Development of a Computer-Based Training (CBT) Course for the FSUTMS Comprehensive Modeling Workshop

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September 2008

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Prepared by:

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Florida International University

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Development of a Computer-Based Training (CBT) Course for the FSUTMS Comprehensive Modeling Workshop

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16. Abstract

FSUTMS training is a major activity of the Systems Planning Office of the Florida Department of Transportation (FDOT). The training aims to establish and maintain quality assurance for consistent statewide modeling standards and provide up-to-date information on recent model enhancements. FSUTMS training workshops have been conducted mainly with a lead instructor in a computer laboratory setting at selected locations. The costs of conducting and attending these workshops are sizable for both FDOT and the participants. This inevitably creates a limiting effect on the workshop availability and participation. The objective of this project is to develop an online alternative of the live version of the FSUTMS Comprehensive Modeling Workshop.

The workshop includes a total of 12 lessons. It provides an overview of the transportation planning process, travel demand forecasting methodologies, and FSUTMS modules and data requirements. It also covers hands-on experience on execution of the FSUTMS Powered by Cube software, interpretation and creation of standard output results, and creation and editing of networks. This report contains the complete voice-over scripts used in the online version of this workshop. The workshop is hosted on the FSUTMSonline web portal together with other FSUTMS online workshops, at this web address: http://www.fsutmsonline.net/online_training/index.html. Since the exercise component of this workshop is presented in streaming videos, the scripts presented in this report for the exercises at the end of each lesson are best used together with the videos.

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The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

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The majority of the materials presented in this CBT were adapted from the Powerpoint files developed by Cambridge Systematics, Inc., Tallahassee for the live, in-person version of the workshop.

The development team members for this workshop include:

- Mr. Terrence Corkery, who served as the FDOT project manager and provided overall project direction;
- Dr. Albert Gan, of LCTR, who served as the FIU project manager and the writer;
- Mr. Atiosis Blanco and Mr. Osmel Matos, also of LCTR, who performed all of the graphic design and integrated text descriptions, animation, videos, and voice-overs;
- Ms. Xiaoxia Zhu, formerly of LCTR, who developed all of the video captures for the workshop exercises; and
- Mr. Joseph Shook, who provided the voice-overs for all lessons.

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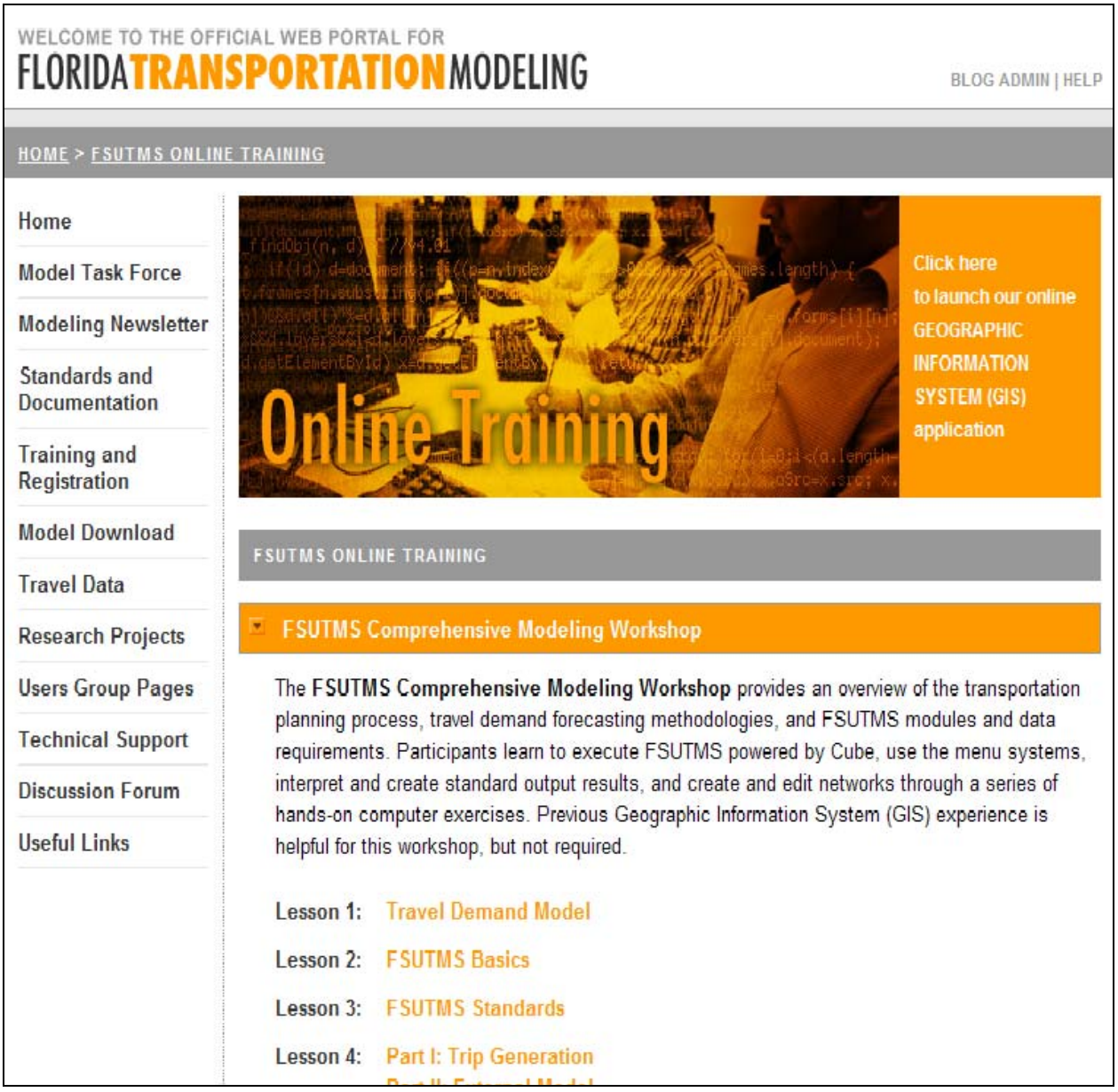
LESSON 1: TRAVEL DEMAND MODEL

Lesson Goals

Welcome to the online training for the FSUTMS Comprehensive Modeling Workshop. FSUTMS stands for Florida Standard Urban Transportation Model Structure. It is a formal set of modeling steps, procedures, software, file formats, and guidelines established by the Florida Department of Transportation for use in travel demand forecasting in the state of Florida.

As you may have read the workshop description, the objective of this workshop is to provide an overview of the transportation planning process, travel demand forecasting methodologies, and FSUTMS modules and data requirements.



We will start the first lesson of this workshop by introducing the traditional four-step modeling process. This process comprises the four basic sequential steps that transportation planners use to estimate the future traffic volumes on our transportation systems. We will also introduce the various types of models used by transportation planners.

What is a Model?

A model might be:

- A person that serves as the subject for an artist?
- A person employed to display merchandise, such as clothing?
- A small object, built to scale, representing another larger object?
- A schematic description of the actions and interactions of the elements of a system?

Only the last definition applies to transportation modeling. More specifically, a model in transportation modeling is one that is known as travel demand model. It is a mathematical model that helps the transportation planners to predict the future traffic volumes on a system of transportation facilities. A transportation facility could be an existing highway or a proposed light-rail route.

A key element in a travel demand model is the transportation network, which represents a real-world transportation system using a series of links and nodes. To predict the travel demand on a transportation network, a transportation modeler looks at both the current and future land use activities and intensities to estimate the need for travel. A land use activity could be a residential unit or a business establishment. The intensity of a specific land use is measured by the amount of the land use activity within a certain area, which is usually a traffic analysis zone, or TAZ. In other words, a TAZ is simply a geographic area that is used to quantify the land use activities in a subarea within a larger study area.

Four-Step Modeling Process

As mentioned earlier, the travel demand model in FSUTMS is built around four sequential steps. These four steps are trip generation, trip distribution, mode choice, and trip assignment.

The trip generation step estimates the number of trips produced by and attracted to each TAZ in a study area. When transportation planners make these estimates, they are based on the socio-economic characteristics, such as the population and employment, in each zone.

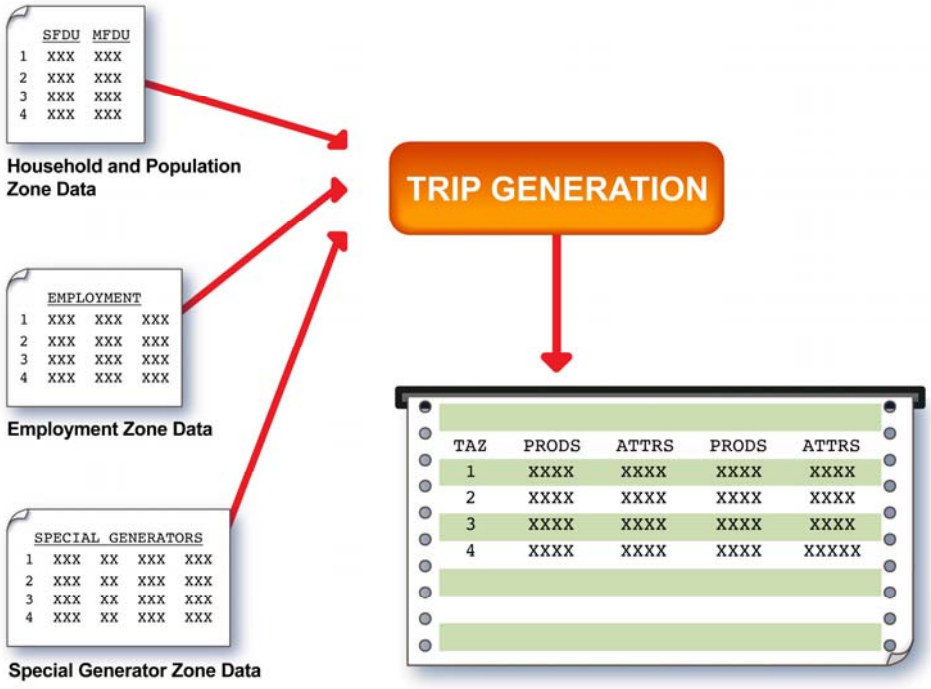
In the trip distribution step, the number of trips made between each pair of zones in a given urban area is determined. This number is generally based on the magnitude land uses of each zone, as well as the travel times that exist between zones.

In the mode choice step, trips are divided into those using the highway network and those using the transit network. In other words, the models predict how the trips will be split among the available modes of travel.

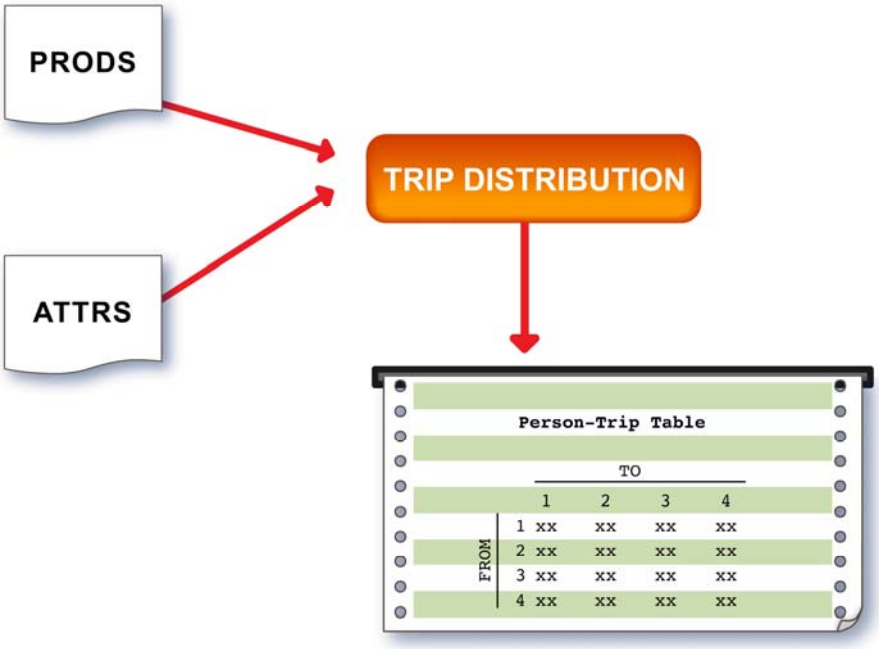
In the trip assignment step, the routes that the trip makers will use are predicted. Note that, among other predictions, these accounts for route diversion resulting from traffic congestion. The assignment step, with input from the previous three steps, results in traffic forecasts for a highway system and ridership forecasts for a transit system.

We will now go into the four steps of the modeling process in further detail.

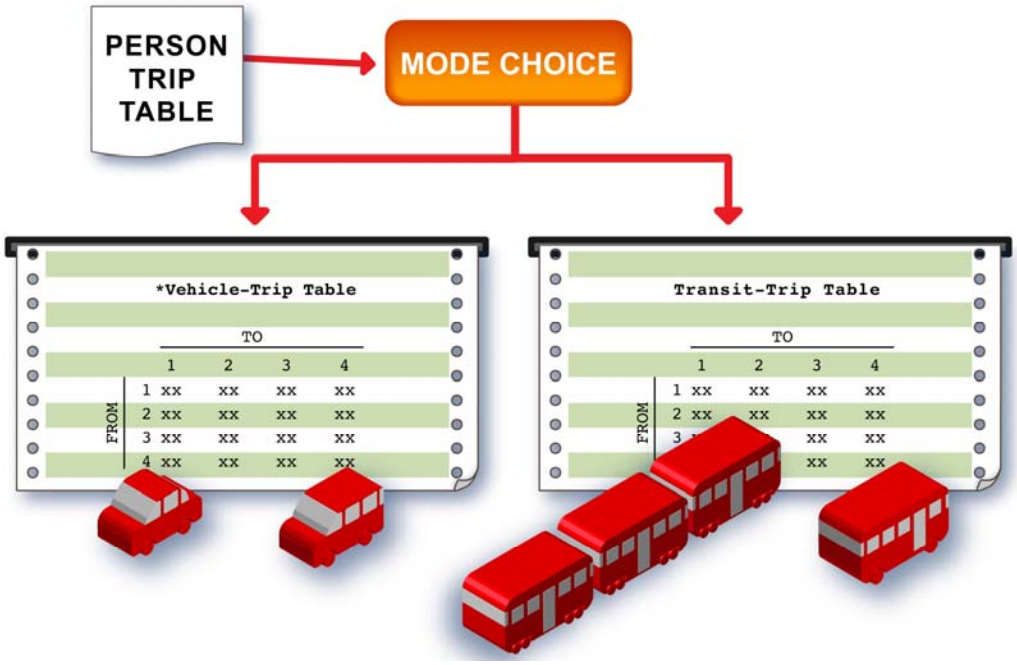
In the trip generation step, the transportation modeler determines the number of trips made. As can be seen here, household and population zone data, employment zone data, and what are called "special generators" all contribute to trip generation. These are output as productions, or the beginning trip end, and attractions, or the destination trip end. Special generators will be described further later on. For now, just remember that they make a contribution to trip generation.



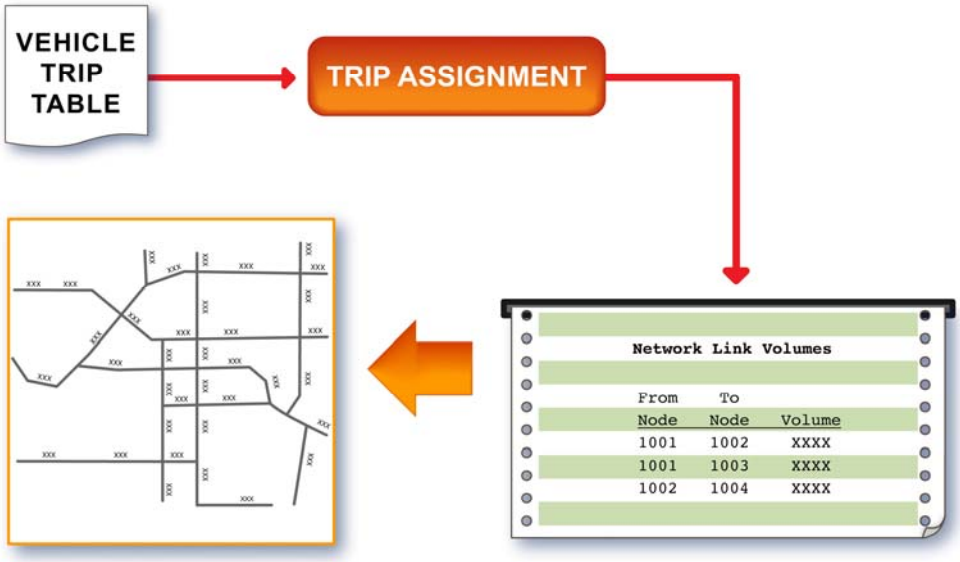
In the trip distribution step, we determine the destinations of the trips. In other words, it is to predict how the trips produced from each zone will be divided among all other zones in the study area. The method used in FSUTMS to distribute trips is by matching the production trip ends to the attraction trip ends based on the relative attractiveness and accessibility of each attraction zone. The attractiveness of a zone in this case is measured in terms of the relative amount of trips attracted to the zone. The accessibility of a zone, on the other hand, is measured based on the level of separation between two zones in relative to the separations among the different pairs of zones. The output from the trip distribution step are trip tables for different trip purposes. Each trip table lists the number of person trips that travel between each pair of zones. For this reason, these trips are also called "trip interchanges".



Mode choice is the step in which the mode(s) of travel are determined. As shown below, the person trip table derived during trip distribution is split. It is divided in the mode choice step into a vehicle trip table and a transit trip table. A vehicle trip table includes trips that were made using personal vehicles such as cars and light trucks as a transportation mode. The transit trip table reflects the choice of travel using motorbus, high-speed rail, etc. Keep in mind that the vehicle trip table is used in the Highway Only Model, also known as the Auto Occupancy Model**.** This model disregards travel by transit.



In the final step, trip assignment, the modeler determines the routes used in making trips. This is accomplished by assigning the vehicle trip table to links on the transportation network. A link, as will be described later, is a stretch of highway or arterial road between two nodes, or points along the network. The output of trip assignment, which was mentioned in the general description of a transportation model, is traffic volumes between two given nodes. Note that trip assignment also accounts for trip makers changing routes due to traffic congestion. It results in traffic forecasts for the highway system and ridership forecasts for the transit system.



Uses of Travel Demand Models

What are the uses for travel demand models? There are many uses for travel demand models. These may include, but are not limited to:

- Metropolitan Planning Organization Plan Updates
- Comprehensive Plans
- Strategic Intermodal System/Florida Interstate Highway System Planning
- Campus Master Plans
- Concurrency Applications
- Congestion Management Systems
- Corridor Studies
- Project Development & Environment Studies
- Interchange Justification /Modification Reports
- Development of Regional Impacts
- Toll Feasibility Studies

Types of Travel Demand Models

Note that there are three types of travel demand models. They are based on the geography of the study area. These include, from smallest to largest:

- Urban Area Models
- Regional Planning Models
- Statewide Models

There are also three types of travel demand models based on mode, or the means of transportation used in making a trip. These include:

- Highway Vehicle Models
- Transit Models
- Freight or Truck Models

Summary

This is the end of Lesson 1. In this lesson, we covered:

- The definition of a model;
- The four-step modeling process, which includes trip generation, trip distribution, mode choice, and trip assignment; and
- Uses and types of travel demand models, the latter of which are based on geography and/or mode.

LESSON 2: FSUTMS BASICS

Lesson Goals

In this lesson on FSUTMS basics, we will first introduce FSUTMS and its brief history. We will then learn about the different available FSUTMS models, and how we can use the FSUTMS Launcher to run these different models in Cube. We will also show you where and how to obtain the input files for these models. Finally, we will go through an exercise in which we will execute a FSUTMS model using Cube.

What is FSUTMS?

As mentioned in the previous lesson, FSTUMS stands for Florida Standard Urban Transportation Model Structure. FSUTMS is a computer-based transportation modeling package. The current version of FSUTMS is developed by Citilabs for the Florida Department of Transportation. FSUTMS implements a travel demand modeling process that is specifically customized for Florida applications.

History of FSUTMS

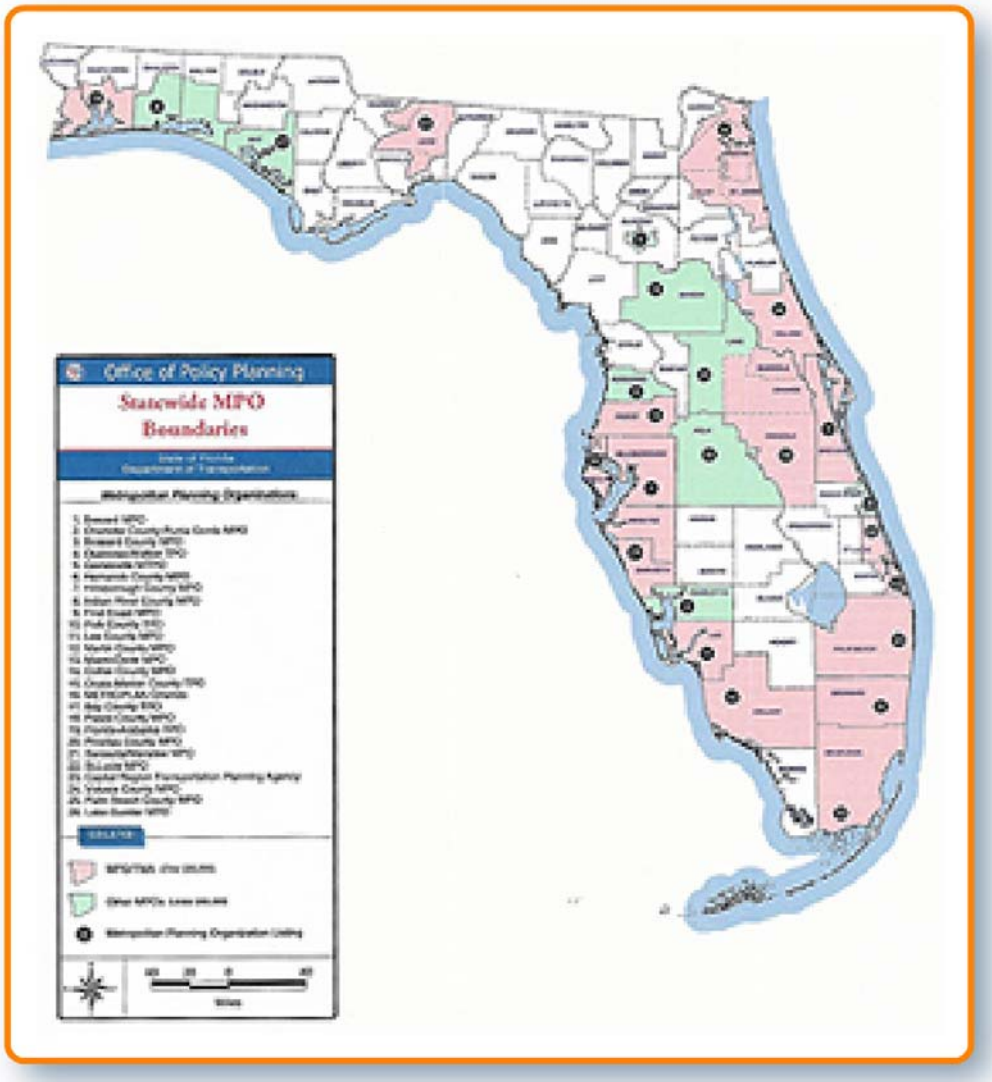
The first version of FSUTMS was developed in 1978. It was built around a set of mainframe programs called the Urban Transportation Planning System, or UTPS. The UTPS was distributed by the Federal Highway Administration (FHWA) in cooperation with the then Urban Mass Transit Administration (UMTA).

The second version of FSUTMS was ready for use in 1985. It was built as a framework around Tranplan. Tranplan comprises a family of urban transportation planning and related software tools, distributed first by the Urban Analysis Group and later by Citilabs. The current FSUTMS, as mentioned earlier, is powered by Cube. Cube is distributed by Citilabs and is a family of urban transportation planning and related GIS software tools.

