. If there is selection set on the node layer that represents the centroids, choose it from the Centroids drop-down list, then choose the fields for the highway node attributes from the UL1, UL2, and UL3 drop-down lists in the Highway Nodes frame.

6. Click the Transit tab to display the Transit page.

7. Check the Export Route System to Transit box.

8. Choose the route layer and selection set to export from the Route Layer and Selection drop-down lists.

9. Choose the route layer fields from Mode, VehType, Headway, Speed, Description, UT1, UT2, UT3, TTF, Dwell, and Layover drop-down lists.

10. If you want to list route nodes only at route stops, check the Use Stops box. Otherwise, the file will list route nodes at every node along the route.

11. Click OK. TransCAD displays the Save Highway Network As dialog box.

12. Type an output highway file name and click Save. TransCAD displays the Save Transit Network As dialog box.

13. Type an output transit file name and click Save.

TransCAD creates the highway and transit EMME/2 batchout files.

Top

Importing Other Planning Data

TransCAD can import data other than networks from stand-alone transportation planning packages. The other forms of data that can be imported are:

Package	Data Types That Can Be Imported
MINUTP	Binary matrices, turn penalty tables
TMODEL	Matrices
TRANPLAN	ASCII matrices, binary matrices, turn penalty tables
EMME/2	ASCII matrices, turn penalty tables, demarcations

For more information, see:
Importing Matrices
Importing Turn Penalty Tables

Top

Importing Matrices

In most cases, importing matrices from stand-alone transportation planning packages is as easy as choosing the input file and typing the name of the resulting matrix file. The matrix file can then be used with all of the TransCAD matrix handling tools.

For more information, see:

⟩ *To Import a MINUTP Binary Matrix File*

1. Choose *Planning-Import Planning Data-Import MINUTP Matrices* to display the Open a MINUTP Matrix dialog box.

2. Choose the MINUTP binary matrix file and click Open. TransCAD displays the Open a MINUTP Matrix dialog box.

3. Type a file name for the TransCAD matrix file and click Save.

TransCAD imports the MINUTP matrix file into a TransCAD matrix file.

⟩ *To Import a TMODEL Matrix File*

1. Choose *Planning-Import Planning Data-Import TMODEL Matrices* to display the Open a TMODEL Matrix dialog box.

2. Choose a TMODEL matrix file with a *.ttb, *.tti, *.tty or *.txy extension and click Open. TransCAD displays the Save As dialog box.

3. Type a file name for the TransCAD matrix file and click Save.

TransCAD imports the TMODEL matrix file into a TransCAD matrix file.

⟩ *To Import a TRANPLAN Binary Matrix File*

1. Choose *Planning-Import Planning Data-Import TRANPLAN Matrices* to display the Open a TRANPLAN Matrix dialog box.

2. Choose a TRANPLAN binary matrix file and click Open. TransCAD displays the Open a TRANPLAN Matrix dialog box.

3. Type a file name for the TransCAD matrix file and click Save.

TransCAD imports the TRANPLAN binary matrix file into a TransCAD matrix file.

Top

) To Import a TRANPLAN ASCII Matrix File

1. Choose *Planning-Import Planning Data-Import TRANPLAN Text Tables* to display the Open a TRANPLAN Table dialog box.

2. Choose a TRANPLAN text table and click Open. TransCAD displays the Open a TRANPLAN Table dialog box.

3. Type a file name for the TransCAD matrix file and click Save.

TransCAD imports the TRANPLAN text table into a TransCAD matrix file.

Top

) To Import an EMME/2 Text Matrix File

1. Make sure that the name of the EMME/2 matrix file has an .in extension.

2. Choose *Planning-Import Planning Data-Import EMME/2 Files* to display the Open EMME/2 Files dialog box.

3. Choose the EMME/2 matrix file and click Open. TransCAD displays the Import EMME/2 Files dialog box.

4. Click the Matrix radio button and click OK. TransCAD displays the Save As dialog box.

5. Type a file name for the TransCAD matrix file and click Save.

TransCAD imports the EMME/2 matrix file into a TransCAD matrix file.

Top

) To Import an EMME/2 Demarcation File

1. Make sure that the name of the EMME/2 demarcation file has an .in extension.

2. Choose **Planning-Import Planning Data-Import EMME/2 Files** to display the Open EMME/2 Files dialog box.

3. Choose the EMME/2 demarcation file and click Open. TransCAD displays the Import EMME/2 Files dialog box.

4. Click the Demarcation radio button.

5. To convert the X-Y coordinates to true geographic coordinates, click Coordinates and enter the transformation settings in the Coordinate System dialog box. Click OK to return to the Import EMME/2 Files dialog box.

6. Click OK. TransCAD displays the Save As dialog box.

7. Type a file name for the TransCAD geographic file and click Save.

TransCAD imports the EMME/2 demarcation file into a TransCAD geographic file.

Top

Importing Turn Penalty Tables

Many stand-alone transportation packages that include turn penalties define them on a node-to-node basis. In these packages, a turn penalty is defined by specifying its beginning, intermediate, and ending node IDs. Most of these stand-alone transportation packages store turn penalty data in a fixed-format text file.

TransCAD stores turn penalty data on a link ID-to-link ID basis and can convert turn penalty data that is in a node-to-node format. Once you convert the turn penalty file, you can use it directly in your network settings as a specific turn penalty file. For more information on using specific turn penalties, see "Turn Penalties" in Chapter 14, *Network Settings*, in the *TransCAD User's Guide*.

To convert turn penalty data, you need to turn the original turn penalty data file into a database format that TransCAD can read. To do this, you can either create a dictionary file for the ASCII data file or use a third-party program such as Microsoft Excel or Access to convert to a compatible database format, such as dBASE. For help in creating a dictionary file, see "About Dictionary Files" in Chapter 9, *Managing Data Tables*, in the *TransCAD User's Guide*.

For more information, see:
To Import a Turn Penalty Table

Top

〉 *To Import a Turn Penalty Table*

1. Choose *File-Open* and open the turn penalty table.

2. Choose *File-Open* and open the line geographic file with which the turn penalty table is associated.

3. Choose *Planning-Import Planning Data-Convert Turn Penalty Tables* to display the Convert Turn Penalties dialog box.

4. Make choices as follows:

To do this...	Do this...
Choose the turn penalty table	Choose a table from the Penalty Table drop-down list
Choose the from node field	Choose a field from the A Node drop-down list
Choose the intermediate node field	Choose a field from the B Node drop-down list
Choose the to node field	Choose a field from the C Node drop-down list
Choose the penalty field	Choose a field from the Penalty drop-down list, or choose None if there is no penalty

5. Click OK. TransCAD displays the Store Results In dialog box.

6. Type a file name for the new turn penalty table and click Save.

TransCAD converts the turn penalty table.

Importing U.S. Census Data

U.S. Census data are very valuable in urban transportation analysis. However, the data are often provided in a manner that makes access difficult. Your version of TransCAD may come with a large amount of U.S. Census data in Caliper geographic files, including nationwide streets and boundary files that are based on the latest versions of the TIGER/Line files. With TransCAD, you can also import all of the point, line, and area data that are stored in TIGER/Line files; for more information, see "Importing U.S. Census Bureau TIGER/Line Files" in Chapter 25, *Managing Geographic Files*, in the *TransCAD User's Guide*.

Your version of TransCAD may also include, for your choice of state, boundaries for 2000 Census summary levels and the full SF 1 (100% data) and SF 3 (sample data) tabulations. The State Data CD for the state includes boundaries for summary levels down to the Block Group and Census Block levels. The SF 1 and SF 3 Data CDs for the state include a table chooser add-in that makes it easy to find the tables you want, out of the 8113 fields in the 286 SF 1 tables and the 16,520 fields in the 813 SF 3 tables. Please see the separate documentation for an explanation of the table chooser add-ins.

In addition, TransCAD has three procedures for importing and manipulating Census data. The procedures all work with the CD-ROM discs published by the Bureau of Transportation Statistics (BTS) and the Bureau of the Census. These utilities will be updated on an ongoing basis as the Census 2000 data become available. The following discussion is based on the structure and content of the 1990 census products.

Two of the procedures are for importing data from the Census Transportation Planning Package (CTPP). CTPP is a set of special tabulations for transportation planners, based on the data collected in the 1990 Census of Population and Housing. CTPP has two components: the

Statewide Element and the Urban Element. The Statewide Element is for all states and the District of Columbia, and is organized into three types of tables: summary statistics based on place of residence (Part A), summary statistics based on place of work (Part B), and journey-to-work data based on all place of residence-place of work pairs (Part C).

The 303 Urban Elements are for regions comprising one or more counties in a metropolitan area. The Urban Element is also organized into three parts, named 1, 2, and 3, which are equivalent to Parts A, B, and C in the Statewide Element.

The CTPP data are among the most valuable datasets available for transportation planners. Included are numerous demographic measures describing the characteristics of the population, including many variables relevant for trip generation analysis. The journey-to-work matrices are usually the only reliable source of information on peak-period flows between origin and destination zones; these data are provided in sufficient modal detail to support many forms of analysis.

The first CTPP procedure lets you open these tables directly. The second CTPP procedure takes the O-D data from the journey-to-work table and converts it into a matrix file. Note that the geographic files that are provided on the CTPP CD-ROM discs can be opened directly using the **File-Open** command.

With the third census procedure you can access the Public Use Microdata Sample (PUMS). PUMS contains complete household records from the U.S. Census for a sample of the population, and is an excellent source of disaggregate data. The procedure organizes the data so that you can open PUMS files directly and view the data either by household or by individual.

Top

Opening CTPP Tables

You can easily open Census Transportation Planning Package (CTPP) tables into TransCAD from CD-ROM discs provided by the Bureau of Transportation Statistics (BTS). You can open CTPP tables from the Statewide Element:

    Part A - Characteristics of the Residence
    Part B - Characteristics of the Workplace
    Part C - Characteristics of the Journey to Work

and from the Urban Element:

    Part 1 - Characteristics of the Residence
    Part 2 - Characteristics of the Workplace
    Part 3 - Characteristics of the Journey to Work

To open CTPP tables, you must have a CD-ROM drive and either the Urban Element or the Statewide Element CD-ROM disc from BTS. The procedure is very similar to opening any other file in TransCAD, in that all you have to do is choose the file to be opened, and TransCAD opens the file. You cannot use the standard **File-Open** command, because of the special format of the CTPP files. Instead you use the **Planning-Census Utilities-Open CTPP Data Table** command to open the file directly from the CD-ROM disc.

The resulting dataview, as with any file opened from a CD-ROM disc, is read-only. Choose *File-Save As* to save the data in a table on a local hard drive or on a file server. To conserve space, before saving the data, hide any columns that you don't want to save and run queries to select only those rows of interest to you. This can all be done using commands described in Chapter 8, *Displaying and Editing Data*, and Chapter 10, *Location and Attribute Queries*, in the *TransCAD User's Guide*.

For more information, see:
To Open CTPP Data Tables
Understanding CTPP Field Names

Top

⟩ *To Open CTPP Data Tables*

1. Place the CTPP CD-ROM disc in your CD-ROM drive.

2. Choose **Planning-Census Utilities-Open CTPP Data Table** to display the Choose a Census File to Open dialog box.

3. Choose a CTPP table and click Open.

TransCAD opens the table and displays the data in read-only format.

Top

Understanding CTPP Field Names

The field names in the dataview resulting from opening a CTPP table are defined by the Census Bureau. The first set of fields defines the geography for which the data in the record apply. They are fields such as STATE, COUNTY, TAZTR, etc.

The remaining fields contain the census data and have field names such as U105_0201. These field names describe the data that are contained in the field. The generic form of the field name is:

    EPTT_XXYYZZ

Where:

E   =   The element: "U" for the Urban Element and "S" for the Statewide Element
P   =   The part of the element: "1", "2", or "3" for the Urban Element and "A", "B", or "C" for the Statewide Element
TT   =   The census table: "01" to "63"
XX   =   The coordinate in the first dimension of the table, if applicable
YY   =   The coordinate in the second dimension of the table, if applicable
ZZ   =   The coordinate in the third dimension of the table, if applicable

The CTPP data are organized in tables. Each table has either 0, 1, 2, or 3 dimensions. Here are some examples of census tables with different dimensions:

Table	# Dim	Contents	Dimensions	Example Field Name
Table 01	0	Total Persons	--	U101
Table 16	1	Mean Income	By # Workers in Household	U116_02
Table 06	2	Persons	By Sex By Age	U106_0301
Table 24	3	Persons	By Hispanic Origin By Race By Means of Transportation to Work	U124_030210

The CTPP CD-ROM discs contain text files that list the census tables, their contents and dimensions. These files can be found in the DOCS folder and they are named after the parts: ctpp_a.txt, ctpp_b.txt, and ctpp_c.txt for the Statewide Element and ctpp_1.doc, ctpp_2.doc, and ctpp_3.doc for the Urban Element.

For example, say you want data in an Urban Element on the number of households that have 3 people and 1 car. If you look in the file CTPP_1.DOC for this information, you'll see that it is in Table 17, as follows:

```
1-17. Number of cells: 45, Cell size:  9                3992    3992
Universe: Households
 HOUSEHOLD SIZE (5) by VEHICLES AVAILABLE (9) [45]
All households
                        Total, vehicles available       3992    3992    1,1
                        No vehicles                      4001    4001    1,2
                        1 vehicle                        4010    4010    1,3
                        2 vehicles                       4019    4019    1,4
                        3 vehicles                       4028    4028    1,5
                        4 vehicles                       4037    4037    1,6
                        5 vehicles                       4046    4046    1,7
                        6 vehicles                       4055    4055    1,8
                        7 or more vehicles               4064    4064    1,9
1 person in household
                        (Repeat  VEHICLES AVAILABLE) (9) 4073    4073    2,1
2 persons in household
                        (Repeat  VEHICLES AVAILABLE) (9) 4154    4154    3,1
3 persons in household
                        (Repeat  VEHICLES AVAILABLE) (9) 4235    4235    4,1
4 or more persons in household
                        (Repeat  VEHICLES AVAILABLE) (9) 4316    4316    5,1
```

The census part (1) and table number (17) are listed in the upper left corner. There are 45 different fields in this table. The right hand column lists the coordinates for each field in the table. The first coordinate is for the first dimension (household size) and the second coordinate is for the second dimension (vehicles available). The coordinate for households with 3 persons is 4, and the coordinate for households with 1 vehicle is 3. So, the field that contains the number of households with 3 persons and 1 car is U117_0403.

Creating Matrices of Journey-to-Work Data

CTPP journey-to-work data are organized such that each row in the table corresponds to travel between a single origin zone and a single destination zone. However, the data are often more useful for transportation applications in an O-D matrix form. You can transform CTPP Part 3 and Part C files into O-D matrices. In addition, the data can be easily aggregated from the base zone level (as found in the CTPP files) to larger zone levels (either Census-defined or user-defined) in the O-D matrix.

To run this procedure, you must have a CD-ROM drive and a CTPP Urban Element or Statewide Element CD-ROM disc from BTS that contains the region of interest. You must choose two files from the CTPP CD-ROM disc to run this procedure:

- A file that contains the journey-to-work data
- An area geographic file

The journey-to-work files on the CTPP Urban Element CD-ROM discs are located in a folder that has the region number as its name. Part 3 file names begin with "P3" and are followed by a region number. For example, the part 3 file for region 4480 (Los Angeles) is named p34480 and is found in the 4480 folder. The journey-to-work files on the CTPP Statewide Element CD-ROM discs are found in a folder that has the state abbreviation as its name. The part C file is named pcfile.

The area geographic file that you choose will determine the aggregation level of the data. In addition, you can select the origins and destination areas that you wish to include in the output matrix by using selection sets. The geographic files are in a subfolder named tv\database within the state or region folder on the CTPP CD-ROM discs.

For the Urban Element, any one of the following area geographic files may be used:

Area Geography	File Name
REGION	reg#_reg.dbd
MSA/CMSA	reg#_msa.dbd
PMSA	reg#_pms.dbd
STUDY AREA	reg#_sa.dbd
ZONE TAZ	reg#_taz.dbd
ZONE TRACT	reg#_tr.dbd
ZONE BLOCK GROUP	reg#_bg.dbd

where *reg#* is the region number of interest.

Each region has slightly different geographic files, so not all of those listed above will be available for a region of interest. If you want the lowest level geography for the region, open the zone geographic file. The zones for a region are either TAZs, tracts, or block groups.

For each Statewide Element (i.e., each state), there is only one geographic file that can be used with this procedure. The file has the state abbreviation as the name and the extension .dbd. This file contains several different layers, and any one of the following can be used for the procedure:

Layer Name	Description
STCO/MCD/PLACE	Places split by MCDs
STCO/PLACE	Places split by counties
STCO/MCD	Minor Civil Divisions (MCDs)
ST/PLACE	Places
COUNTY	Counties

STATE	State

As with the Urban Element, not all of these layers may be available for all states.

You may copy the geographic file (either the Statewide Element or the Urban Element) to a local hard drive or a file server, but do not change the name of the file, the column headings, or column order. You may add columns to the right of the existing columns.

For more information, see:
To Create a CTPP Journey-to-Work Matrix File
About the Journey-to-Work Matrix File
Aggregating Journey-to-Work Data
Aggregating to the CBD for the Urban Element
Aggregating Statistics on Missed Trips

Top

) *To Create a CTPP Journey-to-Work Matrix File*

1. Place the CtPP CD-ROM disc in your CD-ROM drive.

2. If you do not already have an area geographic file open, choose **File-Open** and open a geographic file in the subfolder named tv\database within the state or region folder on the CTPP CD-ROM disc.

3. Choose **Planning-Census Utilities-Create a CTPP Journey-to-Work Matrix** to display the Choose a Journey-to-Work File dialog box.

4. Locate the BTS CD-ROM disc and choose the CTPP Part C (Statewide Element) or Part 3 (Urban Element) file.

5. Click Open. TransCAD displays the Create a CTPP Journey-to-Work Matrix File dialog box.

6. Choose the area geographic file from the Geographic File drop-down list.

7. If you want the matrix to be from a selected set of zones to another selected set of zones, choose these selection sets from the Origin and Destination drop-down lists.

8. Choose the tables that you want to include by checking any of the Table boxes in the Data Tables frame.

9. Choose whether you want the data to be reported for the whole day, just the peak period, or both by checking the appropriate boxes in the Time Periods frame.

10. If you have chosen any of the tables that are reported by mode (Tables 1, 6, and 7), then highlight the modes for which you want the data reported in the Modes scroll list.

11. Click OK. TransCAD displays the Save As dialog box.

12. Type the file name for the output matrix and click Save.

TransCAD creates an O-D matrix file containing the journey-to-work data.

About the Journey-to-Work Matrix File

The row and column headings of the matrix file are taken from the ID field of the area geography that you chose. Use the **Matrix-Labels** command to label the matrix with the Census ID in the CODE field; for more information, see "Labeling the Rows and Columns" in Chapter 18, *Working with Matrices* in the *TransCAD User's Guide.*

Each matrix of the journey-to-work matrix file holds one variable. Choose the matrix to view from the drop-down list on the toolbar. Each matrix will have a name in the form:

> *epaa_bbcc*

where:

- *e* = The element ("U" for Urban Element or "S" for Statewide Element)
- *p* = The part ("3" for Urban Element or "C" for Statewide Element)
- *aa* = The table ("01" through "07")
- *bb* = The time period ("01" for all-day, "02" for peak-period)
- *cc* = The mode, if applicable:
  - 01 = Total commuters
  - 02 = Drove alone
  - 03 = 2-person carpool
  - 04 = 3-person carpool
  - 05 = 4-person carpool
  - 06 = 5-person carpool
  - 07 = 6-person carpool
  - 08 = 7 to 9-person carpool
  - 09 = 10+-person carpool
  - 10 = Bus or trolley bus
  - 11 = Streetcar or trolley car
  - 12 = Subway or elevated
  - 13 = Railroad
  - 14 = Ferryboat
  - 15 = taxicab
  - 16 = Motorcycle
  - 17 = Bicycle
  - 18 = Walked
  - 19 = Other

Aggregating Journey-to-Work Data

When you import CTPP journey-to-work data to an O-D matrix file, you can also aggregate the data

to larger zones that are groups of base zones. To do this, you need a field in the base zone layer (chosen in the Geographic File drop-down list) that contains the IDs of the aggregate zones. Each set of zones that you want to aggregate to a single zone will have the same ID. All steps are then the same as shown above, except that you choose this aggregate zone ID field from the Aggregate To drop-down lists. Note that you can aggregate the origins and destinations to different groups of zones.

Census Aggregations for the Urban Element

For the Urban Element, there are certain Census geographic zones to which you may wish to aggregate. The CODE field in the geographic layer makes this easy to do. No census aggregations are possible from the Region, MSA/CMSA, PMSA, Study Area, or TAZ layers. However, the Zone Tract layer and the Zone Block Group layer both offer several geographic aggregations.

The CODE field for the Zone Tract layer is made up of the following concatenation of subcodes (with number of characters in parentheses):

REGION(4) + STATE(3) + COUNTY(3) + MCD(3) + PLACE(4) + TRACT(6)

You can aggregate to:

Tracts	(AGG_ID=STATE+COUNTY+ TRACT)
Places	(AGG_ID=STATE+PLACE)
MCDs	(AGG_ID=STATE+COUNTY+MCD)
Counties	(AGG_ID=STATE+COUNTY)

The CODE field for the Zone Block Group layer is:

REGION(4*) + STATE(3) + COUNTY(3) + MCD(3) + PLACE(4) + TRACT(6) + BG(1)
(* Regions 34 and 09 only have 2 character IDs)

And you can aggregate to the same levels as tracts, plus:

Block Groups   (AGG_ID=STATE+COUNTY+ TRACT +BG)

To aggregate to any of these levels, use the ***Dataview-Formula Fields*** command to create a formula field in the chosen geographic layer that contains the AGG_ID listed in parentheses. The Substring() function can be used to isolate the different subcodes the CODE field. To use the function, you need to know the starting character position and length of each subcode, as follows:

Subcode	Start	Length
Region	1	4
State	5	3
County	8	3
MCD	11	3
Place	14	4
Tract	18	6
Block Group	24	1

For example, if you are using the Zone Tract layer and you want to aggregate to the place level, choose ***Dataview-Formula Fields*** and enter the following in the Formula text box:

S2I(Substring(CODE,5,3) + Substring(CODE,14,4))

The S2I() function turns the character string into an integer number. You can then choose this formula field in the Create a CTPP Journey-to-Work Matrix File dialog box from both Aggregate To drop-down lists. The resulting O-D matrix file will be from place to place instead of from zone tract to zone tract.

Aggregating to the CBD for the Urban Element

Some Urban Element regions have areas defined as Central Business Districts (CBDs). If CBDs exist for the region of interest, then CBD will be listed as an option in the Destinations drop-down list and you can choose it as the destination zone level. If the CBD is not defined for the region, then the CBD destination option will not be available.

Aggregating Statistics on Missed Trips

Some trips may not be reported because either the origin or the destination is out of the origin or destination selection set, respectively, or out of the region. You can include an origin row and a destination column in the matrices that include these missed trips.

For more information, see:
To Aggregate Statistics on Missed Trips

⟩ *To Aggregate Statistics on Missed Trips*

1. Do Steps 1-10 of the procedure To Create a CTPP Journey-to-Work Matrix File.

2. Click Options to display the Options dialog box.

3. Click the **Include a matrix row & column for regional trips that are not from Origin Set to Destination Set** box.

4. Click OK to return to the Create a CTPP Journey-to-Work Matrix File dialog box.

5. Continue with Step 11 of the procedure To Create a CTPP Journey-to-Work Matrix File.

Each matrix in the matrix file will have an extra row labeled "-1" and an extra column labeled "-1" that includes statistics on the missed trips.

Opening PUMS Data Tables

Public Use Microdata Sample (PUMS) data contain complete household records from the U.S. Census of Population and Housing for 1% to 5% of the population, depending on the type of sample. This is an excellent source of disaggregate data that you can use for transportation analysis.

The PUMS data are available on CD-ROM discs from the U.S. Bureau of the Census. The data are organized by state: the last two characters of each PUMS file name represent the state abbreviation.

PUMS data files have two different types of records: housing units and persons. These records are interspersed throughout the PUMS data file: each household record is followed by a record for each person in the household. The two types of records each have their own dictionary file, which is a file that tells TransCAD where to look in the data file for the different fields of data. Thus, a special procedure is required to view the data.

To view the data in TransCAD, you specify the location of the PUMS data file, and choose whether to view household records only, person records only, or both types of records. If you choose to view both types of records, the resulting dataview contains one record per person, which contains both the household data and the individual data for that person.

The dataview that results from using this procedure displays a temporary file, which will be lost once the dataview is closed. To save the PUMS data, use the *File-Save As* command, and save it as a dBASE, fixed-format text, fixed-format binary, or comma-delimited text file; saving it as a dataview will not save the data. Before saving the data, to conserve space on your local hard drive or file server, change the dataview to display only the desired columns and rows. For example, you will probably want to select records from certain PUMs areas (PUMAs) within the state. For more information on hiding columns see Chapter 8, *Displaying and Editing Data*, and more information on making selections see Chapter 10, *Location and Attribute Queries,* in the *TransCAD User's Guide.*

For more information, see:
To Open a PUMS Data Table

Top

⟩ To Open a PUMS Data Table

1. Place the PUMS Data CD-ROM disc in your CD-ROM drive.

2. Choose *Planning-Census Utilities-Open PUMS Data Table* to display the Choose a PUMS File to Open dialog box.

3. Choose the CD-ROM drive and the PUMS file of interest. Click OK to display the Open PUMS Data Table dialog box.

4. Choose the type of records to view by checking the Household Records box, the Person Records box, or both boxes.

5.   Click OK.

TransCAD opens a dataview of the specified records.

Viewing Travel Patterns Reported in Surveys

It is often useful to be able to visualize the travel and activity patterns that are either reported in a household travel and activity survey or forecasted using a disaggregate model system. Visualization allows you to uncover errors in the data as well as obtain a better sense of the travel and activity that are occurring in the region. This section describes the tools used to visualize such data and create maps such as one that displays the travel and activity patterns reported by two people in a two-person household on the day of the survey.

Creating maps such as these involves two key steps. First, create a geographic file of the travel reported in the survey, and second, use TransCAD's Travel Geography Viewer to view individual and household travel patterns. These steps are described below after the general format of the survey data is described.

For more information, see:
Household Travel and Activity Surveys
Creating Travel Geography
Hints for Proper Setup for Creating Travel Geography
Viewing Individual Travel Patterns
Hints for Proper Setup of Viewing Individual Travel Patterns

Household Travel and Activity Surveys

The tools described here assume that the data are in the standard format of household travel and activity surveys. Such surveys aim to collect household socioeconomic and travel information. Socioeconomic data are collected both at the household level (for example, income, number of people, and relationships among members of the household) and at the person level (for example gender and employment status). In addition, people in the survey are asked to record their travel and activity patterns for one or more days, including when they traveled, where they traveled, why they traveled (that is, the purpose of the activity), and how they traveled there (what mode). These responses are typically processed into databases at the various levels of data collection, for example into a household file, which contains the household data for everyone in the survey; a person file, which contains the person data; and an activity file, which contains the travel and activity data. Examples of such files are shown below. Depending on the survey, there may also be other databases such as a vehicle database or location databases.

The tools described here assume that the data is in the standard format of household travel and activity surveys. Such surveys aim to collect household socioeconomic and travel information.

Socioeconomic data are collected both at the household level (for example, income, number of people, and relationships among members of the household) and at the person level (for example gender and employment status). In addition, each person in the survey is asked to record their travel and activity patterns for one or more days, including when they traveled, where they traveled, why they traveled (that is, the purpose of the activity), and how they traveled there (what mode). These responses are typically processed into databases at the various levels of data collection, for example into a household file, which contains the household data for everyone in the survey; a person file, which contains the person data; and an activity file, which contains the travel and activity data. Depending on the survey, there may also be other databases such as a vehicle database or location databases.

In addition to the tools described below to visualize the travel patterns of individuals, TransCAD has numerous tools in the standard interface to aid in processing such activity surveys, for example **Dataview-Join** (to link information across the different household, person, and activity tables), **Dataview-Statistics** (to generate summary statistics of the data), and **Tools-Locate** (to locate households and activities on a map).

Top

Creating Travel Geography

To visualize travel and activity patterns, a geographic layer must be created from the survey databases. This is done using TransCAD's Route System geographic file type. (See Chapter 16, *Route Systems*, of the *TransCAD User's Guide* for detailed information on route systems and their associated procedures.) A route is a series of line segments that has at least one common attribute. In the case of a travel survey, this common attribute is, for example, the identification number of a person. The series of line segments would then represent the travel that the person reported in the survey. In the case of a multi-day survey, the travel reported by people could translate into multiple "routes," one for each day they reported in the survey. Route systems can also include stop information, which contains data on the activity stops that people reported in the survey (such as the purpose of the activity).