Metropolitan Planning Organizations (MPOs)

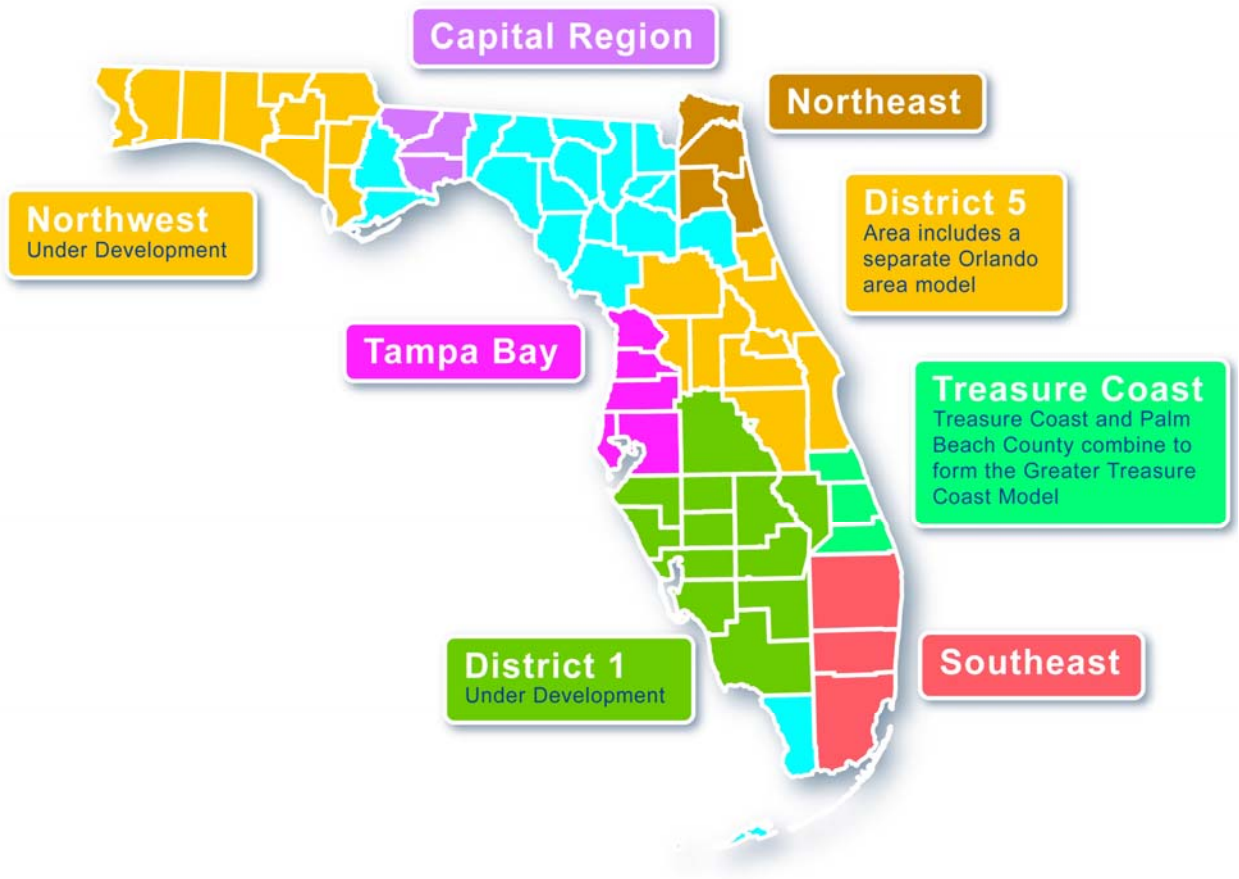
The Metropolitan Planning Organizations, or MPO, are the main agencies in charge of maintaining FSUTMS models. In Florida, there are a total of 26 MPOs and they are listed below in alphabetical order.

- Bay County TPO
- Brevard MPO
- Broward County MPO
- Capital Region TPA
- Charlotte County MPO
- Collier County MPO
- First Coast MPO
- Florida-Alabama TPO
- Gainesville MTPO
- Hernando County MPO
- Hillsborough County MPO
- Indian River County MPO
- Lake-Sumter MPO
- Lee County MPO
- Martin County MPO
- METROPLAN Orlando
- Miami-Dade MPO
- Ocala-Marion County TPO
- Okaloosa-Walton TPO
- Palm Beach County MPO
- Pasco County MPO
- Pinellas County MPO
- Polk County TPO
- Sarasota/Manatee MPO
- St. Lucie MPO
- Volusia County MPO



Urban, Rural, and Regional Model Areas

The map below shows the various regional models. Note that, as shown here, the areas in light blue are generally not included in what are called area-specific models. They are, however, covered in the Statewide Model. Also note that there are currently eight models available at the regional level. Another two are currently under development.



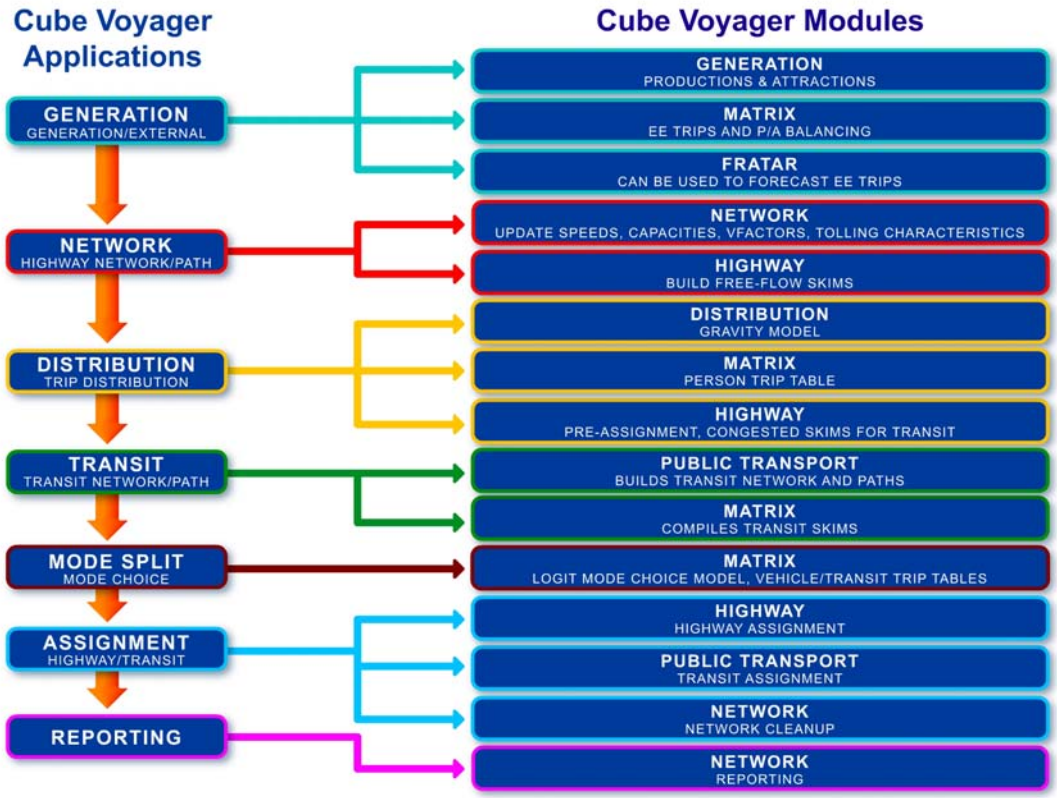
Florida Integrated Statewide Mode1

You should note the following with regard to the Florida Integrated Statewide Model:

- It is a Highway-Only model, meaning that travel by transit is not included in the model.
- It takes the Florida Freight Model and combines it with the Statewide Passenger Model into one integrated model.
- It includes a national network that is used for interstate and international freight trips, as is shown by the blue lines outside the state of Florida.

Cube Relationships

The following diagram shows the relationships between the Cube Voyager applications and the various Cube Voyager modules.



Requirements for Running FSUTMS

The following software and files are required to run FSUTMS:

- Florida Edition of the Cube Base Program
- Florida Edition of the Cube Voyager
- Cube Key, which is to be used by consultants only
- Data files

Items Needed for This Workshop

Throughout this training workshop, we will be working on a number of exercises using FSUTMS. We will be using a model that was developed for training purposes, called the Olympus Model. All of the data files for this model are stored in a folder in your C drive called C:\FSUTMS\general\Olympus.

Note that the Cube programs are stored in another folder under your Program Files folder, called Citilabs, i.e., C:\Program Files\Citilabs.

Another program that comes with your FSUTMS install disk is the FSUTMS Launcher. The launcher is a shell program developed in Macromedia Flash to provide an integrated interface to

run different FSUTMS standard models. Before you begin the exercises, it is a good idea to familiarize yourself with the FSUTMS Launcher interface.

FSUTMS Launcher

To start the launcher, look on the desktop for the Launcher icon and double click on it. This will start the Launcher. Once at the welcome screen, you will have access to all of FDOT's districts, path preferences settings, and web resources for support.

Launching FDOT District Model

On any of the screens of the Launcher, you will have access to a map of Florida that displays all of FDOT's districts. Simply click on the district that contains the model you wish to launch. At the lower right side of the screen, the Launcher will then display all of the available travel models for the district you have selected. Simply click on the model you wish to launch. If the model is not installed in your computer, a contact person's name will appear in the upper right corner of your screen. Click the contact name to send an email requesting the data for the selected model. You may also want to visit the FSUTMSonline portal to check if the model files are posted there for download. Downloading a model from the FSUTMSonline portal will be explained later on this video. If the model is installed in your computer, the Launcher will open Cube Voyager. Now that you know how to launch an FDOT District model, you might be thinking, how to access the Central Office and Turnpike models?

Launching Statewide, Turnpike, and Training Models

Just look in the upper right corner of the Launcher for a button that says "STATEWIDE AND TRAINING MODELS." Click on it. The Launcher will then show all of the available models in the lower right side of the screen. These models include the Florida Statewide Model, the Florida Turnpike Models, the FSUTMS/Cube Olympus training model, the FTOWN Highway Only Sample Model, the FTOWN Single Path Transit Sample Model, and other Training Models. As in the case of FDOT districts, if the model is not installed on your computer, a contact person's name will appear in the upper right corner of your screen. Click on the contact name to send an email requesting data for the selected model. Note that these Models are also accessible on the lower left side of the screen on each district launcher page.

Defining a New Path

The FSUTMS install comes with a default file path for each model. If your model is stored in a different folder other than the default path, you will need to modify the path so that the Launcher will know where to look for your files. To do this, look on any page within the Launcher, on the upper right corner, for a button that says Define Model Path. Click on it. The Define Model Path window will appear. From the drop-down menu, select a district. Now all available models for this district will be displayed. Click the model you are interested in to select it. Modify the model path and catalog file name. You can do this either by typing it directly in the textbox or by clicking the Browse button to open Windows Explorer.

Note that the catalog file contains such information on where the various files are stored and what model parameters to use. If you click in the browse button, you will have to navigate to the new model folder. By default, the Launcher only recognizes *.cat (catalog) files. Once you have located the catalog file, go ahead and select it. Now you will have to click on the Open button to return to the Define Model Path screen. Now click Save, then click OK, and then click Close to exit this window. Note that, for each district, a general model entitled "New Model" is included. This allows for temporary use of a new model that has not yet been added to the Launcher.

Now that you know how to define or modify the path for an existing model, we can go ahead and install a new model in your computer. To install a new model, you must have Internet access. Some of the following tasks will require it. From any Launcher page, at the lower right side of the screen, locate the MODELING PORTAL button and click on it. This will make your default Internet browser launch and load the FSUTMSonline portal.

Once the portal is completely loaded onto your browser, locate on the left vertical menu the hyperlink that says Model Download and click on it. The portal will load a page with a brief welcome text and a list of all of the FDOT's districts, along with their respective travel models. Each travel model name is a hyperlink to a page specifically dedicated to that model. As an example, let's click on the Southeast Florida Regional Planning Model (SERPM) in District 4.

When the Southeast Florida Regional Planning Model (SERPM) page loads, you will find a series of posts (publications) containing different versions for the model. Go ahead and click on the most recent one. As you can see, there are two files available for download for this model, as well as a brief description of the latest updates to this model. Click on any of the file's hyperlinks to proceed to the download page. You will need a password to download any model. To get the password for any model you want to download, you will have to fill out the Access Request Form. To load the form, click on the Access Request Form hyperlink to open the form. By filling out and submitting this form you will initiate a process from which you will receive an e-mail at the e-mail address you provided in the form. This email is just a confirmation that we have received your submitted data and that it is being evaluated. If your request is approved, you will receive a time-limited password to access the page. Copy the password from your email and paste it in the password textbox on the download page. Click Go once you have done this. You can now download the models' files by clicking on the download buttons.

You will see a pop-up confirmation window before you download the file. Click on the Save button. Save the file in a location that is easy to remember. Now let's look for the downloaded files in your hard drive. You will see that the downloaded files are compressed (*.zip) files. Double click on each file to uncompress it. Note that the Launcher will not recognize files in a compressed (*.zip) format. They need to be catalog (*.cat) files in order to be recognized and work properly.

To ensure that the Launcher will recognize that the model is installed, copy the model files into the appropriate folder. The directory structure is C:\fsutms\d?\model_name, where "?" is the district number. After you have extracted all of the files and placed them in the right directory, you will need to define the path for this new model. As we explained earlier, to define a model path you will have to click on the Define Model Path button. At the Define Model Path window,

select a district from the dropdown menu. From the list of Districts, select the model in which you're interested. Click on the browse button to open Windows Explorer. Navigate to where you saved the downloaded model files. Once you have located the catalog file, select it and click on the Open button. Go ahead and click Save. Click OK, then click Close to exit this window.

Now let's return to the Launcher and try to open the newly installed model by clicking on it from the list of models. Your model will now launch Cube Voyager with the new downloaded model data.

FSUTMS Web Portal

Earlier in this lesson you have learned that you can download some of the available model files from the FSUTMS web portal, called FSUTMSonline. The URL for this web portal is www.FSUTMSonline.net. So, what else is available from this web portal? The main items available from this portal are listed on the menu on the left side of the screen.

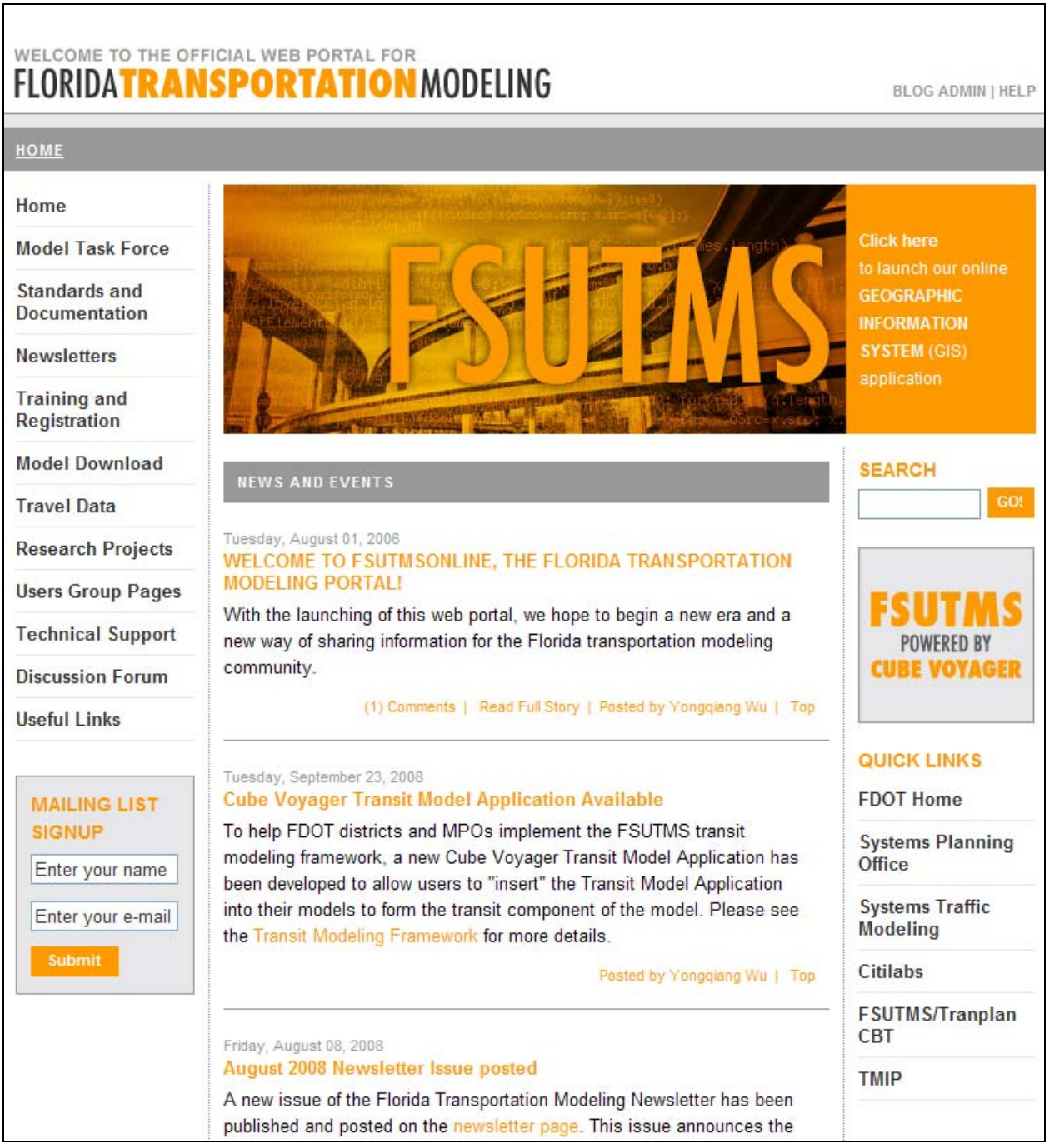
In the Home page you can find various announcements related to FSUTMS model updates, upcoming meetings, new software releases, new publications, etc. In the Model Task Force page, you will be able to find information about the Model Task Force committee and its subcommittees, as well as meeting materials that include presentation files, meeting minutes, etc. The Standards and Documentation page contains documents for the FSUTMS standards as well various other research reports and documents.

In the Newsletters page, you will be able to have access to the current and past issues of FSUTMS newsletters, called the Florida Transportation Modeling. You can sign up for this newsletter by entering your name and email here so that when a new issue is published, you will automatically receive an email notification. If you like to register for a FSUTMS workshop, you can go to the Training and Registration page to see the workshop availability and to complete and submit an online registration.

As demonstrated earlier, you can download the available FSUTMS model files from the Model Download page. The Travel Data page is intended to provide data and travel survey statistics available from different regions in the state of Florida. The Research Projects page lists the past and ongoing research projects that aim to improve FSUTMS. The research reports for past projects can also be accessed here.

In the Users Group page you can find the FSUTMS Users Group in your area, find out the contact information of a user group, read the meeting announcements and so on. You can also sign up to the mailing lists of these groups. If you have a technical question related to FSUTMS, you can go to the Technical Support page to submit an online form to FDOT. The Discussion Forum page is designed to facilitate discussion of various topics related to FSUTMS and transportation modeling in general. The Useful Links page lists the various web pages of planning organizations and publications.

The FSUTMS Launcher page allows you to download and install the latest version of the FSUTMS launcher. The GIS page is currently being developed. It is envisioned as a GIS web portal for agencies to share GIS data.



Exercises

Among the tasks you will complete in this exercise are to view the Olympus input data files and to execute the Cube-Voyager software.

As part of step 1 of this exercise, you will view the input data files. In order to do this, click on the Windows Explorer icon on your desktop. You can also hold down the Windows button on the keyboard and hit "E". Note that either one will open Windows Explorer. Next, browse to the folder: C:\FSUTMS\general\Olympus. This folder contains all of the files and subfolders you will need to run the model. Once you have opened this folder, you will be able to view the Olympus Model file structure shown here.

Next, you will execute the Cube-Voyager software by navigating to the Olympus Model. This is done as follows. First, click on the FSUTMS Launcher icon. Next, select Statewide and Training Models on the FSUTMS Welcome screen. Finally, select the FSUTMS/CUBE Olympus Training Model. The Cube Scenario Manager includes the Scenario Manager for Scenarios, the Scenario Manager for Applications, and data inputs and outputs.

As part of step 2, double click on Base in the Scenario Manager first. This action will display the Scenario Base dialog box that allows the user to execute the entire run by clicking on Run. Click on the Run button. Note that it may take a few minutes for the model to run. Once the model has completed the run successfully, click on the OK button. Click Close to exit this window

You will now be able to review the loaded network which contains the assigned traffic volumes. In order to do this, within the Application Manager, click on the Loaded Daily Network in the flow chart shown here. You can view a map of the loaded network by clicking the Next tab. Click Next again when you are finished viewing the network.

Summary

This concludes Lesson 2 on FSUTMS basics. In this lesson, we have learned:

- FSUTMS' brief history
- The different available FSUTMS models
- How to use the FSUTMS Launcher to run these different models in Cube, and
- Where and how to obtain input files for these different models

LESSON 3: FSUTMS STANDARDS

Lesson Goals

Welcome to Lesson 3. In this lesson, you will learn how the FSUTMS standards are applied in Florida. The standards include those for:

- Input and output file formats
- FSUTMS file folder structure
- File Naming Convention
- Main groups and subgroup of Cube-Voyager model applications
- Cube application manager
- Cube scenario manager

Input and Output File Formats

Each modeling step in Cube involves a set of input and output files that exist in various file formats. Among the Cube input files are:

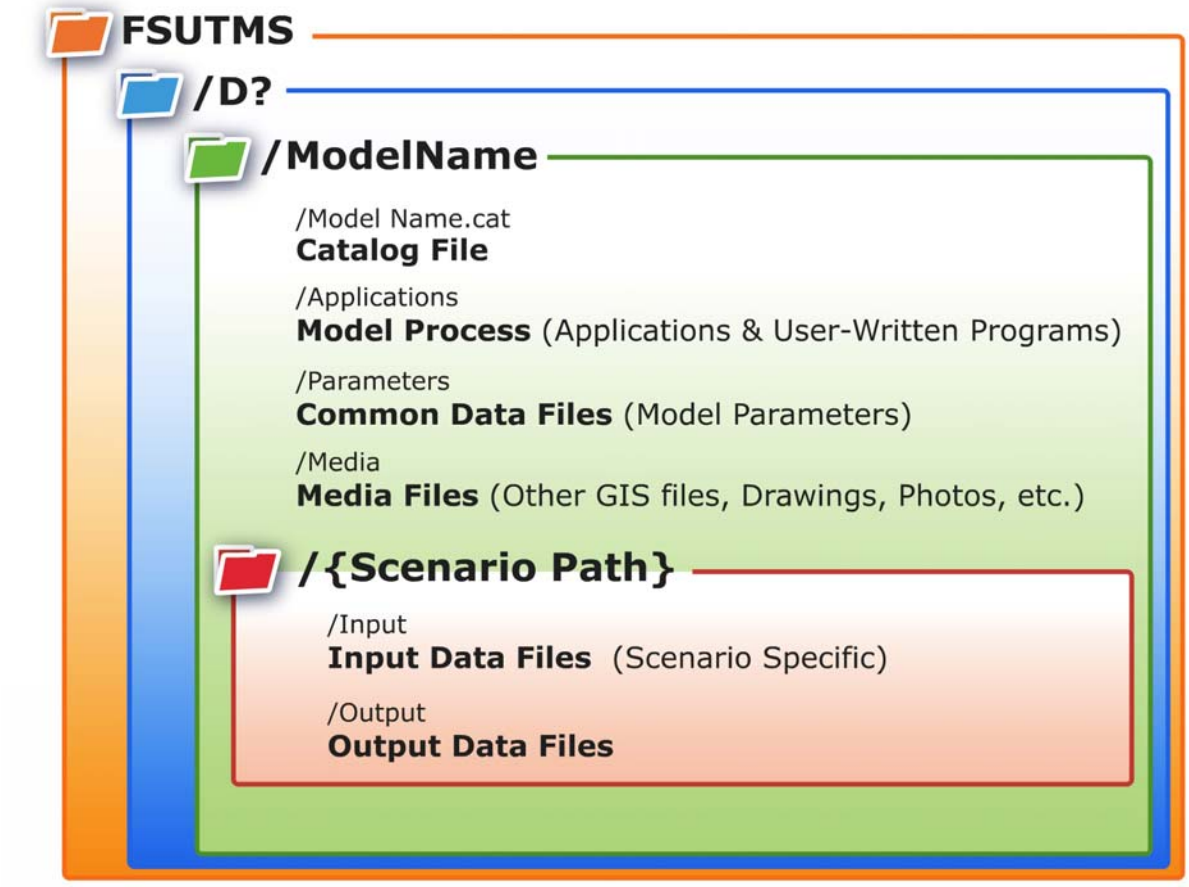
- Socioeconomic data files that are in the dBase file format
- Highway network files, which are in proprietary Voyager binary file formats and can only be opened by Cube
- Transit route files, which are in the standard text file format
- Lookup files, which are CSV text file format
- Script files, which are in the standard text file format

The Cube output files, on the other hand, include:

- Matrices and vector data files, which are in the dBase file format
- Assigned network files and the path files, which are in the Voyager binary files
- Files for reports and messages, which are in the standard text file format

File Folder Structure

The following is list of standard file folder structure used by FSUTMS for different types of files. As you can see from the file path, the main folder is FSUTMS. The next subfolders are organized by the FDOT district number. For example, the subfolder for a model in FDOT district four will have the name "d4". This is then followed by another subfolder for the model name. Additional subfolders are used for specific file purposes as indicated below. Click Next when you are finished viewing this structure.



File-Naming Convention

The file naming convention in Cube follows the following format:

FFFFFFFF_SSS.EXT

The first part, which may consist of up to eight characters, is used to describe the type of data. The second part, which consists of three characters, is used to describe the scenario alternatives. One of these characters represents the alternative and two represent the year. With this format, user-supplied input files have the format YYA, whereas computer-generated output files have the format AYY. In both cases, YY represents the last two digits of the year of interest. "A," in this example, is the alternative. EXT, as you might expect, is the file type extension.

Common File Extensions

Some of the common file extensions used in Cube includes the following:

- CSV for comma delimited text files
- DAT for data files

- DBF for dBASE database files
- FAR for transit fare files
- LIN for transit line files
- MAT for matrix files
- NET for network files
- PEN for turn penalty files
- PRN for print files
- RTE for routes files
- TRN for turning volume files
- TXT for text files

For those of you who are familiar with the TRANPLAN version of FSUTMS, this table shows some of the changes in the file naming conventions between the old TRANPLAN version of FSUTMS and the current Cube-Voyager version. Click when you are finished reading them.

File Names / Model Steps	User-Supplied (Input)		Computer-Generated (Output)	
	TRANPLAN	CUBE VOYAGER	TRANPLAN	CUBE VOYAGER
Generation	eetrips.yya	eetrips_yya.dbf	eetab.ayy	eetable_ayy.mat
	zdata1.yya zdata2.yya	zonedata_yya.dbf	Prods.ayy	panda_ayy.dbf
	grates.syn	attrrates.dbf prodrates.dbf	gen.out	gensummary.prn
Network	links.yya & xy.yya	hwynet_yya.net	hnet.ayy	unloaded_ayy.net
	tcards.yya	turn.pen	fhskims.ayy	freeskim_ayy.mat
	trouteam.yya	troute_yya.lin	tpatham1.ayy	tpathpk1_ayy.rte
Distribution	ff.Syn	ff.dbf	ptrips.ayy	psntrips_ayy.mat
Mode Split	mode.syn	modparam.dat	httab.ayy	hwytrips_ayy.mat
Assignment	vfactor.yya	vfactors.csv	hrldxy.ayy	hwyload_ayy.net
	tolllink.yya	tolllink_yya.dat	tlegsam1.ayy	trnloadpk_ayy.net

Main Groups and Subgroups of Model Application

A model application in Cube can include several steps that it refers to as main groups. For example, the Olympus training model consists of the following main groups:

- Generation
- Highway Network
- Distribution
- Transit Network
- Mode Choice
- Assignment
- Reporting

Some of these main groups can further consist of multiple subgroups. For example, the Generation main groups consist of the external and the internal subgroups; the Distribution main group consists of the Gravity Model and the Pre-assignment subgroups; the Assignment main group consists of the Highway and Transit subgroups; and the Reporting main group consists of the Air Quality and Environmental Justice subgroup plus a subgroup for model evaluation.

Cube Catalog

One major difference between Cube and other modeling software is that all of the model components in Cube, including the models themselves, the graphical workspaces, the scenarios, and the data and results for the scenarios, are all linked within one overall file, referred to as the "Catalog" file. As a result of this linkage, if you want to open a model, you only need to remember the name of the catalog file. Once you've selected your Catalog file and opened it in Cube, you will have access to three "windows" to develop and work with the model. This screen image shows the three windows, which are the scenario manager, the Cube graphics, and the application manager.

Application Manager

As can be seen, when the Application Manager window is opened, the modeling process is presented in a flow-chart form. Information and descriptions are provided in two areas within the flow chart. These include:

- Descriptive text, which may be placed anywhere on the flow chart. This text is useful for describing the processes as necessary or desired, as well as for leaving notes.

- The input and output data files, which are described in "descriptive text". When you click once on one of these files, the physical file name will be shown. When you right-click on the file and select "Properties" from the drop-down box, further information will be displayed.

Scenario Manager

The scenario manager allows you to create and manage the scenarios. It includes the following four sub-windows: Scenarios, Applications, Data, and Keys.

Scenarios Sub-window

The scenario sub-window shows the base scenario and all of the children and siblings of the base scenario. In this sub-window, you can right-click on the base scenario to bring up a menu to do the following:

- Add a child scenario
- Add a sibling scenario
- Delete a scenario
- Edit or run a scenario

- Rename a scenario
- Review the properties of a scenario

After adding a scenario, you can again right-click on it to create another child or sibling scenario for that scenario. This step can be repeated for as many scenarios as needed.

Applications Sub-window

The Applications sub-window lists all the available applications of a model. In this window, you can

- Edit an application
- Rename an application
- Run an application
- Add a key for an application
- View the keys for a selected application only
- Display the available properties of an application

Data Sub-window

This Data sub-window lists all of the input and output files of a scenario. In this sub-window, you can

- Add a sub-folder
- Delete a sub-folder
- Rename a sub-folder
- Select the scenario created or select from among the list of scenarios if more than one scenario has been created
- Add a data file

Keys Sub-window

Keys are used by the developer to assist the user in running the model. The Keys sub-window allows you to:

- Add a key
- Edit the value of a key
- Delete a key
- Rename a key
- Move a key
- Display the properties of a key
- View the keys for selected applications only

Cube Graphics

The Cube Graphics sub-window appears whenever a highway network, shape file, transit network, or intersection data is/are opened. What Cube Graphics provides to the user are comprehensive features for creating and editing networks and data. It also provides GIS functionality. In addition, Cube Graphics also provides the capability to create a wide variety of graphic commands. These graphic commands may include color sets to display volume/capacity ratio, etc.

Exercises

In this exercise we will learn to execute the FSUTMS Launcher, switch to the Applier Mode, and execute the Scenario Manager. In step one of this exercise, we will execute the FSUTMS Launcher. As demonstrated in Lesson 2, this is done by first navigating to the Olympus Model. To do this, first click on the FSUTMS Launcher icon. Then, select Statewide and Training Models on the FSUTMS Welcome screen, and finally, selecting the FSUTMS/CUBE Olympus Training Model.

The Olympus Training Model will appear as shown here. Next, we will try to switch from the developer mode to the applier mode. To do this, right-click on Olympus.cat and select Properties. Now, click on the Model User tab. Click on the Apply Password Protection box. Click the Change Developer Password button and set the password to password. Click OK. Select Model Applier, and click on OK.

Finally, we will work with the Scenario Manager to add a sibling. To do this, click on the + next to Base to view the contents of the scenario. This will display the existing scenarios. Right-click on Cost Feasible and click on Add Sibling. Enter Test 2030 to create a new scenario. This will bring up a dialog box. In the description area, enter the following: "This scenario will be used to test a bridge in 2030." Click OK. This will bring up a new dialog box for the new scenario

We will create a new scenario later. For now, please exit by clicking on Close, selecting No, and then clicking the X in the right hand corner of the screen. Choose not to save.

Summary

This is the end of Lesson 3. In this lesson, we covered the following topics:

- Input and output file formats
- FSUTMS file folder structure
- File Naming Convention
- Main groups and subgroup of Cube-Voyager model applications
- Cube application manager
- Cube scenario manager

LESSON 4, PART 1: TRIP GENERATION

Lesson Goals

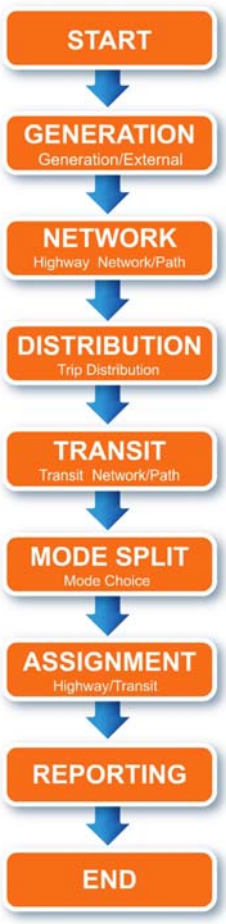
Welcome to Part 1 of Lesson 4 on trip generation. Our goals for this lesson include:

- Basics of trip generation concepts
- Definitions of trip, trip ends, trip productions, and trip attractions
- Trip purposes
- Transportation roadway and zonal networks
- Model input and output files
- Data sources for various model input files
- Regression and cross-classification methods of trip generations

We will also complete an exercise that includes five subtasks.

Overview

Generation is the first step in the FSUTMS model chain. Trip generation is the process of predicting the number of trips that will be made from and to an area. These predictions are based on the calibrated relationships between the number of trips made in an area and the socioeconomic activities within that area. Trip generation typically outputs two sets of trip ends: first, those that are produced by an area, and second, those that are attracted to an area. These trip ends then become the input to the trip distribution, mode choice, and trip assignment models. In trip generation, a "trip end" is not the same as what we normally understand to be a trip. So, how do the two differ from each other?



Trips and Trip Ends

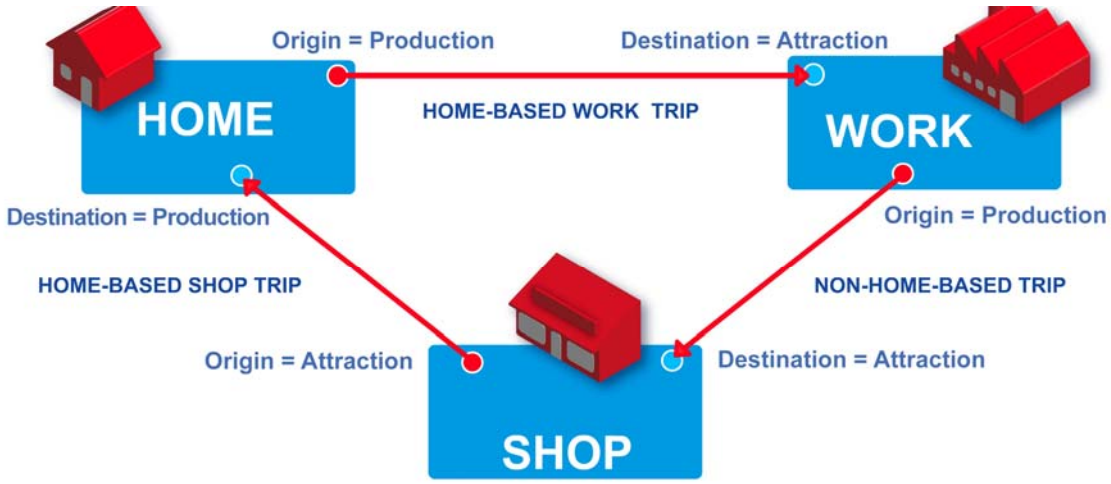
Most of us understand that a trip is one that takes a person from point A to point B. Thus, we can think of a trip as having two ends: a "from" end and a "to" end. These are what we referred to as the trip ends. A trip end can further be classified as either a production trip end or an attraction trip end. These production and attraction trip ends are non-directional. They are later connected in the trip distribution step to form complete trips known as trip interchanges. Remember, a production trip end is not necessarily the origin of a trip, and an attraction trip end is not necessarily the destination of a trip. For simplicity, we normally refer to these production and attraction trip ends as trip productions and trip attractions, or simply productions and attractions.

Trip Productions and Trip Attractions

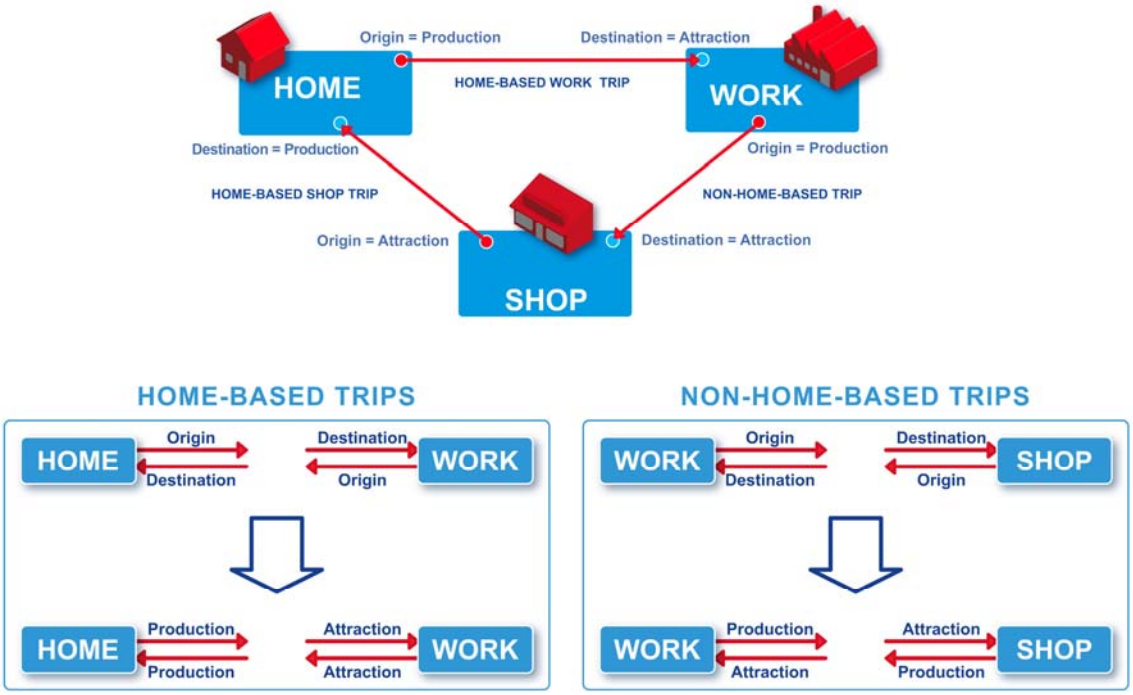
As we have defined previously, a home-based trip is one that has a home at one end of the trip and a non-home-based trip is one that has home at neither ends of the trip. Going from a work place to lunch at a restaurant is a good example of a non-home-based trip. Following these definitions, a trip production is defined as the home end of a home-based trip or the origin of a non-home-based trip. Similarly, a trip attraction is defined as the non-home end of a home-based trip or the destination of a non-home-based trip. In general, trips produced at homes are attracted to areas of employment, education, recreation, shopping and other activities to satisfy the purpose for making a trip.

Trip Production and Trip Attractions Example

For example, if a person starts from home to go to work in the morning, the trip is called a home-based work trip. In this case, the home origin of the trip is a trip production and the work destination of the trip is a trip attraction. In the afternoon, if the person stops at a shop before heading home, the trip is a non-home-based trip because neither ends of the trip is a home. In this case, the work origin of the trip is a trip production and the shop destination is a trip attraction. If the person went home from the shop afterwards, this would be the second home-based trip the person made. In this case, it is a home-based-shopping trip. However, unlike the first home-based trip, the origin of this trip, which is from the shop, is not a trip production but a trip attraction. It is the home destination of this trip that is considered a trip production.



From this example, you can see that by definition, a trip production is always associated with the home end of a home-based trip. Similarly, a trip attraction is always associated with the non-home end of a home-based trip. However, in the case of a non-home-based trip, the origin of a trip is always treated as the trip production and the destination is always treated as a trip attraction. These relationships are summarized in the figures below: the first figure is for home-based trips and the second is for non-home-based trips. On top of each figure it gives the trip-end definition based on trip origin and trip destination and at the bottom they are defined based on trip production and trip attraction. Please click Next when you are ready to go to the next slide.



Basic Generation Units

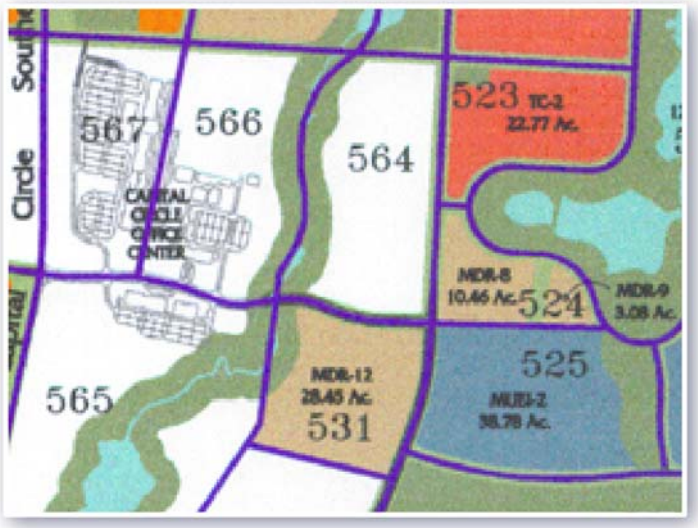
From the previous discussion, we can see that there are two basic units that can generate trips. The first is the household. This is the basic unit for home-based trip productions and it may include dwelling units, apartments, hotel/motels, group quarters, etc. The second basic unit is the employment: This is the basic unit for trip attractions and it may include businesses, factories, plants, office buildings, shopping centers, etc. To simplify the modeling process, data for these basic units are aggregated by small areas called Traffic Analysis Zones, or TAZ. Throughout this WBT, the terms "TAZ" and "zone" will be used interchangeably.

Traffic Analysis Zone (TAZ)

A TAZ is the smallest geographic unit that is used to quantify the activities, travel, and transportation characteristics of a physical location in a study area. A TAZ that is located within a study area is called an internal zone, and a TAZ that lies outside a study area is called an external zone. For reference purposes, each TAZ is assigned a unique number, called the TAZ number. A TAZ may vary in size, depending on the density or nature of the development area. In an urban area, a TAZ may be as small as a single city block. In a rural area, a TAZ may cover an area of several square miles.

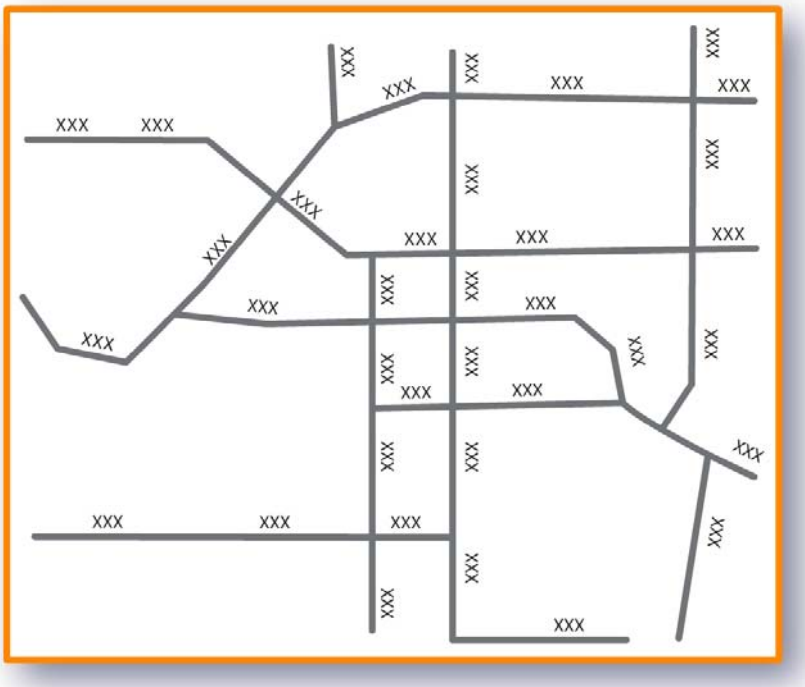
TAZ Delineation

TAZs are generally delineated such that within each TAZ the land use activities, such as residential, commercial, or industrial uses, are relatively homogeneous. TAZ boundaries generally coincide with identifiable physical barriers such as major streets and water bodies.



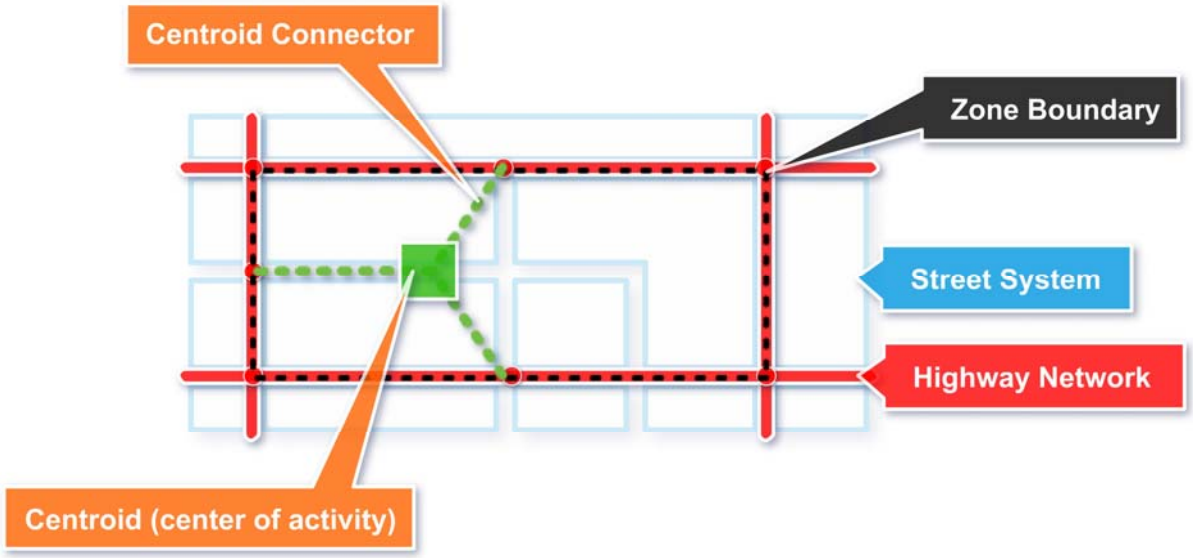
Transportation Networks

A transportation system may consist of street and rail networks that people might use to travel from one TAZ to another. A transportation network in modeling consists of links that represent highway segments or transit lines, and nodes that represent intersections and other break points on the network. Therefore, a study area may have multiple networks for highway and transit systems. The data attributes associated with each link may include travel time, speed limit, capacity, number of lanes, etc. Node attributes may include coordinates, type of intersection, and so on.



Centroid and Centroid Connectors

A special type of node in the link-node network representation we just discussed is centroid. A centroid represents the "center of activity" of a zone. This center of activities is not necessarily located at the geographic center of the zone. Centroids are used as the starting points at which trips are "loaded" onto the network. They are connected to their surrounding roadways by special type of links called centroid connectors. These special types of links are sometimes called imaginary links because they do not exist in the real world system. They exist simply to allow trips generated in a zone to get to the surrounding roadways.