If you have a travel survey with located (or locatable) activity locations and a transportation geographic file, then you can create a route system of travel patterns reported in the travel survey. The required inputs are:

- A line layer, which represents the transportation system
- A network created from the line layer.
- The travel activity database that provides for each person a list of locations that the person visited, with one record per person-activity

The travel patterns that are created in the route system consist of the shortest paths between reported activity locations. The line layer and its associated network are used to find these shortest paths. The shortest path can be based on any cost field contained in the line network, such as length, free-flow travel time, or congested travel time. TransCAD automatically uses the active network and any settings that you have specified using the Network Settings dialog box. For more information on creating networks from line layers and network settings, see Chapter 13, *Networks and Shortest Paths* and Chapter 14, *Network Settings*, in the *TransCAD User's Guide.*

The survey data typically include location data in a form such as addresses, X-Y coordinates, or longitudes and latitudes. Before creating the travel geography, each location reported in the survey

needs to be associated with the ID of the nearest node in the line layer. That is, there must be a field in the travel activity database that provides the location of each activity in terms of a node ID, which must match the node IDs in the line layer. There are many tools in TransCAD that can help associate each location in the original survey with the closest node ID. The first step is to use the location data provided in the survey to create a point geographic layer of the activity locations. See Chapter 12, *Locating Your Data on a Map*, in the *TransCAD User's Guide*, to learn more about creating the activity geographic file. Once you have created a geographic layer of the activities, then each activity location can be mapped to the nearest node in the geographic line file. This is done using the Tag option of the **Edit-Fill** command.

For more information, see:
To Add Node IDs to the Activity Point Layer

In addition to the node ID field, the travel activity database must also contain an integer identification field that determines which sequence of activities is to be linked together in a single route. For example, a field that contains a unique person identification number will result in one route being generated for each person in the database. The database must be ordered by person and activity number (first activity first, second activity second, etc.). If this is not the natural order of the database, then sort the dataview (**Dataview-Sort…**), export the sorted dataview (**File-Save As…**) to a .bin or .dbf file, and open and use this exported dataview when creating the travel geography.

The travel activity database can also contain fields that tell TransCAD whether to create an activity stop at a node location (a field that contains a 1 to include a stop at that location, and a 0 otherwise), and what user ID to assign to that stop (typically a field with a unique number for each record in the travel activity database). In addition, the database can obtain other information about the activities (such as purpose), which will be maintained in the resulting stop layer of the route system.

To show these travel patterns on a map, you create a network of streets that covers the area the persons traveled, then create a route system using the **Route Systems-Utilities-Create from Table** command.

For more information, see:
To Create Travel Geography from a Travel and Activity Survey

The route system consists of two layers: one of the travel patterns, and a point layer of activity stops. For a typical travel survey, this will include hundreds or thousands of routes (one route per person), and even more stops (one point per person-activity). The Travel Geography Viewer can be used to scroll through the database viewing one person (or household) at a time.

If errors were generated in creating the route system, TransCAD also produces and opens a log file. "Not enough nodes to create route #" and "Invalid route specification for route #" are reported for persons who have only 1 or fewer valid activity node IDs in their travel pattern (for example, those with only 1 activity record, those with missing node IDs, or those with multiple activities but all taking place at the same node). Node IDs that are not found in the network or are not connected in the network will also be reported.

Top

⟩ *To Add Node IDs to the Activity Point Layer*

1. Open a map that contains both the activity point layer and the transportation line layer.

2. Make the activity point layer the working layer, and click New Dataview 🖾 to view its associated data.

3. Use *Dataview-Modify Table* to add a new integer field to the table.

4. Highlight the new field in the dataview and choose *Edit-Fill* to open the Fill dialog box.

5. Click the Tag radio button and choose to tag each record with ID from the Node geographic layer.

6. Click OK.

TransCAD enters the ID of the node closest to each of the activity points in the highlighted field.

) *To Create Travel Geography from a Travel and Activity Survey*

1. If you have not already done so:

   - Open the line layer on which the travel geography will be based
   - Create a network from the line layer
   - Open the table that contains the travel survey information (this table must be processed as described above)

2. Click on the map window or choose it from the Windows menu.

3. Choose *Route Systems-Utilities-Create from Table* to display the Create Route System from a Table dialog box. (If the Route Systems menu is not displayed, choose it from the Procedures menu.)

4. Choose the settings according to the following table:

Dialog Box Item	How to use it
Cost Field	Choose the network field used to find the shortest path.
Network	Click to display the Network Settings dialog box, and change the network settings.
Table	Choose the table that contains the travel pattern information.
Route Number	Choose the field that contains the person number. One route will be created for each unique value in this field.
Node ID	Choose the field that contains the location of each activity in terms of the node IDs from the line layer.
Include Stops in Route System	Check to have stops in the route system that correspond to some of the activity locations. (For travel geography, this is usually checked.)
Stop Flag	Choose the field that contains the stop flags (equal to "1" to include a stop at that node and "0" otherwise).
User ID	Choose the field that contains the user IDs for the stops.
Skims	To skim networks, click to display the Network Skim Settings dialog box (see "Skimming Paths" in Chapter 16, *Route Systems,* of the *TransCAD*

5. Click OK. TransCAD displays the Save Route System As dialog box.

6. Type a name for the route system and click OK.

TransCAD creates a new route system from the table and displays the route system on top of the line layer.

Hints for Proper Setup for Creating Travel Geography

*   Routes depicting activity patterns are usually cyclic, since people are very likely to return to their home or origin later in the day. However, should you notice that the resulting travel patterns do not look cyclic or they appear to be too simple for a day travel pattern, this is probably an indication that the table from which the route system was created is *not sorted* by person and activity number. In order for the above procedure to successfully generate each person's travel activity pattern, it is incumbent that <u>the natural order</u> of the table from which the route system is created be sorted so that all entries for a particular person (or route) are grouped together in successive records in the table and that the activities for each person are listed in the order in which they occurred on the diary day. Furthermore, note that simply sorting the dataview (using ***Dataview-Sort***) by Route ID and then by Activity ID does not achieve the objective of changing the natural order of the underlying data table. You can view the natural order of the table either by opening the table fresh or by choosing ***Dataview-Sort*** and then sorting by ***Natural order***. If the natural order of the table is not sorted by person and activity, then it is necessary to do the following: first sort the dataview as required (***Dataview-Sort)***, second export the sorted dataview to a .bin or a .dbf file using ***File-Save As***, third close the existing dataview, and fourth open the newly created .bin or.dbf file. The new file can be then used to create the route system.

*   The route system used with the ***Route Systems-Utilities-Create from Table command*** cannot be created from a table that is part of a joined view. In case it is necessary to use such a joined view to create the route system, then this joined view has to be exported to a .bin or a .dbf format using the ***File-Save As*** command and this .bin or .dbf file has to be opened fresh and used to create the route system.

*   The route system is created such that a route is created for people depicting their activity pattern. Therefore each person has to be assigned a unique ID that will be used as the Route ID when the route system is created. Often, travel activity surveys have a unique ID for every household (Household ID) and list the persons in a particular household by 1, 2, 3 and so on (Person ID). In this case, a unique person ID field must be created. To do so, use the ***Dataview-Modify Table*** command to add a new field to the table. Then highlight this field, choose ***Edit-Fill*** and fill the field with a formula such as *100*[Household ID] + [Person ID]* to create the unique person IDs.

*   In order to map the travel and activity locations of travelers as a route, it is necessary that the activity locations are associated with nodes in the line layer and associated network file. Therefore for the route system to be generated, it is necessary that the table from which the route system is created has an extra field, which contains the node ID that is nearest to where each activity took place. These node IDs can be created in the survey table by means of the Tagg option of the ***Edit-Fill*** command as described in To Add Node IDs to the Activity Point

Viewing Individual Travel Patterns

Once you have created a travel geography database, you can use TransCAD's Travel Geography Viewer to scroll through the travel patterns in the database. The travel geography database was described above; it is a route system (.rts) file in which each travel pattern (for example, each person's travel) is represented by a route in the route layer, and activities are represented by points in a stops layer. Such a file can be created from a travel survey and a road network as described above. With such a geographic file, the Travel Geography Viewer allows you to view travel patterns person-by-person, household-by-household, or by any attribute in the database.

The Travel Geography Viewer is a TransCAD toolbox. You launch the toolbox by choosing *Planning-Planning Utilities-Travel Geography Viewer*. The toolbox allows you to enter a criterion for selecting the travel patterns that you wish to view. For example, you can view the travel pattern for an individual by entering the field that contains unique person IDs and the ID of the individual. Alternatively, you can view the travel patterns for all of the individuals within a particular household by entering the field that contains unique household IDs and the ID of the household. The toolbox also provides buttons to scroll through the records in the database.

For more information, see:
To View Individual or Groups of Travel Patterns

⟩ *To View Individual or Groups of Travel Patterns*

1. Open the route system that contains the travel patterns, and make sure it is the working layer in the current map.

2. Choose *Planning-Planning Utilities-Travel Geography Viewer* to display the Travel Geography Viewer toolbox.

3. Choose the field and enter the field value to be used to select the travel patterns that are displayed.

4. To display all of the travel patterns for which the chosen field equals the entered value, click ▦. TransCAD will create a selection set of the associated routes and stops, and display only these selected features in the map.

5. To display the next or previous travel pattern in the database, click ◀◀ or ▶▶. (These buttons can also be used to find a valid value for a chosen field; click them at any time to find and display a travel pattern based on the chosen field.)

6. Click the Style button and choose one or more style options as follows:

Option	What it does
Zoom to fit	Recenters and rescales the map around the selected travel patterns.
Use default styles	Uses a set of default styles, which are:
	- to display the paths with width 5, topology arrowheads, and offset to the right/left of centerline, and
	- to display the stops with size 18.
	When unchecked, the styles will revert to those in the original map.

Click OK when you are finished.

To further customize the display, use the standard TransCAD features such as the toolbar buttons Theme , Style , Label , and Map Layer .

All information used to select, style, or label the routes or stops must be a part of (or joined to) the route or stop layer. Use Join Dataviews and Formula Fields to prepare these fields.

Top

Hints for Proper Setup of Viewing Individual Travel Patterns

- In order to label the travel patterns displayed by the Travel Geography Viewer with data on activities or persons, it is necessary that any attributes you wish to display are either included in or joined to the route stops or the route system layer. A typical join is to use the unique person ID to join the route system layer to either the person file (which may contain information such as gender and age) or the household file (which may contain information such as household income) from the activity survey. You can save these joins by saving all open windows and settings as a workspace (*File-Save Workspace*), so that the joins to display route/stop information need not be created each time.

- In the Travel Geography Viewer toolbox, the field used to select the travel patterns by default is the Route ID. However, if one desires to view travel patterns by households for instance, it is necessary to incorporate the Household ID field in the route system dataview. Again, this is achieved by means of joins. In this example, a join of the route system dataview table with the household database can be performed so that travel patterns may be viewed based on the Household ID. As in the previous discussion, using workspaces to save the joins for future use is recommended. Further, only integer fields can be used to select the travel patterns to view via the Travel Geography Viewer.

Top

Batch Mode

TransCAD provides facilities for building integrated model applications, creating custom user

interfaces for planning models, and running models without user intervention (i.e., in batch mode). In addition to running models interactively, TransCAD provides great flexibility in building complete model applications, with attractive user interfaces that are easy to learn and use.

This chapter also provides information on building custom applications that utilize travel demand model procedures. To know how to program TransCAD applications, you will need to learn about GISDK, the GIS Developer's Kit that is a comprehensive programming environment included with TransCAD. GISDK contains all of the tools you need to create macros, build add-ins, or create custom applications. This chapter supplements the GISDK documentation that you will find in the on-line help for TransCAD.

For more information, see:

Top

Running Planning Models

There are several ways to run a planning model in TransCAD:

- The model can be run interactively. A detailed guide can lead the user to run the individual TransCAD procedures in the necessary order. All procedures would be run using the standard TransCAD interface.
- A GISDK script could be written to run some or all of the TransCAD procedures that would normally be invoked interactively.
- The model could consist of a mix of interactive and GISDK-produced procedures and links with external programs.

There are several advantages to creating a GISDK program that runs some or all of your various planning procedures:

- The model will be faster since it does not require the additional time necessary for interactive setup.
- Human error will be reduced
- Model and file management will be easier

An easy way to create the GISDK script necessary to run planning procedures is to use the Batch Mode tools. The tools are like a background recorder that allows you to "capture" all the input and output files, parameters and settings associated with a planning procedure. You first turn on the Batch Recorder and make it active. Then, you set up and run planning procedures like you normally would interactively. In this mode, in addition to running the procedure, you would create GISDK script. Then, if you compile and run the script file, the same procedure would be run in batch.

The GISDK script that is created using the Batch Mode tools is fully compatible with the full functionality of GISDK. Thus, you can add all of the GISDK capabilities to your batch-created GISDK script to produce an unlimited amount of applications. Some of the planning applications that can be created are:

- Putting the batch script inside a loop to run the procedures over and over again. Each iteration would have differing input and output files, settings or parameters. Thus, you can run many scenarios in one script file.
- Adding interactive buttons and other dialog box items to your batch script. With just a click of a button, you can run parts of your model or your entire model.
- Adding a scenario management tool that keeps track of inputs, outputs and parameters for each scenario. You can interactive change scenarios and all files and parameters can be saved to a file for later retrieval.

Top

Batch Mode Tools

You can run travel demand models automatically by calling the procedures from a resource file that has been compiled into a UI database. The Batch Mode tools help you write the resource file, by:

- Capturing the settings that you choose in travel demand-related dialog boxes
- Queuing a call to each procedure or command that is to be added to the resource file
- Creating empty output files that can be used as inputs to the next step in the planning process
- Pausing so that you can run procedures normally, then return to writing the resource file
- Saving the queued resources into a resource file
- Letting you edit the resource file to add flow control, calls to GISDK functions or macros, etc.
- Compiling the resource file so that it can be run as an add-in

The following commands can be queued with the Batch Mode Tools:

- ***Planning-Trip Productions-Cross-Classification***
- ***Planning-Quick Response Method***
- ***Planning-Trip Productions-Quick Response***
- ***Planning-Trip Attractions-Quick Response***
- ***Planning-Trip Attractions-ITE Attraction Rate***
- ***Planning-Balance***
- ***Network-Multiple Paths***
- ***Planning-Planning Utilities-Intrazonal Travel Times***
- ***Planning-Trip Distribution-Gravity Evaluation***
- ***Planning-Mode Split-Multinomial Logit Evaluation***
- ***Planning-PA to OD***
- ***Planning-Traffic Assignment***
- ***Planning-Advanced Assignment-Multi-Modal Multi-Class Assignment***
- ***Planning-Advanced Assignment-HOV***
- ***Transit-Multiple Paths***
- ***Transit-Transit Assignment***
- ***Dataview-Join***
- ***Matrix-Indexes,*** Add Matrix Index button
- ***Planning-Batch Editing-Calculate Gap***

- ***Planning-Batch Editing-Update Network Field***
-

In addition, the Nested Logit Model procedure can be called with the Batch Mode Tools.

Creating a Batch Mode Resource File

The Batch Mode toolbox has seven buttons that are used in creating a Batch Mode resource file:

Button	What it does
	Starts the Batch Recorder
	Stops the Batch Recorder
	Pauses the Batch Recorder
	Displays the Batch Editor toolbox
	Enables performing a dry run or a full run
	Compiles the batch script to a UI database
	Changes the scenario settings

When you start the Batch Recorder, any commands that can be queued are added to the Batch Contents. When you pause the Batch Recorder, none of the commands that can be queued are added to the Batch Contents until you start recording again.

When the Batch Recorder is operating, you can choose whether to:

- Just record the command settings
- Do a dry run of the command by creating empty output files
- Do a full run of the command to create actual output files

A dry run is useful when you want to have the outputs of one procedure be the inputs to additional procedures. When you click , the radio list in the toolbox is enabled, so you can choose between a dry run or a full run. When you click again, the radio list is disabled and the Batch Recorder will just record the command settings.

If you want TransCAD to perform the normal post-processing steps while in batch mode (e.g. joining tables or creating themes) check the Do Post Process box. Remove the check to omit these steps.

For many of the procedures, TransCAD will suppress some of the global procedure parameters in the batch script and use default values instead, in order to make the script easier to read. Check the List All Globals box to force TransCAD to list all global parameters in the output batch script.

You can change the default prefix that is appended to each output file, or change the default output

file folder, by clicking ![A] and entering the new settings.

For more information, see:
To Create a Batch Mode Resource File

Top

) *To Create a Batch Mode Resource File*

1. Choose *Planning-Batch Editing-Batch Tools* to display the Batch Mode toolbox.

2. Click ![button] to start the Batch Recorder. TransCAD is ready to queue procedures.

3. If you want to do a dry run or a full run of a command that can be queued, click ![button]. TransCAD enables the radio list. Make a choice as follows:

To do this...	Do this...
A dry run	Click the Dry Run button. TransCAD creates empty output files, to use as input to additional procedures, but will not actually perform the calculations.
A full run	Click the Full Run button. TransCAD runs the procedures and creates actual output files.

   To return to just recording settings, click ![button] again. TransCAD disables the radio list.

4. Choose a command that can be queued with the Batch Mode Tools, make the appropriate settings, and click Queue (which has taken the place of the OK button). TransCAD queues the procedure to the resource file.

5. If you want to pause recording, click ![button]. The button stays depressed. TransCAD lets you use the procedures normally.

   If you have paused recording, click ![button] to resume the Batch Recorder. The button is no longer depressed. TransCAD is ready to queue additional procedures.

6. Return to Step 3 to add queue additional procedures until the travel demand model is complete.

7. Click ![button]. TransCAD stops the Batch Recorder. If you have changed the Batch Contents, TransCAD displays a confirm message.

To do this...	Do this...
Save the Batch Contents	Click Yes. TransCAD displays the Save Batch File As dialog box. Type a file name and click Save. TransCAD saves the Batch Contents into the resource file.
Continue using the Batch Mode Tools	Click Cancel. TransCAD will continue to queue procedures. Return to step 3.
Empty the Batch Contents	Click No. You can return to step 2 to start recording again.

8. Choose *Planning-Batch Editing-Batch Tools* or click the close button in the upper-right corner of the toolbox.

If you have not saved the Batch Contents, TransCAD displays a confirm message.

To do this...	Do this...
Save the Batch Contents	Click Yes. TransCAD displays the Save Batch File As dialog box. Type a file name and click Save. TransCAD saves the Batch Contents into the resource file.
Continue using the Batch Mode Tools	Click Cancel. TransCAD will continue to queue procedures. Return to step 3.
Empty the Batch Contents	Click No.

TransCAD closes the toolbox. You will now be able to use the procedures normally.

Top

Editing a Batch Mode Resource File

The queued procedures provide the basic steps for a travel demand model. The Batch Editor lets you examine and edit the Batch Mode resource file. You can:

- Load a Batch Mode resource file
- Add new steps
- Copy, rename, and delete existing steps
- Rearrange steps
- Choose among frequently-used support functions
- Save the edited Batch Mode resource file

A Batch Array file is created when you save a Batch Mode resource file. It has the same filename plus the extension .arr, and contains information about the steps in the Batch Mode resource file. When you load the Batch Array file, the Batch Mode resource file is loaded as well. If you edit the Batch Mode resource file outside the Batch Editor, the Batch Array file may no longer be correct and you may not be able to load the Batch Mode resource file into the Batch Editor.

For more information, see:
To Edit a Batch Mode Resource File

Top

⟩ To Edit a Batch Mode Resource File

1. Choose **Planning-Batch Editing-Batch Tools** to display the Batch Mode toolbox.

2. Click ⊡. TransCAD displays the Batch Editor toolbox.

3. Make edits as follows:

To do this...	Do this...
Load a Batch Mode resource file	Click Load. TransCAD displays the Open a Batch Array File dialog box.

	Choose a Batch Array file and click Open. TransCAD shows the first step in the text box.
Choose a step	Highlight the step in the scroll list.
Rename the step	Edit the name in the Step Name text box.
Rearrange the step	Click Move Up or Move Down. TransCAD moves the step and renumbers the steps in the scroll list.
Copy the step	Click Copy. TransCAD makes an exact copy and adds it after the original. You should rename the copy to distinguish it from the original.
Delete the step	Click Delete. TransCAD removes the step and renumbers the remaining steps.
Add a new step	Click Add. TransCAD adds a new step and names it based on its current step number.
Edit a step	Click in the text box and make the changes. You can move around the text box with the standard key combinations: PgDn and PgUp to move to the next or previous page, Ctrl-Home and Ctrl-End to move to the top or bottom line, etc.
Add a function	Click Choose a Macro. TransCAD displays the Choose a Macro dialog box. Choose a macro from the scroll list. You can change the text in the Syntax text box before you click OK. TransCAD pastes the text in the Syntax text box into the step.
Save the Batch Contents	Click Save. TransCAD displays the Save Batch File As dialog box. Type a file name and click Save. TransCAD saves the Batch Contents into the Batch Mode resource file.

4. Click the close button in the upper-right corner of the Batch Editor toolbox. TransCAD closes the toolbox and returns to the Batch Mode toolbox. The Batch Contents are preserved even if you have not clicked Save, so you can return to step 2 to resume editing the Batch Contents.

5. Choose *Planning-Batch Editing-Batch Tools* or click the close button in the upper-right corner of the Batch Mode toolbox.

6. If you have changed the Batch Contents, TransCAD displays a confirm message.

To do this...	Do this...
Save the Batch Contents	Click Yes. TransCAD displays the Save Batch File As dialog box. Type a file name and click Save. TransCAD saves the Batch Contents into the resource file.
Continue using the Batch Mode Tools	Click Cancel.
Empty the Batch Contents	Click No.

TransCAD closes the Batch Mode toolbox.

Top

Compiling a Batch Mode Resource File

You must compile the Batch Contents into a UI database so that you can run the travel demand model as an add-in. See the GISDK On-Line Help for information on creating a new add-in.

For more information, see:
To Compile a Batch Mode Resource File

Top

) *To Compile a Batch Mode Resource File*

1. Choose **Planning-Batch Editing-Batch Tools** to display the Batch Mode toolbox.

2. If there are no Batch Contents, use one of the following methods:

To do this...	Do this...
Create new Batch Contents	First do the procedure "To Create a Batch Mode Resource File," then return to this procedure
Load an existing Batch Mode resource file	Click [icon] to display the Batch Mode toolbox, click Load to display the Open Batch Array File dialog box, choose a Batch Array file, and click Open

3. Click [icon] in the Batch Mode Toolbox. TransCAD displays the Save As dialog box. Accept the default filename batch_ui.dbd as the UI database name or type another file name, then click Save. TransCAD compiles the Batch Contents into the UI database.

4. Choose **Planning-Batch Editing-Batch Tools** or click the close button in the upper-right corner of the toolbox.

   If you have changed the Batch Contents, TransCAD displays a confirm message.

To do this...	Do this...
Save the Batch Contents	Click Yes. TransCAD displays the Save Batch File As dialog box. Type a file name and click Save. TransCAD saves the Batch Contents into the resource file.
Continue using the Batch Mode Tools	Click Cancel. You may continue to use the toolbox.
Empty the Batch Contents	Click No.

TransCAD closes the Batch Mode toolbox.

Calling Procedures in Batch Mode

This section contains descriptions of the procedures available in batch mode. The inputs and parameters to these procedures are passed as arrays of options. The structure of the options array is similar to a multi-level GISDK options array. The first level of the array has option groups. Each option group contains the following option pairs:

Name	Contents
Input	Option pairs for database-related arguments
Global	Option pairs for string and numerical variables
Field	Option pairs for network fields and view columns
Flag	Option pairs for logical variables
Output	Option pairs for definition of procedure outputs

Each option pair represents an argument group. Each argument group is an options array in itself,

whose first element corresponds to the argument name and second element corresponds to the value being passed.

In many cases, the arguments being passed consist of multiple values. In these cases, the options array may itself contain additional arrays.

For more information, see:

General Notes on Batch Script Nomenclature

When you run procedures in TransCAD, you normally need to open all the input files first before you run the procedure. When you compile and run a batch script, however, usually none of the files need to be opened before running the script. The batch mode interpreter will be able to open all necessary files and recreate the necessary settings in order to run the procedure. Because of this feature, inputs are in the form of actual file names. If the inputs included a joined view or selection set, information on the two datasets used for the joined view or query used to create the selection set needs to be added as well.

The descriptions of how to call procedures in Batch Mode show the simplest format normally used for indicating input tables or geographic files for each procedure. You can use the appropriate format when input involves selection sets and/or joined views.

The following table describes some general input formats for describing table names, geographic

files, matrices, selection sets, and joined views:

Option Group	Option	Type	Contents			
Input	Options with the word "Set" or "View" in them describing input tables or geographic files	Table	An array of two strings:			
			1	String	The path and file name of the table	
			2	String	The name of the table	
		Geographic file	An array of two strings:			
			1	String	The path and file name of the geographic file, followed by a vertical bar "|" and then the layer name	
			2	String	The name of the layer	
		Table or geographic file using a selection set	An array of four strings:			
			1	String	The path and file name of the table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name.	
			2	String	The name of the table or layer	
			3	String	Selection set name	
			4	String	Query used to create the selection set	
		Table or geographic file with a joined view	An array of five strings			
			1	String	The path and file name of the first table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name.	
			2	String	The path and file name of the second table or geographic file	
			3	String	The key field of the first table or geographic file	
			4	String	The key field of the second table or geographic file	
			5	String	The given name of the joined view	
	Options with the word "Currency" in them describing matrix currencies	Matrix Currencies	An array of four string elements:			
			1	String	The path and file name of the matrix file	
			2	String	The matrix name	
			3	String	The row index	
			4	String	The column index	
	Options with the word "Table"	Table	The file name of the table			
	Options with the word "Field"	Field	The field name			
Field	Options with the word "Field"	Field	Either just the field name, or the layer or table name followed by a period "." and then the field name			
Output	Options with the word "Matrix"	Matrix	An array of two options:			
			1	Array	"Label", a string specifying the name to appear in the title bar of the matrix view	
			2	Array	"File Name", a string specifying the path and file name for the output matrix	
	Options with the word "Table"	Table	The file name of the output table			

The description of each procedure explains the options that are required, and includes an example showing how to assign values to the options array and how to call the procedure.

Cross-Classification Models

Summary: Predicts the number of trips that are generated by or attracted to each zone in a study area, by utilizing cross-classification techniques.

Syntax: RunMacro("TCB Run Procedure", 1, "Crosclas", Options)

Option Group	Option	Type	Contents
Input	Trip Rate Set	Array	An array of two strings: 1 String The path and file name of the trip rate table 2 String The name of the table
	Zone View Set	Array	An array of two strings: 1 String The path and file name of the zone data table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name. 2 String The name of the table or layer
	Output Field 1	String	The name of the field to be filled with the productions/attractions corresponding to the first trip purpose
	Output Field 2	String	The name of the field to be filled with the productions/attractions corresponding to the second trip purpose
	Output Field n	String	The name of the field to be filled with the productions/attractions corresponding to the nth trip purpose.
Global	Number Classifications	Integer	The number of trip classifications in the analysis
	Number Purposes	Integer	The number of trip purposes in the analysis
	Number Units	Integer	The number of rate multiplier fields (sub-fields to multiply trip rates by)
	Urban Pop Option	String	Yes for the cross-classification to consider the population of the urban area, No otherwise.
Field	Unit Field 1	String	The name of the first rate-multiplier field (in the form [view].[Field name])
	Unit Field 2	String	The name of the second rate-multiplier field (in the form [view].[Field name])
	Unit Field n	String	The name of the nth rate-multiplier field (in the form [view].[Field name])
	Purpose Field 1	String	The name of field in the trip rate table corresponding to the rate for the first trip purpose
	Purpose Field 2	String	The name of field in the trip rate table corresponding to the rate for the second trip purpose
	Purpose Field n	String	The name of field in the trip rate table corresponding To the rate for the nth trip purpose
	Unit Class Type 11	String	True if the first unit field for the first classification comes from the zone layer, false if the field is a fixed value
	Unit Class Field 11	String	The name of the field ([view].[field name]) corresponding to the first unit field for the first classification. (This field is specified ONLY IF the corresponding Unit Class Type is TRUE).
	Unit Class Type 12	String	True if the first unit field for the second classification comes from the zone layer, false if the field is a fixed value
	Unit Class Value 12	Real	The numerical value corresponding to the first unit field for the second classification. (This field is specified ONLY IF the corresponding Unit Class

			Type is FALSE).
	Unit Class Type 13	String	True if the first unit field for the third classification comes from the zone layer, false if the field is a fixed value
	Unit Class Field 13	String	The name of the field ([view].[field name]) corresponding to the first unit field for the third classification. (This field is specified ONLY IF the corresponding Unit Class Type is TRUE).
	Unit Class Type 21	String	True if the second unit field for the first classification comes from the zone layer, false if the field is a fixed value
	Unit Class Field 21	String	The name of the field ([view].[field name]) corresponding to the second unit field for the first classification. (This field is specified ONLY IF the corresponding Unit Class Type is TRUE).
	Unit Class Type 22	String	True if the second unit field for the second classification comes from the zone layer, false if the field is a fixed value
	Unit Class Value 22	Real	The numerical value corresponding to the second unit field for the second classification. (This field is specified ONLY IF the corresponding Unit Class Type is FALSE).
	Unit Class Type 23	String	True if the second unit field for the third classification comes from the zone layer, false if the field is a fixed value
	Unit Class Field 23	String	The name of the field ([view].[field name]) corresponding to the second unit field for the third classification. (This field is specified ONLY IF the corresponding Unit Class Type is TRUE).
	Unit Class Type mn	String	True if the mth unit field for the nth classification comes from the zone layer, false if the field is a fixed value
	Unit Class Field mn	String	The name of the field ([view].[field name]) corresponding to the mth unit field for the nth
	OR		classification. This field is specified ONLY IF the corresponding Unit Class Type is TRUE. If the corresponding Unit Class Type is False, then this argument consists of the numerical value corresponding to the mth unit field for the nth classification.
	Unit Class Value mn	Real	
Output	Output Table	String	The full path and file name of the fixed format binary output table (*.bin)

Example:

```
Options = {{"Input",{{"Trip Rate Set",
        {"C:\\CALIPER\\TC40\\TUTORIAL\\DETRCRCL.BIN","DETRCRCL"}},
            {"Zone View Set",
        {"C:\\caliper\\tc40\\Tutorial\\DETROIT.CDF|Detroit TAZs","Detroit TAZs"}},
            {"Output Field 1",              "HBWBP"},
            {"Output Field 2",              "HBSRVP"},
            {"Output Field 3",              "HBOP"},
            {"Output Field 4",              "NHBWBP"},
            {"Output Field 5",              "NHBOP"}}},
        {"Global",   {{"Number Classifications", 3},
            {"Number Purposes",         5},
            {"Number Units",            3},
            {"Urban Pop Option",        "No"}}},
        {"Field",   {{"Unit Field1",              "Detroit TAZs.[HHs w/ Low Inc (20)]"},
            {"Unit Field2",              "Detroit TAZs.[HHs w/ Med Inc (40)]"},
            {"Unit Field3",              "Detroit TAZs.[HHs w/ High Inc (60)]"},
            {"Purpose Field1",           "DETRCRCL.R_HBWBP"},
            {"Purpose Field2",           "DETRCRCL.R_HBSRVP"},
            {"Purpose Field3",           "DETRCRCL.R_HBOP"},
            {"Purpose Field4",           "DETRCRCL.R_NHBWBP"},
            {"Purpose Field5",           "DETRCRCL.R_NHBOP"},
            {"Unit Class Type11",        "True"},
            {"Unit Class Field11",       "Detroit TAZs.ATYPE"},
```

```
                    {"Unit Class Type12",        "False"},
                    {"Unit Class Value12",       20000},
                    {"Unit Class Type13",        "True"},
                    {"Unit Class Field13",       "Detroit TAZs.[HHs w/ Low Inc (20)]"},
                    {"Unit Class Type21",        "True"},
                    {"Unit Class Field21",       "Detroit TAZs.ATYPE"},
                    {"Unit Class Type22",        "False"},
                    {"Unit Class Value22",       40000},
                    {"Unit Class Type23",        "True"},
                    {"Unit Class Field23",       "Detroit TAZs.[HH Size MInc]"},
                    {"Unit Class Type31",        "True"},
                    {"Unit Class Field31",       "Detroit TAZs.ATYPE"},
                    {"Unit Class Type32",        "False"},
                    {"Unit Class Value32",       60000},
                    {"Unit Class Type33",        "True"},
                    {"Unit Class Field33",       "Detroit TAZs.[HH Size HInc]"}}},
            {"Output",   {{"Output Table",        "C:\\temp\\CROSCLAS.BIN"}}}}

            RunMacro("TCB Run Procedure", 1, "Crosclas", Options)
```

Linear Regression

Summary: Predicts the number of trips that are produced or attracted to an area by linear regression methods.