Trip Purposes

In FSUTMS, trips are classified by purpose in order to more accurately simulate the trip behaviors associated with different trip purposes. For example, a social-recreational trip is likely to have more occupants in a vehicle than a work trip. The Generation model accounts for these different characteristics of different trip purposes in terms of variations in trip rates, trip length distributions, average vehicle occupancy, and choice of travel mode. Depending on the complexity of the trip generation model in question, the number of trip purposes may vary from one urban area to another. At a minimum, the trip purposes are divided into the following three categories: home-based work; home-based non-work, and non-home-based trips.

FSUTMS Trip Purposes

FSUTMS uses the following eight trip purposes:

- Purpose 1: Home-Based Work (HBW)
- Purpose 2: Home-Based Shop (HBSH)
- Purpose 3: Home-Based Social/Recreational (HBSR)
- Purpose 4: Home-Based Other (HBO)
- Purpose 5: Non-Home Based (NHB)

- Purpose 6: Truck-Taxi (TT)
- Purpose 7: Internal-External (IE)
- Purpose 8: External-External (EE)

Not all FSUTMS models include all of these trip purposes. Note that the trips generated for the first five purposes are person trips and the trips generated for the last three purposes are vehicle trips.

Model Structures

As highlighted in this flow chart in Cube (on the next page), the Trip Generation Model is the first step in the model chain. Clicking on the GENERATION box in the flow chart will open a sub flow chart that shows all of the components of the trip generation model.

Model Procedures

The specific tasks performed by the trip generation model include:

- Reading the input files and parameters
- Computing the initial trip productions and trip attractions
- Applying any special generators
- Computing internal-external trips
- Balancing the productions and attractions
- Producing a summary output file

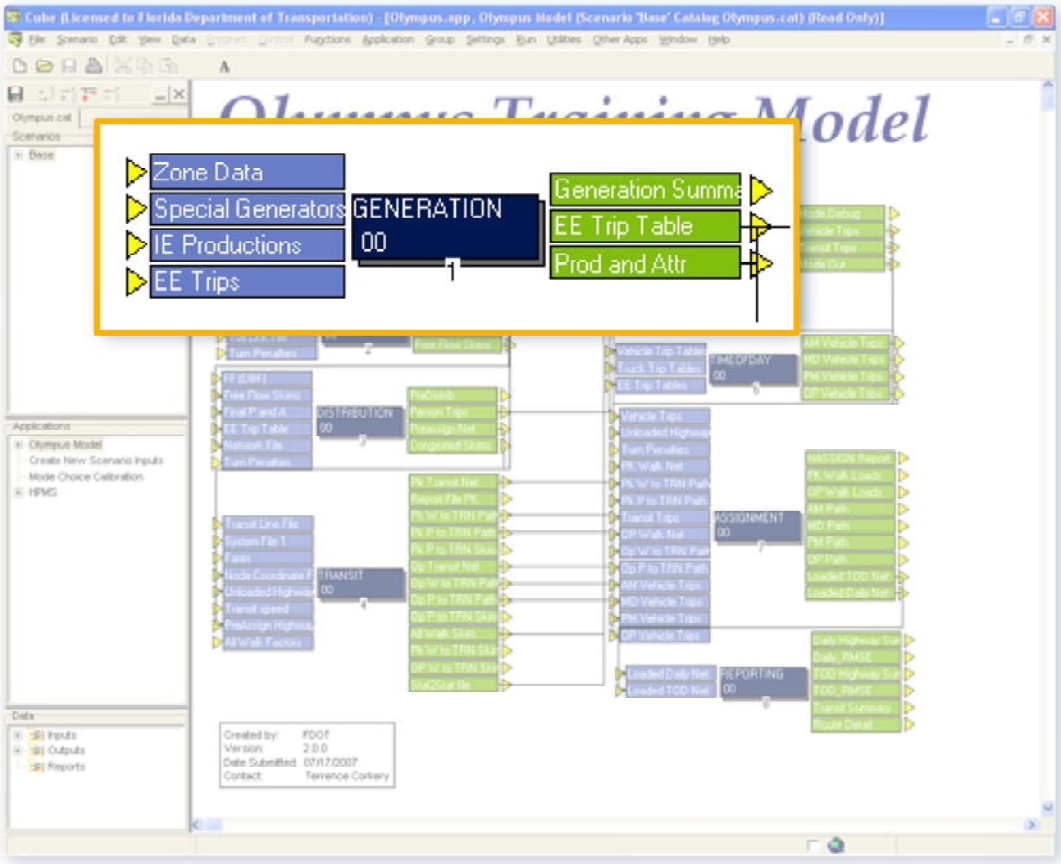
Trip Generation Input Files

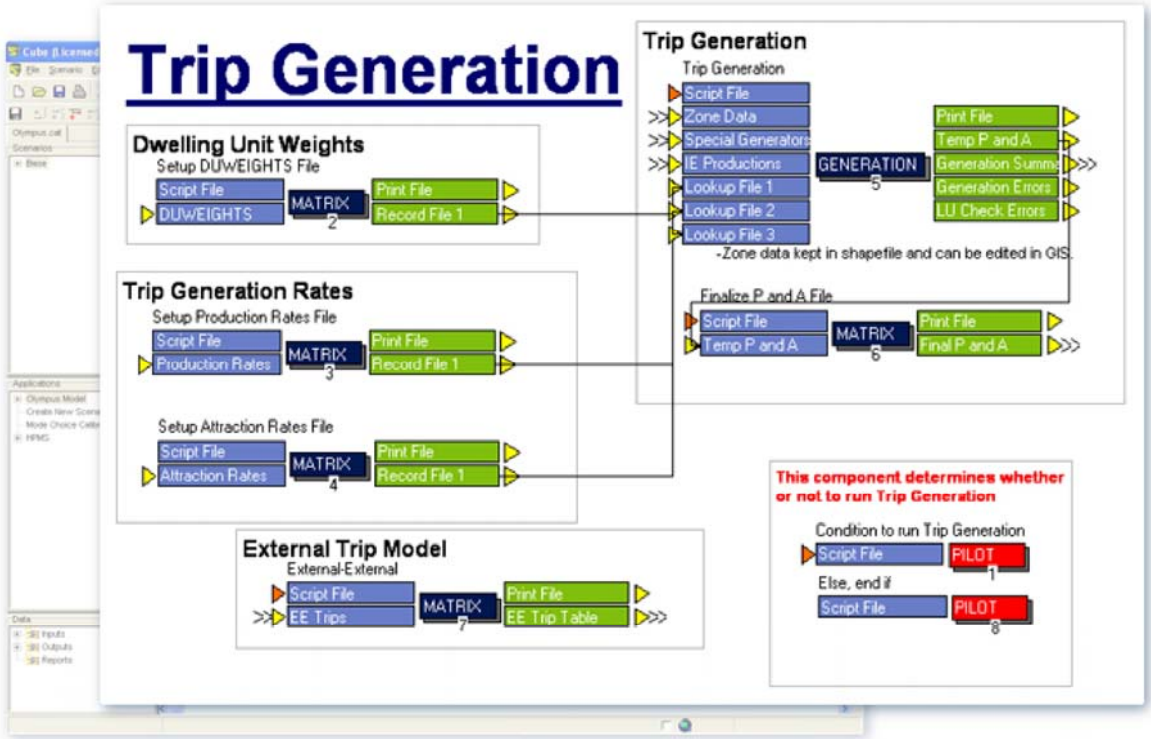
There are three sets of input files for the trip generation model. The first is the zonal data files that include three different files: The Zonedata file that is used to store the household and employment socioeconomic data, the Specgen file that is used to store the data related to special generators, and the EIprods file that is used to store the data for external productions.

The second set of input files includes two files: the Prodrates file that stores the trip production rates, and the Attrrates file that stores the trip attraction rates. The last set of input file consists of only one file called Duweight. This file is used to store the dwelling unit weights, which are in turn used to determine the percentage of households that has a specific household size.

Trip Generation Output Files

There are only two output files from the trip generation model. The first is the PandA.dbf file, which stores the generated trip productions and trip attractions, and the second is the gensummary.prn file, which is the output report file for the Generation model.


Zone Data
Special Generators
IE Productions
EE Trips
GENERATION
00
1
Generation Summa
EE Trip Table
Prod and Attr


Trip Generation
Dwelling Unit Weights
Setup DUWEIGHTS File
Script File
DUWEIGHTS
MATRIX
2
Print File
Record File 1
Trip Generation Rates
Setup Production Rates File
Script File
Production Rates
MATRIX
3
Print File
Record File 1
Setup Attraction Rates File
Script File
Attraction Rates
MATRIX
4
Print File
Record File 1
External Trip Model
External-External
Script File
EE Trips
MATRIX
7
Print File
EE Trip Table
Trip Generation
Trip Generation
Script File
Zone Data
Special Generators
IE Productions
Lookup File 1
Lookup File 2
Lookup File 3
GENERATION
5
Print File
Temp P and A
Generation Summa
Generation Errors
LU Check Errors
-Zone data kept in shapefile and can be edited in GIS.
Finalize P and A File
Script File
Temp P and A
MATRIX
6
Print File
Final P and A
This component determines whether or not to run Trip Generation
Condition to run Trip Generation
Script File
PILOT
1
Else, end if
Script File
PILOT
8

Common Zonal Data Attributes for Trip Productions

The common zonal data attributes for generating trip productions include the following. Click "Next" when you are finished reading.

- SFDU: Single Family Dwelling Units
- SFPOP: Single Family Population
- MFDU: Multi Family Dwelling Units
- MFPOP: Multi Family Population
- HMDU: Hotel/Motel Dwelling Units
- HMPOP: Hotel/Motel Population
- HMOCC: Hotel/Motel Percent Occupancy
- ##_PCTVNP, ##_PCTVAC: Permanent and seasonal vacancies for both single and multi-family
- ##_#AUTO: Percent Auto ownership for 0, 1, and 2+ automobiles for both single and multi-family

Common Zonal Data Attributes for Trip Attractions

The common zonal data attributes for trip attractions are given below. Again, click "Next" when you are finished reading.

- IND_EMP: Industrial Employment
- COMM_EMP: Commercial Employment
- SERV_EMP: Service Employment
- TOT_EMP: Total Employment
- SCHOOL: School Enrollment
- SHORTPARK: Short-Term Parking Costs
- LONGPARK: Long-Term Parking Costs

Sources of Production Zonal Data

Household zonal data that are needed as input to generate trip productions can come from a variety of sources. The primary source of household data is the U.S. Census. The Census publishes the Summary Tape Files, which are a reliable source for information on population and dwelling units. These files also include data on auto availability and vacancy status. Another good source of auto availability data is the Census Transportation Planning Package, or CTPP. Hotel and motel information can be obtained through the DBPR Hotel/Motel Division or through local chambers of commerce. Local planning departments are a good source of many of the required variables. These may include parcel data, development orders, future land use maps, and utility hookups.

Sources of Attraction Zonal Data

Zonal data for trip attractions can also come from a variety of sources. In 2007, FDOT purchased private employment data from InfoUSA for the entire state of Florida. Employment data used in the zonedata file have traditionally been obtained through the Florida Agency for Workforce Innovation, or AWI. The FDOT Policy Planning Office in Tallahassee has access to the AWI records through a confidential employer number-matching program. Public school enrollment data can be obtained from the local school board or the Florida Department of Education, or DOE. Private schools need to be contacted individually, although the DOE does have some data on private schools.

Additional Sources of Employment Data

Other additional sources of employment data include:

- Longitudinal Employment and Household Dynamics, or LEHD
- The Bureau of Economic and Business Research, or BEBR, at the University of Florida
- Local Chambers of Commerce
- Dun and Bradstreet for base year employment data
- Woods and Poole for forecast year employment data

Special Generators

Special generators may be required when normal generation equations produce too many or too few productions or attractions for a particular trip purpose for a given TAZ. Adjustments may be necessary if the trip generation rates applied to the socioeconomic data do not produce the correct number of trip ends. Parks and beaches are examples of cases that may need adjustment. This is because parks and beaches typically have few workers and would produce very few attractions based on employment.

Typical Special Generators

Typical special generators may include:

- Universities
- Community Colleges
- Parks and Beaches
- Shopping Malls
- Shopping Centers
- Military Bases
- Airports
- External Stations
- Group Quarters

Non-typical Special Generators

Some of the non-typical special generators include:

- Hospitals
- Arenas and Civic Centers
- Government Buildings
- Tourist Attractions
- Ports
- Office Complexes
- Disney Employment
- Dog Tracks and Jai Alai

Special Generator Applications

Special Generators, such as those just listed, are generally added during validation for specific problems. The addition of special generators can be in the form of an addition, a subtraction, or the total replacement of the purpose or purposes for production or attraction. Note that generated trips are computed off of the model and then entered in the Specgen file. Model Update Task B outlines specific land uses for the application of special generators.

Adding and Subtracting Special Generator Trips

When a particular land use generates less than the established special generator rates, you add trips to those calculated by the trip generation model. On the other hand, if it is more than the established special generator rates, you subtract trips from those calculated by the trip generation model. Site-generated trips can be computed using Model Update Task B or ITE. You may need to add University and College trips, as these are often not included in the file. Except for group quarters such as dorms and barracks, special generators are usually treated as trip attractions. When Non-Home-based trips are listed as attractions, the equivalent non-home-based productions are automatically calculated.

ITE Trip Generation Manual

ITE Trip Generation Manual is the primary and most important source of special generator data. ITE Trip Generation Manual is based on nationwide research. ITE trip rates are updated when sufficient new data from various surveys are submitted to ITE. New survey data may be submitted to ITE by anyone using forms found in the manual. Any site-based survey can be included.

Limitations of ITE Trip Generation Manual

The ITE Trip Generation manual includes daily and peak trip rates for different land uses. Except for airports, the manual includes only vehicle trip rates. Again with the exception of airports, the manual does not include any data on vehicle occupancy, nor any trip purposes. It

contains an insufficient sample for some land uses. The data in the ITE trip generation manual are mostly used for site impact analysis.

External-Internal Data

The INTEX dbf file contains information on the number of trips produced at the model's external stations for internal-external trips. At the boundary of the study area, two types of trips may occur: Internal-External (IE) and External-External (EE) trips.

Trip Generation Models

Separate trip generation models are calibrated for trip productions and trip attractions. Because trip productions are always associated with the home-ends, trip production models are dependent on household characteristics that may include household type, vehicle ownership, and income level. Trip attractions, on the other hand, are always associated with non-home ends that may include commercial or industrial sites. Trip attraction models are dependent upon variables such as the number of employees, total floor areas, etc. Two common methods used to estimate trip generation are multiple regression and cross-classification

Multiple Regression Method

The multiple regression method of trip generation involves the use of regression equations that express the number of trips, either produced from or attracted to a given zone, as a function of one or more variables.

Consider the following equations:

$$P_i = 37.55 + 1.58 \times HH_i + 2.27 \times AUTO_i$$
$$A_j = 60.86 + 0.84 \times EMP_j$$

In these equations,

- P_i is the total number of trips produced in zone i,
- A_j is the total number of trips attracted in zone j,
- HH_i is the total number of households in zone i,
- $AUTO_i$ is the total number of automobiles owned by households in zone i, and
- EMP_j is the total number of employees in zone j.

P_i and A_j are the dependent variables and HH, AUTO, and EMP are the independent variables.

Interpreting Regression Models

The coefficients associated with each of the independent variables can be thought of as the trip rates associated with variables. For example, the trip rate for the total number of households in the production model is 1.58 trips per household. The constant of 37.55 can be thought of as the

additional number of trips that is not explained by the two independent variables. These coefficients are estimated through a regression method based on the trip survey data.

Generating Trips from Regression Models

Once we are satisfied with the relationships that have been calibrated, we can extrapolate the relationships into the future by entering the forecast land use intensities and by solving the total trips produced and attracted. For example, if a zone is forecast to have 500 households and 1000 automobiles in the year 2025, we will estimate that the zone will produce a total of 3098 production trip ends. This is calculated from the production model as follows:

$$P = 37.55 + 1.58 \times 500 + 2.27 \times 1000 = 3098 \text{ trips}$$

In calibrating a regression model, it is important to verify that the independent variables used are indeed independent, that is, they are not significantly correlated. For example, it is important to make sure that the total number of households and the number of automobiles is not significantly correlated. When two variables are significantly correlated, only one of the two variables should be included in the model.

Cross-Classification Method

Also known as the category analysis, the cross-classification method stratifies trip rates based on household characteristics such as household size and vehicle ownership. The table below shows an example of cross-classification trip production model from FSUTMS.

Dwelling Unit Type	Number of Autos Avail.	Number of Person in Household				
		1	2	3	4	5+
Single - Family	0	0.40	0.80	1.15	1.40	1.50
	1	0.50	1.10	1.50	1.75	1.90
	2+	1.05	2.00	2.45	2.60	2.65
Multi - Family	0	0.15	0.35	0.55	0.80	1.00
	1	0.45	0.65	0.90	1.00	1.10
	2+	1.20	1.55	1.85	2.05	2.15
Hotel/Motel Units		0.25	0.20	0.15	0.10	0.10

In this example, the numbers shown in this table are trip rates, i.e., the number of trips made per household. You can see that the trip rates are cross-classified by household type, household size, and number of cars owned by a household. Note that for the cases where the number of automobiles and the number of family members is larger than the table can accommodate, the model will default to the maximum case number of trips.

Generating Trips from Cross-Classification Models

To calculate the trip ends generated by a zone using cross-classification, the number of households in each stratum is multiplied by the corresponding trip rate. The total trip ends generated by the zone is then obtained by summing up the resulting trip ends from each stratum.

Type of Cross-Classification Models

In FSUTMS, two types of cross-classification models have been used: the standard cross-classification model, and the lifestyle cross-classification model. The key difference between these two models is in the variables that they use. The standard models use the traditional variables such as household size and vehicle ownership, while the lifestyle models use the less traditional lifestyle variables such as whether a household has children or retirees.

This standard cross-classification model is used for developing home-based trip productions in most of the smaller urban area models. The lifestyle models have been used for developing home-based trip productions in FDOT Districts 4, 6, and 7. They have also been used for developing home-based productions in Volusia County in the Central Florida Model.

Developing Trip Rates

Trip rates are developed and determined from household surveys that describe travel characteristics. The data for these surveys are obtained through telephone interviews or mail-back surveys taken from members of selected dwelling units. In most cases, members of a household are asked to keep a trip diary or log of all trips during a 24-hour period or longer. The surveys are then continued until sufficient data is obtained for each cell in the matrix, such that the required statistical analysis for sampling is met.

Trip Production Rates

Trip production rates are calculated in person trips and are collected by purpose. Note that, as shown in the previous example matrix, transient dwelling units, or hotel/motel units, are assumed to have one auto per occupied room. Production rates can also be calculated by other classifications, such as retired and working families with or without children.

Trip Rate Method

In the trip rate model, trip rates are used for developing attractions. They are also used for developing non-home-based productions and trips for special generators. An example is provided here: 250 employees x 6.1 trips/employee = 1,525 trip attractions.

Exercises

In this exercise, you will review trip generation inputs, execute trip generation, review trip generation outputs, update socioeconomic data and re-run the model, and, finally, review revised outputs.

To review trip generation inputs, begin by clicking on the Cube icon on your desktop. This displays a blank Cube screen with a dialog box. For the purposes of this exercise, click on the OK button. This will display the scenario manager for Olympus. Under Data, click on the + sign next to Inputs and then click on the + sign again next to Generation. This will display the input files for Generation. The files include:

- Zone Data, which contains population, dwelling units, employment, and school enrollment data
- Production Rates, which contains the trip production rates
- Attraction Rates, which contains the trip attraction rates
- Special Generators, which contains the special generator data
- Internal-External Productions, which contains the external station productions
- External-External Trips, which contains the external-to-external trips
- Dwelling Unit Weights, which contains the weights to distribute a given population amongst the dwelling units

Please note that dwelling unit weights, production rates, and attraction rates are not scenario specific. They would typically only be calibrated during model validation. Now, under Trip Generation in the Data window, double-click on each of the input files to view the file information.

Next, you will execute the application. To do so, first, open the Scenario Manager for the Base Scenario. Under "Please Select Model Steps", check only Trip Generation. Next, click Run. This will allow you to execute just the trip generation application. When the model is finished running, go to the Data window, click on the + sign next to Outputs and then click on the + sign again next to Trip Generation. Finally, click on the Generation Summary and the Productions and Attractions files to view the output files.

Now, based on the output files from the previous demo, you will be able to answer the following questions:

- How many home-based work productions (HBWP) are in TAZ 389? 860
- How many non-home based attractions (NHBA) are in TAZ 396? 976
- How many total home-based other productions (Purpose 4) are there in the model? 79978

Now you will have a chance to update the socioeconomic data and re-run the model. Assuming that you work at an MPO and you are asked to review the impact of zonal data changes in zone 263 for the year 2002 model. The zone currently has a middle school that was opened in 2001. The proposed developments include a high school with an enrollment of 2000 and a total of 1500 single family dwelling units. For this exercise, you will assume a ratio of 0.07 teachers and support staff per student and a household size of 2.60 persons per dwelling unit.

We will now try to update the socioeconomic data to include these changes and then re-run the model. To do this, begin by clicking on the Cube icon on the desktop. This displays a blank Cube screen with a dialog box. Click on the OK button. This will display the scenario manager

for Olympus. Since this is a model review, we do not want to update the existing files. Instead, we will create a new scenario and update the files for this run. To do this, first, right-click on the Olympus.cat catalog file name tab and select Properties. Then select the Model Applier option. Within the Scenario box, right-click on Base, then click on Add Child. Name this child Y2002 and click on Enter. This will open the Scenario Properties dialog box. In the box, type the description "This run is to evaluate TAZ 263 land use changes." Click OK when you a finished. e Scenario Base for Y2002 dialog and run menu will appear.

Although Cube will automatically create a scenario folder, it will not create the input and output subdirectories automatically, nor will it copy the input data from the parent scenario automatically. These will need to be done using the Create New Scenario Inputs application. To do this, first, change the Model Year to 02. Change the application by selecting Create New Scenario Inputs. When you are asked if you would like to save the changes you have made to the scenario, go ahead and save them. Finally, click Run.

To complete the exercise, double-click on the Zone Data file in the Data window under Inputs and then Generation, just like you have done before. After the file is open, go ahead and make the changes to zone 263. Note that you will have to manually calculate the total productions and attractions for zone 263 from the Productions and Attractions file. To do this more easily, open the file in Excel to calculate the desired totals. The changes include:

- Add 1,500 to SF Dwelling Units
- Add 3,900 to SF Population
- Add 2,000 to School Enrollment
- Add 140 to Service Employees (2,000 students x 0.07)
- Add 140 to Total Employees

When you are done entering the data, click Save. Next, we will execute the trip model just like what we did before: First, open the Scenario Manager for the Base Scenario. Under Please Select Model Steps, check only Trip Generation. Click Run. When the model is finished running, go to the Data window, click on the + sign next to Outputs and then click on the + sign again next to Trip Generation. Finally, click on the Generation Summary and the Productions and Attractions files to view the output files.

Now, try opening Cube Voyager and by following the steps provided in the previous demo video, find the changes to Zone 263 for the following items?

Item	Before	After
Dwelling Units	_____	_____
Population	_____	_____
School Enrollment	_____	_____
Service Employment	_____	_____
Total Employment	_____	_____
Total Productions	_____	_____
Total Attractions	_____	_____

Answers:

Item	Before	After
SF Dwelling Units	7	1,507
SF Population	14	3,914
School Enrollment	68	2,068
Service Employment	452	592
Total Employment	874	1,014
Total Productions	1,439	11,748
Total Attractions	3,801	11,006

Summary

This concludes Part I of Lesson 4. In this lesson, we have learned about:

- Basics of trip generation concepts
- Definitions of trip, trip ends, trip productions, and trip attractions
- Trip purposes
- Transportation roadway and zonal networks
- Model input and output files
- Data sources for various model input files
- Regression and cross-classification methods of trip generations

We also completed an exercise that included five subtasks.