Syntax: RunMacro("TCB Run Procedure", 1, "Linear Evaluation", Options)

Option Group	Option	Type	Contents
Input	Zone Set	Array	An array of two strings: 1 String The path and file name of the zone data table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name. 2 String The name of the table or layer
Global	Method	Integer	1 = Regression, 2 = Binary Logit
	Model File	String	Model file used to estimate regression
	Coefficients	Array	Array of coefficients used for the constant and independent fields
Field	Dependent	String	The view and field name of the dependent variable. Syntax is of the form [view].[Field name].
	Independents	Array	An array of strings containing the view and field names of all independent fields. Syntax is of the form [view].[Field name].

Example:
```
        Options = {{"Input",       {{"Zone Set",
            {"C:\\caliper\\tc40\\Tutorial\\vermont.DBD|MCD",
                                        "MCD"}}}},
            {"Field",  {{"Dependent",        "MCD.HBW_P"},
                  {"Independents",        {"MCD.[DWELLING-UNITS]",
                                        "MCD.[RETAIL-EMPLOYMENT]",

            "MCD.[NONRETAIL-EMPLOYMENT]"}}}},
            {"Global", {{"Method",       1},
                  {"Model File",    "C:\\caliper\\tc40\\Tutorial\\hbw.mod"},
```

```
{"Coefficients",    {3.66,
                            0.322,
                            1.7,
                            1.7}}}}}
```

RunMacro("TCB Run Procedure", 1, "Linear Evaluation", Options)

Quick Response Method All

Summary: Predicts the number of trips that are generated by and attracted to each zone in the study area, by utilizing quick response methods.

Syntax: RunMacro("TCB Run Procedure", 1, "QRM All", Options)

Option Group	Option	Type	Contents
Input	Zone View	String	An array of two strings:
			1 String The path and file name of the zone data table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name.
			2 String The name of the table or layer
	Zone Set	Array	An array of two strings:
			1 String The path and file name of the zone data table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name.
			2 String The name of the table or layer
	Production Table	Array	A single element array consisting of a string identifying the path and file name of the table where productions are stored
	Attraction Table	Array	A single element array consisting of a string identifying the path and file name of the table where the attractions are stored
Global	Model Option	String	Prod & Attr, Prod, or Attr, depending on the desired procedure
	Classify By	Integer	The field that the procedure will use to classify by. The possible values are: 0: none (use average rates), 1: Income/HH, 2: Autos/HH, 3: Inc/HH_&_ Autos/HH.
	Population	Integer	The urban population in thousands
	Production Option	String	Average to use average rates, Rates HH to use household rates, or Car Based to use car-based rates
	Income Option	String	None to use no income option, Income Based to use Income, or Car Based for an auto-based analysis
	Balance Method	String	The method to use for balancing the productions and attractions. Possible values: None, Hold Productions, and Hold Attractions.
	Inflation	Real	The rate of inflation. The default value is 1.
	Number of Purposes	Integer	The number of trip purposes
	Ext Names	Array	An array of strings identifying the various trip purposes by name
Field	Total HH	String	The view and field name containing the values for total households. Syntax is of the form [view].[Field name].
	Dwelling	String	The view and field name containing the values for the number of dwelling units. Syntax is of the form [view].[Field name].
	Retail Employment	String	The view and field name containing the values of retail employment. Syntax is of the form [view].[Field name].
	Non-Ret Employment	String	The view and field name containing the value of non-retail employment. Syntax is of the form [view].[Field name].
	Income	String	The view and field name containing the values of household income. Syntax is of the form [view].[Field name].
Output	Output Table	String	The path and file name for the output production and attraction table

Example: Options = {{"Input",   {{"Zone View",

```
                    {"C:\\caliper\\tc40\\Tutorial\\Vt_mcd.DBD|MCD","MCD"}},
                        {"Zone Set",
                    {"C:\\caliper\\tc40\\Tutorial\\Vt_mcd.DBD|MCD", "MCD"}},
                        {"Production Table",
                    {"C:\\PLATFORM\\TC40\\TAB\\PROD_TGP.DBF"}},
                        {"Attraction Table",
                    {"C:\\PLATFORM\\TC40\\TAB\\ATTR_TGP.DBF"}}}},
                    {"Field",  {{"Total HH",                "MCD.[TOT-HH]"},
                        {"Dwelling",                "MCD.[DWELLING-UNITS]"},
                        {"Retail Employment", "MCD.[RETAIL-EMPLOYMENT]"},
                        {"Non-Ret Employment", "MCD.[NONRETAIL-EMPLOYMENT]"},
                        {"Income",                "MCD.[INC/HH]"}}},
                    {"Global",        {{"Model Option", "Prod & Attr"},
                        {"Classify By",                2},
                        {"Population",                100},
                        {"Production Option",      "Rates HH"},
                        {"Income Option",          "Income Based"},
                        {"Balance Method",        "Hold Productions"},
                        {"Inflation",                1},
                        {"Number of Purposes", 4},
                        {"Ext Names",                {"HBW",
                                                    "HBNW",
                                                    "HBO",
                                                    "NHB"}}}},
                    {"Output", {{"Output Table",          "C:\\temp\\QRM_ALL.BIN"}}}}

            RunMacro("TCB Run Procedure", 1, "QRM All", Options)
```

Top

QRM Production

Summary: Predicts the number of trips that are generated by each zone in the study area by utilizing quick response methods for computing trip productions.

Syntax: RunMacro("TCB Run Procedure", 1, "QRM Production", Options)

Option Group	Option	Type	Contents
Input	Zone View	String	An array of two strings: 1 String The path and file name of the zone data table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name. 2 String The name of the table or layer
	Zone Set	Array	An array of two strings: 1 String The path and file name of the zone data table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name. 2 String The name of the table or layer
	Production Table	Array	A single element array consisting of a string identifying the path and file name of the table where productions are stored
Global	Model Option	String	The value Prod
	Classify By	Integer	The field that the procedure will use to classify by. The possible values are: 0: none (use average rates), 1: Income/HH, 2: Autos/HH, 3: Inc/HH_&_ Autos/HH.
	Population	Integer	The urban population in thousands
	Production Option	String	Average to use average rates, Rates HH to use household rates, or Car Based to use car-based rates

Option Group	Option	Type	Contents
	Income Option	String	None to use no income option, Income Based to use Income, or Car Based for an auto-based analysis
	Inflation	Real	The rate of inflation. The default value is 1.
	Number of Purposes	Integer	The number of trip purposes
	Ext Names	Array	An array of strings identifying the various trip purposes by name
Field	Total HH	String	The view and field name containing the values for total households. Syntax is of the form [view].[Field name].
	Income	String	The view and field name containing the values of household income. Syntax is of the form [view].[Field name].
Output	Output Table	String	The path and file name for the output production table

Example:
```
Options = {{"Input",          {{"Zone View",
               {"C:\\caliper\\tc40\\Tutorial\\Vt_mcd.DBD|MCD","MCD"}},
                        {"Zone Set",
               {"C:\\caliper\\tc40\\Tutorial\\Vt_mcd.DBD|MCD", "MCD"}},
                        {"Production Table",
               "C:\\PLATFORM\\TC40\\TAB\\PROD_TGP.DBF"}}},
          {"Field",          {{"Total HH",      "MCD.[TOT-HH]"},
                        {"Income",              "MCD.[INC/HH]"}}},
          {"Global",         {{"Model Option",  "Prod"},
                 {"Classify By",     2},
                 {"Population",     100},
                 {"Production Option",       "Rates HH"},
                 {"Income Option", "Income Based"},
                 {"Inflation",                 1},
                 {"Number of Purposes", 4},
                 {"Ext Names",     {"HBW",
                                    "HBNW",
                                    "HBO",
                                    "NHB"}}}},
          {"Output",         {{"Output Table",  "C:\\temp\\QRM_PROD.BIN"}}}}

RunMacro("TCB Run Procedure", 1, "QRM Production", Options)
```

Top

QRM Attraction

Summary: Predicts the number of trips that are attracted to each zone in the study area, by utilizing quick response methods for trip attraction.

Syntax: RunMacro("TCB Run Procedure", 1, "QRM Attraction", Options)

Option Group	Option	Type	Contents
Input	Zone View	String	An array of two strings:
			1 String The path and file name of the zone data table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name.
			2 String The name of the table or layer
	Zone Set	Array	An array of two strings:
			1 String The path and file name of the zone data table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name.
			2 String The name of the table or layer
	Attraction Table	Array	A single element array consisting of a string identifying the path and file name of the table where the attractions are stored

Global	Model Option	String	Prod & Attr, Prod, or Attr, depending on the desired procedure
	Number of Purposes	Integer	The number of trip purposes
	Ext Names	Array	An array of strings identifying the various trip purposes by name
	Dwelling	String	The view and field name containing the values for the number of dwelling units. Syntax is of the form [view].[Field name]
	Retail Employment	String	The view and field name containing the values of retail employment. Syntax is of the form [view].[Field name].
	Non-Ret Employment	String	The view and field name containing the value of non-retail employment. Syntax is of the form [view].[Field name].
Output	Output Table	String	The path and file name for the output attraction table

Example:

```
Options =      {{"Input",    {{"Zone View",
          {"C:\\caliper\\tc40\\Tutorial\\Vt_mcd.DBD|MCD","MCD"}},
                    {"Zone Set",
          {"C:\\caliper\\tc40\\Tutorial\\Vt_mcd.DBD|MCD","MCD"}},
                    {"Attraction Table",
          "C:\\PLATFORM\\TC40\\TAB\\ATTR_TGP.DBF"}}},
          {"Field",  {{"Dwelling",         "MCD.[DWELLING-UNITS]"},
                    {"Retail Employment",      "MCD.[RETAIL-EMPLOYMENT]"},
                    {"Non-Ret Employment",
          "MCD.[NONRETAIL-EMPLOYMENT]"}}},
          {"Global", {{"Model Option",         "Attr"},
                    {"Number of Purposes",     4},
                    {"Ext Names",         {"HBW",
                                        "HBNW",
                                        "HBO",
                                        "NHB"}}}},
          {"Output",                    {{"Output Table",
          "C:\\temp\\QRM_ATTR.BIN"}}}}

RunMacro("TCB Run Procedure", 1, "QRM Attraction", Options)
```

ITE Trip Attraction

Summary: Predicts the number of trips that are attracted to each zone in the study area, by applying ITE trip rates through either a weighted average technique or a regression equation.

Syntax: RunMacro("TCB Run Procedure",1, "ITE", Options)

Option Group	Option	Type	Contents
Input	Data Set	Array	An array of two strings:
			1 String The path and file name of the table containing the land use information
			2 String The name of the table
	ITE DB Set	Array	An array of three strings:
			1 String The path and file name of the ITE data table
			2 String The name of the table
Global	Method Index	Integer	The method selected. Possible values are: 1: use average rates, 2: use regression equations, or 3: use land use or zone-specific methods.
	Method Default	Integer	Used when Method Index is set to 3 to specify which method to use for missing values in the model type field. Possible values are: 1: use average rates, or 2: use regression equations. A value is always passed, regardless of the value of Method Index.

	Method	Integer	The method used. Possible values are: 1: when Method Index is 1, 2: when Method Index is 2, 4: when Method Index is 3 and Method Default is 1, or 5: when Method Index is 3 and Method Default is 2.
Field	Land Uses	Array	An array of strings specifying the various land uses to be considered in the analysis (in the form [view].[Field name]). Each land use must contain three elements specifying the necessary fields: the land use variable, the land use value (intensity), and the corresponding model type. The number of elements in this array is equal to the number of land uses to be considered in the analysis.
	Land Use IDs	Array	An array of integers corresponding to each land use being considered
	Land Use Selected	Array	An array of integers corresponding to the selected land used as they appear in the interface scroll list
Flag	Output Enter/Exit	Integer	The value 1 for exit and entering vehicles to be included in output, 0 otherwise
	Hours	Array	An array of 9 integers, all 0 or 1. The value of 1 is used to indicate the desire of reporting the given time period in the output.
Output	Output Table	String	The full path and file name of the fixed format binary output table (*.bin)

Example:

```
Opts =          {{"Input",        {{"Data Set",
{"C:\\caliper\\tc40\\Tutorial\\UTOWN_ZN.DBD|Zone","Zone"}},
                                    {"ITE DB Set",
            {"C:\\PLATFORM\\TC40\\TAB\\ITEDATA.BIN","itedata"}}}},
            {"Field",              {{"Land Uses",      {"Zone.C210_VAR",
                                    "Zone.C210_VALUE",
                                    "Zone.C210_MOD",
                                    "Zone.C220_VAR",
                                    "Zone.C220_VALUE",
                                    "Zone.C220_MOD",
                                    "Zone.C710_VAR",
                                    "Zone.C710_VALUE",
                                    "Zone.C710_MOD",
                                    "Zone.C130_VAR",
                                    "Zone.C130_VALUE",
                                    "Zone.C130_MOD",
                                    "Zone.C550_VAR",
                                    "Zone.C550_VALUE",
                                    "Zone.C550_MOD",
                                    "Zone.C610_VAR",
                                    "Zone.C610_VALUE",
                                    "Zone.C610_MOD"}},
                    {"Land Use IDs",  {210,
                                    220,
                                    710,
                                    130,
                                    550,
                                    610}},
                    {"Land Use Selected", {1,
                                    2,
                                    3,
                                    4,
                                    5,
                                    6}}}},
            {"Global", {{"Method Index",            1},
                                    {"Method Default",   1},
                                    {"Method", 1}}},
            {"Flag",  {{"Hours",       {1,
                                    1,
                                    0,
                                    0,
                                    0,
                                    1,
                                    0,
                                    0,
                                    0}}}},
```

{"Output", {{"Output Table",   "C:\\temp\\ITE_OUT.BIN"}}}}

RunMacro("TCB Run Procedure", 1, "ITE", Options)

Top

Balance

Summary: Alleviates the inevitable discrepancy between the predicted number of productions and attractions, by applying a user-specified method to balance the two vectors so that the number of productions equals the number of attractions.

Syntax: RunMacro("TCB Run Procedure", 1,"Balance", Options)

Option Group	Option	Type	Contents
Input	Data View	Array	An array of two strings:
			1 String The path and filename of the table or geographic file containing the P's and A's. If a geographic file, followed by a vertical bar "|" and then the layer name.
			2 String The name of the table or layer
	Data Set	Array	An array of two strings:
			1 String The path and filename of the table or geographic file containing the P's and A's. If a geographic file, followed by a vertical bar "|" and then the layer name.
			2 String The name of the table or layer
	V1 Holding Set	Array	An array of strings (an element for each trip purpose) specifying the values to hold constant while balancing Vector 1
	V2 Holding Set	Array	An array of strings (an element for each trip purpose) specifying the values to hold constant while balancing Vector 2
Global	Pairs	Integer	Number of production and attraction pairs
	Holding Method	Integer	The methodology for balancing the vectors. Possible values: 1: hold Vector 1 constant, 2: hold Vector 2 constant, 3: weighted sum, and 4: sum to value.
	Percent Weight	Real	The percent by which to weigh vector 1 in a weighted sum balance. The default value is 50.
	Sum Weight	Integer	The sum that the two vectors should add to in a sum to value balance. The default is 100 and must be passed.
	V1 Options	Array	An array of integers (an element for each trip purpose) allowing or disallowing the changing of the original set of records. Possible values: 1: allow all record values to be changed, 0: do not allow record values to be changed.
	V2 Options	Array	An array of integers (an element for each trip purpose) allowing or disallowing the changing of the original set of records. Possible values: 1: allow all record values to be changed, 0: do not allow record values to be changed.
	Store Type	Integer	An integer specifying the option to store the balanced vectors as either real numbers or integers. Possible values: 1: Real, 2: Integer.
Field	Vector 1	String	The view and field name containing the Production or Attraction field to be used as Vector 1. Syntax is of the form [view].[Field name].
	Vector 2	String	The view and field name containing the Production or Attraction field to be used as Vector 2. Syntax is of the form [view].[Field name].
Output	Output Table	String	A string specifying the path and file name for the binary output flow table

Example: Options =   {{"Input",{{"Data Set",
       {"C:\\caliper\\tc40\\Tutorial\\Vtbal.CDF|MCD","MCD"}},

```
                                  {"Data View",
            {"C:\\caliper\\tc40\\Tutorial\\Vtbal.CDF|MCD","MCD"}}}},
                        {"V1 Holding Set",      {,,}},
                        {"V2 Holding Set",      {,,}}}},
            {"Field", {{"Vector 1",        {"MCD.HBW_P",
                                            "MCD.HBNW_P",
                                            "MCD.NHB_P"}},
                        {"Vector 2",        {"MCD.HBW_A",
                                            "MCD.HBNW_A",
                                            "MCD.NHB_A"}}}},
            {"Global", {{"Pairs",          3},
                        {"Holding Method",       {1,
                                                  3,
                                                  4}},
                        {"Percent Weight",      {50,
                                                 50,
                                                 50}},
                        {"Sum Weight",    {100,
                                            100,
                                            100000}},
                        {"V1 Options",     {1,
                                            1,
                                            1}},
                        {"V2 Options",          {1,
                                                 1,
                                                 1}},
                        {"Store Type",          1}}},
            {"Output", {{"Output Table",          "C:\\temp\\BALANCE.BIN"}}}}

            RunMacro("TCB Run Procedure", 1, "Balance", Options)
```

Top

Shortest Path Matrix

Summary: Computes a shortest path matrix using a user-defined impedance field, and reports any number of skim matrices that the user specifies.

Syntax: RunMacro("TCB Run Procedure", "TCSPMAT", Options)

Option Group	Option	Type	Contents	
Input	Origin Set	Array	An array of four strings:	
			1	String	The path and file name of the geographic file that contains the, followed by a vertical bar "|" and then the name of the node layer
			2	String	The name of the layer of containing the origins
			3	String	The name of the selection set containing the origins
			4	String	The query used to create the selection set containing the origins
	Destination Set	Array	An array of four strings:	
			1	String	The path and file name of the geographic file that contains the, followed by a vertical bar "|" and then the name of the node layer
			2	String	The name of the layer of containing the destinations
			3	String	The name of the selection set containing the destinations
			4	String	The query used to create the selection set containing the destinations
	Via Set	Array	An array of four strings:	

		1	String	The path and file name of the geographic file that contains the origins, followed by a vertical bar "	" and then the name of the node layer
		2	String	The name of the layer of containing the intermediate nodes
		3	String	The name of the selection set containing the intermediate nodes
		4	String	The query used to create the selection set containing the intermediate nodes
	Network	String		The path and file name of the street network file (*.net)
Global	Output Type	String		The specification of whether the shortest path calculation is to be stored as a route system or as a matrix. Possible values are: Matrix, for matrix and Route System, for route system.
Fields	Nodes	String		The name of the nodes layer and ID field in the form [layer].ID field
	Minimize	String		The network field name to be minimized when computing shortest path
Output	Output Matrix	Array		An array of two options:
		1	Array	"Label", a string specifying the name to appear in the title bar of the matrix view
		2	Array	"File Name", a string specifying the path and file name for the output matrix of shortest paths

Example:

```
Opts = {{"Input",   {{"Network",       "C:\\caliper\\tc40\\Tutorial\\PLAN_NET.NET"},
                      {"Origin Set",
              {"C:\\caliper\\tc40\\Tutorial\\PLAN_NET.DBD|Nodes",
                                        "Nodes",
                                        "centroids",
                                        "Select * where taz <> null"}},
                      {"Destination Set",
              {"C:\\caliper\\tc40\\Tutorial\\PLAN_NET.DBD|Nodes",
                                        "Nodes",
                                        "centroids"}},
                      {"Via Set",
              {"C:\\caliper\\tc40\\Tutorial\\PLAN_NET.DBD|Nodes",
                                        "Nodes"}}}},
          {"Field",   {{"Minimize",        "[TRAVEL TIME]"},
                       {"Nodes",           "Nodes.ID"}}},
          {"Global",          {{"Output Type",   "Matrix"}}},
          {"Output",          {{"Output Matrix", {{"Label",
                                        "Shortest Path"},
                                       {"File Name",
                                        "C:\\temp\\SPMAT.MTX"}}}}}}

RunMacro("TCB Run Procedure", 1, "TCSPMAT", Options)
```

Intrazonal Travel Times

Summary: Performs a procedure that computes the intrazonal travel times.

Syntax: RunMacro("TCB Run Procedure", 1,"Intrazonal", Options)

Option Group	Option	Type	Contents	
Input	OD Matrix Currency	Array	An array of four strings:	
			1 String	The path and file name of the matrix file
			2 String	The matrix name
			3 String	The row index
			4 String	The column index
Global	Factor	Integer	The value by which to factor the resulting average of neighboring zone	

				costs
	Neighbors	Integer		The number of zones to consider as neighboring zones. Procedure will choose the zones with the least cost as the neighbors.
	Operation	Integer		The value 1 to replace values in the matrix, or 2 to add to the values in the matrix
	Treat Missing	Integer		The value 1 to treat missing matrix entries as 0, or 2 to treat the missing matrix entries as missing (procedure will not apply)

Example: Options =   {{"Input",{{"OD Matrix Currency", {"C:\\TransCAD\\Tutorial\\Od.mtx",

"Vehicles",
"Rows",
"Columns"}}}},

{"Global", {{"Factor",   1},
       {"Neighbors",   2},
       {"Operation",   1},
       {"Treat Missing", 1}}}
}

RunMacro("TCB Run Procedure",1, "Intrazonal", Options)

Top

Creating Distance Matrix

Summary: Creates an "as the crow flies" distance matrix from an input point layer.

Syntax: RunMacro("TCB Run Procedure",1, "Gravity", Options)

Option Group	Option	Type		Contents	
Input	Origin Set	Array		An array of four strings:	
			1	String	The path and file name of the geographic file that contains the, followed by a vertical bar "|" and then the name of the node layer
			2	String	The name of the layer of containing the origins
			3	String	The name of the selection set containing the origins
			4	String	The query used to create the selection set containing the origins
	Destination Set	Array		An array of four strings:	
			1	String	The path and file name of the geographic file that contains the, followed by a vertical bar "|" and then the name of the node layer
			2	String	The name of the layer of containing the destinations
			3	String	The name of the selection set containing the destinations
			4	String	The query used to create the selection set containing the destinations
Global	Map Unit Label	String		Units to use to determine distance	
	Map Unit Size	Real		Map unit size	
Output	Output Matrix	Array		An array of two options:	
			1	Array	"Label", a string specifying the name to appear in the title bar of the matrix view
			2	Array	"File Name", a string specifying the path and file name for the output matrix

Example: Options = {{"Input",   {{"Origin Set",
            {"C:\\caliper\\tc40\\Tutorial\\BOSTON.CDF|CDF Node Layer",
                              "CDF Node Layer",

```
                                {"Destination Set",
                {"C:\\caliper\\tc40\\Tutorial\\BOSTON.CDF|CDF Node Layer",
                                                "CDF Node Layer",
                                                "Selection"}}}},
                {"Global", {{"Map Unit Label",    "Miles"},
                        {"Map Unit Size",  1}}},
                {"Output", {{"Output Matrix",     {{"Label",
                                                "Output Matrix"},
                                                {"File Name",
                                                "C:\\temp\\EUCMAT.MTX"}}}}}}

        RunMacro("TCB Run Procedure", 1, "EUCMat", Options)
```

Gravity Evaluation

Summary: Applies a previously-calibrated gravity model and/or friction factors to perform a trip distribution, to predict the spatial pattern of trips or other flows between origins and destinations.

Syntax: RunMacro("TCB Run Procedure",1, "Gravity", Options)

Option Group	Option	Type	Contents
Input	PA View Set	Array	An array of two strings: 1 String The path and file name of the PA View table 2 String The name of the table
	FF Matrix Currencies	Array	An array of arrays of matrix currencies for each friction factor matrix. Each matrix currency is stored as a separate array with four string elements: 1 String The path and file name of the matrix file 2 String The matrix name 3 String The row index 4 String The column index
	Imp Matrix Currencies	Array	An array of arrays of matrix currencies for each Impedance Matrix. Each matrix currency is stored as a separate array with four string elements: 1 String The path and file name of the matrix file 2 String The matrix name 3 String The row index 4 String The column index
	FF Tables	Array	An array of arrays of strings identifying the full path and file name of the friction factor lookup tables. Each trip purpose contains a corresponding friction factor lookup table.
	KF Matrix Currencies	Array	An array of arrays of matrix currencies for each matrix of K-factors. Each matrix currency is stored as a separate array with four string elements: 1 String The path and file name of the matrix file 2 String The matrix name 3 String The row index 4 String The column index
Global	Purpose Names	Array	An array of strings representing each trip purpose
	Iterations	Array	An array of integers specifying the maximum number of iterations for the procedure to complete
	Convergence	Array	An array of real numbers specifying the convergence criteria for each trip purpose in this analysis
	Constraint Type	Array	An array of strings specifying the constraint type for each trip purpose. Possible values: Doubly, Rows (production), or Columns (attraction).
	Fric Factor Type	Array	An array of strings specifying the derivation of the friction factors used in the analysis. Possible values: Gamma, Inverse, Exponential, Table, or

			Matrix.
	A List	Array	An array of real numbers representing the values for the constant a in the various friction factor generating functions for each trip purpose
	B List	Array	An array of real numbers representing the values for the constant b in the various friction factor generating functions for each trip purpose
	C List	Array	An array of real numbers representing the values for the constant c in the various friction factor generating functions for each trip purpose
Field	Prod Fields	Array	An array of production field names, in the form [view].[Field name]
	Attr Fields	Array	An array of attraction field names, in the form [view].[Field name]
	FF Table Fields	Array	An array of friction factor table fields, in the form [view].[Field name]
	FF Table Times	Array	An array of friction factor table time fields, in the form [view].[Field name]
Flag	Use K Factors	Array	An array consisting of the values 0 (no) or 1 (yes) depending on whether or not K-factors are considered in the procedure for each trip purpose.
Output	Output Matrix	Array	An array of two options:
			1 Array "Label", a string specifying the name to appear in the title bar of the matrix view
			2 Array "File Name", a string specifying the path and file name for the output matrix

Example:

```
Options = {{"Input", {{"PA View Set",
            {"C:\\caliper\\tc40\\Tutorial\\UTOWN_ZN.DBD|Zone"}
                                "Zone"}},
            {"FF Matrix Currencies",
{{"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
                                "Origin-Destination",
                                "Origin-Destination"},
                                {"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
                                "Origin-Destination",
                                "Origin-Destination"},
                                {"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
                                "Origin-Destination",
                                "Origin-Destination"}}},
            {"Imp Matrix Currencies",
{{"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
                                "Origin-Destination",
                                "Origin-Destination"},
                                {"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
                                "Origin-Destination",
                                "Origin-Destination"},
                                {"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
                                "Origin-Destination",
                                "Origin-Destination"}}},
            {"FF Tables",
{{"C:\\PLATFORM\\TC40\\TAB\\ATTR_TGP.DBF",
                                "C:\\PLATFORM\\TC40\\TAB\\ATTR_TGP.DBF",

"C:\\PLATFORM\\TC40\\TAB\\ATTR_TGP.DBF"}}},
            {"KF Matrix Currencies",
{{"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
                                "Origin-Destination",
                                "Origin-Destination"},
                                {"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
                                "Origin-Destination",
                                "Origin-Destination"},
                                {"C:\\caliper\\tc40\\Tutorial\\UTOWN_D.MTX",
                                "Travel Time",
```

                                        "Origin-Destination",
                                        "Origin-Destination"}}}}},
            {"Field",{{"Prod Fields",   {"Zone.HBW_P",
                                        "Zone.HBNW_P",
                                        "Zone.NHB_P"}},
                                {"Attr Fields",   {"Zone.HBW_A",
                                        "Zone.HBNW_A",
                                        "Zone.NHB_A"}},
                    {"FF Table Fields",   {"ATTR_TGP.HBW",
                                        "ATTR_TGP.HBW",
                                        "ATTR_TGP.HBW"}},
                    {"FF Table Times",   {"ATTR_TGP.HBW",
                                        "ATTR_TGP.HBW",
                                        "ATTR_TGP.HBW"}}}},
            {"Global", {{"Purpose Names",   {"HBW",
                                        "HBNW",
                                        "NHB"}},
                                {"Iterations",   {10,
                        10,
                        10}},
                                {"Convergence",   {0.001,
                        0.001,
                        0.001}},
                                {"Constraint Type",   {"Double",
                        "Double",
                        "Double"}},
                                {"Fric Factor Type",   {"Gamma",
                        "Inverse",
                        "Exponential"}},
                                {"A List",   {100000,
                        1,
                        1}},
                                {"B List",   {3,
                        50000,
                        0.3}},
                                {"C List",   {1,
                        0.01,
                        100}}}},
            {"Flag", {{"Use K Factors", {0,
                                        0,
                                        0}}}},
            {"Output", {{"Output Matrix",   {{"Label",
                                        "Output Matrix"},
                                        {"File Name",
                                        "C:\\temp\\CGRAV.MTX"}}}}}}

            RunMacro("TCB Run Procedure", 1, "Gravity", Opts)

Trip Length Distribution

Summary: Creates a trip length distribution table from an input travel time matrix and an input O-D matrix.

Syntax: RunMacro("TCB Run Procedure",1, "TLD", Options)

Option Group	Option	Type	Contents
Input	Base Currency	Array	An array of four string elements:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Impedance Currency	Array	An array of four string elements:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
Global	Start Option	Integer	1 = Start at specified time, 2 = start at minimum time
	Start Value	Integer	Start value time
	End Option	Integer	1 = End at specified time, 2 = end at maximum time
	End Value	Integer	End value time
	Method	Integer	1 = Number of Bins, 2 = Bin size
	Number of Bins	Integer	Number of bins
	Size	Integer	Bin size
	Statistics Option	Integer	1 = Include statistics in report, 0 = otherwise
	Min Value	Integer	Ignore values below this value
	Max Value	Integer	Ignore values above this value
Output	Output Matrix	Array	An array of two options:
			1 Array "Label", a string specifying the name to appear in the title bar of the matrix view
			2 Array "File Name", a string specifying the path and file name for the output matrix

Example: Options = {{"Input", {{"Base Currency",   {"C:\\caliper\\tc40\\Tutorial\\TLD_OD.MTX",
                                               "FLOW",
                                               "Network Nodes (Selection)",
                                               "Network Nodes (Selection)"}},
                          {"Impedence Currency", {"C:\\caliper\\tc40\\Tutorial\\TLD_SP.MTX",
                                               "LENGTH",
                                               "RCIndex",
                                                 "RCIndex"}}}},
                {"Global", {{"Start Option",   2},
                         {"Start Value",   0},
                         {"End Option",   2},
                         {"End Value",   60},
                         {"Method",   2},
                         {"Number of Bins",   10},
                         {"Size",   5},
                         {"Statistics Option",   1},
                         {"Min Value",   0},
                         {"Max Value",   0}}},
                {"Output", {{"Output Matrix",   {{"Label",
                                               "Output Matrix"},
                                               {"File Name",
                                               "C:\\temp\\TLD.MTX"}}}}}}

          RunMacro("TCB Run Procedure", 1, "TLD", Options)

Multinomial Logit Evaluation

Summary: Performs a multinomial logit evaluation, by applying a previously-calibrated multinomial logit model to forecast future shares of each mode alternative. Evaluation may be performed on either a disaggregate or an aggregate data set.

Syntax: RunMacro("TCB Run Procedure",1, "MNL Evaluation", Options)

Option Group	Option	Type	Contents
Input	View Set	Array	An array of two strings: 1 String — The path and file name of the table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name. 2 String — The name of the table or layer
	Destination Set	Array	An array of two strings: 1 String — The path and file name of the table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name. 2 String — The name of the table or layer
	Model Table	Array	An array of one string element specifying the path and file name of the Model Table, typically stored as a fixed format binary file (*.bin)
	Matrix Currencies	Array	An array of matrix currencies specifying the matrix currencies of the impedance matrix and any other cost matrix applicable to the evaluation (i.e. transit fare matrix). Each currency is a four element array: 1 String — The path and file name of the matrix file 2 String — The matrix name 3 String — The row index 4 String — The column index
Global	Number of Modes	Integer	The number of travel modes to be considered.
	Model Name	String	A string value specifying the name of the model to apply.
Field	ID Field	String	The field in the view specifying the ID of the zone. This view can be either a table or a geographic layer.
	Origin Field	String	This field is necessary only when the user specifies that the evaluation be completed on at a disaggregate level. That is, the global parameter for Aggregate (below) is set to 0. When used, this parameter refers to the field specifying the origin zone of the trip end.
	Destination Field	String	This field is necessary only when the user specifies that the evaluation be completed on at a disaggregate level. That is, the global parameter for Aggregate (below) is set to 0. When used, this parameter refers to the field specifying the destination zone of the trip end.
Flag	Aggregate	Integer	The value 1 to complete the evaluation using aggregated data, or 0 to use disaggregate data.
	Delete Case	Integer	This option refers to the handling of missing values. A value of 1 will drop the mode with the missing value while a value of 2 will drop the entire record with the missing value.
Output	Output Matrix	Array	An array of two options: 1 Array — "Label", a string specifying the name to appear in the title bar of the matrix file 2 Array — "File Name", a string specifying the path and file name for the output matrix of shortest paths

Example: Options = {{"Input", {{"View Set",
      {"C:\\caliper\\tc40\\Tutorial\\UTOWN_ZN.DBD|Zone"},"Zone"}}
            {"Destination Set",
      {"C:\\caliper\\tc40\\Tutorial\\UTOWN_ZN.DBD|Zone"},"Zone"},
            {"Model Table",
      "C:\\CALIPER\\TC40\\TUTORIAL\\MODTAB6.BIN"},
            {"Matrix Currencies",
      {{"C:\\caliper\\tc40\\Tutorial\\BUSFARE.MTX",
                              "Bus Fare",
                              "Rows",
                              "Columns"},

```
                          {"C:\\caliper\\tc40\\Tutorial\\IMPEDNCE.MTX",
                                                 "AUTO TT",
                                                 "RCIndex",
                                                 "RCIndex"}}}},
          {"Field", {{"ID Field",                "Zone.ID"}}},
          {"Global",        {{"Number of Modes", 3},
                                          "Model Name",
                                          "Coefficients"}}},
          {"Flag", {{"Aggregate",        1},
                                          {"Delete Case",
                                          1}}},
          {"Output", {{"Output Matrix",       {{"Label",
                                          "Output Matrix"},
                                          {"File Name",
                                          "C:\\temp\\MNL_EVAL.MTX"}}}}}}
```

RunMacro("TCB Run Procedure", 1, "MNL Evaluation", Options)

Top

P-A to O-D Transformation

Summary: Performs a conversion of productions and attractions to origins and destinations.

Syntax: RunMacro("TCB Run Procedure", "PA2OD", Options)

Option Group	Option	Type	Contents
Input	PA Matrix Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Lookup Set	Array	An array of three strings:
			1 String The path and file name of the hourly lookup table
			2 String The selection set on this table (if any)
			3 String The name of the table.
Global	Method Type	String	Either PA to OD or Time of Day
	Start Hour	Integer	The hour to begin reporting
	End Hour	Integer	The hour to end reporting
	Cache Size	Integer	The cache size for storing matrix values; the default is 50000
	Average Occupancies	Real	The average vehicle occupancy for each trip purpose
	Adjust Occupancies	Array	An array of strings specifying the field where hourly adjustments to vehicle occupancies are stored, or No for no adjustment factor. The array contains an element for each trip purpose.
	Peak Hour Factor	Real	The Peak Hour Factor to be applied to adjust the number of trips
Field	Matrix Cores	Array	An array of string elements specifying the matrices of the trip purposes that will be used in the PA to OD Transformation
	Hourly AB Field	Array	An array of strings specifying the view (hourly table) and field containing the departing percentages for each of the various trip
	Hourly BA Field	Array	An array of strings specifying the view (hourly table) and field of containing the returning percentages for each of the various trip purposes
	Adjust Field	String	The name of the field that contains the values for adjusting the vehicle occupancy by time of day
Flag	Separate Matrices	String	Yes for reporting each hour separately in a matrix core, No otherwise
	Convert to Vehicles	String	Yes to convert person trips to vehicle trips, no otherwise. These

			string values are stored in an array whose elements are each purpose.
	Include PHF	Integer	1 to adjust trips by a peak hour factor, 0 otherwise
	Adjust Peak Hour	Integer	1 to adjust peak hour by time of day, 0 otherwise
Output	Output Matrix	Array	An array of two option element arrays:

1.   Array   "Label", a string specifying the name to appear in the title bar of the matrix file (e.g., PA to OD)
2.   Array   "File Name", a string specifying the path and file name for the matrix

Example:

```
Opts = {{"Input", {{"PA Matrix Currency",
              {"C:\\caliper\\tc40\\Tutorial\\UTWN_PA.MTX",
                        "HBW",
                        "Row ID's",
                        "Col ID's"}},
                {"Lookup Set",
              {"C:\\PLATFORM\\TC40\\TAB\\HOURLY.BIN",
                        "HOURLY"}}}},
        {"Field",                  {{"Matrix Cores",              {1,
                  2,
                  3}},
                {"Adjust Fields",
              {"HOURLY.OCCADJ_HBW",
                        "HOURLY.OCCADJ_HBNW",
                        "HOURLY.OCCADJ_NHB"}},
                {"Peak Hour Field",        {,,}},
                {"Hourly AB Field",
              {"HOURLY.DEP_HBW",
                        "HOURLY.DEP_HBNW",
                        "HOURLY.DEP_NHB"}},
                {"Hourly BA Field",
              {"HOURLY.RET_HBW",
                        "HOURLY.RET_HBNW",
                        "HOURLY.RET_NHB"}}}},
        {"Global", {{"Method Type",                "PA to OD"},
                {"Start Hour",                    7},
                {"End Hour",                       9},
                {"Cache Size",              500000},
                {"Average Occupancies", {1.1,
                  1.5,
                  1.5}},
                {"Adjust Occupancies",       {"Yes",
                  "Yes",
                  "Yes"}},
                {"Peak Hour Factor",        {0,
                  0,
                  0}}}},
        {"Flag", {{"Separate Matrices",              "No"},
                {"Convert to Vehicles",       {"Yes",
                  "Yes",
                  "Yes"}},
                {"Include PHF",               {"No",
                  "No",
                  "No"}},
                {"Adjust Peak Hour",          {"No",
                  "No",
                  "No"}}}},
        {"Output", {{"Output Matrix",                {{"Label",
                        "PA to OD"},
                        {"File Name",
                        "C:\\temp\\PA2OD.MTX"}}}}}}

RunMacro("TCB Run Procedure", 1, "PA2OD", Opts)
```

Traffic Assignment

Summary: Creates a batch routine that will run a traffic assignment, using any of the available TransCAD assignment methods. All other advanced traffic assignment procedures have the same option parameters as standard traffic assignment.

Syntax: RunMacro("TCB Run Procedure", 1, "Assignment", Options)

Option Group	Option	Type	Contents
Input	Database	String	The path and the file name of the geographic database
	Network	String	The path and file name of the street network file
	OD Matrix Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
Global	Load Method	Integer	The assignment method: 1: All or Nothing, 2: STOCH, 3: Capacity Restraint, 4: Incremental, 5: User Equilibrium, 6: Stochastic User Equilibrium, 7: System Equilibrium.
	Load Factor	Real	Load Factor value
	Theme Info	Array	Array of {max voc value, step value, start color number, end color number, via color number}
	Alpha Value	Real	The default value for alpha
	Beta Value	Real	The default value for beta
	Iterations	Integer	The number of iterations
	Convergence	Real	The convergence value
	Stoch Function	Integer	The function for stochastic assignments: 1: Normal is the default, 2: Gumbel, 3: Uniform
	Stoch Error	Real	The error term for the stochastic function (5 is the default)
	Cold Start	Real	Seconds to use for cold start, if cold start option enabled
	Skip Value	Real	Real value to use to skip small values, if option enabled
	Critical Link Flows	Array	An array of critical links to use for each critical link set, if critical link analysis option is enabled
	Movement Set Name	String	Node set name to use if Report Movements option is enabled
Field	FF Time	String	The field in the street database that contains the free-flow time information for each link
	Capacity	String	The field in the street database that contains the value of capacity for each link
	Alpha	String	The field in the street database that contains the specific alpha values for each link, or null to use a default value for all links
	Beta	String	The field in the street database that contains the specific values of beta for each link, or null to use a default value for all links
	Preload	String	Preload field, if any
	Link Flow	String	Field to save link flow, if enabled in options
	Warm Start	String	Field to use for warm start, if enabled in options
Flag	Do Emission	Integer	1 for the procedure to do a cold start analysis, 0 otherwise
	Do Tabulation	Integer	The flow range and v/c range matrices (0: no, 1: Yes, requires additional inputs for v/c and flow matrix names)
	Do Skipping	Integer	1 to skip small values, 0 otherwise
	Do Warm Start	Integer	1 to do warm start, 0 otherwise
	Do Turn Movement	Integer	1 to report node movements, 0 otherise
	Do Theme	Integer	1 to create themes after assignment, 0 otherwise
Output	Flow Table	String	The path and file name for the output flow table
	Flow Matrix	Array	Array of output flow tabulation label and matrix file name, only if Do Tabulation flag is 1
	VOC Matrix	Array	Array of output VOC tabulation label and matrix file name, only if Do Tabulation flag is 1

Movement Table	String	Output file name of node movements, only if Do Turn Movement flag is 1
Critical Matrix	Array	An array of two options, only if Critical Link Flows option is present:

    1   Array   "Label", a string specifying the name to appear in the title bar of the critical link set OD matrix view

    2   Array   "File Name", a string specifying the path and file name for the critical link set OD matrix

Example:

```
Opts = {{"Input",   {{"Database",        "C:\\caliper\\tc40\\Tutorial\\plan_net.DBD"},
                      {"Network",
            "C:\\caliper\\tc40\\Tutorial\\plan_net.net"},
                      {"OD Matrix Currency", {"C:\\caliper\\tc40\\Tutorial\\Plan_od.mtx",
                                        "Flows",
                                        "Zone to Node",
                                        "Zone to Node"}},
                      {"Critical Link Table",
            "C:\\CALIPER\\TC40\\TUTORIAL\\CRIT.DBF"}}},
          {"Field",   {{"FF Time",                 "[TRAVEL TIME]"},
                       {"Capacity",                "CAPACITY"},
                       {"Alpha",                   "ALPHA"},
                       {"Beta",                    "BETA"},
                       {"Preload",                 "None"},
                       {"Link Flow",               "Type"},
                       {"Warm Start",              "Type"}}},
          {"Global",           {{"Load Method",            5},
                       {"Load Factor",            1},
                       {"Theme Info",             {1.8,
                                        0.25,
                                        27,
                                        6,
                                        8}},
                       {"Alpha Value",    0.15},
                       {"Beta Value",             4},
                       {"Convergence",            0.01},
                       {"Iterations",             20},
                       {"Cold Start",             505},
                       {"Skip Value",             0.01},
                       {"Critical Link Flows",    {1}},
                       {"Movement Set Name", "Critical Nodes"}}},
          {"Flag",    {{"Do Emission",            1},
                       {"Do Theme",               1},
                       {"Do Skipping",            1},
                       {"Do Warm Start",          1},
                       {"Do Turn Movement", 1}}},
          {"Output",{{"Flow Table",               "c:\\temp\\ASN_LinkFlow.bin"},
                     {"Flow Matrix",                  {{"Label",
                                        "Flow Matrix"},
                                        {"File Name",
                                        "c:\\temp\\ASN_Flow.mtx"}}},
                     {"VOC Matrix",     {{"Label",
                                        "VOC Matrix"},
                                        {"File Name",
                                        "c:\\temp\\ASN_voc.mtx"}}},
                     {"Movement Table",         "c:\\temp\\ASN_Movement.bin"},
                     {"Critical Matrix",            {{"Label",
                                        "Critical Matrix"},
                                        {"File Name",
                                        "c:\\temp\\ASN_Critical.mtx"}}}}}}}

RunMacro("TCB Run Procedure", 1, "Assignment", Options)
```

Assignment with User-Defined Volume Delay Functions

Summary: Performs an assignment using a user-defined volume delay function (VDF). Uses the same procedure name and arguments as Traffic Assignment, with the addition of several new arguments.

Syntax: RunMacro("TCB Run Procedure",1, "Assignment", Options)

Option Group	Option	Type	Contents
Global	Cost Function File	String	Name of VDF file to use
	VDF Defaults	Array	VDF default values
Field	VDF Fld Names	Array	Array of network field names used by the VDF

Example:
```
ExtraOpts =
        {{"Field",    {{"VDF Fld Names",      {"T0",
                                               "Cap",
                                   "Alpha",
                                   "Beta",
                                   "None"}}}},
        {"Global",   {{"Cost Function File",     "Bpr.vdf"},
                 {"VDF Defaults",          {,,
                                    0.15,
                                    4,}}}}}
```

Traffic Assignment (Multi-Modal Multi-Class Assignment)

Summary: Completes a multi-modal multi-class assignment, to assign different classes and modes of trips to a network simultaneously. The algorithm assumes that there are k vehicle modes or classes to be assigned.

Syntax: RunMacro("TCB Run Procedure", 1, "MMA", Options)

Option Group	Option	Type	Contents
Input	Database	String	The path and file name of the geographic database
	Network	String	The path and file name of the street network file
	OD Matrix Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Toll Matrix Currency	Array	An array of four strings:

		1 String	The path and file name of the matrix file
		2 String	The matrix name
		3 String	The row index
		4 String	The column index
	Exclusion Link Sets	Array	An array of sets for each O-D matrix used, each consisting of an array of:
		1 String	The geographic filename + "|" + layer name
		2 String	The layer name
		3 String	Selection set name
		4 String	Query used to create selection set
Global	Load Method	Integer	The assignment method: 1: all or nothing, 2: STOCH, 3: Capacity Restraint 4:Incremental, 5: User Equilibrium, 6: Stochastic User Equilibrium, 7: System Equilibrium
	Load Factor	Real	Load factor value
	Alpha Value	Real	The default value for alpha
	Beta Value	Real	The default value for beta
	Iterations	Integer	The number of iterations
	Convergence	Real	The convergence value
	Stoch Function	Integer	Specifies the random function generator to be used with stochastic assignments (1: Normal, 2: Gumbel, 3: Uniform)
	Stoch Error	Integer	Error term for stochastic function (5 is the default)
	Number of Classes	Integer	Number of vehicle classes
	Class PCEs	Array	An array of real values corresponding to the Passenger Car Equivalent for each vehicle class
	Class VOI"s	Array	An array of real values corresponding to the value of impedance for each vehicle class
	Cost Function File	String	Volume delay function file name to use
	VDF Defaults	Array	VDF function default values
Field	Class Toll Cores	Array	Toll matrix names to use for each vehicle class.
	Vehicle Classes	Array	Class matrices to use
	Fixed Toll Fields	Array	Fixed toll fields to use for each vehicle class
	VDF Fld Names	Array	Array of network field names that the user VDF uses
Output	Flow Table	String	The path and file name for the output flow table

Example:

```
Options = {{"Input",        {{"Database",     "C:\\tutorial\\masspike.DBD"},
                            {"Network",       "C:\\tutorial\\masshwy.net"},
                            {"OD Matrix Currency", {"H:\\ANDRES\\TOLLS\\OD_FLOW.MTX",
                                              "Car Flow",
                                              "Highway Xsection (I-X Centroids)",
                                              "Highway Xsection (I-X Centroids)"}},
                            {"Toll Matrix Currency", {"H:\\ANDRES\\TOLLS\\alltolls.mtx",
                                              "All Tolls (heavy truck)",
                                              "Rows",
                                              "Columns"}},
                            {"Exclusion Link Sets", {,,}}}},
           {"Field",  {{"Class Toll Cores",      {"All Exits (car)",
                                              "All Tolls (light truck)",
                                              "All Tolls (heavy truck)"}},
                            {"Vehicle Classes",        {1,
                                              2,
                                              3}},
                            {"Fixed Toll Fields",      {"[Link Toll]",
                                              "[Link Toll]",
                                              "[Link Toll]"}},
                            {"VDF Fld Names",        {"[Time (min)]",
                                              "[Link Toll]",
                                              "None",
                                              "None",
                                              "None"}}}},
           {"Global", {{"Load Method",5},
                            {"Load Factor",    1},
                            {"Alpha Value",    0.15},
                            {"Beta Value",     4},
                            {"Convergence",   0.01},
                            {"Iterations",              20},
                            {"Number of Classes", 3},
```

```
                        {"Class PCEs",    {1,
                                           4,
                                           10}},
                        {"Class VOIs",    {1,
                                           1,
                                           1}},
                        {"Cost Function File",        "Bpr.vdf"},
                        {"VDF Defaults",  {,,
                                          0.15,
                                          4,}}}},
              {"Output", {{"Flow Table",   "C:\\temp\\SUP_LINKFLOW.BIN"}}}}

              RunMacro("TCB Run Procedure", 1, "MMA", Options)
```

Top

HOV Assignment

Summary: Performs a traffic assignment procedure that assists the user in analyzing the performance of High Occupancy Vehicle (HOV) lanes, by assigning the HOV and non-HOV demand matrices simultaneously.

Syntax: RunMacro("TCB Run Procedure", 1, "HOV", Options)

Option Group	Option	Type	Contents
Input	Database	String	The path and the file name of the geographic database
	Network	String	The path and file name of the network file
	OD Matrix Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Exclusion Sets	Array	An array of string elements:
			1 String The path and file name of the dataview containing the street records
			2 Array An array of string names of the exclusion sets
			3 String The name of the database (i.e. streets)
Global	Load Method	Integer	The desired assignment method: 1: Incremental, 5: User Equilibrium, 6: Stochastic User Equilibrium, 7: System Equilibrium
	Matrix Cores	Array	An array of integers specifying the matrices of the O-D matrix file to be used in the assignment. The listing begins at the integer 1, the number representing the first matrix of the matrix file.
	Alpha Value	Real	The desired default value for alpha, used when link-specific values of alpha are not available
	Beta Value	Real	The desired default value for beta, used when link-specific values of beta are not available
	Iterations	Integer	The desired number of procedure iterations
	Convergence	Real	The convergence criteria for the procedure
	Stoch Error	Integer	The error term for stochastic function (5 is the default)
	Stoch Function	Integer	The stochastic assignments: 1: Normal (the default), 2: Gumbel, 3: Uniform
Field	FF Time	String	The field in the street database that contains the free-flow time information for each link
	Capacity	String	The field in the street database that contains the value of capacity for each link
	Alpha	String	The field in the street database that contains the specific alpha values for each link, or null to use a default value for all links
	Beta	String	The field in the street database that contains the specific values of beta for each link, or null to use a default value for all links

Output	Flow Table	String	The path and file name for the output flow table

Example: Options =   {{"Input", {{"Database",   "C:\\caliper\\tc40\\Tutorial\\HOV.CDF"},
                    {"Network",   "C:\\caliper\\tc40\\Tutorial\\Hov.net"},
                    {"OD Matrix Currency", {"C:\\caliper\\tc40\\Tutorial\\Hov.mtx",
                                           "Local",
                                           "Node",
                                           "Node"}},
                    {"Exclusion Sets",{{{"C:\\caliper\\tc40\\Tutorial\\HOV.CDF|Streets"},
                                           "Streets",
                                           "HOV Lanes"},}}}},
          {"Field", {{"FF Time",   "T0"},
                    {"Capacity",   "Cap"},
                    {"Alpha",   "Alpha"},
                    {"Beta",   "Beta"},
                    {"Preload",   "None"}}},
          {"Global", {{"Load Method",   5},
                    {"Load Factor",   1},
                    {"Alpha Value",   0.15},
                    {"Beta Value",   4},
                    {"Convergence",   0.01},
                    {"Iterations",   20},
                    {"Matrix Cores",   {1,
                         2}}}},
          {"Output", {{"Flow Table",   "C:\\temp\\HOV_LINKFLOW.BIN"}}}}

          RunMacro("TCB Run Procedure", 1, "HOV", Options)

Top

O-D Matrix Estimation

Summary: Creates a batch routine that will run an O-D matrix estimation using any available TransCAD assignment methods.

Syntax: RunMacro("TCB Run Procedure", 1, "Assignment", Options)

Option Group	Option	Type	Contents
Input	Database	String	The path and the file name of the geographic database.
	Network	String	The path and file name of the street network file.
	OD Matrix Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
Global	Load Method	Integer	The assignment method: 1: All or Nothing, 2: STOCH, 3: Capacity Restraint, 4: Incremental, 5: User Equilibrium, 6: Stochastic User Equilibrium, 7: System Equilibrium
	Load Factor	Real	Load Factor value
	Theme Info	Array	Array of {max voc value, step value, start color number, end color number, via color number}
	Alpha Value	Real	The default value for alpha
	Beta Value	Real	The default value for beta
	Iterations	Integer	The number of iterations
	Convergence	Real	The convergence value
	ODME Iterations	Integer	The number of ODME iterations
	ODME Convergence	Real	The ODME convergence value

Field	FF Time	String	The field in the street database that contains the free-flow time information for each link
	Capacity	String	The field in the street database that contains the value of capacity for each link
	Alpha	String	The field in the street database that contains the specific alpha values for each link, or null to use a default value for all links
	Beta	String	The field in the street database that contains the specific values of beta for each link, or null to use a default value for all links
	Preload	String	Preload field, if any
	Count	String	Traffic count flow
Output	Flow Table	String	The path and file name for the output flow table.
	Estimated OD Matrix	Array	An array of two option element arrays:

		1	Array	"Label", a string specifying the name to appear in the title bar of the matrix file
		2	Array	"File Name", a string specifying the path and file name for the matrix

Example:

```
Options =          {{"Input",          {{"Database",
        "C:\\caliper\\tc40\\Tutorial\\plan_net.DBD"},
                {"Network",
        "C:\\caliper\\tc40\\Tutorial\\plan_net.net"},
                {"OD Matrix Currency", {"C:\\caliper\\tc40\\Tutorial\\Plan_od.mtx",
                                "Flows",
                                "Zone to Node",
                                        "Zone to Node"}}}},
        {"Field", {{"FF Time",              "[TRAVEL TIME]"},
                {"Capacity",                "CAPACITY"},
                {"Alpha",                   "ALPHA"},
                {"Beta",                    "BETA"},
                {"Preload",                 "None"},
                {"Count",                   "[GROUND COUNTS]"}}},
        {"Global", {{"Load Method",5},
                {"Load Factor",             1},
                {"Alpha Value",     0.15},
                {"Beta Value",              4},
                {"Convergence",   0.01},
                {"Iterations",      20},
                {"ODME Iterations",         10},
                {"ODME Convergence", 0.1}}},
        {"Output", {{"Flow Table",   "c:\\temp\\ODMELinkFlow.bin"},
                {"Estimated OD Matrix", {{"Label",
                                "Estimated OD Matrix"},
                                {"File Name",
                                "c:\\temp\\ODME_OD.mtx"}}}}}}

RunMacro("TCB Run Procedure", 1, "ODME", Options)
```

Top

Transit Shortest Path Attribute Matrix (Transit Skim)

Summary: Computes a matrix that indicates the characteristics of the transit shortest path between pairs of traffic analysis zones or stops, using any of the transit shortest pathfinding options.