LESSON 4, PART II: EXTERNAL MODEL

Lesson Goals

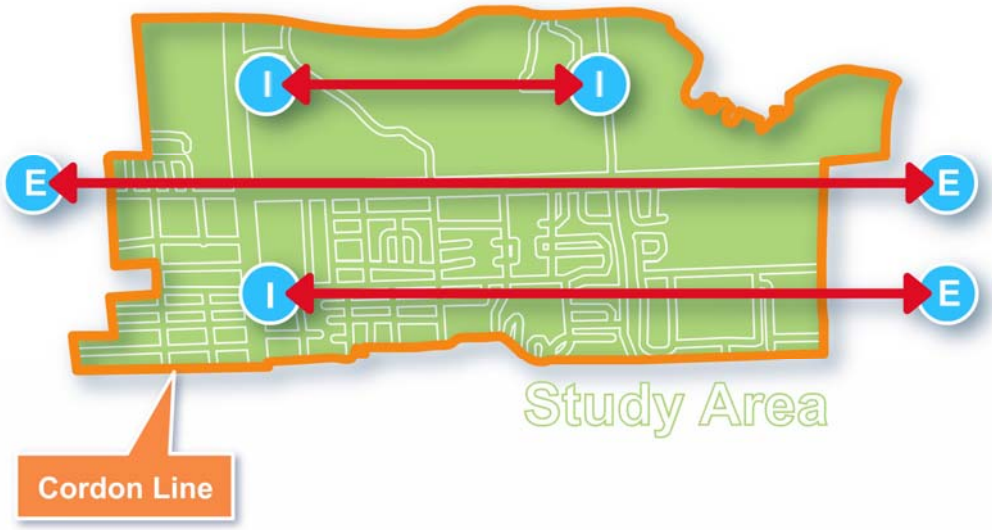
Welcome to Part II of Lesson 4. In this lesson we will learn about the external model in FSUTMS, which is part of the Trip Generation step. Specifically, we will cover:

- Different types of trips
- Different external survey methods
- Input and output files for External model
- Development of future external trips

In particular we will go through in detail a spreadsheet program, called Traffic Trends Analysis Tool, that can be used to forecasts future external trips.

Type of Trips

There are three types of trips based on their relationship to the cordon line that defines the boundaries of a study area. The first is the internal-internal trips. These have both trip ends inside the study area. The second type of trips is the external-external trips, or EE trips. These have both trip ends outside the study area, but they do pass through it. The third type of trips includes both internal-external and external-internal trips. These have one trip end inside and one trip end outside the study area.



External Model

The External model is used to produce an EE trip table for a study area. As mentioned, these are trips that pass through the study area without stopping. The EE trip tables are generally developed from surveys conducted at the external stations. The external stations are typically located at main entrances to a study area, such as a freeway location near the cordon line to capture the pass-through traffic. The external model takes the existing EE trip table in a DBF

format and builds a trip table matrix that can be read by Cube. The existing trip table can be expanded by a Fratar program to match the expected growth at the external stations. Alternatively, future year EE trips can be entered manually through application of spreadsheets and trend data.

External Travel Surveys

External travel surveys are conducted to collect data at external stations to understand the travel behavior of trips entering and/or leaving the study area. Questions are asked of drivers to understand where the driver is coming from, where the driver is going to, and why the driver is making the trip. These surveys are necessary to develop EE trip origin and destination matrices as well to determine EE and IE trip splits. Some external travel survey methods that have been used include vehicle intercept, rest stop intercept, video mail-back, and video coordination. We will look at each of these methods next.

Vehicle Intercept Survey Method

Vehicle intercept, as the name implies, involves pulling vehicles over and asking drivers questions about the trips they are making. To control traffic and encourage cooperation from drivers, presence of law enforcement officers is necessary for this method. This type of survey is generally more robust than the other methods as it is able to achieve a high response rates and a high degree of control over the sampling method. However, this method is no longer permitted in Florida,

Rest Stop Intercept Survey Method

The rest stop intercept method requires approaching drivers who have stopped at a rest stop. Many rest stops are privately owned. In such a case, the cooperation of the owner is necessary to conduct the survey. In many cases, the owner's cooperation may be difficult to acquire. This can impose limits on the sampling method. This method can also be affected by a high degree of self-selection bias because it depends on a driver’s decision to stop at that specific location.

Video Mail-Back Survey Method

The video mail-back method requires setting up cameras to photograph vehicle license plates. These license plates are then cross-checked against DMV records to determine the drivers' addresses. Surveys are then mailed to the drivers. As one might imagine, many drivers will not respond to the request to fill out the survey and this result in poor response rates. Another drawback of the video mail-back method is that the video captures are often not clear enough to accurately identify license plates.

Video Coordination Survey Method

Like the video mail-back method, this method involves setting up cameras to capture images of vehicle license plates. These images are then coordinated with other video captures around the perimeter of the study area. Video coordination only provides information regarding EE O&D

trips and EE and IE splits. This method is not able to capture the trip purposes of travelers. Like the video mail-back method, limits in video technology can make it difficult to accurately identify license plates.

External Input and Output Files

There is only one input file for the external model to store the data from the external travel surveys. The name of the file follows this format: EETRIPS_yya.dbf. There is also one output file for the external model that follows this file name format: EETABLE_ayy.mat file. This matrix file is used to store the balanced EE trip table.

Development of Future EE Trips

EE trip tables for the base year must be developed before the growth of through trips can be extrapolated to future years. One method of developing a future-year EE trip table from base-year trip estimates is to use growth factors for each external station in the input data.

As shown in the equation below, the growth factor for a new forecast year can be calculated as the ratio of the current count to the old count volume at the same external station:

$$\text{Growth Factor} = \frac{\text{Current Count}}{\text{Old Count Volume at the External Station}}$$

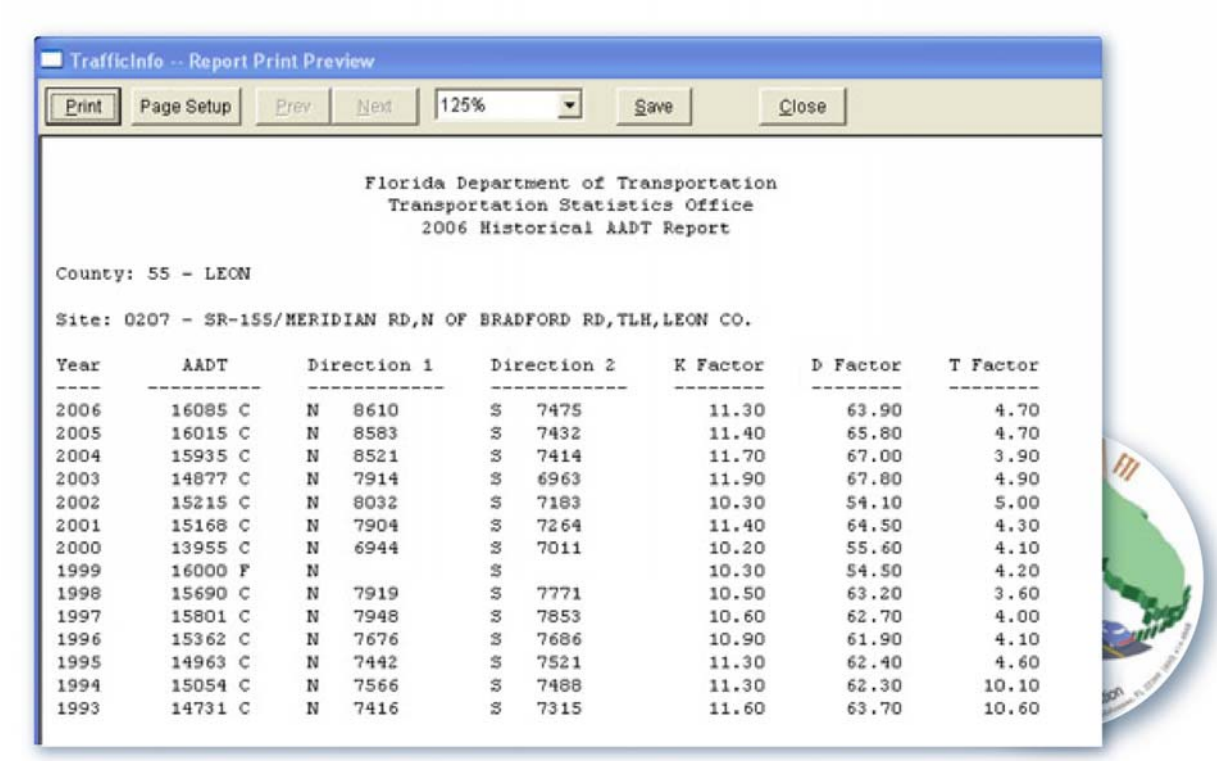
Instead of specifying using the growth factors, you may also use a spreadsheet to factor the zone-to-zone EE trips and then generate a new input data table. In fact, it is more common to factor E-E trips this way because specifying growth factors in the input file make it hard to interpolate or extrapolate data for other intermediate years.

Historical Traffic Counts

A major source of historical traffic count data is the Florida Traffic Information (FTI) CD distributed by the FDOT Statistics Office. This CD includes a complete set of traffic data reports collected for all traffic count locations on the State Highway System. The Historical Annual Average Daily Traffic (AADT) Report includes the directional and total AADT volumes for as many years as data have been collected from every traffic monitoring site. A sample AADT report is shown here (see next page).

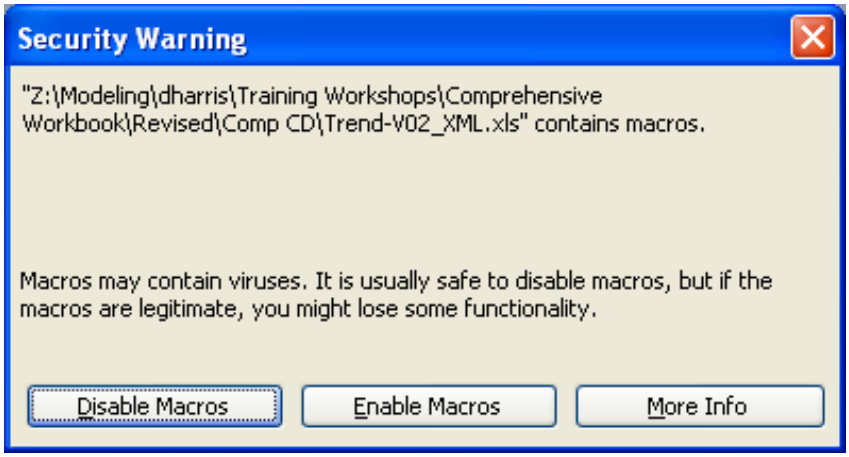
Long-Term Projections

While trends from historic counts can serve as good indicators of growth in the short-term to mid-term, for longer-term growth projections, other data sources may be more appropriate. For examples, the population and employment forecasts from the University of Florida Bureau of Economic and Business Research (BEBR) provide a good data source for this purpose. The data are available for both the modeled county and adjacent counties, making them a good source of data for external zones.



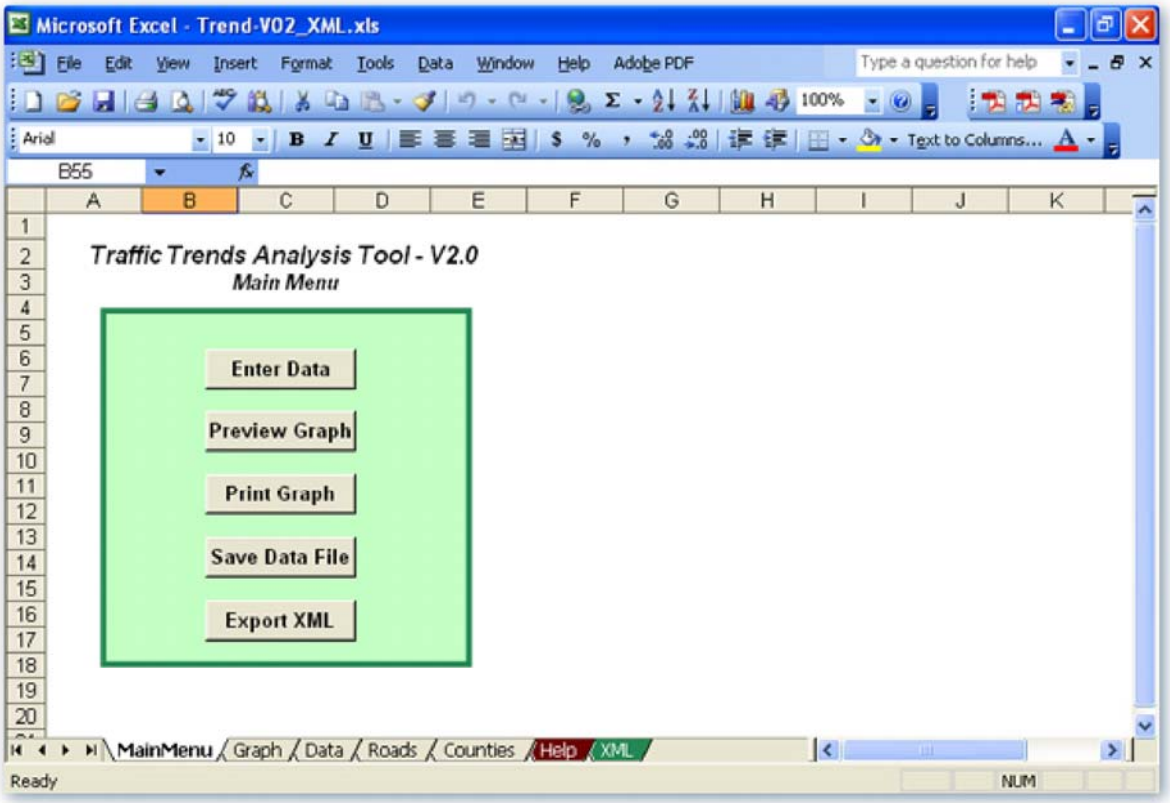
Traffic Trends Analysis Tool

The Traffic Trends Analysis Tool is an Excel application that uses time series forecasting methods to predict traffic volumes at traffic count stations. The Excel file for the application is called Trend-V02_XML.xls and can be obtained from the FDOT Systems Planning Office. After saving the application file to your drive, you can double-click the file to open it and then select the Enable Macros button on the pop-up window.



As soon as you click the Enable Macros button, the program main menu will open. It will list the following four functions:

- The Enter Data button allows you to enter basic information and historical traffic counts for the count station to be analyzed. The program will perform the regression analysis to fit a line to the data entered based on a selected model type.
- The Preview Graph button allows you to preview the output prior to printing the results.
- The Print Graph button allows you to create an Adobe PDF file from Microsoft Excel.
- The Save Data File button allows you to save the data to a workbook under a user-specified name.
- The Export XML button allows you to export data that will be saved in the XML format.

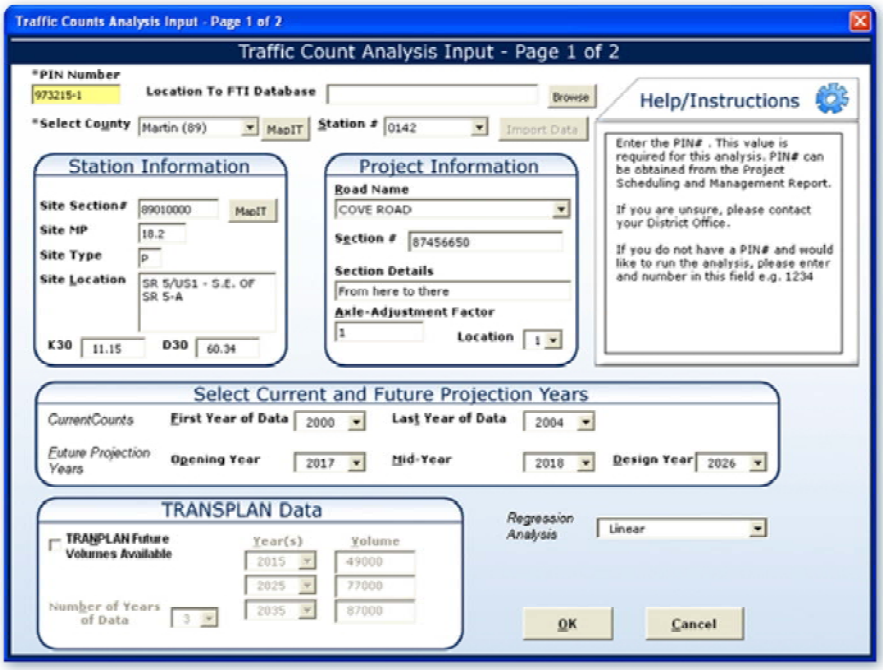


Data Inputs for Traffic Trends Analysis Tool

After you click the Enter Data button, a screen will pop up. The screen allows you to specify:

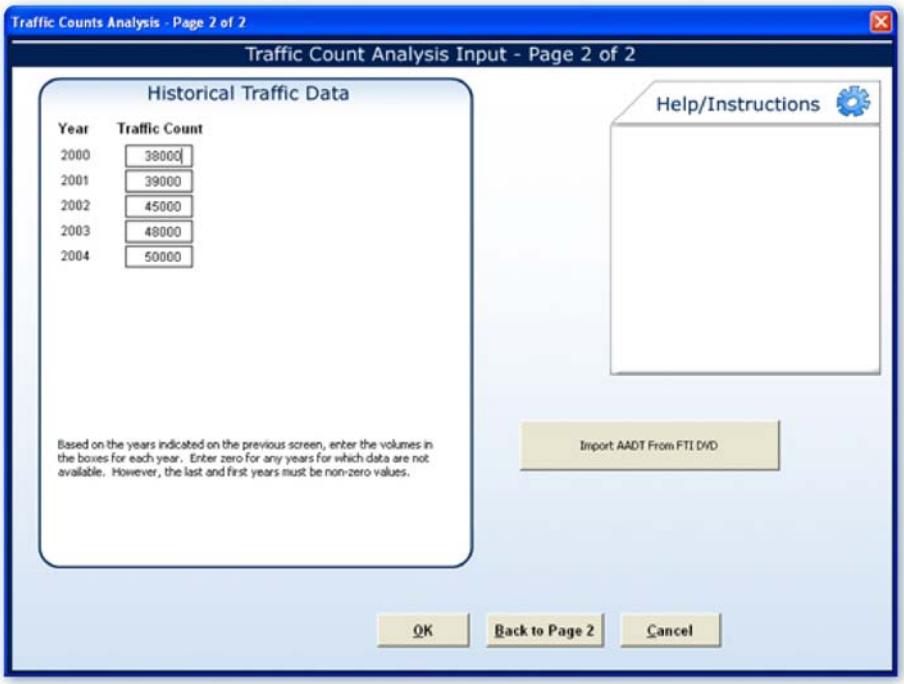
- PIN Number, FTI Database, County and Station Number
- Count station information
- Project information
- Current and future project years
- Volume estimates from planning model
- Regression model

The three types of available regression models are straight line growth, exponential growth, and decaying exponential growth.



Traffic Counts for Traffic Trends Analysis Tool

After you click on OK in the Enter Data screen, a second screen will appear to allow you to enter the traffic counts for each of the Current Counts data years. For any year for which data are not available, you should enter a zero in the cell. However, the first and the last years must have traffic counts. You may click the Back to Page 1 button to change the range of years.

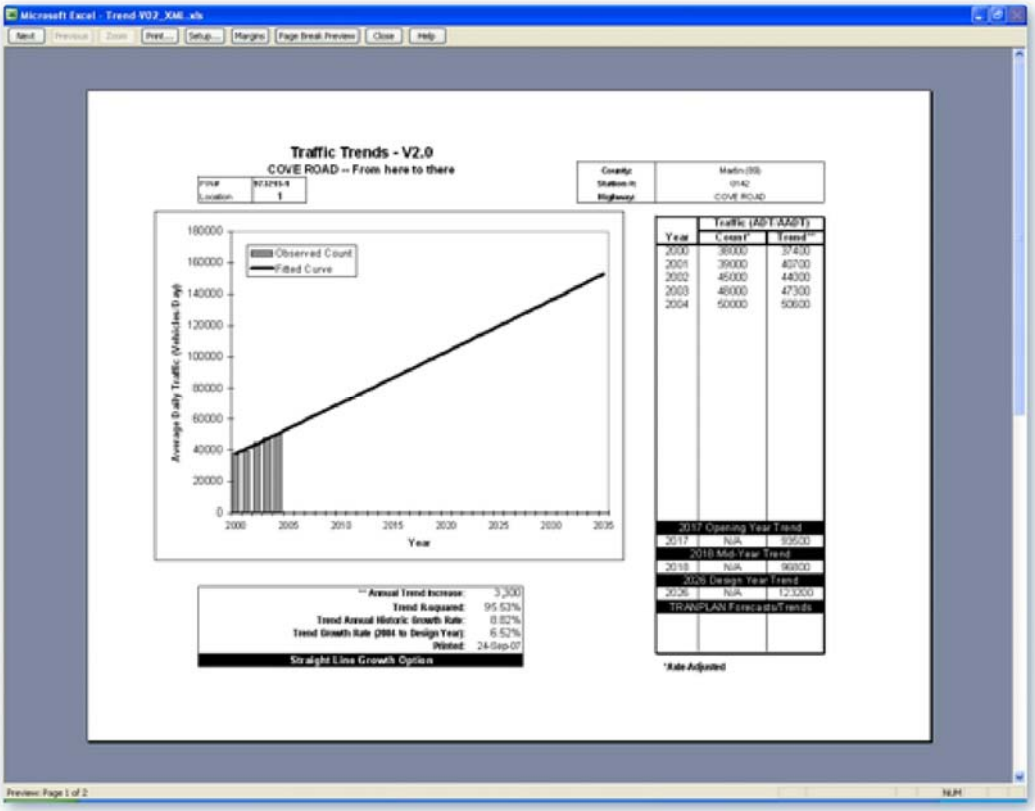


Regression Analysis in Traffic Trends Analysis Tool

After clicking on the **OK** button on the Enter Data screen, the program will fit the chosen regression model to the historical counts and, if entered, the future year volumes. The output also includes the R-squared value for model comparisons. The higher this value is, the better the regression model estimates the data trend.

Visualization in Traffic Trends Analysis Tool

The modeled traffic trend can be viewed on the Graph worksheet by clicking the Print Graph button on the main menu. The graph shows a regression line plotted against a bar chart. Note that both the actual counts and the modeled volumes are given beside the plot. A table summarizing the regression analysis is given below the plot. Next we will go through two exercises for practice.



Exercises

In this exercise we will open an EE output trip matrix to view data, and forecast future external trip data.

To view the external trips in the output matrix file, first, click on the Cube icon on the desktop. A blank Cube screen with a dialog box will appear. Click on the "OK" button. This will display the scenario manager for Olympus. Under Data, click on the + sign next to Outputs and then do

the same again next to Trip Generation. Double click on External Trip Table to display the external trips generated during trip generation. Now, use the EE trip matrix you just opened to find the answers to the following questions:

- What are the total number of trips in the matrix? 63,820
- What are the total number of trips from 639 to 645? 23,263
- What are the total number of trips from 639 to 648? 150
- What are the total number of trips from 645 to 639? 23,263
- What are the total number of trips from 648 to 639? 150

In the second exercise, we will learn to project future volumes with the assistance of the Traffic Trends Analysis Tool and the FDOT historical volumes. As the first step, we will load the Trend-V02_XML.xls program. To do so, click on the Excel icon on the desktop. Click on File Open. For this exercise chose the file C:\FSUTMS\general\Olympus\archives\trend-v02_xml.xls.

A pop-up box will appear with a security warning that macros may contain viruses. It is safe to click on Enable Macros to run the program. This will take you to the main menu of the Traffic Analysis Trends Tool. As mentioned, the menu contains five options:

- Enter Data
- Preview Graph
- Print Graph
- Save Data File, and
- Export XML

If this menu does not appear automatically, click on the Main Menu tab at the bottom of the screen as shown here.

We will begin step 2 by clicking on Enter Data on the main menu to invoke the data entry screen shown here. On this screen, first enter the General, Station, and Project information that is shown here. For the purposes of this exercise, we will enter the following count information:

- Enter 1988 as the first year of data,
- Enter 2000 as the last year of data,
- Enter 2010 as the opening year,
- Enter 2020 as the mid-year, and
- Enter 2030 as the design year.

Note that we do not want to view TRANPLAN data in this exercise, so leave the TRANPLAN Future Volumes Available box unchecked. Now, select "Linear" from the Regression Analysis drop-down box. Click OK.

Screen 2 of the Traffic Counts Analysis Input interface will appear after you click OK. You will use this screen in Step 3 of this exercise. In performing Step 3, simply enter the data by year shown here, then click OK. This will open Page 2 of the Traffic Count Analysis Input screen. As part of step 3, we will enter the following traffic counts:

Peak Season Weekday Counts		
Station/Zone	Historical	AADT
801	Year	Counts
	1987	16,978
	1988	21,968
	1989	18,112
	1990	17,598
	1991	18,323
	1992	23,500
	1993	18,600
	1994	17,500
	1995	20,100
	1996	21,000
	1997	23,000
	1998	23,800
	1999	24,900
	2000	25,000

Once we have entered the data by year and clicked OK, we are ready to perform the fourth and final step in this exercise, which is to preview graph, print graph, and save data file. On the main menu, simply click on Preview Graph. Obviously, a printer must be attached before exercising this option. Finally, click on "Save Data File" on the main menu. We have the option to either save file with the same name or a new name. Click Save to save all the data that we entered.

Summary

This completes the exercises on the External model and is the end of Part II of Lesson 4. In this lesson we covered the following major topics:

- Different types of trips
- Different external survey methods
- Input and output files for External model
- Development of future external trips

LESSON 5, PART I: HIGHWAY NETWORKS

Lesson Goals

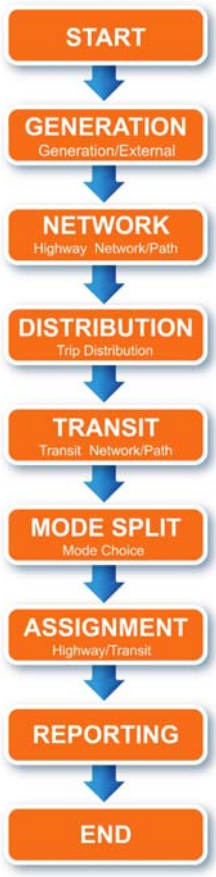
Welcome to Part I of Lesson 5 on Highway Networks. In this lesson we will cover the following major topics:

- Overview of transportation networks in general
- Highway networks
- Compatibility of zonal and highway network
- Model structure and procedures
- Model input and output files
- Network coding and attributes
- Area type and facility type
- Screenlines, cutlines, and cordon lines
- Traffic counts
- Default input speeds and capacities

We will also complete a total of four exercises at the end.

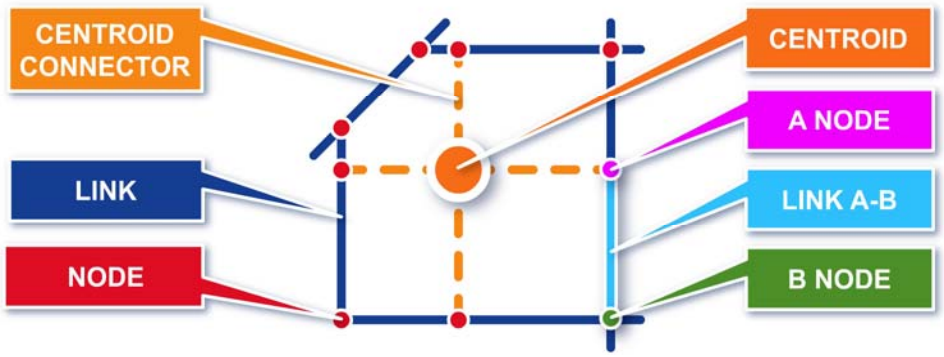
Overview

Network is the second step in the FSUTMS model chain. In FSUTMS, a network is a representation of an existing or a proposed transportation system in a format that the computer can process. In general, a transportation system is either a highway system, represented by a highway network, or a transit system, represented by a transit network. The focus of this lesson is on highway networks. Transit networks will be covered in Lesson 7.



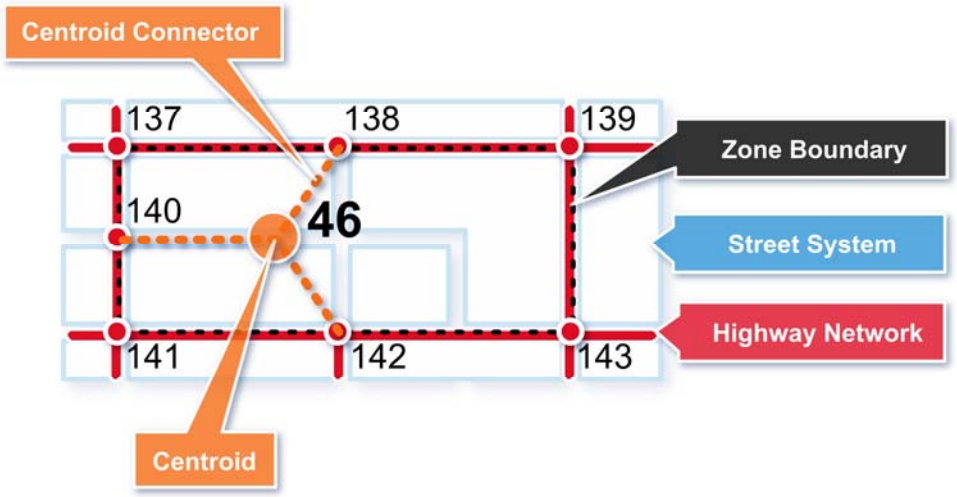
Highway Networks

A highway network is comprised of a system of links and nodes that describes the roadway system of a study area. A node represents a point in the transportation network where a roadway feature starts, ends, curves sharply, or when two roadways intersect each other. A link, on the other hand, represents the section of a transportation network that is between two adjacent nodes. A highway network must interact with a zonal network in order for the trips generated from each zone to access the highway system. You may recall from the previous lesson that a TAZ is the smallest geographic unit that is used to quantify the activities, travel, and transportation characteristics of an area within a larger study area. You may also recall that each TAZ has a centroid that identifies the center of activity of an area, and that a centroid is connected to the surrounding highway network through one or more centroid connectors.



From Streets to Networks

Based on the definitions we have just discussed in the previous slide, this figure shows how several street blocks are included in a zone that has a zone number 46. The zone number is usually labeled next to the zone centroid. The zone controid is connected to the streets which are normally used to form the zone boundaries. As you can see, the streets are represented by a series of links and nodes.



Compatibility of Zonal and Highway Networks

From the previous discussion, we can see that the TAZ zonal system and the highway network are very much linked to each other. It is, therefore, important to consider the compatibility between the zones and the transportation network. Several guidelines exist to assess this compatibility. First, zones should be connected to the lowest level of facility included in the network. Second, zones should be connected to the transportation network based on actual access locations such as local streets and major driveways. If multiple access points exist along a corridor, a mid-point location should be used. Third, zone centroids should not be connected to four-legged intersections. Fourth, as a convention, a zone should not generate more than 15,000-20,000 productions and attractions. Fifth, bisecting zones with highway network links should be avoided, so that freeways, arterials and collectors should form zone boundaries. Other

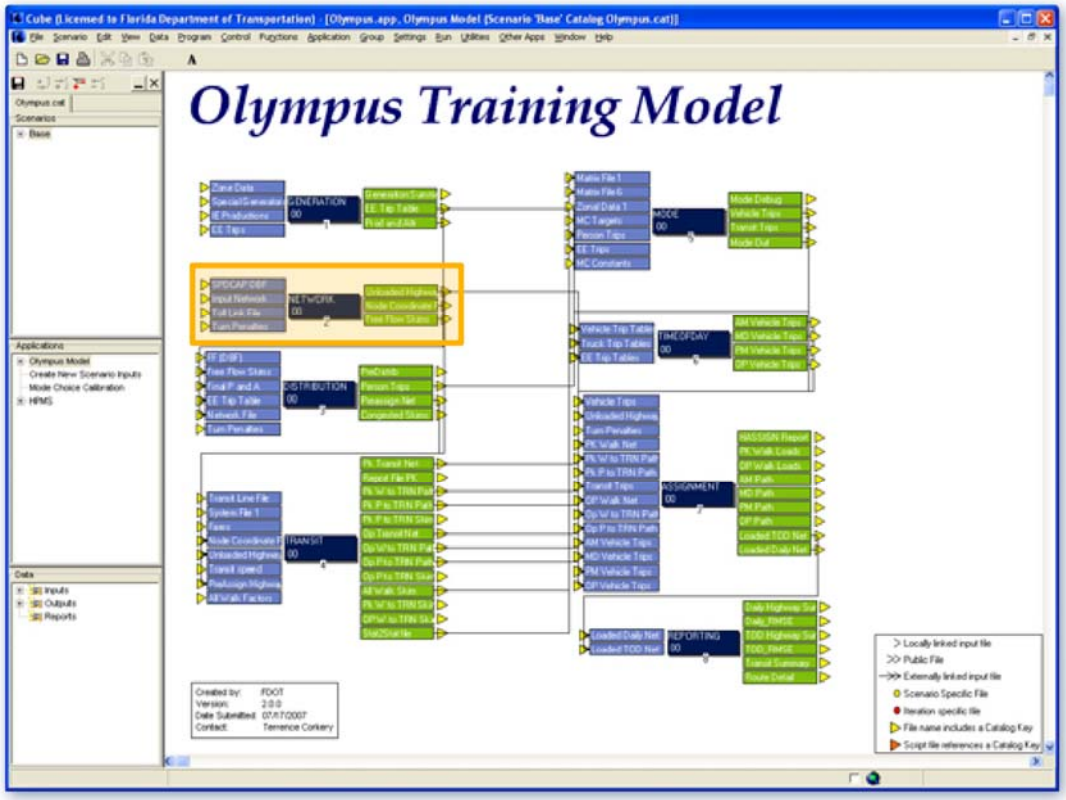
considerations in delineating zone boundaries include physical features such as rivers and bays; political boundaries such as county lines and city limits, and land use considerations such as to separate special generators and to achieve land use uniformity.

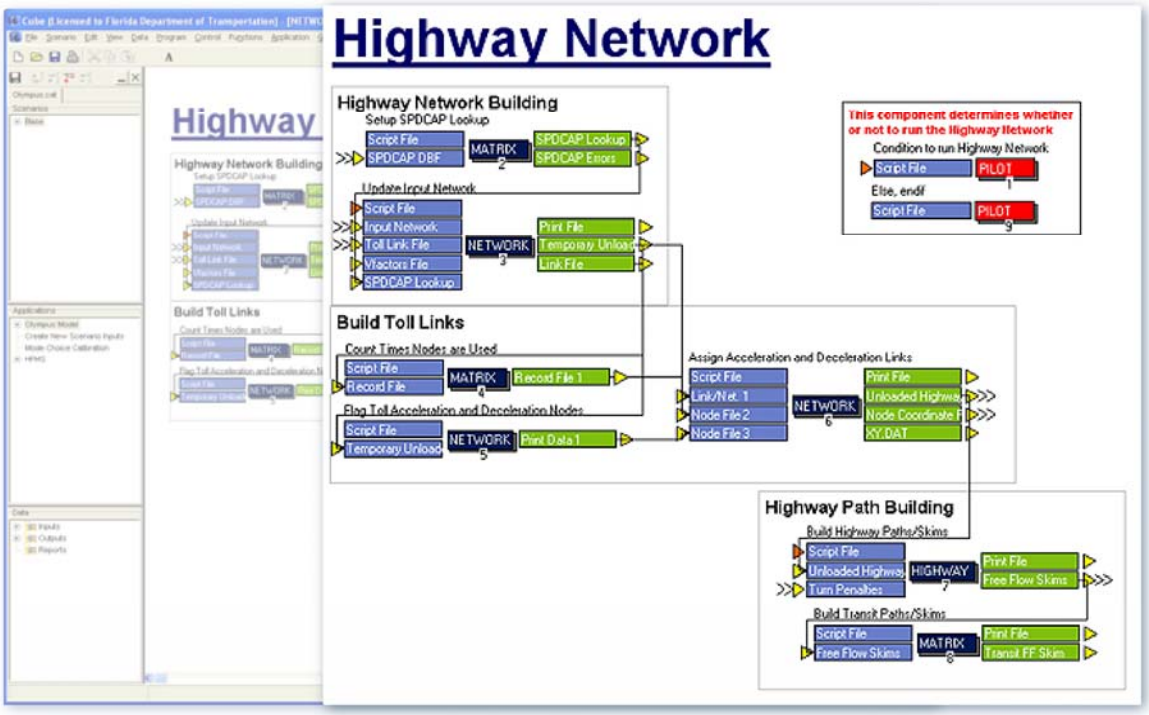
Model Structure and Procedures

In FSUTMS, the Highway Network model is the modeling engine for creating the highway networks. What it does is to combine network attributes in a series of files and generate an unloaded network for use in subsequent model steps. To be more specific, the Highway Network model first reads the input files that include highway network files, turn penalties and prohibitors, speed/capacity lookup tables, and several variable factors. The model then produces a network, reformatted speed/capacity, and tables for variable factors. In Cube, the network can be displayed by clicking on a network file in the model flow chart. t is noted here that although Highway Network is part of the second step in the model chain, it does not require any output from the Generation step. The outputs from the Highway Network step are later used o develop travel time skims, which you will learn in Part II of this lesson, and o perform highway assignments, which will be discussed in Part I of Lesson 9.

Olympus Model Flow Chart

This flow chart shows the Network step in the FSUTMS model chain for the Olympus model. Clicking the NETWORK box in this flow chart will open a second flow chart that shows the detailed model structures for the Highway Network model. Click Next when you are ready to view this second flow chart.





Model Input and Output Files

As we have just mentioned, the highway network model reads a number of input files. These input files include:

- Speed-cap file, which comprises speed/capacity lookup tables
- Turn penalty file, which contains turn penalties and prohibitors
- Tolllink file, which, as you might expect, contains toll link and toll plaza information
- Vfactors file, which is a variable factors file

Using these inputs, the highway network model will generate an unloaded network file with this file format: unloaded.ayy.net. Note that although the v-factors file is used as an input for updating the network, the information it contains is used specifically during highway assignment. As such, the vfactors file is discussed in greater detail in Lesson 9, which covers the Assignment step of the FSUTMS model chain.

Network Data Sources

Several GIS databases can serve as potential input data sources for highway networks. Two of these sources are the Dynamap mapping files purchased by the Florida Department of Transportation for the entire state, and over 300 GIS layers that can be downloadable free of charge from the Florida Geographic Data Library, or FGDL, of the University of Florida. To download the layers visit www.fgdl.org.

Network Coding

In a typical urbanized area, network link characteristics are built and refined during the model calibration or model update process. Refinements are typically based upon local area knowledge, recent Transportation Improvement Programs (TIPs), and FDOT's Roadway Characteristics Inventory (RCI) database. Districts and MPOs are also encouraged to develop network data from an updated GIS database for better geographic accuracy.

Key Link Characteristics

There are three key characteristics that must be included for links. The first key characteristic is area type, denoted by AT. It describes the type of land uses surrounding roadway. The second key characteristic is facility type, denoted by FT. It describes the categories of roadway types. The third key characteristic is number of lanes, denoted by NL. It describes the through lanes by direction. Note that these characteristics are used to determine the speed and capacity of each network link for most Florida models.

Area Type Codes

In1998, the HNET Enhancements Study recommended the current area type codes to the Model Task Force. Each area code is comprised of two digits. The first digit, from 1 to 5, is used to categorize the primary area type and the second digit is used to categorize the subcategory. A total of 15 standard area types were defined. Put your mouse over each primary category to see the subcategories and click Next when you are ready to move to the next slide.

1x CBD Areas
- 11 Urbanized Area (over 500,000) Primary City Central Business District
- 12 Urbanized Area (under 500,000) Primary City Central Business District
- 13 Other Urbanized Area Central Business Districts and Small City Downtown
- 14 Non-Urbanized Area Small City Downtown

2x CBD Fringe Areas
- 21 Typical Central Business District (CBD) Fringe Areas
- 22 CBD Fringe Strip Commercial (used in some areas)

3x Residential Areas
- 31 Residential Area of Urbanized Areas
- 32 Undeveloped Portions of Urbanized Areas
- 33 Transitioning Areas/Urban Areas over 5,000 Population
- 34 Beach Residential

4x Outlying Business District (OBD) Areas
- 41 High Density Outlying Business District
- 42 Other Outlying Business District
- 43 Beach Outlying Business District

5x Rural Areas
51 Developed Rural Areas/Small Cities under 5,000 Population
52 Undeveloped Rural Areas

Facility Type Recommendations

The HNET Enhancements Study also recommended the current facility type codes that are currently being used. Similar to area type codes, facility type codes are also two-digit, with the first digit being used for primary categories and the second digit for subcategories. The first digit can range from 1 to 9. Put your mouse over each primary category in order to see the subcategories. Click next when you are ready to move to the next slide.

1x Freeways and Expressways
2x Divided Arterials
3x Undivided Arterials
4x Collectors
5x Centroid Connectors
6x One-Way Facilities
7x Ramps
8x HOV Facilities
9x Toll Facilities

Other Network Attributes

In addition to from-node, to-node, facility type, area type, and number of lanes, a highway network may also include definitions for:

- Screenlines and cutlines
- Direction, which indicates if it is one-way operation
- Traffic counts, which could include
  - Directional Daily Peak Season Weekday Average Daily Traffic (PSWADT)
  - Traffic Count Station ID
  - Source of traffic count
- Geographic location code, which is an optional code that can be used to identify subareas of a network
- Toll plaza ID number
- Model Output Conversion Factor
- Street name
- County ID
- Posted speed

We will explain some of these data items in the next few slides.

Screenlines, Cutlines, and Cordon Lines

A screenline is an imaginary line that is usually defined along a physical barrier, such as a river or railroad tracks, that splits the study area into parts. The number of vehicles crossing this line is compared with those from home interview survey in order to validate the accuracy of the survey data. The crossing vehicles may also be compared with those estimated from the model as part of model calibration. Cutlines are lines that are drawn on a map to represent a subset of the roadway facility of interest such as a corridor. Cordon lines, as we have defined in the previous lesson, are lines that are used to define the boundary or extent of a study area. External interviews are conducted at stations along these lines.

Traffic Counts

Traffic counts represent the number of vehicles moving along a link from one node to another. They are added to all links crossing the screenlines, cutlines, and cordon lines. In Cube, post processing scripts are used to sum these traffic counts on screenlines and cutlines and then used to compare the assigned volumes versus these counts. Traffic counts may be available from FDOT, city and county records. They must be collected if existing counts are not available. FDOT Traffic counts are adjusted to represent peak season weekday average daily traffic (PSWADT) for the study area before they are added to the link records. The peak season counts are the 13 highest consecutive weeks of traffic counts at permanent count stations within the study area.

Reference Publications

Some of the references related to traffic counts and published by FDOT include:

- Design Traffic Procedure Topic No. 525-030-120-g (http://www2.dot.state.fl.us/proceduraldocuments/procedures/bin/525030120.pdf)
- Project Traffic Forecasting Handbook (http://www.dot.state.fl.us/planning/statistics/trafficdata/ptf.pdf)
- Traffic Monitoring Handbook (http://www.dot.state.fl.us/planning/statistics/tmh/)
- FDOT 2002 Quality/Level of Service Handbook (http://www.dot.state.fl.us/planning/systems/sm/los/los_sw2.shtm#handbook)

Default Input Capacities and Speeds

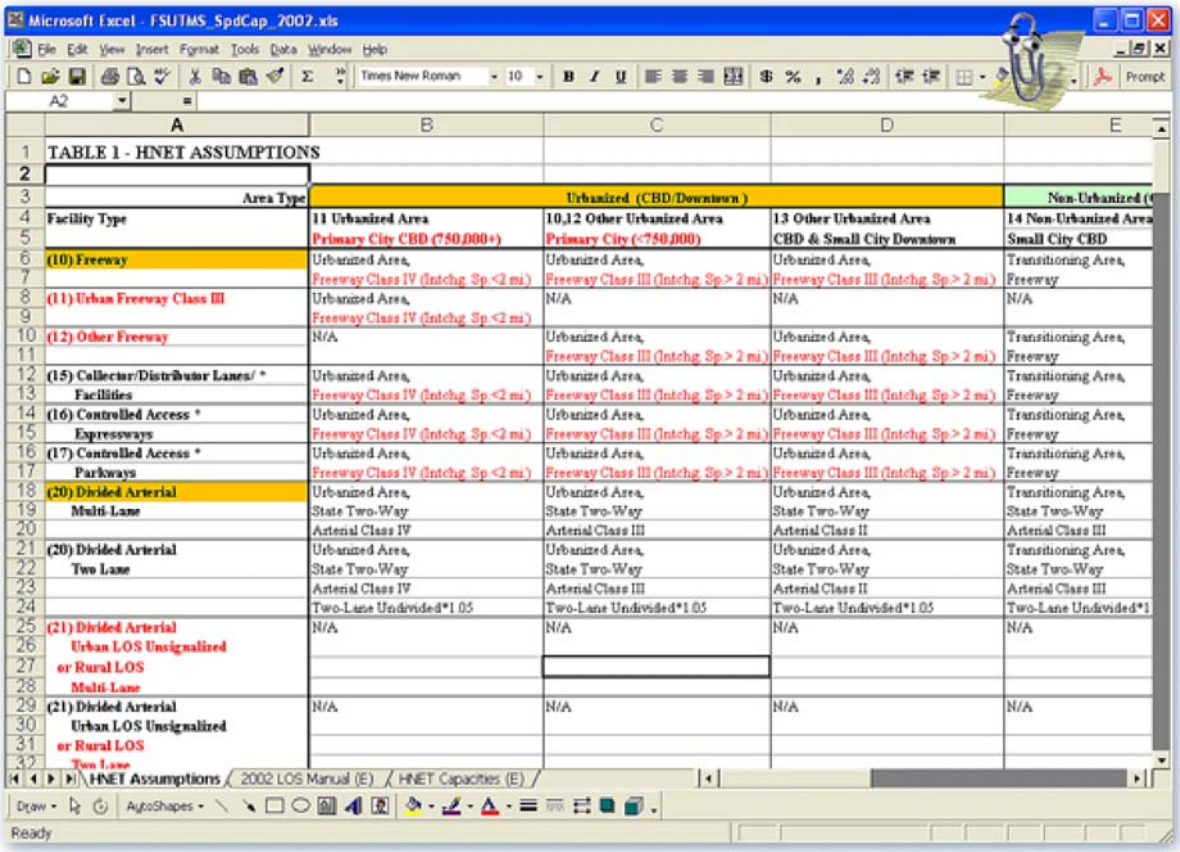
FDOT research indicates that coding network speeds and capacities on a link-by-link basis is prone to error. Therefore, appropriate values are automatically assigned to each link during execution of the Highway Network model based on the specific area type, facility type, and number of lanes.

The default input capacities are obtained from a look-up table, generally referred to as the "Speed-Cap" table. The current default capacities in the look-up table are based on Tables F-1, F-2, and F-3 of the 2002 FDOT Quality/LOS Handbook. These tables provide the generalized

two-way peak-hour volumes for different facilities. These two-way volumes are then divided in half to obtain the LOS E directional volumes. Further, to get the capacities in vehicles per hour per lane, the directional volumes are divided by the number of lanes. Note that the default capacities assume that area types can generally be equated with FDOT LOS Handbook signal spacing categories.

The same "Speed-Cap" look-up table that is used to determine the capacities is also used to determine the default speeds. You may view the default Speed-Cap table from the spreadsheet file that comes with the Olympus model. There are three tables in this spreadsheet file. They are referred to as Table 1, Table 2, and Table 3 in the spreadsheet file.