Syntax: RunMacro("TCB Run Procedure", 1, "Transit Skim", Options)

Option Group	Option	Type	Contents
Input	Database	String	The path and the file name of the geographic database
	Network	String	The path and file name of the transit network file (*.tnw)
	Origin Set	Array	An array of four strings:
			1 String The path and file name of the database that contains the origins
			2 String The name of the layer of containing the origins
			3 String The selection set on the layer containing the origins
			4 String The query used to create the selection set
	Destination Set	Array	An array of three or four strings:
			1 String The path and file name of the database that contains the destinations
			2 String The name of the layer of containing the destinations
			3 String The selection set on the layer containing the destinations
			4 String The query used to create the selection set. Omitted if the query is the same as the one used for the origin set.
Global	Skim Method	Integer	The method to be used in computing the transit shortest path. The values are: 1: Shortest Path, 2: Optimal Strategies,:3 = Path Finder.
	Skim Var	Array	An array of integers specifying the network attributes to skim. Each attribute is assigned a number based upon its location in the scroll list. The first element in the list is always assigned to 1.
	OD Layer Type	Integer	1 = Stop to Stop; 2 = Node to Node
Output	Output Matrix	Array	An array of two options:
			1 Array "Label", a string specifying the name to appear in the title bar of the matrix file
			2 Array "File Name", a string specifying the path and file name for the output matrix of shortest paths

Example:

```
Options =          {{"Input",{{"Database",        "C:\\caliper\\tc40\\Tutorial\\Sp_str.CDF"},
                        {"Network",
                "C:\\caliper\\tc40\\Tutorial\\TRANSIT.TNW"},
                        {"Origin Set",       {{"C:\\caliper\\tc40\\Tutorial\\Sp_str.CDF|Node"},
                                        "Node",
                                        "Centroids",
                                        "Select * where TAZ <> null"}},
                        {"Destination Set",
                {{"C:\\caliper\\tc40\\Tutorial\\Sp_str.CDF|Node"},
                                        "Node",
                                        "Centroids"}}}},
                {"Global", {{"Skim Method",3},
                        {"Skim Var",         {1,
                                             2,
                                             3,
                                             4,
                                             5}},
                        {"OD Layer Type",        2}}},
                {"Output", {{"Skim Matrix",  {{"Label",
                                             "Skim Matrix (Pathfinder)"},
                                             {"File Name",
                                             "C:\\temp\\TR_SKIM.MTX"}}}}}}

        RunMacro("TCB Run Procedure", 1, "Transit Skim", Options)
```

[Top](#)

Transit Trip Assignment

Summary: Performs a transit assignment using any of the available methods in TransCAD to estimate the number of passengers utilizing each link in a transit network, as a function of transit level of service and fare.

Syntax: RunMacro("TCB Run Procedure",1, "Transit Assignment", Options)

Option Group	Option	Type	Contents
Input	Transit RS	String	The path and file name for the route system
	Network	String	The path and file name for the transit network (*.tnw)
	OD Matrix Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Critical Set	Array	An array of 4 strings containing {stops geographic file, stop layer name, critical stop selection set name, query used to create selection set name}
	Movement Set	Array	An array of 2 strings containing {movement table file name, movement table dataview name}
	Line OD Set	Array	An array of 2 strings containing {transit route system name, route system layer name, route selection set, query used to create route selection set}
Global	Assignment Method	Integer	The desired assignment method. The values are: 1: all or nothing, 2: Optimal Strategies, 3: Pathfinder, 4: User Equilibrium, 5: Stochastic User Equilibrium
	Iterations	Integer	The desired number of iterations. Only for UE and SUE.
	Convergence	Real	The convergence criteria for the procedure. Only for UE and SUE.
	OD Layer Type	Integer	A value specifying whether the O-D matrix is stop-based or node-based. The values are: 1: Based on Stop Layer, or 2: Based on Node Layer.
Flag	Do OnOff Report	Integer	The value 1 to report boarding/alightings, or 0 for no report
	Do Aggre Report	Integer	The value 1 to aggregate segment counts or 0 for no aggregation
	Do Skimming	Integer	The value 1 to enable skimming or 0 for no skimming
Output	Flow Table	String	The path and file name for the binary output flow table
	OnOff Table	String	The path and file name of the binary on-off table
	Movement Table	String	The path and file name of the output movement table
	Line OD Table	String	The path and file name of the output Line O-D table
	Critical Matrix	Array	An array of two options:
			1 Array "Label", a string specifying the name to appear in the title bar of the matrix file
			2 Array "File Name", a string specifying the path and file name for the output matrix

Example:

```
Options = {{"Input", {{"Transit RS",      "C:\\caliper\\tc40\\Tutorial\\transit.rts"},
                {"Network",          "C:\\caliper\\tc40\\Tutorial\\TRANSIT.TNW"},
                {"OD Matrix Currency",
          {"C:\\caliper\\tc40\\Tutorial\\TR_OD.MTX",
                                "OD",
                                "zones to nodes",
                                "zones to nodes"}},
                {"Critical Set",
          {{"C:\\caliper\\tc40\\Tutorial\\transitS.DBD|Stops"},
                                "Stops",
                                "Critical Stops",
                                "Select * where critstopflag = 1"}},
                {"Movement Set",
          {"C:\\CALIPER\\TC40\\TUTORIAL\\CRIT_MOVE.DBF",
                                "crit_move"}},
                {"Line OD Set",         {"C:\\caliper\\tc40\\Tutorial\\transit|Route
     System",
                                "Route System",
                                "Critical Routes",
                                "Select * where critrouteflag = 1"}}}},
```

```
{"Global",                    {{"Assignment Method",      4},
            {"OD Layer Type",          2},
            {"Iterations",        20},
            {"Convergence",            0.0001}}},
    {"Flag",   {{"Do OnOff Report",      1},
            {"Do Aggre Report",        1}}},
    {"Output",{{"Flow Table",              "c:\\temp\\TASN_FLW.bin"},
            {"Walk Flow Table",        "c:\\temp\\TASN_WFL.bin"},
            {"Aggre Table",        "c:\\temp\\TASN_AGG.bin"},
            {"OnOff Table",        "c:\\temp\\TASN_ONO.bin"},
            {"Movement Table",          "c:\\temp\\TASN_MOV.bin"},
            {"Line OD Table",          "c:\\temp\\TASN_LOD.bin"},
            {"Critical Matrix",          {{"Label",
                        "Critical Matrix"},
                        {"File Name",
                        "c:\\temp\\TASN_CRT.mtx"}}}}}}
```

RunMacro("TCB Run Procedure", 1, "Transit Assignment", Options)

Nested Logit Model

Summary:　　　Performs a series of multinomial logit evaluations within a nested structure.

Syntax:　　　RunMacro("TCB Run Operation", 1, "NLM", Options)

Option Group	Option	Type	Contents
Input	Model File	String	The path and filename of the nested logit model file (created interactively)
	Variable Views	Array	An array of all dataviews involved in the logit model. Each dataview is an array of two strings:
			1　String　The path and file name of the table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name.
			2　String　The name of the table or layer
	Variable Currencies	Array	An array of matrix currency information for each matrix used in the evaluation. Each element in this array is a four element array consisting of four strings:
			1　String　The path and file name of the matrix file
			2　String　The matrix name
			3　String　The row index
			4　String　The column index
	Base View Set	Array	The base view which is an array of two strings:
			1　String　The path and file name of the table or geographic file. If a geographic file, followed by a vertical bar "|" and then the layer name.
			2　String　The name of the table or layer
Output	Probability Matrix	Array	An array of two options:
			1　Array　"Label", a string specifying the name to appear in the title bar of the matrix file
			2　Array　"File Name", a string specifying the path and file name for the output matrix of shortest paths

Example:　　　Options = {{"Input", {{"Model File",   "C:\\caliper\\tc40\\nlm_mod1.nlm"},
            {"Variable Views",
        {{"C:\\caliper\\tc40\\Tutorial\\UTOWN_ZN.DBD|Zone",
                        "Zone"}}},

```
                    {"Variable
Currencies",{{"C:\\caliper\\tc40\\Tutorial\\IMPEDNCE.MTX",
                                    "AUTO TT",
                                    "RCIndex",
                                    "RCIndex"},
                          {"C:\\caliper\\tc40\\Tutorial\\BUSFARE.MTX",
                          "Bus Fare",
                          "Rows",
                          "Columns"}}},
                 {"Base View Set",
           {"C:\\caliper\\tc40\\Tutorial\\UTOWN_ZN.DBD|Zone",
                                    "Zone"}}}},
              {"Output", {{"Probability Matrix",{{"Label",
                                    "Probability Matrix"},
                          {"File Name",
                          "C:\\temp\\NLM_PROB.MTX"}}}}}}

         RunMacro("TCB Run Operation", 1, "NLM", Options)
```

Top

Update Network Field

Summary: Updates one or more network fields from the line layer.

Syntax: RunMacro("TCB Run Operation", 1, "Update Network Field", Options)

Option Group	Option	Type	Contents
Input	Database	String	Line geographic file name
	Network	String	Network file name
	Link Set	Array	Array of {Geographic file name and layer name, highway layer name}
Global	Field Indices	String	Name of network field to update
	Options	Array	An array of option pairs:
		1	Link Fields Array of {AB update field, BA update field}
		2	Constants Array of constants used for updating

Example: Options = {{"Input",   {{"Database",
              "C:\\caliper\\tc40\\Tutorial\\plan_net.DBD"},
                     {"Network",   "C:\\caliper\\tc40\\Tutorial\\plan_net.net"},
              {"Link Set",
              {{"C:\\caliper\\tc40\\Tutorial\\plan_net.DBD|Highways/Streets"},
                                    "Highways/Streets"}}}},
              {"Global", {{"Fields Indices",   "[TRAVEL TIME]"},
                     {"Options",   {{"Link Fields",
                                    {{"[Highways/Streets].[TRAVEL TIME]",
                                    "[Highways/Streets].[TRAVEL TIME]"}}},
                                    {"Constants",
                                    {3}}}}}}}

         RunMacro("TCB Run Operation", 1, "Update Network Field", Options)

Top

Fill Dataview

Summary: Fills a field in a dataview with a fixed number, a sequence of numbers, the result of a formula, or the result of tagging based on another layer.

Syntax: RunMacro("TCB Run Operation", 1, "Fill Dataview", Options)

Option Group	Option	Type	Contents
Input	Dataview Set	Array	Array of Dataview file name, layer, and optionally, selection set name and query
Global	Fields	Array	Input field names to fill
	Method	String	"Value", "Sequence", "Formula" or "Tag"
	Parameter	String	Formula or value or sequence with which to fill

Example: Options =   {{"Input", {{"Dataview Set",
                          {"C:\\caliper\\tc40\\Tutorial\\BOSTON.CDF|Streets",
                                                      "Streets"}}}},
                      {"Global", {{"Fields",   {"Speed"}},
                              {"Method",   "Formula"},
                              {"Parameter",   "Length/[TIME (min)]/60"}}}}

          RunMacro("TCB Run Operation", 1, "Fill Dataview", Options)

Top

Create Formula Field

Summary: Creates a formula field in a dataview.

Syntax: RunMacro("TCB Run Operation", 1, "Formula Field", Options)

Option Group	Option	Type	Contents
Input	View Set	Array	Array of Dataview file name, layer, and optionally, selection set name and query
Global	Field Name	String	New formula field name
	Formula Text	String	Formula
	Field Type	String	"Integer", "String" or "Real"

Example: Options = {{"Input", {{"View Set",
                      {"C:\\caliper\\tc40\\Tutorial\\BOSTON.CDF|Streets",
                                                      "Streets"}}}},
                      {"Global", {{"Field Name",   "TIME"},
                            {"Formula Text",   "Length/Speed*60"},
                            {"Field Type",   "Real"}}}}

          RunMacro("TCB Run Operation", 1, "Formula Field", Options)

Top

Batch Mode Tutorial

This interactive example shows you how to use Batch Mode in TransCAD and how to generate a Batch Mode resource file. We will use Vermont as a case study. The following files serve as inputs to the Batch Mode process:

File	Description
vthwy.dbd	Vermont highway line layer with free-flow travel times, capacities, and alpha and beta values. On the node layer, values of NTYPE = "Centroid" denote centroid nodes.
vt_mcd.dbd	Vermont TAZ area layer. Contains socioeconomic and employment data such as Dwelling Units, Retail and Non-Retail Employment, Households, and Average Income.
vtbatch.net	Vermont network file associated with vthwy.dbd.
vtsp.mtx	Highway Skim Matrix of shortest path times from TAZ to TAZ.

All of these files are located in the Tutorial folder of TransCAD program folder. There is a workspace called vtbatche.wrk that contains all of these files.

In this example, you are going to do three of the four steps in the planning process: Trip Generation, Trip Distribution and Trip Assignment. The following methods will be used for these three steps: QRM (Quick Response Method) Production, QRM Attraction, Gravity Evaluation, and Traffic Assignment with the User Equilibrium method. Before you run these procedures in Batch Mode, you will implement this model interactively so that you can see the results of each procedure. Before you run these examples, you should refer to the earlier chapters in this manual, making sure that you understand what each of these procedures does, what are the required inputs, and what are the outputs.

Before running each procedure, you should inspect all input files and input fields to understand what inputs are being used for that procedure. After running each procedure, you should examine all output tables, matrices, and report and log files to see what the outputs are created by the procedures. Once you have gone through the input and output files and understand the interactions between the procedures, you will be ready to perform the same steps in Batch Mode.

) Tutorial: To Run Trip Generation-Quick Response

1. Choose *File-Open Workspace* and open the workspace vtbatche.wrk.

2. Make sure that the working layer is the MCD layer.

3. Choose *Planning-Quick Response Method* to display the QRM - Trip Generation and Balancing dialog box.

4. Choose Income/HH from the Classify By drop-down list, INC/HH from the Inc/HH (000s) drop-down list, and Hold Productions from the Balancing Method drop-down list. The other settings can remain at their defaults.

5. Click OK. TransCAD displays the Store Output Table In dialog box. You can accept the default file name and folder, or type a new file name.

6. Click Save. TransCAD performs the Quick Response Method, displays the results in a dataview, and displays the Results Summary dialog box. You can click Show Warnings to review the log file and click Show Report to review the report file.

7. Click Close.

TransCAD closes the Results Summary dialog box.

) **Tutorial: To Run Trip Distribution-Gravity Evaluation**

1. Choose **Planning-Trip Distribution-Gravity Evaluation** to display the Gravity Evaluation dialog box.

2. Choose MCD+QRM_ALL from the Dataview drop-down list.

3. Type "HBW" in the Purpose Name text box and press Enter. TransCAD fills in the Production and Attraction fields.

4. Click the Friction Factors tab. You will use the defaults of a Gamma function to estimate friction factors. The impedance matrix will be Shortest Path (T0) and the a, b, and c settings will remain at their defaults.

5. Click OK. TransCAD displays the Save As dialog box. You can accept the default file name and folder, or type a new file name.

6. Click Save. TransCAD performs the gravity evaluation on the HBW purpose, displays the output matrix, and displays the Results dialog box.

7. TransCAD displays the Results Summary dialog box. You can click Show Warnings to review the log file and click Show Report to review the report file.

8. Click Close.

TransCAD closes the Results Summary dialog box.

) **Tutorial: To Run Traffic Assignment**

1. Choose the map window by clicking on it or choosing **Window-Map-VT MCDs** from the menu. Make the highway layer the current layer by choosing Highway from the drop-down list on the toolbar.

2. Choose **Planning-Traffic Assignment** to display the Traffic Assignment dialog box.

   If a network is not open, TransCAD will display the File Open dialog box. Choose the network vtbatch.net and click Open. TransCAD will display the Network Settings dialog box. Click OK to close the dialog box.

   You will use the default settings shown above.

3. Click OK. TransCAD displays the Store Flow Table In dialog box. You can accept the default file name and folder, or type a new file name.

4. Click Save. TransCAD performs a 20-iteration User Equilibrium assignment, saves the results to a binary table, automatically joins it to vmthwy.dbd, and displays the Results Summary dialog box. You can click Show Warnings to review the log file and click Show Report to review the report file.

5. Click Close to close the Results Summary dialog box.

6. Choose **File-Close All** and click No to All.

TransCAD closes all of the windows.

For more information, see:
Running Procedures in Batch Mode
Extending the Batch Macro

Running Procedures in Batch Mode

Running procedures in Batch Mode is similar to running procedures interactively. The only real difference is that the Batch Mode recorder is on while you prepare and run the procedure and, by using the dry run option, the output files are just empty files.

) Tutorial: To Run and Chain the Three Procedures in Batch Mode

1. Choose *File-Open Workspace* and open the workspace vtbatche.wrk.

2. Choose *Planning-Batch Editing-Batch Tools* to display the Batch Mode toolbox.

3. Click ⬤ to start the Batch Recorder and click ▶ to do a dry run.

4. Make sure that your working layer is the MCD layer.

5. Choose *Planning-Quick Response Method* to display the QRM dialog box.

   Notice that the OK button is replaced with the Queue button.

6. Choose Income/HH from the Classify By drop-down list, INC/HH from the Inc/HH (000s) drop-down list, and Hold Productions from the Balancing Method drop-down list. The other settings can remain at their defaults.

7. Click Queue. TransCAD displays the Store Output Table In dialog box. You can accept the default file name and folder, or type a new file name.

8. Click Save. TransCAD will perform a dry run of the quick response method, without actually producing any output, and display the Results Summary dialog box.

9. Click Close. TransCAD closes the Results Summary dialog box.

10. Choose *Planning-Trip Distribution-Gravity Evaluation* to display the Gravity Evaluation dialog box.

11. Choose QRM_ALL from the Dataview drop-down list.

12. Type "HBW" in the Purpose Name text box and press Enter. TransCAD fills in the Production and Attraction fields.

13. Click the Friction Factors tab. You will use the defaults of a Gamma function to estimate friction factors. The impedance matrix will be Shortest Path (T0) and the a, b, and c settings will remain at their defaults.

14. Click Queue. TransCAD displays the Save As dialog box. You can accept the default file name

and folder, or type a new file name.

15. Click Save. TransCAD does a dry run of the gravity evaluation on the HBW purpose and displays an empty matrix. Although a dry run does not actually perform a Gravity Evaluation, it does produce an output file that is needed for the next step.

16. Make sure the map window is the current window.

17. Change the working layer to the Highway layer.

18. Choose **Planning-Traffic Assignment** to display the Traffic Assignment dialog box.

    If a network is not open, TransCAD will display the File Open dialog box. Choose the network vtbatch.net and click Open. TransCAD will display the Network Settings dialog box. Click OK to close the dialog box.

    You will use the default settings shown above.

19. Click Queue. TransCAD displays the Store Flow Table In dialog box. You can accept the default file name and folder, or type a new file name.

20. Click Save. TransCAD does a dry run of the traffic assignment and displays the Results Summary dialog box.

21. Click Close. TransCAD closes the Results Summary dialog box.

    You have performed all of the procedures that you want batched together. It is now time to see the Batch Mode resource file.

22. Click ![icon] in the Batch Mode toolbox to display the Batch Editor toolbox. You will notice that all three procedures have been recorded. You can go through the code and see what has been generated.

23. Click ![icon] in the Batch Mode toolbox to stop the Batch Recorder. TransCAD displays a Confirm dialog box.

24. Click Yes to display the Save Batch File As dialog box, type a file name, and click Save. TransCAD saves the Batch Contents as a Batch Mode resource file.

You are now ready to compile and run your Batch Mode resource file. It should look like this:

```
Macro "Batch Macro"
   RunMacro("TCB Init")
// STEP 1: QRM All
   Opts = {{"Input",          {{"Zone View",
         {"C:\\caliper\\tc40\\Tutorial\\vt_mcd.DBD|MCD","MCD"}},
                  {"Zone Set",            {"C:\\caliper\\tc40\\Tutorial\\vt_mcd.DBD|MCD","MCD"}},
                  {"Production Table",    {"C:\\CALIPER\\TC40\\TAB\\PROD_TGP.DBF"}},
                  {"Attraction Table",    {"C:\\CALIPER\\TC40\\TAB\\ATTR_TGP.DBF"}}}},
         {"Field",        {{"Total HH",           "MCD.[TOT-HH]"},
                  {"Dwelling",            "MCD.[DWELLING-UNITS]"},
                  {"Retail Employment",   "MCD.[RETAIL-EMPLOYMENT]"},
                  {"Non-Ret Employment", "MCD.[NONRETAIL-EMPLOYMENT]"},
                  {"Income",              "MCD.[INC/HH]"}}},
         {"Global",       {{"Model Option", "Prod & Attr"},
                  {"Classify By",         2},
                  {"Production Option",    "Rates HH"},
                  {"Income Option",       "Income Based"},
```

```
                    {"Balance Method",          "Hold Productions"},
                    {"Number of Purposes",   4},
                    {"Ext Names",                {"HBW",
                                                  "HBNW",
                                  "HBO",
                                  "NHB"}}}},
          {"Output",         {{"Output Table",  "C:\\caliper\\tc40\\tutorial\\QRM_ALL.BIN"}}}}

    if !RunMacro("TCB Run Procedure", 1, "QRM All", Opts) then goto quit

// STEP 2: Gravity
    Opts = {{"Input",          {{"PA View Set",   {"c:\\caliper\\tc40\\tutorial\QRM_ALL.BIN","QRM_ALL"}},
                    {"FF Matrix Currencies", {{"C:\\caliper\\tc40\\Tutorial\\Vt_sp.mtx",
                                    "T0",
                                    "RCIndex",
                                    "RCIndex"}}},
                    {"Imp Matrix Currencies", {{"C:\\caliper\\tc40\\Tutorial\\Vt_sp.mtx",
                                    "T0",
                                    "RCIndex",
                                    "RCIndex"}}},
                    "FF Tables",               {{"C:\\caliper\\tc40\\QRM_ALL.BIN"}}},
                    {"KF Matrix Currencies", {{"C:\\caliper\\tc40\\Tutorial\\Vt_sp.mtx",
                                    "T0",
                                    "RCIndex",
                                    "RCIndex"}}}}},
          {"Field",           {{"Prod Fields",   {"QRM_ALL.HBW_P"}},
                    {"Attr Fields",              {"QRM_ALL.HBW_A"}},
                    {"FF Table Fields",          {"QRM_ALL.ID1"}},
                    {"FF Table Times",           {"QRM_ALL.ID1"}}}},
          {"Global",          {{"Purpose Names",          {"HBW"}},
                    {"Iterations",               {10}},
                    {"Convergence",              {0.001}},
                    {"Constraint Type",          {"Double"}},
                    {"Fric Factor Type",         {"Gamma"}},
                    {"A List",                   {1}},
                    {"B List",                   {0.3}},
                    {"C List",                   {0.01}}}},
          {"Flag",            {{"Use K Factors",           {0}}}},
          {"Output",          {{"Output Matrix",           {{"Label",
                                    "Output Matrix"},
                                    {"File Name",
                                    "C:\\temp\\CGRAV.MTX"}}}}}}

    if !RunMacro("TCB Run Procedure", 2, "Gravity", Opts) then goto quit


// STEP 3: Assignment
    Opts = {{"Input",          {{"Database",                    "C:\\caliper\\tc40\\Tutorial\\Vthwy.DBD"},
                    {"Network",         "C:\\caliper\\tc40\\Tutorial\\Vtbatch.net"},
                    {"OD Matrix Currency", {"C:\\temp\\CGRAV.MTX",
                                    "HBW",
                                    "Row ID's",
                                    "Col ID's"}}}},
          {"Field",           {{"FF Time",                   "T0"},
                    {"Capacity",                 "Capacity"},
                    {"Alpha",                    "Alpha"},
                    {"Beta",                     "Beta"},
                    {"Preload",                  "None"}}},
          {"Output",          {{"Flow Table",                   "C:\\temp\\ASN_LINKFLOW.BIN"}}}}

    if !RunMacro("TCB Run Procedure", 3, "Assignment", Opts) then goto quit
```

```
    done:
    Return( RunMacro("TCB Closing", 1, "TRUE" ) )
    quit:
    Return( RunMacro("TCB Closing", 0, "TRUE" ) )
EndMacro
```

) **Tutorial: To Compile the Batch Mode Resource File**

1. Choose *File-Close All* to close all the windows.

2. Choose *Tools-Add-Ins*, highlight GIS Developer's Kit, and click OK to display the GISDK toolbox.

3. Click , choose the Batch Mode resource file saved in the previous procedure, and click Open. TransCAD compiles the resource file.

4. Click , type "Batch Macro" in the Name text box, and click OK.

TransCAD runs the three procedures and displays a message that the macro ran successfully. TransCAD also launches the Notepad program to display a text file that describes the procedures completed in the batch process. The full text of this resource file can be found under the tutorial directory. It is called batchexample1.rsc. Before you compile and run this file, you should change all input and output file references to be consistent with the tutorial and output directories in your computer.

) **Tutorial: To Create an Interface to Run Batch Macros**

Once the Batch Mode resource file is created, you are ready to create an interface so that users can quickly and easily run batch macros. There are several ways that this can be done. The simplest method involves adding an item in the TransCAD add-in list:

1. In the GISDK toolbox, click , choose the Batch Mode resource file saved in the previous procedure, and click Open. TransCAD displays the Save As dialog box.

2. Type a filename (for example c:\program files\transcad\batchui.dbd) and click Save. TransCAD compiles your Batch Mode resource file to a UI database.

3. Choose *Tools-Add-Ins* and click Setup to display the Setup Add-ins dialog box.

4. Click Add and enter the description, name, and UI database name of the batch macro. Make sure that the name matches the macro name exactly, and that the UI database matches the path and filename of the compiled database.

You can now run the batch macro by choosing *Tools-Add-Ins* , choosing you add-in and clicking OK.

You can also run the batch macro from a simple dialog box. The following code generates a simple dialog box with a button that runs the batch macro:

```
            Dbox "Batch Run Example" title: "Run Batch"
            Button "Run Batch" 1, 1, 15 do
                    RunMacro("Batch Macro")
```

```
                Return()
        Enditem
        Button "Cancel" 1, 3, 15 do
                Return()
        Enditem
```

You can also break up your batch macro into components and run each component separately. For example, you can divide up your batch code in the following manner:

```
Macro "Batch Macro Generation"
   RunMacro("TCB Init")
// STEP 1: QRM All
   Opts = {{"Input",          {{"Zone View",
           {"C:\\caliper\\tc40\\Tutorial\\vt_mcd.DBD|MCD","MCD"}},
                   {"Zone Set",              {"C:\\caliper\\tc40\\Tutorial\\vt_mcd.DBD|MCD","MCD"}},
                   {"Production Table",      {"C:\\CALIPER\\TC40\\TAB\\PROD_TGP.DBF"}},
                   {"Attraction Table",      {"C:\\CALIPER\\TC40\\TAB\\ATTR_TGP.DBF"}}}},
           {"Field",          {{"Total HH",              "MCD.[TOT-HH]"},
                   {"Dwelling",              "MCD.[DWELLING-UNITS]"},
                   {"Retail Employment",     "MCD.[RETAIL-EMPLOYMENT]"},
                   {"Non-Ret Employment", "MCD.[NONRETAIL-EMPLOYMENT]"},
                   {"Income",                "MCD.[INC/HH]"}}},
           {"Global",         {{"Model Option", "Prod & Attr"},
                   {"Classify By",           2},
                   {"Production Option",      "Rates HH"},
                   {"Income Option",          "Income Based"},
                   {"Balance Method",         "Hold Productions"},
                   {"Number of Purposes",    4},
                   {"Ext Names",              {"HBW",
                                              "HBNW",
                                  "HBO",
                                  "NHB"}}}},
           {"Output",   {{"Output Table",          "C:\\caliper\\tc40\\tutorial\\QRM_ALL.BIN"}}}}

   if !RunMacro("TCB Run Procedure", 1, "QRM All", Opts) then goto quit

   done:
   Return( RunMacro("TCB Closing", 1, "TRUE" ) )
   quit:
   Return( RunMacro("TCB Closing", 0, "TRUE" ) )
EndMacro

Macro "Batch Macro Distribution"
// STEP 2: Gravity
   RunMacro("TCB Init")
   Opts = {{"Input",          {{"PA View Set",   {"c:\\caliper\\tc40\\tutorial\\QRM_ALL.BIN","QRM_ALL"}},
                   {"FF Matrix Currencies", {{"C:\\caliper\\tc40\\Tutorial\\Vt_sp.mtx",
                                  "T0",
                                  "RCIndex",
                                  "RCIndex"}}},
                   {"Imp Matrix Currencies", {{"C:\\caliper\\tc40\\Tutorial\\Vt_sp.mtx",
                                  "T0",
                                  "RCIndex",
                                  "RCIndex"}}},
                   {"FF Tables",      {{"c:\\caliper\\tc40\\tutorial\\QRM_ALL.BIN"}}},
                   {"KF Matrix Currencies", {{"C:\\caliper\\tc40\\Tutorial\\Vt_sp.mtx",
                                  "T0",
                                  "RCIndex",
                                  "RCIndex"}}}}},
           {"Field",          {{"Prod Fields",   {"QRM_ALL.HBW_P"}},
                   {"Attr Fields",            {"QRM_ALL.HBW_A"}},
                   {"FF Table Fields",        {"QRM_ALL.ID1"}},
```

```
                {"FF Table Times",          {"QRM_ALL.ID1"}}}},
         {"Global",          {{"Purpose Names",          {"HBW"}},
                {"Iterations",              {10}},
                {"Convergence",          {0.001}},
                {"Constraint Type",       {"Double"}},
                {"Fric Factor Type",      {"Gamma"}},
                {"A List",                  {1}},
                {"B List",                  {0.3}},
                {"C List",                  {0.01}}}},
         {"Flag",          {{"Use K Factors",          {0}}}},
         {"Output",          {{"Output Matrix",          {{"Label",
                                  "Output Matrix"},
                                  {"File Name",
                                  "C:\\temp\\CGRAV.MTX"}}}}}}

    if !RunMacro("TCB Run Procedure", 2, "Gravity", Opts) then goto quit
    done:
    Return( RunMacro("TCB Closing", 1, "TRUE" ) )
    quit:
    Return( RunMacro("TCB Closing", 0, "TRUE" ) )
EndMacro

Macro "Batch Macro Assignment"
// STEP 3: Assignment
    RunMacro("TCB Init")
    Opts = {{"Input",          {{"Database",                  "C:\\caliper\\tc40\\Tutorial\\Vthwy.DBD"},
                {"Network",                  "C:\\caliper\\tc40\\Tutorial\\Vtbatch.net"},
                {"OD Matrix Currency", {"C:\\temp\\CGRAV.MTX",
                                  "HBW",
                                  "Row ID's",
                                  "Col ID's"}}}},
         {"Field",          {{"FF Time",                  "T0"},
                {"Capacity",              "Capacity"},
                {"Alpha",                 "Alpha"},
                {"Beta",                  "Beta"},
                {"Preload",               "None"}}},
         {"Output",          {{"Flow Table",                  "C:\\temp\\ASN_LINKFLOW.BIN"}}}}

    if !RunMacro("TCB Run Procedure", 3, "Assignment", Opts) then goto quit

    done:
    Return( RunMacro("TCB Closing", 1, "TRUE" ) )
    quit:
    Return( RunMacro("TCB Closing", 0, "TRUE" ) )
EndMacro
```

Notice that at the beginning of every macro, the function RunMacro("TCB Init") is called and at the end of every macro, a Return() function, the quit: label, and another Return() function are added. It is now fairly straightforward to design an interface that runs all three of these procedures separately:

```
Dbox "Batch Run Example" title: "Run Batch"
Button "Run Trip Generation" 1, 1, 20 do
        RunMacro("Batch Macro Generation")
Enditem

Button "Run Trip Distribution" 1, 3, 20 do
        RunMacro("Batch Macro Distribution")
Enditem

Button "Run Trip Assignment" 1, 5, 20 do
        RunMacro("Batch Macro Assignment")
```

```
        Enditem
        Button "Close" 1, 7, 20 do
                Return()
                Enditem
        EndDbox
```

The dialog box looks like this:
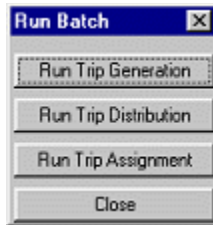
This file can be found under the tutorial directory and is called batchexample2.rsc. Before you compile and run this file, you should change all input and output file references to be consistent with the tutorial and output directories in your computer.