Table 1 is for the HNET assumptions. This table lists the specific types of area and facility for different combinations of area and facility type codes.



Microsoft Excel - FSUTMS_SpdCap_2002.xls

	A	B	C	D	E
1	TABLE 1 - HNET ASSUMPTIONS				
2					
3	Area Type	Urbanized (CBD/Downtown)			Non-Urbanized (
4	Facility Type	11 Urbanized Area	10,12 Other Urbanized Area	13 Other Urbanized Area	14 Non-Urbanized Area
5		Primary City CBD (750,000+)	Primary City (<750,000)	CBD & Small City Downtown	Small City CBD
6	(10) Freeway	Urbanized Area,	Urbanized Area,	Urbanized Area,	Transitioning Area,
7		Freeway Class IV (Intchg. Sp <2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway
8	(11) Urban Freeway Class III	Urbanized Area,	N/A	N/A	N/A
9		Freeway Class IV (Intchg. Sp <2 mi.)			
10	(12) Other Freeway	N/A	Urbanized Area,	Urbanized Area,	Transitioning Area,
11			Freeway Class III (Intchg. Sp > 2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway
12	(15) Collector/Distributor Lanes/ *	Urbanized Area,	Urbanized Area,	Urbanized Area,	Transitioning Area,
13	Facilities	Freeway Class IV (Intchg. Sp <2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway
14	(16) Controlled Access *	Urbanized Area,	Urbanized Area,	Urbanized Area,	Transitioning Area,
15	Expressways	Freeway Class IV (Intchg. Sp <2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway
16	(17) Controlled Access *	Urbanized Area,	Urbanized Area,	Urbanized Area,	Transitioning Area,
17	Parkways	Freeway Class IV (Intchg. Sp <2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway Class III (Intchg. Sp > 2 mi.)	Freeway
18	(20) Divided Arterial	Urbanized Area,	Urbanized Area,	Urbanized Area,	Transitioning Area,
19	Multi-Lane	State Two-Way	State Two-Way	State Two-Way	State Two-Way
20		Arterial Class IV	Arterial Class III	Arterial Class II	Arterial Class III
21	(20) Divided Arterial	Urbanized Area,	Urbanized Area,	Urbanized Area,	Transitioning Area,
22	Two Lane	State Two-Way	State Two-Way	State Two-Way	State Two-Way
23		Arterial Class IV	Arterial Class III	Arterial Class II	Arterial Class III
24		Two-Lane Undivided*1.05	Two-Lane Undivided*1.05	Two-Lane Undivided*1.05	Two-Lane Undivided*1
25	(21) Divided Arterial	N/A	N/A	N/A	N/A
26	Urban LOS Unsignalized				
27	or Rural LOS				
28	Multi-Lane				
29	(21) Divided Arterial	N/A	N/A	N/A	N/A
30	Urban LOS Unsignalized				
31	or Rural LOS				
32	Two Lane				

HNET Assumptions / 2002 LOS Manual (E) / HNET Capacities (E)

Ready

Table 2 lists the generalized two-way peak-hour volumes for different facilities at level of service E.

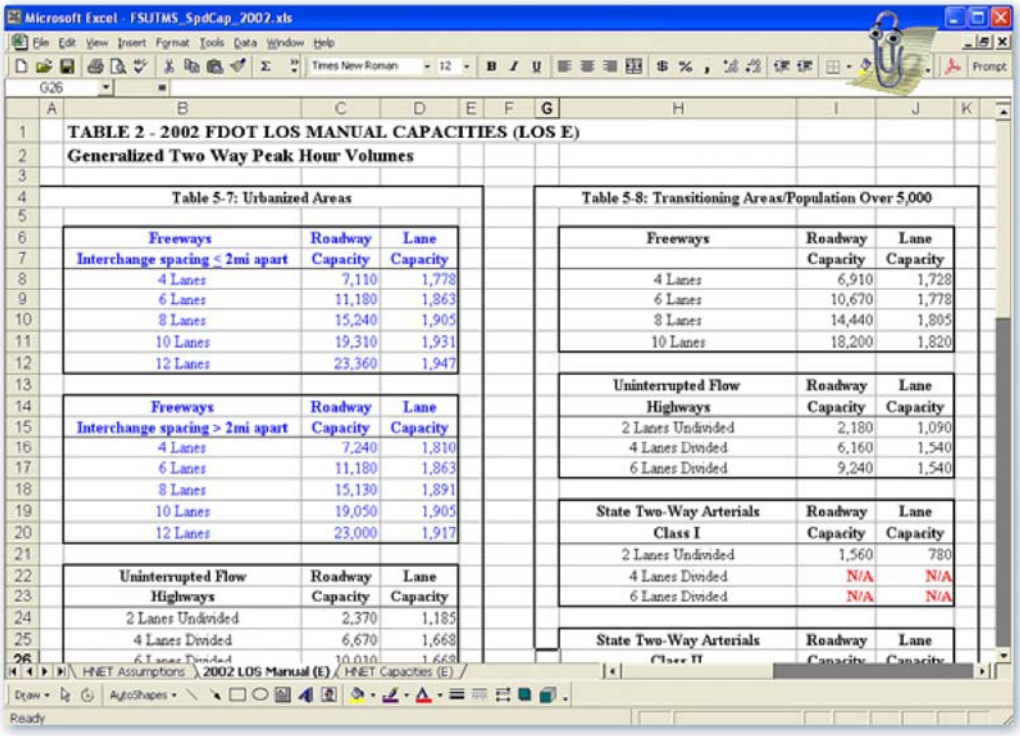


TABLE 2 - 2002 FDOT LOS MANUAL CAPACITIES (LOS E)
Generalized Two Way Peak Hour Volumes

Table 5-7: Urbanized Areas

Freeways Interchange spacing ≤ 2mi apart	Roadway Capacity	Lane Capacity
4 Lanes	7,110	1,778
6 Lanes	11,180	1,863
8 Lanes	15,240	1,905
10 Lanes	19,310	1,931
12 Lanes	23,360	1,947

Freeways Interchange spacing > 2mi apart	Roadway Capacity	Lane Capacity
4 Lanes	7,240	1,810
6 Lanes	11,180	1,863
8 Lanes	15,130	1,891
10 Lanes	19,050	1,905
12 Lanes	23,000	1,917

Uninterrupted Flow Highways	Roadway Capacity	Lane Capacity
2 Lanes Undivided	2,370	1,185
4 Lanes Divided	6,670	1,668
6 Lanes Divided	10,010	1,668

Table 5-8: Transitioning Areas/Population Over 5,000

Freeways	Roadway Capacity	Lane Capacity
4 Lanes	6,910	1,728
6 Lanes	10,670	1,778
8 Lanes	14,440	1,805
10 Lanes	18,200	1,820

Uninterrupted Flow Highways	Roadway Capacity	Lane Capacity
2 Lanes Undivided	2,180	1,090
4 Lanes Divided	6,160	1,540
6 Lanes Divided	9,240	1,540

State Two-Way Arterials Class I	Roadway Capacity	Lane Capacity
2 Lanes Undivided	1,560	780
4 Lanes Divided	N/A	N/A
6 Lanes Divided	N/A	N/A

State Two-Way Arterials Class II	Roadway Capacity	Lane Capacity

Finally, Table 3 lists the default capacities that were developed with information from Table 1 and Table 2.

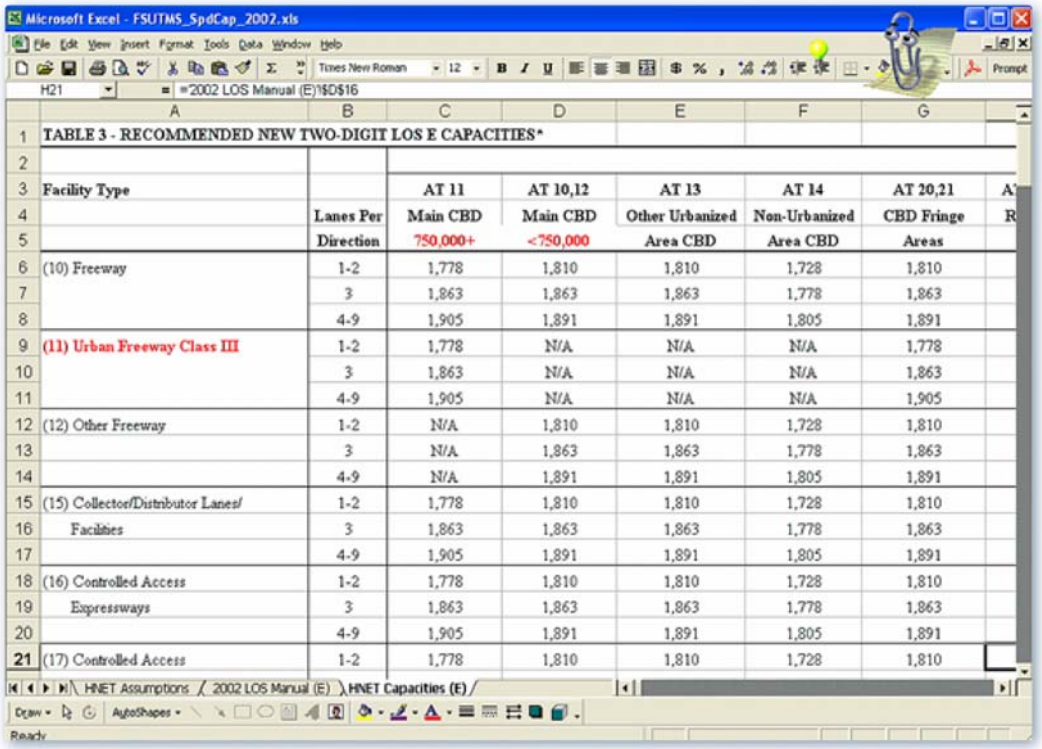


TABLE 3 - RECOMMENDED NEW TWO-DIGIT LOS E CAPACITIES*

Facility Type	Lanes Per Direction	AT 11 Main CBD 750,000+	AT 10,12 Main CBD <750,000	AT 13 Other Urbanized Area CBD	AT 14 Non-Urbanized Area CBD	AT 20,21 CBD Fringe Areas
(10) Freeway	1-2	1,778	1,810	1,810	1,728	1,810
	3	1,863	1,863	1,863	1,778	1,863
	4-9	1,905	1,891	1,891	1,805	1,891
(11) Urban Freeway Class III	1-2	1,778	N/A	N/A	N/A	1,778
	3	1,863	N/A	N/A	N/A	1,863
	4-9	1,905	N/A	N/A	N/A	1,905
(12) Other Freeway	1-2	N/A	1,810	1,810	1,728	1,810
	3	N/A	1,863	1,863	1,778	1,863
	4-9	N/A	1,891	1,891	1,805	1,891
(15) Collector/Distributor Lanes/	1-2	1,778	1,810	1,810	1,728	1,810
Facilities	3	1,863	1,863	1,863	1,778	1,863
	4-9	1,905	1,891	1,891	1,805	1,891
(16) Controlled Access	1-2	1,778	1,810	1,810	1,728	1,810
Expressways	3	1,863	1,863	1,863	1,778	1,863
	4-9	1,905	1,891	1,891	1,805	1,891
(17) Controlled Access	1-2	1,778	1,810	1,810	1,728	1,810

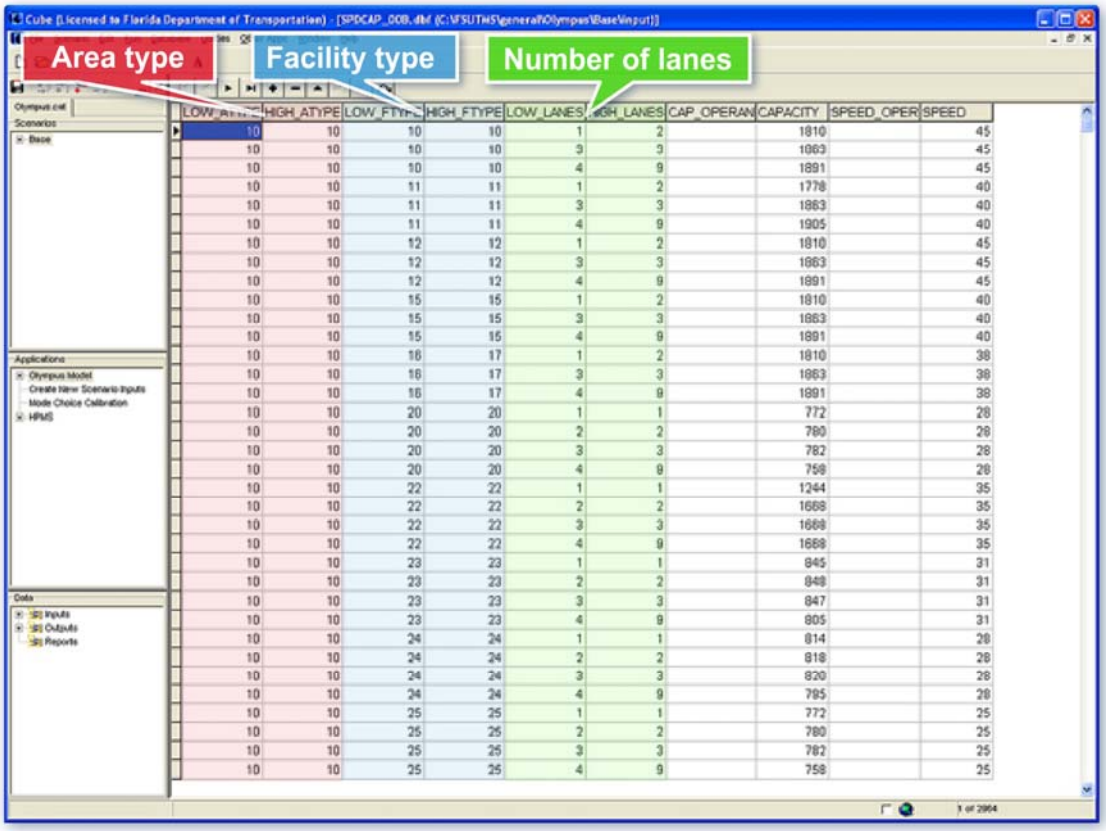
The spreadsheet file that comes with the Olympus model can be found at the following folder:

C:\fsutms\general\Olympus\documents\ fsutms_spdcap_2002.xls

We have also put a copy of this file on this website. Go ahead and click here to open the file to view the three tables. The recommended SPDCAP file that stores the speed-cap table can be found at this standard folder:

C:\fsutms\general\Olympus\parameters\spdcap.dbf

The dbf file is subsequently converted to a CSV format for input to the Cube Voyager network program. Note that the area type, facility type and the number of lanes are coded as ranges; the lower type is set at the beginning of the range and the higher type is set at the end of the range.



Exercises

For Part I of this lesson, we will complete a total of four exercises.

- For the first exercise, we will review highway network inputs
- For the second exercise, we will practice various network editing functions
- We will then update the speeds and capacities in the network
- Finally, we will review the updated network

For the first exercise, which is to review the highway network inputs, we will begin by clicking on the Cube icon on the desktop. This displays a blank Cube screen with a dialog box. For the purposes of this exercise, click OK. This will display the scenario manager for the Olympus model. In the Data window, click on the "+" sign next to Inputs and then click again on the "+" sign next to Network. Now, double-click the SPDCAP DBF file to open the speed-cap table. After you have reviewed the table, click the inner X button to close the table. Next, double-click on Input Network to open a plot of the highway network. After you have reviewed the network, click the inner X button to close it. This completes the first exercise.

We will now begin the second exercise, which is to practice network editing. For this demonstration we will use a training network. Close Cube by clicking on the X button and then click on File Open and navigate to C:\FSUTMS\general\Olympus\Archive. Click the Training.NET file on the list and click Open to open the file. Note that this training network is provided in order to practice various network editing functions.

With the Training.NET open, click on Edit drop-down menu and select Options. This will open the Network Option dialog box. On this dialog box, adjust the display size setting by changing the size for centroids from 0 to 8. Similarly, change the size for nodes from 0 to 2. Next, change the color and style for centroids to red triangle. Do the same for nodes, but change to display them in black circles. Click Close to close this dialog box. The plot should reflect the new colors and sizes you have just specified. Next, we will plot the different types of facility in the network in different colors. In order to do that, click the Link/Line/Boundary Color tool button. This opens the Highway Layer Link Specification dialog box. On the main menu of this dialog box on top, click on Insert nine times. This creates a total of nine rows of input that will allow us to define the color and style of each of the nine levels of primary facility types.

On the first row, select solid line, select red color, enter size 4, enter facility types 10 to 19 by typing in FTYPE=10-19. Similarly, on the second row, select solid line, select blue color, enter size 3, enter FTYPE=20-29. Continue on the same actions, on the third row, select solid line, select green color, enter size 2, enter FTYPE=30-39. On the fourth row, select solid line, select black color, enter size 1, enter FTYPE=40-49. On the fifth row, select dashed line, select grey color, enter size 1, enter FTYPE=50-59. On the sixth row, select solid line, select pink color, enter size 1, enter FTYPE=60-69. On the seventh row, select solid line, select azury color, enter size 1, enter FTYPE=70-79. On the eighth row, select solid line, select orange color, enter size 1, enter FTYPE=80-89. Finally, on the last row, select solid line, select brown color, enter size 4, and enter FTYPE=90-99. Once all of the facility types are fully specified, click the Close menu item on top to close this dialog box. The different categories of highway links will be displayed in different colors and line widths.

We will now try to post values and save posting sets. Click the Post drop-down menu and select All Link. This opens the Posting Selection dialog box. On this dialog box, select FYPE below the blue line, select fix color, and then select red color. Next, select ATYPE, fix color, and then select green color. Finally, select LANES, fix color, and then select blue color. Now, enter Big Three as the name of the posting set. Click OK. The facility type, area type, and number of lanes will be displayed for all links. We will now try to add a link to the network. In order to do this,

we will first need to zoom into the location where the link is to be added. Click the View drop-down menu and then select Center on Nodes. Enter node 3155. Click OK. Enter 4683 for window width. Click OK. The display will zoom into node 3155 with the specified display scale. Now, select the Post drop-down menu and then select All Nodes. Click OK The node numbers will be displayed. Next, select the Link drop-down menu and then select Add Two-Way. Now, position your mouse cross-hair over node 3155. Click, drag, and release over node 3050. The new link is now added. Next, hit the ESC key and then click the new link to view its attributes. The link has only distance. You can also edit the attributes on the same box. Right-click on the link and select Delete to delete the link.

We will now add the same link, from node 3155 to node 3050, by using Copy and Paste. We will copy the attributes for the new link from those from link 3155-3157. Right-click on the link and select Copy. Right-click again. This time select Paste. The cross-hair will appear. Position the cross-hair over node 3155. Click, drag, and release over node 3050. The new link is pasted. Hit the ESC key and select the new link to view its attributes. The link carries the same attribute values as that of the link it copied from. We will now add automatic intersections to the highway network. Click the View drop-down menu and then select Center on Nodes. Enter node 3344. Click OK. Enter 4833 for window width. Click OK. The display will zoom into node 3344 with the specified display scale. Click on the Node drop-down menu and select Automatic Numbering. Set New Node Number 3200 and click on Automatic Numbering. Next, click on the Link drop-down menu and then select Automatic Intersection. Right-click on link 3343-3344 and select Copy. Right click and select Paste from 3344 to 3157. Position the cross-hair over node 3344. Click, drag, and release over node 3157. The new link is pasted. You can see that an intersection crossing the green link is automatically created and numbered.

We will now edit the highway network to add attributes and calculations. Click on the Link drop-down menu, select Attribute, and then select Add. This opens a window for you to enter the name of the new attribute. Enter TEST as the new name. Click Ok. Enter N for numeric data type. Click OK. Click Cancel. Click on the Link drop-down menu, select Compute. In the computation area, right-click and select Insert. Enter equation TEST=CAPACITY*1.10. Click OK. Accept other defaults and click Apply. A link update confirmation message box appears. Click OK and click Close. Now, click on a link to see the attributes. The TEST field should show a value that is 10% more than the capacity. Close the attribute table. Click the X inner button. Click Yes to save changes to the training file and click Yes again to save the project file. Click Save. This completes the second of four exercises for this lesson.

We will now update the speeds and capacities of the highway network. Note that by running the Network step of the model, the input network is modified to include speeds, capacities, tolling characteristics, and other attributes needed to run the model. This is known as updating the network. Open Olympus.cat and then open the Scenario Manager for Base. Under “Please Select Model Steps You would Like to Run”, unchecked all steps other than the Network step. Click on Run. This allows you to run only the highway network portion of the model. This completes the third exercise.

We will now review the updated highway network. In the Data window, double-click Outputs, double-click Network, and double-click Unloaded Highway Network. This opens and displays

the highway network. We will now compare attributes of the network. With the network displayed, click on the Post drop-down menu and select All Nodes. This action will display the Posting Selection dialog box. In the Selection Criteria box, type in N <= 653 to display all the TAZ numbers. Click on OK. To display all the node numbers, go back to the same dialog box and remove N <= 653 from the Selection Criteria Box. Click OK.

We will now compare the attributes from the original Input Network and the Unloaded Highway Network built by the Highway Network model. Click on a link in the network and scroll to the bottom of the attribute list. In the data window, double-click Inputs and then Network and then Input Network. Click on the same link in the Input Network to bring up the attribute list. Go to the Windows drop-down menu and select Tilt Vertical. This will open the two networks side-by-side for comparison. Move the two attribute lists as needed. Notice that the Unloaded Highway Network has more attributes that were added by the Highway Network model. Close the Input Network. Close the attribute list of the Unloaded Highway Network and then maximize the window.

We will now display TAZ boundaries in the background. With the network displayed, click on the Post drop-down menu and click on Clear All Postings. This will remove all node numbers. Click on the Layer Control icon and make sure the BDY file is checked. Double-click on the BDY file to display the Boundary Layer Parameters dialog box. On the Boundary Layer Parameters dialog box, click on Fill Color and All Done. This action will display all the TAZ boundaries in color.

Summary

This completes Part I of Lesson 5. In this lesson we covered the following major topics:

- Overview of transportation networks in general
- Highway networks
- Compatibility of zonal and highway network
- Model structure and procedures
- Model input and output files
- Network coding and attributes
- Area type and facility type
- Screenlines, cutlines, and cordon lines
- Traffic counts
- Default input speeds and capacities

We also completed a total of four exercises.

LESSON 5, PART II: HIGHWAY PATHS

Lesson Goals

Welcome to Part II of Lesson 5 on Highway Paths. In this lesson, we will cover the following major topics:

- Overview of the highway path model
- Minimum path building process
- Model input and output files
- Time penalties and turn prohibitors
- CTOLL parameter
- Toll model and toll link coding
- Terminal times
- Intrazonal times

At the end of this lesson, we will complete two exercises.

Overview

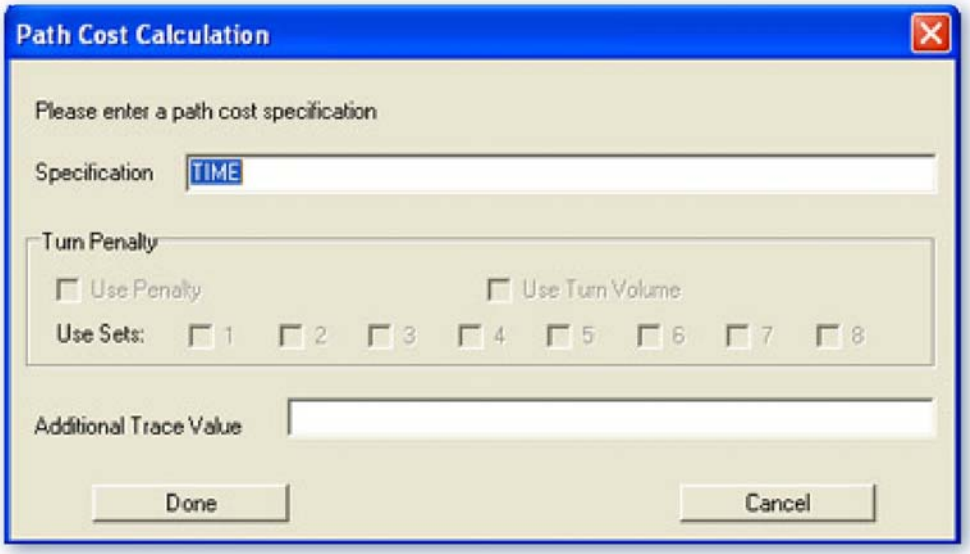
The Highway Network Path-Building model is executed right after the Highway Network model is executed during the Networks step in the FSUTMS model chain. For ease of reference, we will refer to the Highway Network Path-Building model as simply the Highway Path model. The purpose of the Highway Path model is to use information from the unloaded highway network file generated by the Highway Network model to calculate matrices of travel times and distances between each pair of zones in the network.