Extending the Batch Macro

The above batch example is useful in many cases and can be used as a starting point for designing more complicated macros. In the above example, an input shortest path skim matrix was assumed. It was called vtsp.mtx and was located in the Tutorial folder. In this example, you will create the matrix vtsp.mtx in Batch Mode and then hook the matrix and batch code into the rest of the macro.

) **Tutorial: To Run the Network/Paths-Multiple Paths Command**

1. Choose *File-Open* and open the highway geographic file vthwy.dbd in the Tutorial folder.

2. Choose *File-Open* and open the network vtbatch.net.

3. Choose *Map-Layers*, highlight the Intersection layer and click Show Layer. The centroid nodes are marked as NTYPE = "Centroid" in the Intersection layer.

4. Choose *Selection-Select By Condition* and type the condition NTYPE = "Centroid". Name the selection set "Centroid." TransCAD selects all the centroids.

5. Choose *Planning-Batch Editing-Batch Tools* to display the Batch Mode toolbox, click ● to start the Batch Recorder, click ▶ to enable the radio buttons, and click Full Run.

6. Choose *Network/Paths-Multiple Paths*, choose T0 from the Minimize drop-down list, and choose Centroid from the From and To drop-down lists.

7. Click Queue. TransCAD displays the Save As dialog box.

8. Type "VTSP.MTX" as the output matrix file name and click Save. Because the input to the

batch mode is a selection set, TransCAD displays a dialog box asking you to enter the query. Click Yes to display the Select by Condition dialog box.

9. Type NTYPE = "Centroid" as the query and click OK. TransCAD runs the Multiple Paths procedure, displays the output matrix in a window, creates the batch code for this procedure and displays the Results Summary dialog box.

10. Click Close. TransCAD closes the Results Summary dialog box.

11. Click ▣ in the Batch Mode toolbox to display the Batch Editor toolbox. You will see the following batch code:

```
Opts =    {{"Input",   {{"Network",        "C:\\caliper\\tc40\\Tutorial\\VTBATCH.NET"},
                        {"Origin Set",      {"C:\\caliper\\tc40\\Tutorial\\VTHWY.DBD|Intersection",
                                            "Intersection",
                                            "Selection",
                                            "Select * where NTYPE = 'Centroid'"}},
                        {"Destination Set",  {"C:\\caliper\\tc40\\Tutorial\\VTHWY.DBD|Intersection",
                                            "Intersection",
                                            "Selection"}},
                        {"Via Set",         {"C:\\caliper\\tc40\\Tutorial\\VTHWY.DBD|Intersection"}
                                            "Intersection"}}}},
            {"Field",   {{"Minimize",       "T0"},
                        {"Nodes",           "Intersection.ID"}}},
            {"Output",  {{"Output Matrix",  {{"Label",
                                            "Shortest Path"},
                                            {"File Name",
                                            "C:\\temp\\VTSP.MTX"}}}}}}

if !RunMacro("TCB Run Procedure", 1, "TCSPMAT", Opts) then goto quit
```

12. Copy the text inside the Batch Editor, click Load and load your existing batch code (saved in Step 24 of "Tutorial: To Run and Chain the Three Procedures in Batch Mode"), click Add and paste the text into a new Step 4, type "Shortest Path" in the Step Name edit box, and click Move Up to move it to Step 2 in your existing batch code.

Now you can add intrazonal trips to your matrix.

13. Make sure that the matrix created in the previous steps is your current window, the Batch Editor toolbox is displayed, and ● is depressed so that the Batch Recorder is on.

14. Choose **Planning-Planning Utilities-Intrazonal Travel Times** to display the Intrazonal Impedance Calculation dialog box.

15. The default settings will be used. Click Queue. TransCAD displays the Results Summary dialog box.

16. Click Close. TransCAD has generated the following batch code:

```
Opts = {{"Input",   {{"Matrix Currency",   {"C:\\temp\\VTSP.MTX",
                                            "Shortest Path - T0",
                                            "RCIndex",
                                            "RCIndex"}}}}}

if !RunMacro("TCB Run Procedure", 2, "Intrazonal", Opts) then goto quit
```

17. Use the Batch Editor toolbox to move this batch code up to Step 3 of the model.

18. Click Save in the Batch Editor toolbox to display the Save Batch File As dialog box.

19. Type a file name, and click Save. TransCAD saves the Batch Contents as a Batch Mode resource file.

20. Choose *File-Close All* and click No to All.

TransCAD closes all of the windows.

Batch Mode Extensions

Batch mode processing in TransCAD applies to more than just the planning procedures. Many of the auxiliary operations typically performed in planning models can also be interactively set in batch mode. These functions include various matrix operations, calculating gap, updating network attributes, and doing feedback loops. This section will describe how to perform these operations in batch mode and present a comprehensive example of tying these operations together.

For more information, see:
Matrix Operations in Batch
Calculating Gaps
Updating Network Fields
Feedback Loops in TransCAD

Matrix Operations in Batch

Many of the matrix manipulation tools in TransCAD are also batch-enabled. The setup for these tools in Batch Mode is similar to the setup for any planning procedure: open all of your matrices in TransCAD, open the Batch Mode toolbox, set it to start recording, and then perform the matrix operation. Like the planning procedures, the OK button in the matrix operation dialog boxes will be replaced with a Queue button. Once you click Queue, the Batch Recorder generates a script for the operation and the user can view the script in the Batch Editor toolbox. The dry run and full run features, however, are not relevant for matrix operations. All matrix commands except for *Matrix-Contents* will be performed regardless of the dry run settings. The following show how to use matrix operations in Batch Mode.

For more information, see:
Add Matrix Core
Drop Matrix Core
Rename Matrix Core
Matrix Quicksum
Add Matrix Index
Fill Matrix
Combine Matrices

Add Matrix Core

Summary: Adds a matrix to a matrix file.

Syntax: RunMacro("TCB Run Operation", 1, "Add Matrix Core", Options)

Option Group	Option	Type	Contents
Input	Input Matrix	String	Input matrix name
	New Core	String	New matrix name

Example: Options = {{"Input", {{"Input Matrix", "C:\\caliper\\tc40\\Tutorial\\FLINTBRY.MTX"},
                              {"New Core",   "Matrix 2"}}}}

        RunMacro("TCB Run Operation", 1, "Add Matrix Core", Options)

Drop Matrix Core

Summary: Deletes a matrix from a matrix file.

Syntax: RunMacro("TCB Run Operation", 1, "Drop Matrix Core", Options)

Option Group	Option	Type	Contents
Input	Input Matrix	String	Input matrix name
	Drop Core	String	Name of matrix to drop

Example: Options = {{"Input", {{"Input Matrix", "C:\\caliper\\tc40\\Tutorial\\FLINTBRY.MTX"},
                              {"Drop Core",   "Matrix 2"}}}}

        RunMacro("TCB Run Operation", 1, "Drop Matrix Core", Options)

Rename Matrix Core

Summary: Renames a matrix.

Syntax: RunMacro("TCB Run Operation", 1, "Rename Matrix Core", Options)

Option Group	Option	Type	Contents
Input	Input Matrix	String	Input matrix name
	Target Core	String	Matrix name to rename
	Core Name	String	New name

Example: Options = {{"Input", {{"Input Matrix", "C:\\caliper\\tc40\\Tutorial\\FLINTBRY.MTX"},
                          {"Target Core", "New Core"},
                          {"Core Name", "Renamed Core"}}}}

          RunMacro("TCB Run Operation", 1, "Rename Matrix Core", Options)

Matrix Quicksum

Summary: Adds all matrices in a matrix file together.

Syntax: RunMacro("TCB Run Operation", 1, "Matrix Quicksum", Options)

Option Group	Option	Type	Contents		
Input	Matrix Currency	Array	An array of four strings:		
			1	String	The path and file name of the matrix file
			2	String	The matrix name
			3	String	The row index
			4	String	The column index

Example: Options = {{"Input", {{"Input Currency", {"C:\\caliper\\tc40\\Tutorial\\OD.MTX",
                                     "Vehicles",
                                     "Rows",
                                     "Columns"}}}}}

          RunMacro("TCB Run Operation", 1, "Matrix QuickSum", Options)

Add Matrix Index

Summary: Adds an index to a matrix.

Syntax: RunMacro("TCB Run Operation", 1, "Rename Matrix Core", Options)

Option Group	Option	Type	Contents
Input	Current Matrix	String	Input matrix file
	Index Type	String	"Row", "Column", or "Both"
	View Set	Array	Array of {index source view file name, view name, selection set name, query used to create selection set}
	Old ID Field	Array	Array of {index source view file name, old ID field}

| | New ID Field | Array | Array of {index source view file name, new ID field} |
| Output | New Index | String | New index name |

Example:

```
Options = {{"Input",        {{"Current Matrix",
              "C:\\caliper\\tc40\\Tutorial\\OD.MTX"},
                     {"Index Type",              "Both"},
                     {"View Set",
              {"C:\\caliper\\tc40\\Tutorial\\FL_ZONE.CDF|Flintbury Zones"}
                                        "Flintbury Zones",
                                        "Selected Zones",
                                        "Select * where selectzoneflag = 1"}},
                     {"Old ID Field",
              {"C:\\caliper\\tc40\\Tutorial\\FL_ZONE.CDF|Flintbury Zones",
                                             "ZONE"}},
                     {"New ID Field",
              {"C:\\caliper\\tc40\\Tutorial\\FL_ZONE.CDF|Flintbury Zones",
                                             "ID"}}}},
                     {"Output",   {{"New Index",          "Selected Zones"}}}}

RunMacro("TCB Run Operation", 1, "Add Matrix Index", Options)
```

Fill Matrix

Summary: Fills a matrix.

Syntax: RunMacro("TCB Run Operation", 1, "Rename Matrix Core", Options)

Option Group	Option	Type	Contents
Input	Matrix Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Core Currencies	Array	Only used for methods 7,8,9,10 and 11. An array of other matrix currencies to use to fill the input matrix currency. Each currency is a four element array consisting of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Data Set	Array	Array of 2 containing {file name of table, table name}. Only for method 12.
Global	Method	Integer	1: Fill with fixed value, 2: Add values to cell, 3:Subtract values from cells, 4:Clear Cells, 5:Multiply cells by value, 6:Divide cells by value, 7:Add matrices cell by cell, 8:Subtract matrices cell by cell, 9:Multiply matrices cell by cell, 10:Divide matrices cell by cell, 11:Fill matrix with formula, 12:Multiply matrix by vector
	Cell Range	Integer	1: Selected cells, 2: All cells, 3: Cells on diagonal
	Matrix Range	Integer	1: This matrix, 2: Selected matrices, 3: All matrices
	Matrix List	Array	An array of all matrices in the matrix. Only used for methods 1,2,3,4, 5 and 6
	Value	Real	Fixed value used only for methods 1,2,3,4,5,6
	Matrix K	Array	Array of factors to multiply input matrices by. Only for methods 7,8,9,10,11.
	Expression Text	String	Expression used for formula. Only for method 11.
	Force Missing	String	"Yes": missing values are kept missing, "No": missing values are treated as zero

Fill Option	Array	Array of {{"ID Field", Data table ID field}, {"Value Field", Data table data field}, {"Apply by Rows", "Yes" or "No"}, {"Missing is Zero", "Yes" or "No"}. Only for method 12.

Example 1: Filling with a Single Value

```
Opts = {{"Input",    {{"Matrix Currency",
       {"C:\\caliper\\tc40\\Tutorial\\FLINTBRY.MTX",
                                       "Matrix 3",
                                       "WAHOO ZONES (all)",
                                       "WAHOO ZONES (all)"}}}},
       {"Global",          {{"Method",        1},
              {"Value",          3},
              {"Cell Range",    2},
              {"Matrix Range",  1},
              {"Matrix List",      {"FLINTBURY ZONES",
                                       "New Core",
                                       "Matrix 3"}}}}}
```

RunMacro("TCB Run Operation", 1, "Fill Matrices", Opts)

Example 2: Adding Matrices Cell by Cell

```
   Opts = {{"Input",           {{"Matrix Currency",
{"C:\\caliper\\tc40\\Tutorial\\FLINTBRY.MTX",
                                       "Matrix 3",
                                       "WAHOO ZONES (all)",
                                       "WAHOO ZONES (all)"}},
              {"Core Currencies",
          {{"C:\\caliper\\tc40\\Tutorial\\FLINTBRY.MTX",
                                       "FLINTBURY ZONES",
                                       "WAHOO ZONES (all)",
                                       "WAHOO ZONES (all)"},
                                       {"C:\\caliper\\tc40\\Tutorial\\OD.MTX",
                                       "Vehicles",
                                       "Rows",
                                       "Columns"}}}}},
       {"Global",          {{"Method"                7},
              {"Cell Range",             2},
              {"Matrix K",         {1,
                                       1,
                                       1,
                                       1,
                                       1,
                                       1}},
              {"Force Missing",         "Yes"}}}}
```

RunMacro("TCB Run Operation", 1, "Fill Matrices", Opts)

Example 3: Filling a Matrix with a Formula

```
   Opts = {{"Input",    {{"Matrix Currency",
{"C:\\caliper\\tc40\\Tutorial\\FLINTBRY.MTX",
                                       "Matrix 3",
                                       "WAHOO ZONES (all)",
                                       "WAHOO ZONES (all)"}}}},
       {"Global",          {{"Method",            11},
              {"Cell Range",             2},
              {"Matrix K",         {1,
                                       1,
                                       1,
                                       1,
                                       1,
                                       1}},
```

```
                                {"Expression Text",        "[FLINTBURY ZONES] + [New Core]"},
                                {"Force Missing",          "Yes"}}}}

                RunMacro("TCB Run Operation", 1, "Fill Matrices", Opts)
```

Example 4: Multiplying a Matrix with a Vector

```
        Opts = {{"Input",        {{"Matrix Currency",  {"C:\\caliper\\tc40\\Tutorial\\OD.MTX",
                                                        "Vehicle Minutes",
                                                        "Rows",
                                                        "Columns"}},
                        {"Data Set",
                        {"C:\\caliper\\tc40\\Tutorial\\FL_ZONE.CDF|Flintbury Zones",
                                                        "Flintbury Zones"}}}},
                {"Global",  {{"Method",       12},
                        {"Fill Option",      {{"ID Field",
                                                        "[Flintbury Zones].ZONE"},
                        {"Value Field",      "[Flintbury Zones].POPULATION"},
                        {"Apply by Rows","Yes"},
                        {"Missing is Zero",          "Yes"}}}}}}

        RunMacro("TCB Run Operation", 1, "Fill Matrices", Opts)

        RunMacro("TCB Run Operation", 1, "Add Matrix Index", Options)
```

Top

Combine Matrices

Summary: Combines two or more matrices into a single matrix file.

Syntax: RunMacro("TCB Run Operation", 1, "Combine Matrix Files", Options)

Option Group	Option	Type	Contents
Input	Matrix Currencies	Array	An array of matrix currencies, each of which is an array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
Global	Operation	String	"Union": combine all ID's together, "Intersection": combine only intersecting ID's
Output	Combined Matrix	Array	An array of two options:
			1 Array "Label", a string specifying the name to appear in the title bar of the matrix file
			2 Array "File Name", a string specifying the path and file name for the output matrix of shortest paths

Example:
```
        Options = {{"Input",   {{"Matrix Currencies",
        {{"C:\\caliper\\tc40\\Tutorial\\BASEOD.MTX",
                                                        "HBW",
                                                "Row ID's",
                                                "Col ID's"},
                                        {"C:\\caliper\\tc40\\Tutorial\\BASEOD.MTX",
                                        "HBNW",
                                        "Row ID's",
                                        "Col ID's"},
```

```
                              {"C:\\caliper\\tc40\\Tutorial\\BASEOD.MTX",
                              "NHB",
                              "Row ID's",
                              "Col ID's"},
                              {"C:\\caliper\\tc40\\Tutorial\\OD.MTX",
                              "Vehicles",
                              "Rows",
                              "Columns"},
                              {"C:\\caliper\\tc40\\Tutorial\\OD.MTX",
                              "Travel minutes",
                              "Rows",
                              "Columns"},
                              {"C:\\caliper\\tc40\\Tutorial\\OD.MTX",
                              "Vehicle Minutes",
                              "Rows",
                              "Columns"}}}}},
           {"Global",   {{"Operation",       "Union"}}},
           {"Output",   {{"Combined Matrix",   {{"Label",
                              "Union Combine"},
                              {"File Name",
                              "C:\\temp\\MATRIX1.MTX"}}}}}}

        RunMacro("TCB Run Operation", 1, "Combine Matrix Files", Options)
```

Update Matrices

Summary: Updates or merges one or several matrices into a target matrix.

Syntax: RunMacro("TCB Run Operation", 1, "Merge Matrices", Options)

Option Group	Option	Type	Contents
Input	Target Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Source Currencies	Array	An array of matrix currencies, each of which is an array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
Global	Rows	Array	An array of strings indicating the Row IDs to merge into
	Columns	Array	An array of strings indicating the Column IDs to merge into
	Missing Option	Array	An array to treat missing values as zero in the form {"Force Missing", string} where string is "Yes" or "No"

Example:

```
        Options = {{"Input",        {{"Target Currency",
                   {"C:\\caliper\\tc40\\Tutorial\\OD.MTX",
                                   "Vehicle Minutes",
                                   "Rows",
                                   "Columns"}},
                   {"Source Currencies", {{"C:\\caliper\\tc40\\Tutorial\\Plan_od.mtx",
                                   "Flows",
                                   "Zone to Node",
```

```
                                                 "Zone to Node"}}}}},
              {"Global",    {{"Rows",              {"2", "3", "4"}},
                             {"Columns",           {"2", "3", "4"}},
                             {"Missing Option",{{"Force Missing",
                                                 "No"}}}}}}

              RunMacro("TCB Run Operation", 1, "Merge Matrices", Options)
```

Aggregate Matrix

Summary: Summarizes a matrix into aggregate levels.

Syntax: RunMacro("TCB Run Operation", 1, "Rename Matrix Core", Options)

Option Group	Option	Type	Contents
Input	Matrix Currency	Array	An array of four strings:
			1 String The path and file name of the matrix file
			2 String The matrix name
			3 String The row index
			4 String The column index
	Aggregation Table	String	Name of aggregation table file name to use
Global	Row Names	Array	An array of {matrix id field name, aggregation id field name}
	Column Names	Array	An array of {matrix id field name, aggregation id field name}

Example:

```
     Options = {{"Input",    {{"Matrix Currency",    {"C:\\caliper\\tc40\\Tutorial\\OD.MTX",
                                                      "QuickSum",
                                                      "Rows",
                                       "Columns"}},
                             {"Aggregation Table",    "C: \\FLINTBURY ZONES.BIN"}}},
              {"Global",   {{"Row Names",            {"[FLINTBURY ZONES].ZONE",
                                                      "[FLINTBURY ZONES:1].DISTRICT"}},
                             {"Column Names",          {"[FLINTBURY ZONES].ZONE",
                                                      "[FLINTBURY ZONES].DISTRICT"}}}}

              RunMacro("TCB Run Operation", 1, "Aggregate Matrix", Options)
```

Transpose Matrix

Summary: Transposes a matrix.

Syntax: RunMacro("TCB Run Operation", 1, "Transpose Matrix", Options)

Option Group	Option	Type	Contents
Input	Input Matrix	String	Input matrix file name
Output	Transposed Matrix	Array	An array of two options:
			1 Array "Label", a string specifying the name to appear in the

| 2 | Array | "File Name", a string specifying the path and file name for the output matrix of shortest paths |

Example: Options = {{"Input",   {{"Input Matrix",
"C:\\caliper\\tc40\\Tutorial\\OD.MTX"}}},
            {"Output",   {{"Transposed Matrix", {{"Label",
                                    "Vehicle Matrices Transpose"},
                                {"File Name",
                                    "C:\\temp\\Matrix1.mtx"}}}}}}

            RunMacro("TCB Run Operation", 1, "Transpose Matrix", Options)

Calculating Gaps

Gap calculations let you compare the relative difference between two different numerical fields in the same or different dataviews. If separate dataviews are used, both dataviews must contain the same number of records and both dataviews must have a unique ID field. Example uses of gap calculations are determining system-wide differences in assignment results or determining differences between two data samples.

In non-Batch Mode, TransCAD will calculate the relative difference and display the results. In Batch Mode, TransCAD calculates the relative difference, compares the result with a convergence difference and lets you exit a loop based on the convergence criteria. This function in Batch Mode is useful when you want to use feedback loops in TransCAD. An example of how you can use the gap tool in Batch Mode as part of a feedback loop will be shown in "Feedback Loops in TransCAD" later in this chapter.

The formula for the gap calculation is:

$$gap = \sqrt{\frac{\sum_{i=1}^{n}(v_i - w_i)^2}{\sum_{i=1}^{n}v_i^2 + \sum_{i=1}^{n}w_i^2}}$$

where:
    v = value in first dataview and field
    w = value in second dataview and field
    n = total number of records
    0 < gap < 1

To perform gap calculations, you would open the two dataviews on which you wish to perform the gap calculation and then choose *Planning-Batch Editing-Calculate Gap*.

For more information, see:
To Perform Gap Calculations in Interactive Mode

) *To Perform Gap Calculations in Interactive Mode*

1. Open the two dataviews on which you want to perform gap calculation.

2. Choose **Planning-Batch Editing-Calculate Gap** to display the Calculate Gap dialog box.

3. Choose the dataviews from the Dataview drop-down lists, the unique ID fields from the ID Field drop-down lists, and comparison value fields from the Comparison Field drop-down lists.

4. Click OK (or Queue in Batch Mode).

TransCAD calculates the relative gap and display the results. Here is an example of the resulting Batch Mode code:

```
Macro "Batch Macro"
        RunMacro("TCB Init")
// STEP 1: Check Convergence
        Opts =   {{"Input",           {{"View A Table",  "C:\\A.BIN"},
                            {"View B Table",   "C:\\B.BIN"}},
                 {"Global",           {{"A Fields",        {"A.ID1",
                                                           "A.TOT_Flow"}},
                            {"B Fields",          {"B.ID1",
                                                           "B.TOT_Flow"}},
                            {"Gap Criterion",   0.01}}}}

        if RunMacro("TCB Run Operation", 1, "Check Convergence", Opts) then goto done

        done:
        Return( RunMacro("TCB Closing", 1) )
        quit:
        Return( RunMacro("TCB Closing", 0) )
    EndMacro
```

The code follows all the rules and conventions defined with ordinary batch code. The return value of check convergence is 1 if the gap is within convergence criteria and 0 otherwise.

Updating Network Fields

The basic network update capability in TransCAD lets you update an already defined network link attribute; for more information, see "Updating Network Link Attribute Fields" in Chapter 13, *Networks and Shortest Paths*, of the *TransCAD User's Guide*. The **Planning-Batch Editing-Update Network Field** command extends the network update capabilities. In particular, you can:

- Create new network attributes that do not already exist in a network file
- Update a network attribute with a linear combination of fields

- Tie network updates into batch mode processing

To perform network updating, you need to open the updated line layer, open the network, and choose **Planning-Batch Editing-Update Network Field**. In both the interactive mode and batch mode, the network values will be updated.

For more information, see:
To Perform Network Field Updating

Top

) *To Perform Network Field Updating*

1. Open the line geographic file from which the network was created. If necessary, open dataviews that contain the updated data and join them to the line database.

2. Open the network.

3. Make sure that the dataview that contains the updated data is the current dataview.

4. Choose **Planning-Batch Editing-Update Network Field** to display the Update Network Link Costs dialog box.

5. The editable Update Field drop-down list lists all of the attributes in the network. Either choose an existing field or type a new field to create.

6. Choose the field in the dataview with which to update the network from the Update From drop-down list. Each field you choose from this drop-down list will be added to the update field scroll list. You can adjust the "weight" of each update field in the Constant edit box. You can drop fields by highlighting the field in the scroll list and clicking Drop.

7. Click OK (or Queue in Batch Mode).

TransCAD updates the present or new network attribute with the linear combination of the update fields. Here is an example of the resulting Batch Mode code:

```
Options = {{"Input",          {{"Database",              "C:\\caliper\\tc40\\Tutorial\\plan_net.DBD"},
               {"Network",        "C:\\caliper\\tc40\\Tutorial\\plan_net.net"},
               {"Link Set",       {"C:\\caliper\\tc40\\Tutorial\\plan_net.DBD|Highways/Streets"},
                                    "Highways/Streets"}}},
          {"Global",  {{"Fields Indices",       "[TRAVEL TIME]"},
               {"Options",        {{"Link Fields",
                                         {{"[Highways/Streets].[TRAVEL TIME]",
                                         "[Highways/Streets].[TRAVEL TIME]"}}},
                                         {"Constants",
                                         {3}}}}}}}

    RunMacro("TCB Run Operation", 1, "Update Network Field", Options)
```

Top

Feedback Loops in TransCAD

The previous batch example showed how you can use the Batch Editor to produce a relatively simple planning model. In the Vermont example, the trip generation, impedance matrix, trip distribution, and trip assignment steps were tied together. The model began with trip generation and ended with assignment. The following flow diagram describes this process:
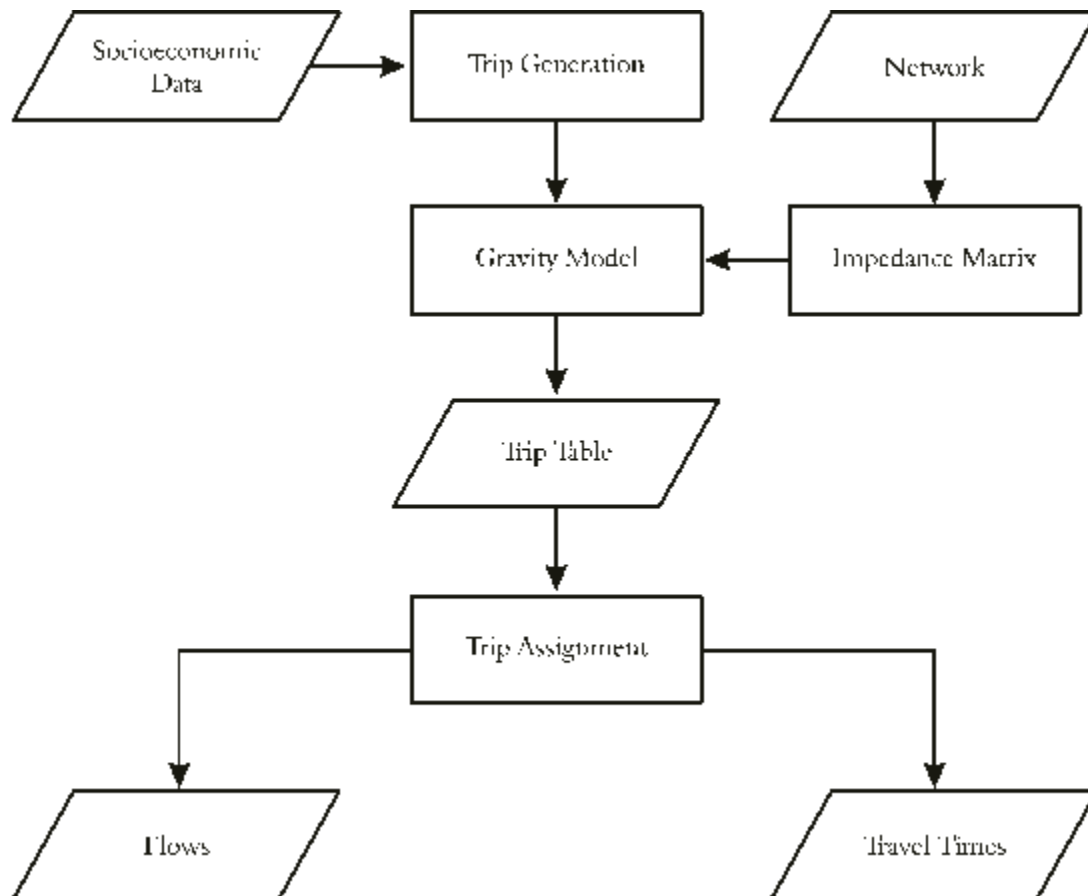
One potential inaccuracy with this model is that, in many cases, the impedance matrix is calculated based on uncongested travel times. This may not properly estimate the real travel times to go from TAZ to TAZ. An improvement to this modeling procedure is to take the congested travel times output from the assignment model, update the network, re-calculate the impedance matrix using the congested travel time, and then re-run the rest of the model.

This procedure of feeding the travel times back into the front end of the process is repeated until either a set number of iterations have elapsed or a convergence criteria is reached. A popular convergence criteria is the relative difference in assignment flows between the nth iteration and the n-1th iteration.

This type of modeling process is typically called a feedback loop and is shown in the following diagram:
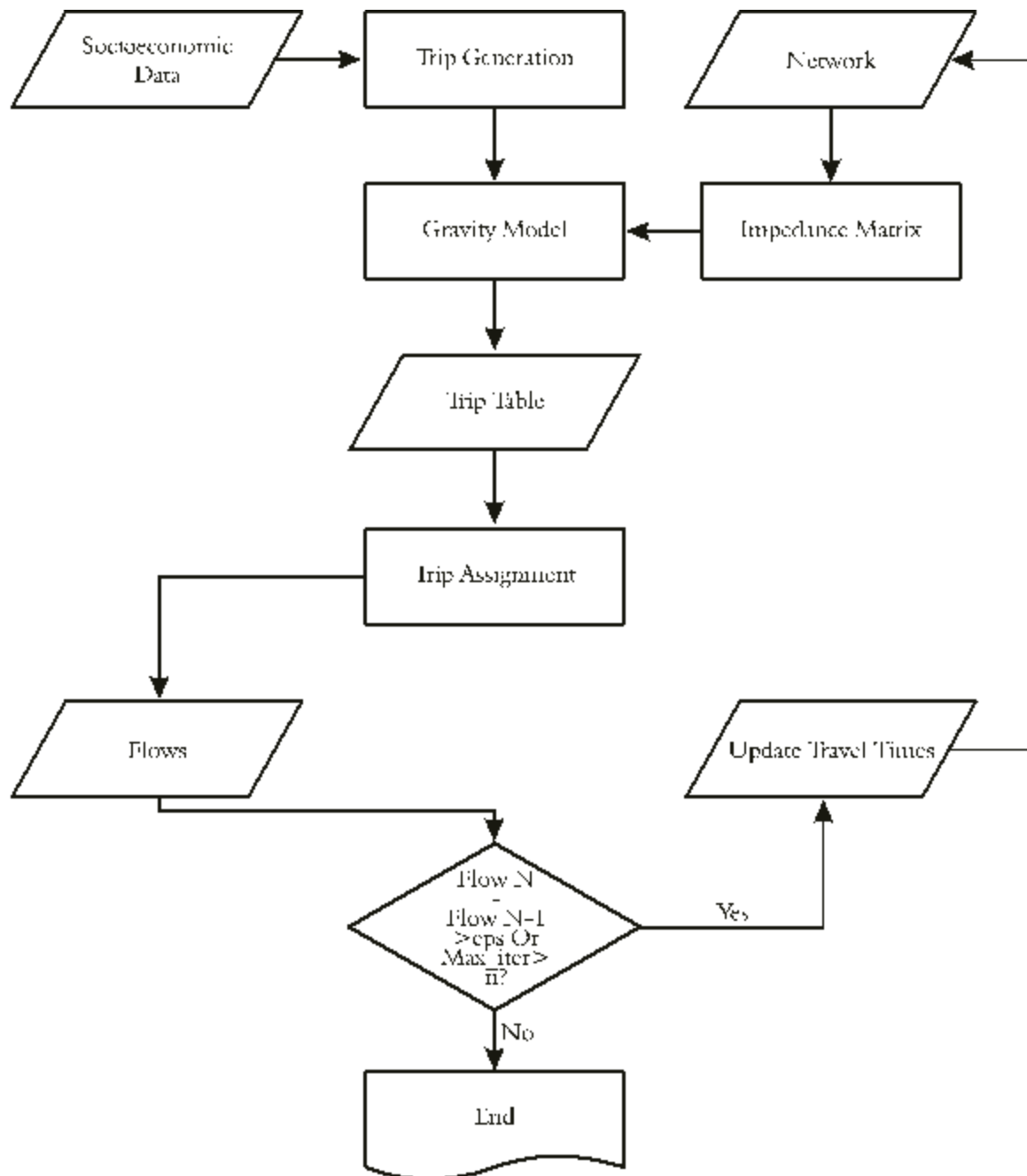
In GISDK, there is a special shared variable called feedback_iteration that helps you define a looping structure and enables feedback looping. To perform feedback looping in TransCAD, you would first generate GISDK code using the interactive batch mode normally, and then wrap a "for...end" loop using the feedback_iteration variable around the batch code. Here is an example:

```
Macro "Batch Macro"
        RunMacro("TCB Init")
        Shared feedback_iteration
        for feedback_iteration = 1 to 10 do

// STEP 1: TCSPMAT
Opts = {{"Input",   {{"Network",        "C:\\caliper\\tc40\\Tutorial\\PLAN_NET.NET"},
```

```
                    {"Origin Set",      {"C:\\caliper\\tc40\\Tutorial\\PLAN_NET.DBD|Nodes",
                                                "Nodes",
                                        "centroids",
                                        "Select * where taz <> null"}},
                    {"Destination Set",         {"C:\\caliper\\tc40\\Tutorial\\PLAN_NET.DBD|Nodes",
                                        "Nodes",
                                        "centroids"}},
                    {"Via Set",         {"C:\\caliper\\tc40\\Tutorial\\PLAN_NET.DBD|Nodes",
                                                "Nodes"}}}},
                    {"Field",           {{"Minimize",            "[TRAVEL TIME]"},
                    {"Nodes",           "Nodes.ID"}}},
                    {"Global",          {{"Output Type",         "Matrix"}}},
                    {"Output",          {{"Output Matrix",       {{"Label",
                                                "Shortest Path"},
                                        {"File Name",
                                        "C:\\temp\\SPMAT#^.MTX"}}}}}}

    RunMacro("TCB Run Procedure", 1, "TCSPMAT", Options)

        if !RunMacro("TCB Run Procedure", "TCSPMAT", Opts) then goto quit

    // STEP 2 Gravity Model
    // STEP 3 PA 2 OD
    // STEP 4 Trip Assignment

    end     // for iteration
        feedback_iteration = null

                    done:
                    Return( RunMacro("TCB Closing", 1) )
                    quit:
                    Return( RunMacro("TCB Closing", 0) )
    EndMacro
```

This example wraps a feedback loop around the four-step process of impedance matrix, gravity, PA-OD, and assignment such that these steps will be repeated 10 times. Note that feedback_iteration must be declared as a shared variable before the looping begins and must be set back to null after the looping ends. You can either add feedback loops either by directly changing your batch code or by interactively adding the code from within the Batch Editor.

You may also notice that the output matrix name takes on a special form. In addition to SPMAT, you can also see the characters "#^". This is a special code that lets TransCAD automatically generate separate output files for each feedback iteration. An explanation of what these codes mean follows in the next example.

) **Tutorial: To Create Feedback Loops in Batch Mode**

1. Choose *File-Open* and open the map M_PATH.MAP in the Tutorial folder.

2. Choose *Planning-Batch Editing-Batch Tools* to display the Batch Mode toolbox.

3. Click ⬤ in the Batch Mode toolbox to start the Batch Recorder.

4. Click **A** in the Batch Mode toolbox to display the Scenario Setting dialog box, type "MY" in the Name edit box, type "c:\temp" in the Path edit box, and click OK. TransCAD sets all output files and dataview files to have a prefix of "MY" in the c:\temp folder.

5. Choose *Network/Paths-Multiple Paths* to display the Multiple Shortest Path dialog box.

6. Choose TIME from the Minimize drop-down list, FROM Points from the From drop-down list and TO Points from the To drop-down list.

7. Click Queue. TransCAD displays the Save As dialog box.

8. Type "SP#" as the file name and click Save. When you are asked if you want to save each of the queries click No. TransCAD generates the script code for the shortest path matrix procedure.

9. Click [icon] in the Batch Mode toolbox to display the Batch Editor toolbox.

10. Click Choose Macro, choose Feedback Loop Begin from the scroll list, and click OK. TransCAD automatically adds the GISDK script that defines the feedback_iteration variable and starts the looping structure. By default, the for loop will loop ten times.

11. Click Choose Macro again, choose Feedback Loop End, and click OK. TransCAD automatically adds the GISDK script that ends the looping structure and resets the feedback_iteration variable.

12. Click Save to display the Save Batch File As dialog box, type a file name and click Save to save the generated script to a resource file.

    Now you can compile the resource and run it.

13. Choose **Tools-Add-Ins**, highlight GIS Developer's Kit, and click OK to display the GISDK toolbox.

14. Click [icon], choose the batch file you just saved, and click Open. TransCAD compiles the resource file.

15. Click [icon], type "Batch Macro" in the Name text box, and click OK. TransCAD runs the batch script, produces all necessary output files, and displays a message that the macro ran successfully.

16. Click OK. TransCAD launches the Notepad program to display a log file called BATCH.LOG that details the procedures run during the script.

17. Choose **File-Close All**.

TransCAD closes all of the windows.

In Step 8 of this example you may have noticed that a "#" sign was added to the end of the output file name. When this is done within the feedback loop, TransCAD produces a separate output file for each iteration named MYSP#1.MTX, MYSP#2.MTX, etc. The "MY" prefix came from the Scenario Settings in the Batch Mode Toolbox. If you do not append a "#" sign to the end of an output file name during feedback, TransCAD will overwrite the output file in each successive iteration. In the actual script, you will notice that "SP#.MTX" was translated to "SP#^.MTX". The "^" symbol indicates to TransCAD that "^" should be replaced with the current value of feedback_iteration.

For more information, see:
Feedback Loops with a Convergence Criteria

Top

Feedback Loops with a Convergence Criteria

The above feedback example loops through the batch code a set number of iterations. Alternatively, you can set a feedback loop to iterate until a convergence criterion is met. To help define and code the convergence criterion, you can use the gap calculation capabilitity described earlier in this section.

The convergence test is commonly applied on assignment flows after trip assignment. The flows from the nth assignment iteration are compared with the flows from the n-1th assignment iteration. If the relative differences of the flows are under an epsilon amount then you would stop the feedback loop; otherwise you would continue iterating. Usually you would only apply this test from the second iteration onwards, as the first iteration assignment result would have no previous result with which to compare.

To apply the convergence test in your batch script, you can either insert the Calculate Gap batch macro code directly into your batch script using the example code shown previously and customize it, or you can generate the code using the Batch Editor. The previous example code shows the gap test applied to two separate dataviews. Within the context of the feedback loop, however, the comparison will be between dataviews generated between iterations. The code, therefore, needs to change slightly:

```
Macro "Batch Macro"
        RunMacro("TCB Init")
Shared feedback_iteration
        for feedback_iteration = 1 to 10 do

if feedback_iteration > 1 then do
// STEP 1: Check Convergence
        Opts =   {{"Input",{{"View A Table",  "C:\\A#<.BIN"},
                            {"View B Table",            "C:\\A#^.BIN"}}},
                 {"Global",         {{"A Fields",       {"A#<.ID1",
                                                         "A#<.TOT_Flow"}},
                            {"B Fields",        {"A#^.ID1",
                                                         "A#^.TOT_Flow"}},
                             {"Gap Criterion",          0.01}}}}

        if RunMacro("TCB Run Operation", "Check Convergence", Opts) then goto done

        end     // if
end     // for iteration
        feedback_iteration = null
                done:
                Return( RunMacro("TCB Closing", 1) )
                quit:
                Return( RunMacro("TCB Closing", 0) )
    EndMacro
```

Notice that the inputs to "View A Table" and "View B Table" are similar to A#.BIN. The difference is that that A table has a "<" suffix while the B table has a "^" suffix, where "^" means that the current value of feedback_iteration should replace the "^" and "<" means that the previous value of feedback_iteration should replace the "<". Thus if feedback_iteration = 2 then the tables would be A#1.BIN and A#2.BIN respectively. Notice also how this gap check is only performed if feedback_iteration > 1. The loop exits when either convergence is met or after 10 iterations.

Generally, you can use the "<", "^" and ">" symbols to specify previous, current and future iterations. You can put a number after the "<" or ">" symbols to go back or forward more than one iteration. Here are examples of how Batch Mode would interpret these symbols when feedback_iteration = 5.

Symbol	Meaning	Example	Interpretation
<	Go back x iterations	SPMAT#<.MTX	SPMAT#4.MTX
		SPMAT#<3.MTX	SPMAT#2.MTX
^	Current iteration	SPMAT#^.MTX	SPMAT#5.MTX
>	Go forward x iterations	SPMAT#>.MTX	SPMAT#6.MTX
		SPMAT#>3.MTX	SPMAT#8.MTX

) **Tutorial: To Use Gap Calculations in Batch Mode**

1. Choose *File-Open Workspace* and open the workspace traffic assign.wrk in the Tutorial folder.

2. Choose *Planning-Batch Editing-Batch Tools* to display the Batch Mode toolbox.

3. Click in the Batch Mode toolbox to start the Batch Recorder, and click to do a dry run and produce output files.

4. Click to display the Scenario Setting dialog box, type "MY2" in the Name edit box, and click OK. TransCAD sets all output files and dataview files to have a prefix of "MY2."

5. Choose *Planning-Traffic Assignment* to display the Traffic Assignment dialog box.

6. All of the defaults are correct. Click Queue to display the Store Flow Table In dialog box.

7. Type "ASSN#" as the file name and click Save. TransCAD creates the batch code, creates an empty assignment results table, and displays the Results Summary Dialog box.

8. Click Close. TransCAD closes the Results Summary Dialog box.

9. Choose *File-New*, highlight Dataview, click OK, choose ASSN#1, and click Open to display the empty assignment table.

10. Choose *Planning-Batch Editing-Calculate Gap* to display the Calculate Gap dialog box, choose ASSN#1 from both Dataview drop-down lists, ID1 from both ID Field drop-down lists, and TOT_Flow from both Comparison Field drop-down lists. The Gap Value of 0.01 represents the convergence criteria.

11. Click Queue. TransCAD generates the batch code for calculating the gap, with the correct special codes in the dataview file names.

12. Click in the Batch Mode toolbox to display the Batch Editor toolbox.

13. Highlight Assignment in the scroll list, click Choose Macro, choose Feedback Loop Begin from the scroll list, and click OK. TransCAD automatically adds the GISDK script that defines the feedback_iteration variable and starts the looping structure. By default, the for loop will loop ten times.

14. Highlight Check Convergence in the scroll list, click Choose Macro again, choose Feedback Loop End, and click OK. TransCAD automatically adds the GISDK script that ends the looping structure and resets the feedback_iteration variable.

15. Click Choose Macro again, select If Not First Iteration, and click OK. Click Choose Macro one last time, choose End of If-end Statement, and click OK. This makes sure that your Check Convergence step is only performed if you are on your second or higher iteration.

16. Click Save to display the Save Batch File As Dialog box.

17. Type a file name and click Save. TransCAD saves your macro to a resource file.

18. Choose *File-Close All* and click No to All.

TransCAD closes all of the windows. Here is the resulting batch macro code:

```
Macro "Batch Macro"
   RunMacro("TCB Init")
// STEP 1: Assignment
 Shared feedback_iteration
 for feedback_iteration = 1 to 10 do

   Opts =         {{"Input",{{"Database",              "C:\\caliper\\tc40\\Tutorial\\plan_net.DBD"},
                  {"Network",        "C:\\caliper\\tc40\\Tutorial\\plan_net.net"},
                  {"OD Matrix Currency", {"C:\\caliper\\tc40\\Tutorial\\Plan_od.mtx",
                              "Flows",
                              "Zone to Node",
                              "Zone to Node"}}}},
         {"Field",           {{"FF Time",              "[TRAVEL TIME]"},
                  {"Capacity",              "CAPACITY"},
                  {"Alpha",                 "ALPHA"},
                  {"Beta",                  "BETA"},
                  {"Preload",               "None"}}},
         {"Global",        {{"Load Method", 5},
                  {"Load Factor",           1},
                  {"Alpha Value",           0.15},
                  {"Beta Value",            4},
                  {"Convergence",   0.01},
                  {"Iterations",            20}}},
         {"Output",          {{"Flow Table",              "C:\\temp\\ASSN#^.bin"}}}}

   if !RunMacro("TCB Run Procedure", 1, "Assignment", Opts) then goto quit

 // STEP 2: Check Convergence
  if feedback_iteration > 1 then do

   Opts =         {{"Input",   {{"View A Table",          "C:\\TEMP\\ASSN#<.BIN"},
                  {"View B Table",             "C:\\TEMP\\ASSN#^.BIN"}},
         {"Global",   {{"A Fields",               {"[ASSN#<].ID1",
                                   "[ASSN#<].TOT_Flow"}},
                  {"B Fields",         {"[ASSN#^].ID1",
                                   "[ASSN#^].TOT_Flow"}},
                  {"Gap Criterion",          0.01}}}}

   if RunMacro("TCB Run Operation", 2, "Check Convergence", Opts) then goto done

  end    // for iteration
  feedback_iteration = null

  end    // if

  done:
  Return( RunMacro("TCB Closing", 1, "TRUE" ) )
  quit:
  Return( RunMacro("TCB Closing", 0, "TRUE" ) )
```

EndMacro

Putting It All Together: A Comprehensive Example

Now that you have all the individual components, you are ready to create a full example using a mixture of planning procedures, feedback looping, matrix operations and gap calculations. The data files you will use for this example come from a Metropolitan Planning Organization in Massachusetts. The data consist of a line layer, a network, and a zonal layer.

The zonal layer consists of 350 TAZ's, where Zones 1-691 are internal zones and Zones 2001-2049 are external zones. Socioeconomic data such as total households, dwelling units, retail and non-retail employment are also found in the zone layer. The line layer has attribute information on street names, travel times, capacities, and BPR function alpha and beta parameters for traffic assignment. The node layer has information on whether the node is a centroid or not and, if it is a centroid, the TAZ with which it is associated. Unlike some planning models, the node ID does not correspond with its associated TAZ ID, thus the example will demonstrate how you can map centroids to TAZs.

These files serve as inputs to this batch example:

File	Description
feed.dbd	Highway line layer (newnet segments) with free-flow travel times, capacities, and alpha and beta parameter values. On the node layer (newnet nodes), a value where TAZ ID is not missing denotes a centroid node and its associated TAZ.
feedtaz.dbd	TAZ area layer with socioeconomic and employment data such as Dwelling Units, Retail and Non-Retail Employment and Households
feed.net	Network file associated with feed.dbd.

The example includes the following steps:

1. For trip generation, use the generic Quick Response Method to produce balanced productions and attractions.

2. Create a new network field called COST and fill it with the travel times. This cost field will be used for all of the minimization algorithms and for updating.

3. Start the feedback loop.

4. Separately, using the network, create an impedance matrix and calculate intrazonal travel times.

5. Use the productions and attractions from Step 1 along with the impedance matrix from Step 4 to run a gravity model to produce a production-attraction (P-A) matrix.

6. Take the P-A matrix from Step 5, run the P-A to O-D procedure, and produce an O-D matrix.

7. Take the O-D matrix from Step 6, the network, and the line data, and run the Trip Assignment procedure to produce vehicle flows and updated travel times

8. Update the network cost field with these travel times.

9. Calculate the gap between iterations of vehicle flows. If the gap is within a convergence criteria or the iterations exceed a maximum number then quit, otherwise go to Step 3.

The following flow diagram details the steps and indicates the input and output file names:

```
┌─────────────────────┐
│   Update Network     │
└─────────────────────┘

┌──────────────────┐   ┌─────────────────────┐              ┌─────────────────────┐
│ Socioeconomic Data│──▶│  Trip Generation    │              │      Network        │
│  FEEDTAZ.DBD      │   │   QRM_ALL.BIN       │              │     FEED.NET        │◀──
└──────────────────┘   └─────────────────────┘              └─────────────────────┘
                                 │                                      │
                                 ▼                                      ▼
                       ┌─────────────────────┐      ┌─────────────────────┐
                       │   Gravity Model      │◀─────│  Impedance Matrix   │
                       └─────────────────────┘      │   SPMAT#.MTX        │
                                 │                   └─────────────────────┘
                                 ▼
                       ┌─────────────────────┐
                       │    Trip Table        │
                       │   CGRAV.MTX          │
                       └─────────────────────┘
                                 │
                                 ▼
                       ┌─────────────────────┐
                       │     PA to OD         │
                       │    PA2OD.MTX         │
                       └─────────────────────┘
                                 │
                                 ▼
                       ┌─────────────────────┐
                       │  Trip Assignment     │
                       └─────────────────────┘

┌──────────────────┐                                 ┌─────────────────────┐
│     Flows         │                                 │ Update Travel Times │
│   ASSN#.BIN       │                                 │    ASSN#.BIN        │──
└──────────────────┘                                 └─────────────────────┘

              ┌─────────────────┐
              │   ASSN(n)        │
              │     -            │  Yes
              │ ASSN(n-1)>0.01 or│────────▶
              │  max_iter<10     │
              └─────────────────┘
                      │ No
                      ▼
              ┌─────────────────┐
              │      End         │
              └─────────────────┘
```
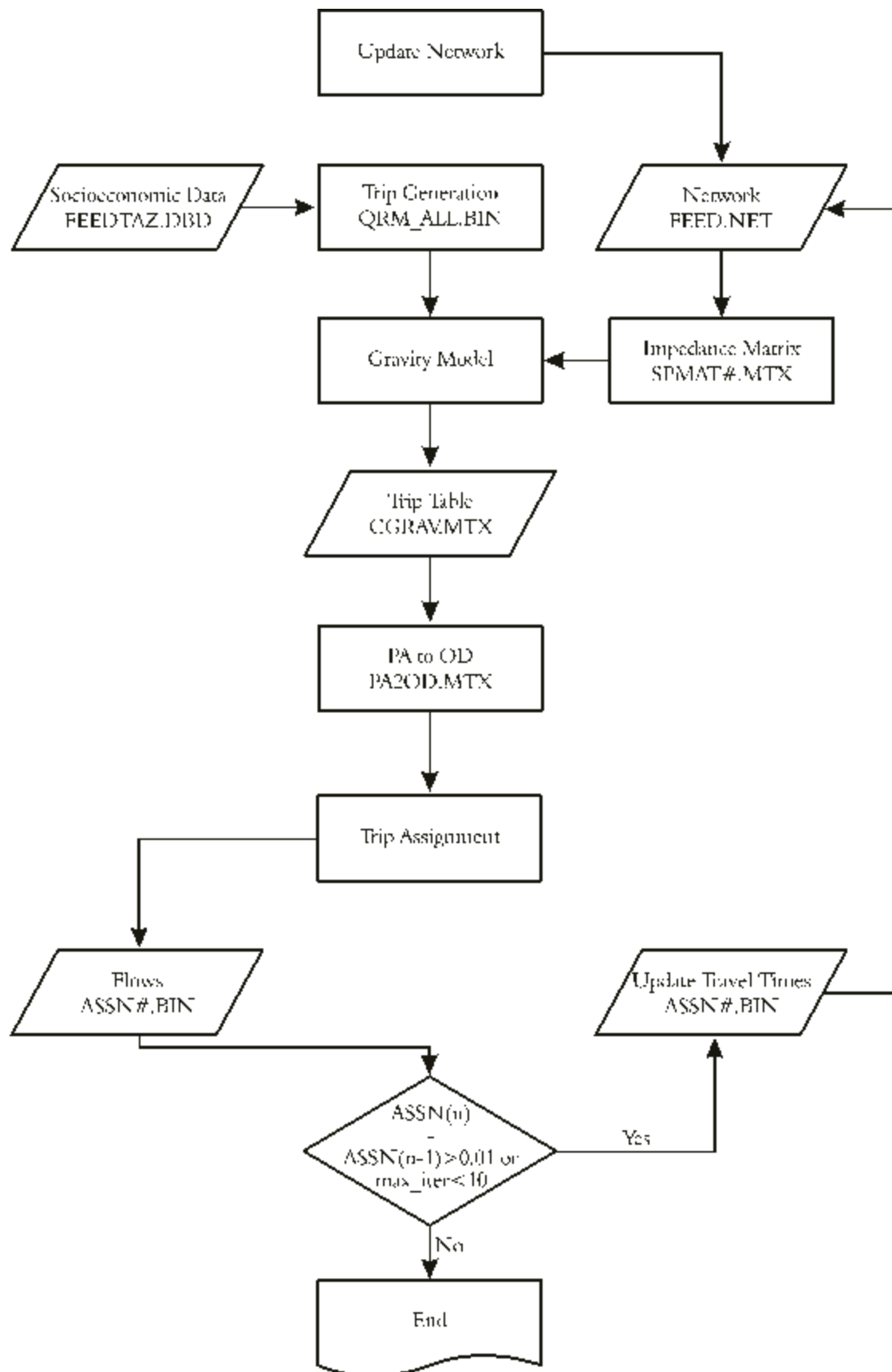
) **Tutorial: To Put It All Together**

1. Choose *File-Open* and open the map file feedback.map in the Tutorial folder. TransCAD opens the map containing a line database and TAZ database. There is a selection set on the node layer called "centroids" that define the centroid nodes.

2. Choose *Planning-Batch Editing-Batch Tools* to display the Batch Mode Toolbox.

3. Click ● in the Batch Mode toolbox to start the Batch Recorder, and click ▶ to do a dry run and produce output files.

4. Click 🗗 in the Batch Mode toolbox to display the Batch Editor toolbox.

Running Trip Generation, Attraction, and Balancing

5. Choose *Planning-Quick Response Method* to display the QRM dialog box:

6. Choose TAZS from the Apply to drop-down list. For balancing, choose Hold Productions from the Method drop-down list.

7. Click the Queue button and click Save to accept the default output file. TransCAD displays the Results Summary dialog box.

8. Click Close. TransCAD generates the batch script for QRM and produces an empty output file. This should be the first step in the Batch Editor.

Updating the Network and Calculating Impedance Skims

9. Make sure that the working layer is Highways/Streets and choose *Planning-Batch Editing-Update Network Fields* to display the Update Network Link Costs dialog box.

10. Type "COST" in the Update Field editable drop-down list, choose [TRAVEL TIME] from the Update From drop-down list, and click Queue. TransCAD updates the new COST field with the travel time and generates the batch code. This should be the second step in the Batch Editor.

11. Choose *Network/Paths-Multiple Paths* to display the Multiple Shortest Path dialog box:

12. Choose [TRAVEL TIME] from the Minimize drop-down list, centroids from the From and To drop-down lists, and click Queue.

13. Type "SPMAT#" as the file name, and click Save. When you are asked if you want to save the query click Yes, type "TAZ <> null" in the Condition edit box, and click OK. TransCAD produces an empty matrix, generates the appropriate code, and displays the Results Summary dialog box.

14. Click Close. TransCAD closes the Results Summary dialog box. The new code should be the third step in the Batch Editor.

Running the Gravity Model

The matrix is from node ID to node ID. For the gravity model to work, you need this matrix to be from TAZ ID to TAZ ID. Fortunately, the node layer has a correspondence between TAZ ID and Node ID. The node IDs are in the ID field and the TAZ IDs are in the TAZ field. To switch the IDs you will use the *Matrix-Indices* command.

15. Choose **Matrix-Indices** to display the Matrix Indices dialog box and click Add Index to display the Add Matrix Index dialog box.

16. Choose Nodes from the Original Dataview drop-down list and ID from the Original Field drop-down list, type "TAZ" in the New Index Name edit box, choose TAZ from the second Field drop-down list and centroids from the Selection drop-down list, and click Queue. When you are asked if you want to save the query, click No. TransCAD creates the new index, generates the appropriate batch code as the fourth step in the Batch Editor, and returns to the Matrix Indices dialog box.

17. Choose TAZ from both the Rows and Columns drop-down lists. TransCAD switches the indices from node IDs to TAZ IDs.

18. Click Close. TransCAD closes the Matrix Indices dialog box.

19. Choose **Planning-Trip Distribution-Gravity Evaluation** to display the Gravity Evaluation dialog box.

20. Choose QRM_ALL from the Dataview drop-down list, type "HBW" in the Name edit box, and press Enter. TransCAD fills in the Production and Attraction fields.

21. Click Queue and click Save to accept the default file name. TransCAD produces an empty output P-A matrix and generates the necessary batch code as the fifth step in the Batch Editor.

Running P-A to O-D Conversion

22. Choose **Planning-P-A to O-D** to display the Convert P-A Matrix to O-D Matrix dialog box.

23. Choose Output Matrix from the P-A Matrix File drop-down list, remove the check from the **Report each hour separately** box, and check the **Use Matrix HBW** box.

24. Click Queue and click Save to accept the default file name. TransCAD produces an empty P-A to O-D matrix and displays the Results Summary dialog box.

25. Click Close. TransCAD generates the batch code as the sixth step in the Batch Editor.

Running Trip Assignment

Currently, the P-A to O-D matrix is in the form of TAZ ID to TAZ ID. For trip assignment to run successfully, it needs to be in the form of Node ID to Node ID. You need to add a matrix index to convert the IDs from TAZ IDs back to Node IDs.

26. Choose **Matrix-Indices** to display the Matrix Indices dialog box and click Add Index to display the Add Matrix Index dialog box.

27. Choose Nodes from the Original Dataview drop-down list and TAZ from the Original Field drop-down list, type "NODES" in the New Index Name edit box, choose ID from the second Field drop-down list and centroids from the Selection drop-down list, and click Queue. When you are asked if you want to save the query, click No. TransCAD creates the new index, generates the appropriate batch code as the seventh step in the Batch Editor, and returns to the Matrix Indices dialog box.

28. Choose NODES from both the Rows and Columns drop-down lists. TransCAD switches the index from TAZ IDs to node IDs.

29. Click Close. TransCAD closes the Matrix Indices dialog box.

30. Change the current window to the map window and change the working layer to the Highways/Streets layer.

31. Choose **Planning-Traffic Assignment** to display the Traffic Assignment dialog box.

32. Make sure that the method is User Equilibrium, the matrix file is PA to OD, and the Time field is [TRAVEL TIME].

33. Type "3" in the Iterations edit box and click Queue. TransCAD displays the Store Flow Table In dialog box.

34. Type "ASSN#" as the file name and click Save. TransCAD produces an empty assignment dataview and displays the Results Summary dialog box.

35. Click Close. TransCAD generates the batch code as the eighth step in the Batch Editor.

36. Choose **File-New**, highlight Dataview, click OK, choose ASSN#1, and click Open to display the empty assignment dataview.

Calculating the Gap

37. Choose **Planning-Batch Editing-Calculate Gap** to display the Calculate Gap dialog box.

38. Choose ASSN#1 from both Dataview drop-down lists, ID1 from both ID Field drop-down lists, and TOT_Flow from both Comparison Field drop-down lists.

39. Click Queue. TransCAD generates the batch code as the ninth step in the Batch Editor.

    You need to make sure that the gap calculation is not invoked on the first iteration. To do this, make sure that the ninth step (Check Convergence) is highlighted in the Batch Editor.

40. Click Choose Macro in the Batch Editor toolbox, choose If Not First Iteration, and click OK. Click Choose Macro again, choose End of If-end Statement and click OK. Now the ninth step only runs if feedback_iteration is greater than 1.

Updating the Network

41. Click in the Batch Mode toolbox to pause the Batch Recorder.

42. Choose **Dataview-Join** to display the Join dialog box.

43. Choose Highways/Streets and ID from the first Table and Field drop-down lists, choose ASSN# and ID1 from the second Table and Field drop-down lists, and click OK. TransCAD joins the assignment results to the line layer.

44. Click again in the Batch Mode toolbox to resume the Batch Recorder.

45. Change the current window to the map window and the working layer to Highway/Streets.

46. Choose **Planning-Batch Editing-Update Network Field** to display the Update Network Link Costs dialog box.

47. Type "Cost" in the Update Field editable drop-down list, choose AB_Time from the Update From drop-down list, and click Queue. TransCAD updates the new Cost field with the travel time and generates the batch code as the tenth step in the Batch Editor.

Adding the Feedback Loop

Now you can wrap a feedback loop around these steps. The feedback loop should go from the point where you run the shortest path matrix (third step) to the point where we update the network costs (tenth step).

48. Highlight 3 TCSPMAT in the scroll list in the Batch Editor toolbox, click Choose Macro, highlight Feedback Loop Begin in the scroll list, and click OK. TransCAD adds the beginning of the feedback_iteration code before the third step.

49. Highlight 10 Update Network Field in the scroll list, click Choose Macro, highlight Feedback Loop End in the scroll list, and click OK. TransCAD adds the end of the feedback_iteration code after the tenth step.

Running the Batch Macro

Your macro is now completed and ready to be saved, compiled and run.

50. Click Save in the Batch Editor toolbox to display the Save Batch File As dialog box.

51. Type a file name and click Save. TransCAD saves the batch macro to a .RSC file.

52. Choose *File-Close All* to close all of the windows.

53. Choose *Tools-Add-ins*, highlight GIS Developer's Kit, and click OK to display the GISDK toolbox.

54. Click , choose the batch file you just saved, and click Open. TransCAD compiles the resource file.

55. Click , type "Batch Macro" in the Name text box, and click OK.

TransCAD runs the batch script, produces all necessary output files, and displays a message that the macro ran successfully. TransCAD also launches the Notepad program to display a log file called BATCH.LOG that details the procedures run during the script. Here are the output files from the procedure:

Procedure	Output File
Quick Response	QRM_ALL.BIN
Shortest Path Matrix	SP#1.MTX - SP#10.MTX
Gravity	CGRAV.MTX
PA to OD	PA2OD.MTX
Assignment	ASSN#1 - ASSN#10.BIN

Here is the batch code that is generated:

```
Macro "Batch Macro"
   RunMacro("TCB Init")

   TransCAD_Path  = "c:\\program files\\transcad"
   DataPath      = TransCAD_Path + "\\Tutorial\\"
   TablePath     = TransCAD_Path + "\\TAB\\"
   OutputPath     = GetEnvironmentVariable("TEMP") + "\\"

// STEP 1: QRM All
   Opts = {{"Input", {{"Zone View",          {DataPath + "PLAN_TAZ.DBD|TAZ",
                                                "TAZ"}},
                      {"Zone Set",           {DataPath + "PLAN_TAZ.DBD|TAZ",
                                                "TAZ"}},
                      {"Production Table",   {TablePath + "PROD_TGP.DBF"}},
                      {"Attraction Table",   {TablePath + "ATTR_TGP.DBF"}}}},
            {"Field",   {{"Total HH",          "TAZ.[TOT-HH]"},
                      {"Dwelling",           "TAZ.[DWELLING-UNITS]"},
```

```
                              {"Retail Employment",    "TAZ.[RETAIL-EMPLOYMENT]"},
                              {"Non-Ret Employment", "TAZ.[NONRETAIL-EMPLOYMENT]"},
                              {"Ext Productions",      {"TAZ.[Ext HBWP]",
                                                        "None",
                                                        "None",
                                                        "None"}},
                              {"Ext Attractions",      {"TAZ.[Ext HBWA]",
                                                        "None",
                                                        "None",
                                                        "None"}},
                              {"Zone Type",            "TAZ.EXTERNAL"}}},
              {"Global", {{"Model Option",       "Prod & Attr"},
                              {"Classify By",          1},
                              {"Population",           100},
                              {"Production Option",    "Average"},
                              {"Income Option",        "None"},
                              {"Balance Method",       "Hold Productions"},
                              {"Inflation",            1},
                              {"Number of Purposes"    4},
                              {"Ext Names",            {"HBW",
                                                        "HBNW",
                                                        "HBO",
                                                        "NHB"}},
                              {"Zone Code",            0}}},
              {"Output", {{"Output Table",        OutputPath + "QRM_ALL.BIN"}}}}

    if !RunMacro("TCB Run Procedure", 1, "QRM All", Opts) then goto quit



// STEP 2: Update Network Field
    Opts = {{"Input",                    {{"Database"    DataPath + "PLAN_NET.DBD"},
                      {"Network",         DataPath + "PLAN_NET.NET"},
                      {"Link Set",        {DataPath + "PLAN_NET.DBD|Highways/Streets",
                                          "Highways/Streets"}}}},
              {"Global", {{"Fields Indices",   "[TRAVEL TIME]"},
                      {"Options",          {{"Link Fields",
                                          {{"[Highways/Streets].[TRAVEL TIME]",
                                          "[Highways/Streets].[TRAVEL TIME]"}}},
                                          {"Constants",
                                          {1}}}}}}}

    if !RunMacro("TCB Run Operation", 2, "Update Network Field", Opts) then goto quit


// STEP 3: TCSPMAT
  Shared feedback_iteration
  for feedback_iteration = 1 to 10 do

    if feedback_iteration = 1 then do
                      SkimField =  "[TRAVEL TIME]"
                      CoreLabel =  "Shortest Path - [TRAVEL TIME]"
                    end
                  else do
                      SkimField =  "__MSATime"
                      CoreLabel =  "Shortest Path - __MSATime"
                    end
    Opts = {{"Input",                    {{"Network",     DataPath + "PLAN_NET.NET"},
                      {"Origin Set",      {DataPath + "PLAN_NET.DBD|Nodes",
                                          "Nodes",
                                          "centroids",
                                          "Select * where TAZ <> null"}},
```

```
                        {"Destination Set", {DataPath + "PLAN_NET.DBD|Nodes",
                                             "Nodes",
                                             "centroids"}},
                        {"Via Set",         {DataPath + "PLAN_NET.DBD|Nodes",
                                             "Nodes"}}}},
           {"Field",  {{"Minimize",         SkimField},
                        {"Nodes",           "Nodes.ID"}}},
           {"Global", {{"Output Type",      "Matrix"}}},
           {"Output", {{"Output Matrix",    {{"Label",
                                             "Shortest Path"},
                                            {"File Name",
                                             OutputPath + "SPMAT#^.MTX"}}}}}}

   if !RunMacro("TCB Run Procedure", 3, "TCSPMAT", Opts) then goto quit


// STEP 4: Add Matrix Index
   Opts = {{"Input",              {{"Current Matrix"      OutputPath + "SPMAT#^.MTX"},
                  {"Index Type",   "Both"},
                  {"View Set",     {DataPath + "PLAN_NET.DBD|Nodes",
                                   "Nodes", "centroids"}},
                  {"Old ID Field", {DataPath + "PLAN_NET.DBD|Nodes",
                                   "ID"}},
                  {"New ID Field"  {DataPath + "PLAN_NET.DBD|Nodes",
                                   "TAZ"}}}},
           {"Output", {{"New Index",   "TAZ"}}}}

   if !RunMacro("TCB Run Operation", 4, "Add Matrix Index", Opts) then goto quit



// STEP 5: Gravity
   Opts = {{"Input",                      {{"PA View Set",     {OutputPath + "QRM_ALL.BIN",
                                           "QRM_ALL"}},
                                          {"FF Matrix Currencies",     {{OutputPath + "SPMAT#^.MTX",
                                           CoreLabel,
                                           "TAZ",
                                           "TAZ"}}},
                  {"Imp Matrix Currencies", {{OutputPath + "SPMAT#^.MTX",
                                           CoreLabel,
                                           "TAZ",
                                           "TAZ"}}},
                  {"FF Tables"           {{OutputPath + "QRM_ALL.BIN"}}},
                  {"KF Matrix Currencies",  {{OutputPath + "SPMAT#^.MTX",
                                           CoreLabel,
                                           "TAZ",
                                           "TAZ"}}}}},
                  {"Field",                {{"Prod Fields",      {"QRM_ALL.HBW_P"}},
                  {"Attr Fields",           {"QRM_ALL.HBW_A"}},
                  {"FF Table Fields",       {"QRM_ALL.ID1"}},
                  {"FF Table Times",        {"QRM_ALL.ID1"}}}},
           {"Global"  {{"Purpose Names",    {"HBW"}},
                  {"Iterations",            {10}},
                  {"Convergence",           {0.001}},
                  {"Constraint Type",       {"Double"}},
                  {"Fric Factor Type",      {"Gamma"}},
                  {"A List",                {1}},
                  {"B List"                 {0.3}},
                  {"C List",                {0.01}}}},
                  {"Flag",                 {{"Use K Factors",   {0}}}},
           {"Output", {{"Output Matrix",    {{"Label",
                                            "Output Matrix"},
```

```
                                              {"File Name",
                                               OutputPath + "CGRAV.MTX"}}}}}}

    if !RunMacro("TCB Run Procedure", 5, "Gravity", Opts) then goto quit


// STEP 6: PA2OD
    Opts = {{"Input", {{"PA Matrix Currency",  {OutputPath + "CGRAV.MTX",
                                               "HBW",
                                               "Row ID's",
                                               "Col ID's"}}}},
         {"Field",   {{"Matrix Cores",        {1}},
                    {"Adjust Fields",        {}},
                    {"Peak Hour Field",      {}}}},
         {"Global", {"Method Type",          "PA to OD"},
                    {"Start Hour",           0},
                    {"End Hour",             23},
                    {"Cache Size",           500000},
                    {"Average Occupancies", {1.5}},
                    {"Adjust Occupancies",  {"No"}},
                    {"Peak Hour Factor",     {0}}}},
         {"Flag",    {{"Separate Matrices",   "No"},
                    {"Convert to Vehicles",  {"No"}},
                    {"Include PHF",          {"No"}},
                    {"Adjust Peak Hour",     {"No"}}}},
         {"Output", {{"Output Matrix",        {{"Label", "PA to OD"},
                                               {"File Name", OutputPath + "PA2OD.MTX"}}}}}}

    if !RunMacro("TCB Run Procedure", 6, "PA2OD", Opts) then goto quit


// STEP 7: Add Matrix Index
    Opts =  {{"Input",                  {{"Current Matrix",       OutputPath + "PA2OD.MTX"},
                    {"Index Type",       "Both"},
                    {"View Set"          {DataPath + "PLAN_NET.DBD|Nodes",
                                         "Nodes",
                                         "centroids"}},
                    {"Old ID Field",     {DataPath + "PLAN_NET.DBD|Nodes",
                                         "TAZ"}},
                    {"New ID Field",     {DataPath + "PLAN_NET.DBD|Nodes",
                                         "ID"}}}},
         {"Output", {{"New Index",       "NODES"}}}}

    if !RunMacro("TCB Run Operation", 7, "Add Matrix Index", Opts) then goto quit


// STEP 8: Assignment
    Opts = {{"Input"  {{"Database",        DataPath + "PLAN_NET.DBD"},
                    {"Network",          DataPath + "PLAN_NET.NET"},
                    {"OD Matrix Currency",   {OutputPath + "PA2OD.MTX",
                                         "HBW (0-24)",
                                         "NODES",
                                         "NODES"}}}},
         {"Field",   {{"FF Time",          "[TRAVEL TIME]"},
                    {"Capacity",         "CAPACITY"},
                    {"Alpha"             "ALPHA"},
                    {"Beta",             "BETA"},
                    {"MSA Flow",         "__MSAFlow"},
                    {"MSA Cost",         "__MSATime"},
                    {"Preload",          "None"}}},
         {"Global", {{"Load Method",      5},
                    {"Load Factor",      1},
```

```
                   {"Alpha Value",        0.15},
                    {"Beta Value",        4},
                   {"Convergence"         0.01},
                   {"Iterations",         3},
                   {"MSA Iteration",      feedback_iteration}}},
         {"Output", {{"Flow Table",       OutputPath + "ASSN#^.bin"}}}}

    if !RunMacro("TCB Run Procedure", 8, "Assignment", Opts, &Ret) then goto quit
    rmse = Ret[2].[MSA RMSE]


//    Check Convergence
   if feedback_iteration > 1 then do
      if rmse < 200 then goto done
   end


   end    // for iteration
   feedback_iteration = null

    done:
    Return( RunMacro("TCB Closing", 1, "TRUE" ) )
    quit:
    Return( RunMacro("TCB Closing", 0, "TRUE" ) )
endMacro
```

This file is available electronically in the TransCAD tutorial directory. It is called batchexample3.rsc. Before you compile and run this file, you should change all input and output file references to be consistent with the tutorial and output directories in your computer.

[Top](#)

Building Custom Applications

GISDK code and batch macros can be combined with user-written code to create all sorts of custom planning applications. These applications can range from data entry aids to the most elaborate regional travel demand models, with different models from spatial subsets of zones or disaggregate observations.

Caliper Corporation can assist you in building these applications, adding in your own code, converting existing models, and working with our internal data structures. Caliper Corporation Technical Support will provide you with additional information on all of these topics.

[Top](#)

References

Agresti, A. 1984 *Analysis of Ordinal Categorical Data.* Wiley series in probability and mathematical

statistics. Applied probability and statistics. New York: Wiley.

Aldrich, J. H. & Nelson, F. D. 1984 *Linear Probability, Logit, and Probit Models*. Sage university papers series. Quantitative applications in the social sciences ; no. 07-045. Beverly Hills: Sage Publications.

Allsop, R. E. 1974 Some Possibilities for Using Traffic Control to Influence Trip Distribution and Route Choice. In *Sixth International Symposium on Transportation and Traffic Theory*, pp. 345-374.

Avriel, M. 1976 *Nonlinear Programming: Analysis and Methods*. Prentice-Hall series in automatic computation. Englewood Cliffs, N.J.: Prentice-Hall.

Beckman, M., et al. 1956 *Studies in the Economics of Transportation*: Yale University Press.

Ben-Akiva, M. E. & Lerman, S. R. 1985 *Discrete Choice Analysis : Theory and Application to Travel Demand*. MIT Press series in transportation studies; 9. Cambridge, Mass.: MIT Press.

Boyce, D., Ran, B. & LeBlanc, L. J. 1993 A Combined Dynamic Model Departure Time/Route Choice Model with Multiple Groups of Travelers. In *TRB 72nd Annual Meeting*. Washington, DC.

BPR. 1964 *Traffic Assignment Manual for Application with a Large, High Speed Computer*. Washington,: U. S. Dept. of Commerce Bureau of Public Roads Office of Planning Urban Planning Division;.

Branston, D. 1976 Link Capacity Functions: A Review. *Transportation Research* **10**, 223-236.

Brownstone, D. M. & Small, K. A. 1985 *Efficient Estimation of Nested Logit Models*. Irvine Calif.: Institute of Transportation Studies University of California Irvine.

Cantarella, G. E., Improta, G. & Sortza, A. 1991 Iterative Procedure for Equilibrium Network Traffic Signal Settings. *Transportation Research* **25A**, 241-249.

Daganzo, C. 1983 Stochastic Network Equilibrium with Multiple Vehicle Types and Asymmetric, Indefenite Link Cost Jacobians. *Transportation Science* **17**, 282-300.

Daganzo, C. & Sheffi, Y. 1977 On Stochastic Models of Traffic Assignment. *Transportation Science* **16**, 332-360.

Daly, A. 1987 Estimatig Tree Logit Models. *Transportation Research B.* **21B**.

Davidson, K. B. 1966 A Flow Travel Time Relationship for Use in Transportation Planning. *Australian Road Research Board* **3**, 183-194.

Dial, R. 1971 A Probabilistic Multipath Traffic Assignment Algorithm which Obviates Path Enumeration. *Transportation Research* **5**, 83-111.

Dial, R. 1996 Bicriterion Traffic Assignment: Basic Theory and Elementary Algorithms. *Transportation Science* Vol. 30, No. 2. 93-111.

Dickinson, T. J. 1981 A Note on Traffic Assignment and Signal Timings in a Signal Controlled Network. *Transportation Research* **15B**, 267-271.

Douglas, A. A. & Lewis, R. J. 1970 Trip Generation Techniques 2. Zonal Least-Squares Regression Analysis. *Traffic Engineering & Control* **12**.

Evans, S. P. 1976 Derivation and Analysis of Some Models for Combining Trip Distribution and Assignment. *Transportation Research* **10**, 37-57.

Fricker, J. 1989 Two Procedures to Calibrate Traffic Assignment Models. In *Second Conference on Applications of Transportation Planning Methods*. Orlando, FL.

Fricker, J. & Moffet, D. 1993 Traffic Assignment Model Calibration when Precision is Essential. In *63rd Annual Meeting of the Institute of Transportation Engineers*.

Gartner, N. H., Gershwin, S. B., Little, J. D. C. & Ross, P. 1980 Pilot Study of Computer-Based Urban Traffic Management. *Transportation Research* **14B**, 203-217.

Harker, P. T. & Friesz, T. L. 1984 Bounding the Solution of the Continuous Equilibrium Network Design Problem. In *In Proceedings of the Ninth International Symposium of Transportation and Traffic Theory*. Delft: VNU Science Press.

Harvey, G. & Deakin, E. 1993 A Manual of Regional Transportation Modeling Practice for Air Quality Analysis: Report prepared by Deakin, Harvey, Skabardonis and others for the National Association of Regional Councils.

Hurdle, P. T. 1984 Signalized Intersection Delay Models - A Primer for the Uninitiated. *Transportation Research Record* **971**, 96-104.

ITE. 1995 *Trip generation*. ITE publication ; no. IR-016B. Washington, D.C. (525 School St., S.W., Suite 210, Washington, D.C. 20024-2729): ITE Technical Council Committee 6A-32.

Janson, B. N. 1991 Convergent Algorithm for Dynamic Traffic Assignment. *Transportation Research Record* **1328**, 69-80.

Kern, C. & Lerman, S. 1977 Models for Predicting the Impact of Transportation Policies on Retail Activity. In *Paper presented to the Annual Meeting of*.

Koppelman, F. 1976 Guidelines for Aggregate Travel Predictions Using Disaggregate Choice Models. *Transportation Research Record* **610**.

LeBlanc, L. J. 1973 Mathematical Programming Algorithms for Large Scale Network Equilibrium and Network Design Problems. In *Department of Industrial Engineering*, pp. 142. Evanston, IL: Northwestern University.

Lerman, S. & Manski, C. 1979 Sample Design for Discrete Choice Analysis of Travel Behavior: The State of the Art. *Transportation Research* **A13**, 29-44.

Lerman, S. R. 1975 A Disaggregate Behavioral Model of Urban Mobility Decisions, pp. 336 leaves.

List, G. & Turnquist, M. 1993 Goods Movement: Regional Analysis and Database (Final Report): University Transportation Research Center.

Louviere, J. 1988 Conjoint Analysis of Stated Preferences. *Journal of Transport Economics* **XXII**.

Luk, J. Y. K. 1978 Tests on a Heuristic Algorithm for a Combined Area Traffic Control - Assignment Problem. In *ARRB*, vol. 9, pp. 213-220.

Maddala, G. S. 1983 Limited-dependent and Qualitative Variables in Econometrics. *Cambridge University Press*.

Manheim, M. L. 1979 *Fundamentals of Transportation Systems Analysis*. MIT Press series in transportation studies ; 4-. Cambridge, Mass.: MIT Press.

Martin, W. A. & McGuckin, N. A. 1998 Travel Estimation Techniques for Urban Planning. In *National Cooperative Highway Research Program 365*, pp. 170. Washington, D.C.: Transportation Research Board National Research Council ; National Academy Press.

McFadden, D. 1974 *Conditional Logit Analysis of Qualitative Choice Behavior*. Frontiers in

Econometrics. New York: Academic Press.

McFadden, D. 1977 Quantitative Methods for Analyzing Travel Behavior of Individuals: Some Recent Developments. In *International Conference on Behavioral Travel Modeling*. Adelaide, Australia.

McNeil, S. & Hedrickson, C. 1985 A Regression Formulation of the Matrix Estimation Problem. *Transportation Science* **19**, 278-292.

Metaxatos, P., Boyce, D., Florian, M. & Constantin, I. 1995 Implementing Combined Model of Origin-Destination and Route Choice in EMME/2 System. *Transportation Research Record* **1493**.

National Research Council (U.S.). Transportation Research Board. 1985 *Highway Capacity Manual*. Special report ; 209. Washington, D.C.: Transportation Research Board National Research Council.

National Research Council (U.S.). Transportation Research Board. 2000 *Highway Capacity Manual*. Washington, D.C.: Transportation Research Board National Research Council.

Nielsen, O. A. 1993 A New Method for Estimating Trip Matrices from Counts. In *Institute of Roads, Traffic and Town Planning*: The Technical University of Denmark.

Oppenheim, N. 1995 *Urban Travel Demand Modeling : From Individual Choices to General Equilibrium*. New York: Wiley.

Ortúzar, J. D. & Willumsen, L. G. 1994 *Modeling Transport*. Chichester, England: John Wiley & Sons.

Patriksson, M. 1994 *The Traffic Assignment Problem : Models and Methods*. Topics in Transportation. Utrecht, The Netherlands: Vsp.

Pindyck, R. S. & Rubinfeld, D. L. 1981 *Econometric Models and Economic Forecasts*. New York: McGraw-Hill.

Regueros, A. 1992 A Traffic Assignment Methodology for Pointwise Flow-Delay Functions. In *Dep. of Civil Engineering*, pp. 180. Haifa, Israel: Israel Institute of Technology, TECHNION.

Regueros, A., Prashker, J. & Mahalel, D. 1993 Equilibrium Assignment Method for Pointwise Flow-Delay Relationships. *Transportation Research Record* **1413**, 114-121.

Sheffi, Y. 1978 Transportation Networks Equilibration with Discrete Choice Models. In *Dept. of Civil Engineering*, pp. 131 pages. Cambridge, MA: Massachusetts Institute of Technology.

Sheffi, Y. 1979 Estimating Choice Probabilities among Nested Alternatives. *Transportation Research B* **13**, 113-205.

Sheffi, Y. 1984 *Urban Transportation Networks : Equilibrium Analysis with Mathematical Programming Methods*. Englewood Cliffs, N.J.: Prentice-Hall.

Sheffi, Y. & Powell, W. 1982 An Algorithm for the Equilibrium Assignment Problem with Random Link Times. *Networks* **12**, 191-207.

Simkowitz, H. 1993 GIS Applications Benefit from Census Transportation Planning Data. *GIS World*.

Slavin, H. 1979 The Transport of Goods and Urban Spatial Structure. Cambridge, England: University of Cambridge.

Slavin, H. 1996 An Integrated, Dynamic Approach to Travel Demand Forecasting. *Transportation*

Research **23**, 313-350.

Slavin, H., Liss, M. & Ziering, E. 1991 Integrated Transportation GIS and Demand Forecasting System. Newton, MA: report prepared by Caliper Corporation for the New York City Transit Authority and the Metropolitan Transportation Authority of New York.

Sobel, K. L. 1980 Travel Demand Forecasting by using the Nested Multinomial Logit Model. *Transportation Research Record* **775**, 48-55.

Sosslau, A. B., Hassam, A. B., Carter, M. & Wickstrom, G. 1978 Quick-Response Urban Travel Estimation Techniques and Transferable Parameters : User's Guide. In *National Cooperative Highway Research Program report 187*, pp. 229. Washington: Transportation Research Board National Research Council.

Spiess, H. 1990 Conical Volume-Delay Functions. *Transportation Science* **24**, 153-158.

Spiess, H. & Florian, M. 1989 Optimal Strategies: A New Assignment Model for Transit Networks. *Transportation Research* **23B**, 83-102.

Studenmund, A. H. & Cassidy, H. J. 1992 *Using Econometrics : A Practical Guide*. New York: HarperCollins.

Tan, H., Gershwin, S. B. & Athans, M. 1979 Hybrid Optimization in Urban Traffic Networks. MIT, Cambridge, MA: Research Report DOT-TSC-RSC-79-7.

Turnquist, M. & Gur, Y. 1979 Estimation of Trip Tables from Observed Link Volumes. *Transportation Research Record* **730**, 1-6.

USDOT. 1986 Urban Transportation Planning System (UTPS). Washington, DC: Urban Mass Transit Administration and the Federal Highway Administration.

Van Vuren, T., Van Vliet, D. & Smith, M. J. 1987 The Interaction between Signal Control Policies and Route Choice: Real Life Results. University College London: Paper prepared for the 20th Universities Transport Studies Group Annual Meeting.

Van Zuylen, J. H. & Willumsen, L. G. 1980 The Most Likely Trip Matrix Estimated from Traffic Counts. *Transportation Research* **14B**, 281-293.

Wardrop, J. G. 1952 Some Theoretical Aspects of Road Traffic Research. *Proc. Inst. Civil Engineers* **Part 2**, 325-378.

Webster, F. V. 1958 Traffic Signal Settings. Road Research Technical Paper 39. London: Road Research Laboratory.

Webster, F. V. & Cobbe, B. M. 1966 Traffic Signals, Road Research Technical Paper. *HMSO, London* **56**.

Willumsen, L. G. 1981 Simplified Transport Models based on Traffic Counts. *Transportation* **10**, 257-278.

Wilson, A. G. 1970 *Entropy in Urban and Regional Modelling*. Monographs in spatial and environmental systems analysis ; 1. London: Pion.

Wilson, A. G. 1974 *Urban and Regional Models in Geography and Planning*. London, New York,: Wiley.

Yang, H., Sasaki, T., Iida, Y. & Asakura, Y. 1992 Estimation of Origin-Destination Matrices from Link Traffic Counts on Congested Networks. *Transportation Research* **26B**, 417-434.

Zangwill, W. I. 1969 *Nonlinear Programming; A Unified Approach*. Englewood Cliffs, N.J.:

Prentice-Hall.