Minimum Path Building Process

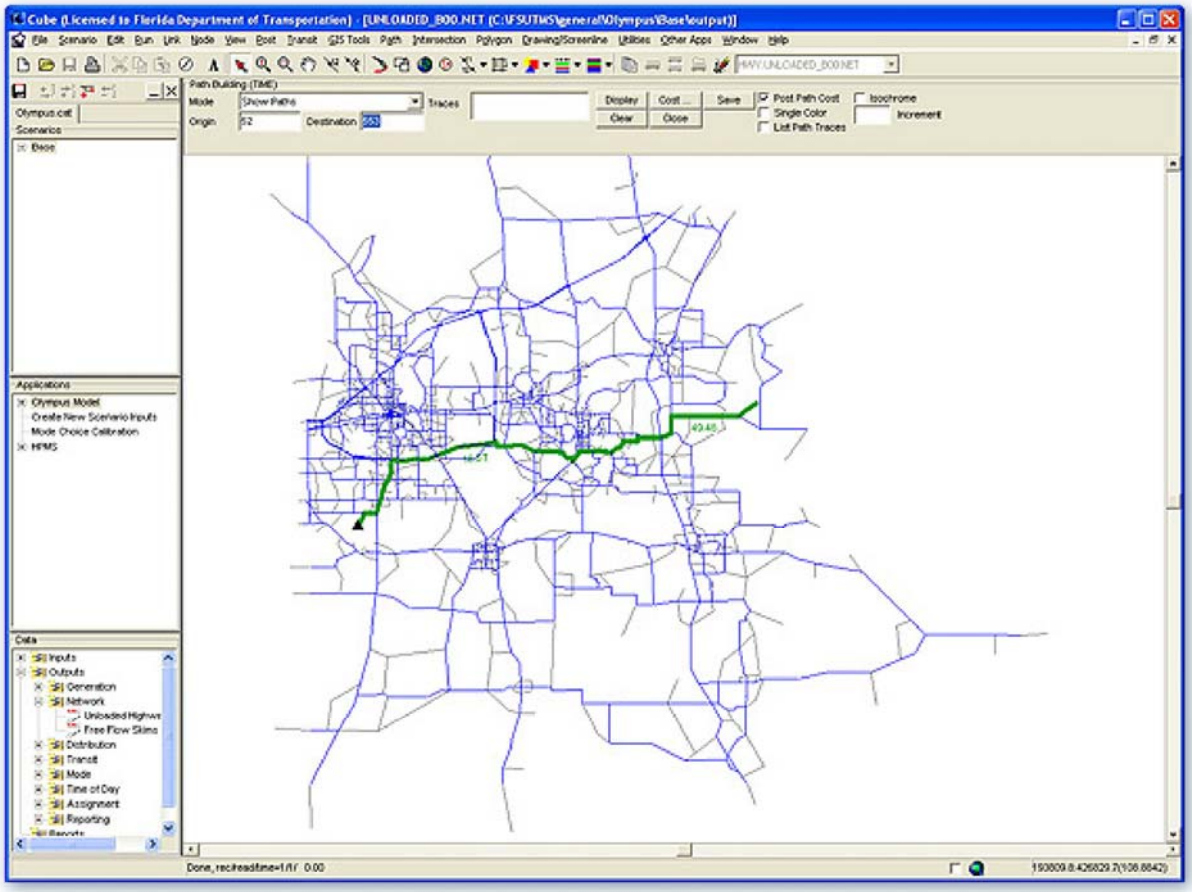
In the previous slide, the time and distance matrices are generally referred to as the "skims". Skims are accumulated over the minimum highway paths based on link lengths and uncongested free-flow travel speeds coded in the highway network database. The minimum paths identify the driving time or distance from point A to point B along a path in order to determine the total driving time or distance required to traverse the path between each pair of zones in the network. During the minimum-path building process, the minimum time paths are also updated with any coded time penalties, tolls, terminal times, and intrazonal times. These output skims are then used in the subsequent steps in the FSUTMS model chain.

Minimum Paths Using Cube

Cube is able to build and display paths based on either time or distance. Paths can be built not only between any pair of zone centroids, but also between any pair of regular nodes. To build a path between any two nodes, click on Path on the main menu and then select Build. This will bring up a dialog box like this.



In this example, "TIME" is specified for impedance. Clicking on Done on this dialog box to close it and then clicking on any two nodes on the map will instantaneously display a shortest-time path between the nodes. This figure shows an example of the resulting path.



Model Input and Output Files

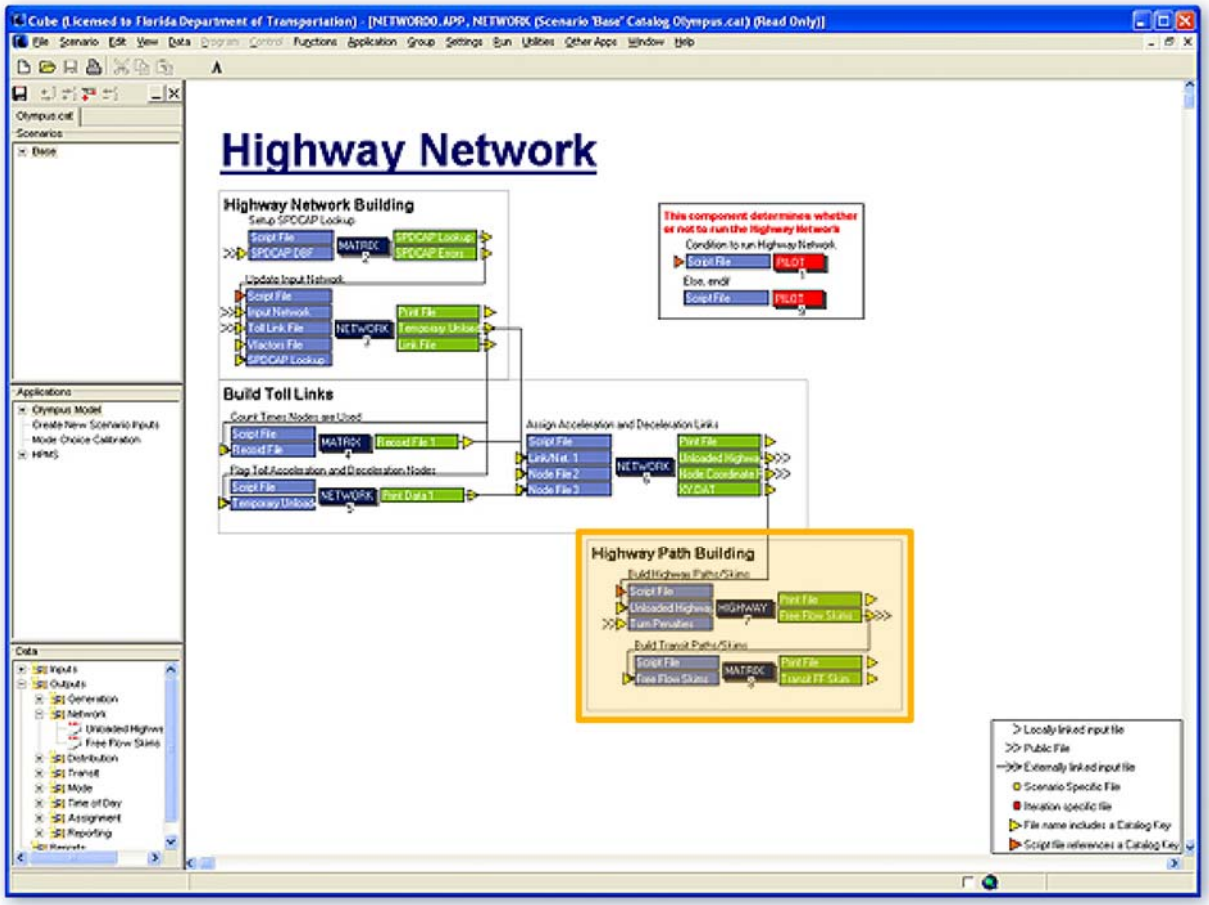
The only required input file for the Highway Path model is the unloaded highway network file generated by the Highway Network model. The name of the file follows the format of unloaded_ayy.net. An optional input file, commonly referred to as the "Turn Penalties" file, is used to specify time penalties and turn prohibitors. The name of this file uses the format of turn_yya.pen. We will cover time penalties and turn prohibitors in more detail in the next slide.

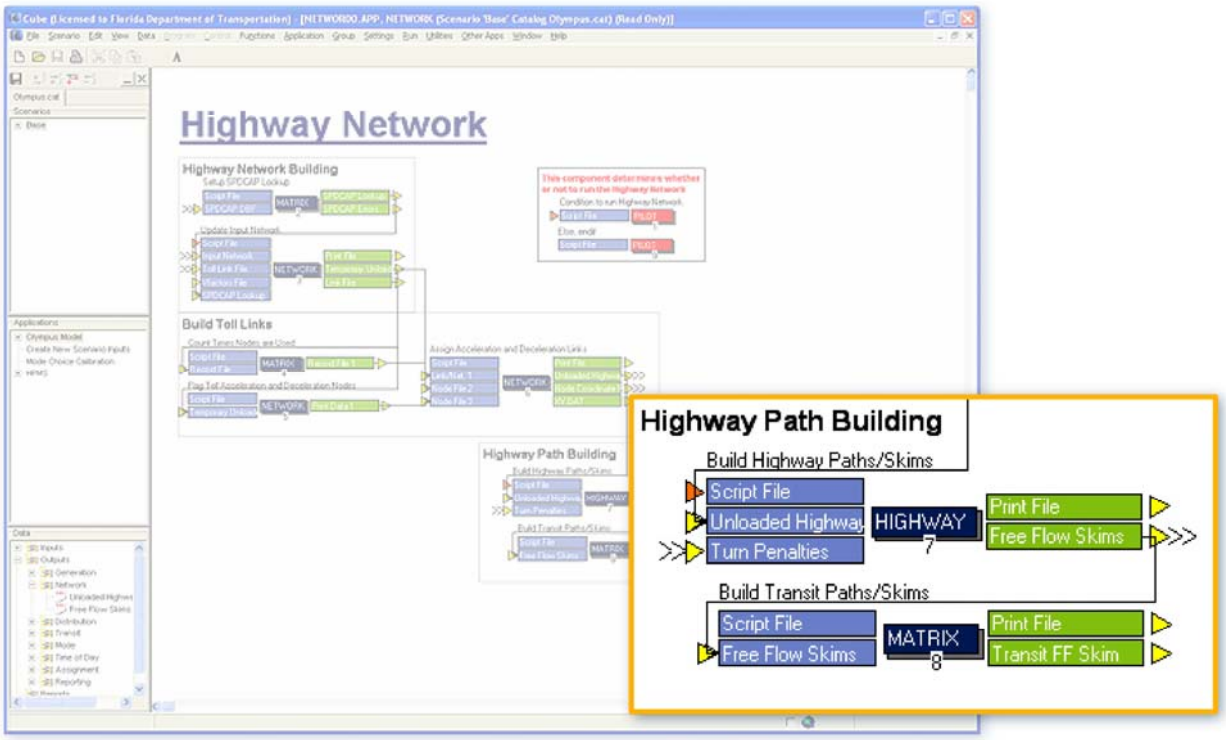
Using information from these input files, the Highway Path model generates an output file with the filename format freeskim_ayy.mat. This output file stores the free-flow skim matrices for:

- Minimum time path
- Minimum distance path
- Terminal time
- Walking distance

Highway Path Model Flow Chart

This flow chart highlights the Highway Path model within the overall Highway Network model of the Olympus model.



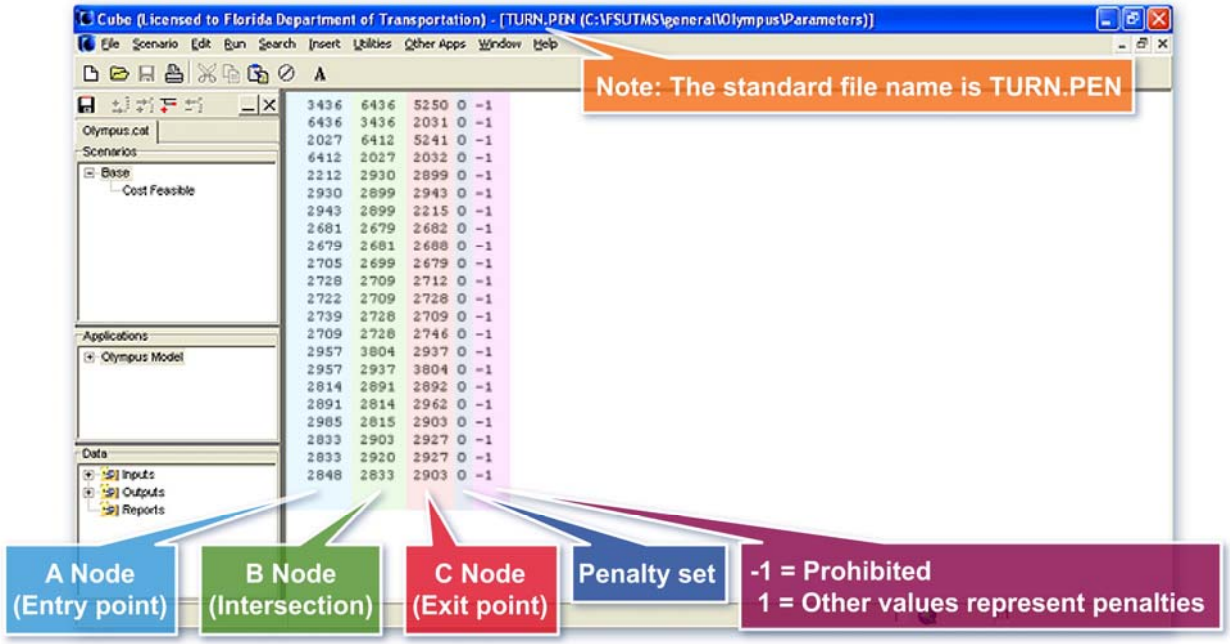


Time Penalties and Turn Prohibitors

What are time penalties and turn prohibitors? Time penalties are values of time that can be added to a link. They are added when the standard computations of impedance do not adequately account for perceived barriers on a specific link in the network. A common use for penalties is on bridge links, where the perceived barrier to travel is higher. For example, a resident of a barrier island may intentionally limit the number of trips made to the mainland, and even travel a longer distance on the island to shop rather than cross a bridge to serve the same travel need. Turn prohibitors, on the other hand, are applied to prevent the model from allowing a turn that is not permitted. For example, these could be a prohibited left turns, a directional ramp, or a continuous median on an arterial street.

Turn Prohibitors File

Turn prohibitors are stored in a file with the filename format turn_yya.pen. This figure shows an example of such a file. There are five data items for each row in this file. The first three data items are nodes that are used to define a turning movement. The first node indicates the entry point of the turn. The second node is where the turn occurs and the third indicates the exit point after the turn. The fourth data item is for penalty set, which is not currently used. Finally, the last data item is used to indicate either a penalty value or a prohibitor. If a "-1" is entered, it indicates a prohibited turn. Any other values entered are treated as the amount of time penalties in minutes.



Toll Model

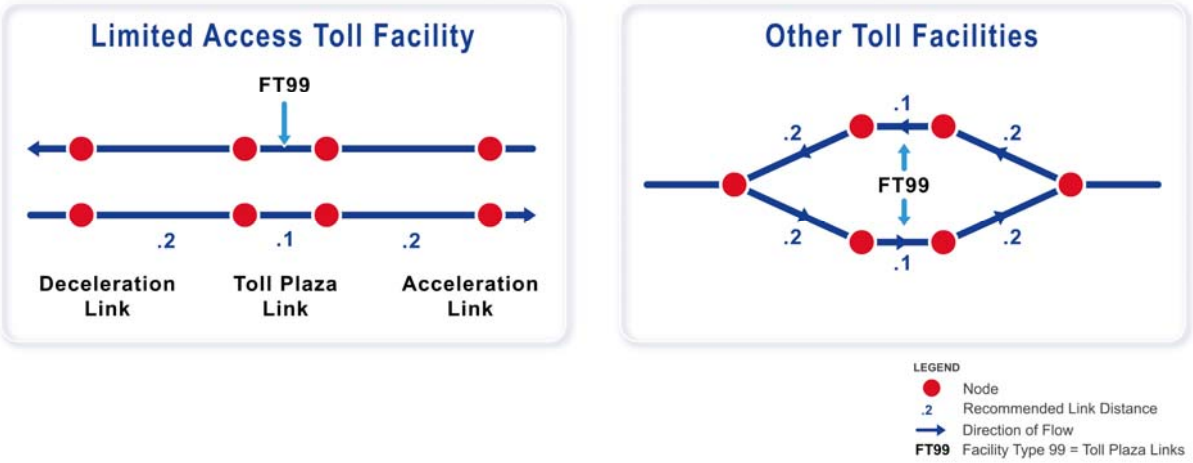
Toll procedures are used in FSUTMS models where toll facilities are present. At this point, the FSUTMS Standards do not include anything different from the original Toll Facilities model. The toll procedures require the modification of highway network to identify toll links, and the creation or modification of TOLLLINK data file with ANODE and BNODE and toll input data.

CTOLL Parameter

An important input parameter to the toll model is CTOLL. CTOLL represents the impedance of a toll, in terms of hour per dollar, as a component of the total impedance of a link. Typical CTOLL values can range between 0.03 and 0.05 hours per dollar. This range of values came from the suggested calculation that first takes the inverse of the average wage rate in dollars per hour to get a time value in hours per dollar. This time value is then multiplied by a percentage to account for the proportion of the time value that affects route choice.

Toll Link Coding

The toll model requires toll facilities to be coded as three one-way segments that include a deceleration link, a toll plaza link, and an acceleration link. The two figures below show how these links are coded. The first is for limited access facilities and the second is for other toll facilities. You can see from these figures that the toll link is coded as facility type 99. The numbers shown in these graphs are the recommended link distances in miles. Note that the travel time on the toll link is the sum of the delay at the plaza and the time value of the toll.



Toll Link File

The tolllink_yya.dat file contains information on the network characteristics of each toll plaza in the highway network. A TOLLLINK data file is only required in urban areas where toll facilities currently exist or are planned. The purpose of the TOLLLINK file is to account for the costs and delays associated with using toll facilities in the computation of travel impedances. These costs and delays have an impact on a potential user's decision to travel on a given toll facility.

Two sample records from a TOLLLINK file are shown below:

```
 1 1   4525   4526 EB EXT AIRPORT RD          3   3    .25 0:05 1 1   1   0   .10
 2 1   5388   5387 WB ENT AIRPORT RD          3   3    .25 0:05 1 1   1   0   .10
```

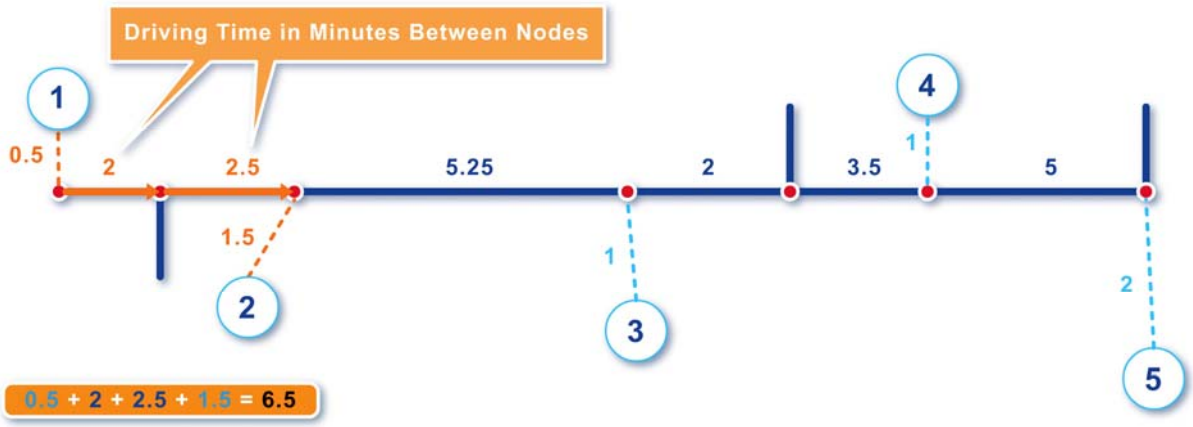
Click here (http://www.fsutmsonline.net/images/uploads/mtf-files/datadictionary.pdf) to see the data dictionary for the TOLLLINK file on page 11, or click Next to go to the next slide.

Implementation of Toll Procedure

The implementation of the toll procedure in Cube for FSUTMS is relatively straightforward. The model first reads the TOLLLINK file and then appends the cost and service time attributes to the highway network as link attributes. The impact of tolls to highway skims are then calculated directly from the link attributes during the highway network phase of the model.

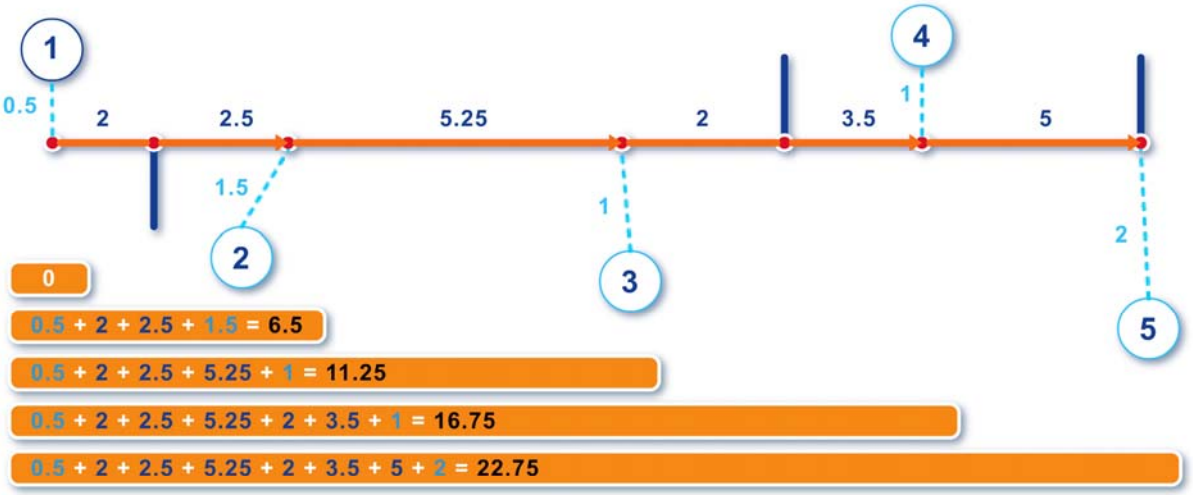
Highway Path Process

The Highway Path process skims the minimum time paths and then outputs a matrix of accumulated times between each pair of zones in the freeskim file. As indicated earlier the minimum time includes the in-vehicle driving time plus any time penalties. For example, in the sample network below, the driving time between zone pair 1 and 2 would be 6.5 minutes, which is the sum of 0.5, 2, 2.5, and 1.5 minutes.



Skim Times

Through the process described in the previous slide, Cube computes the skim times for all possible zone pairs and produces a time skim matrix for both directions. The example matrix shows only the driving times going from zone 1 to all of the other zones.



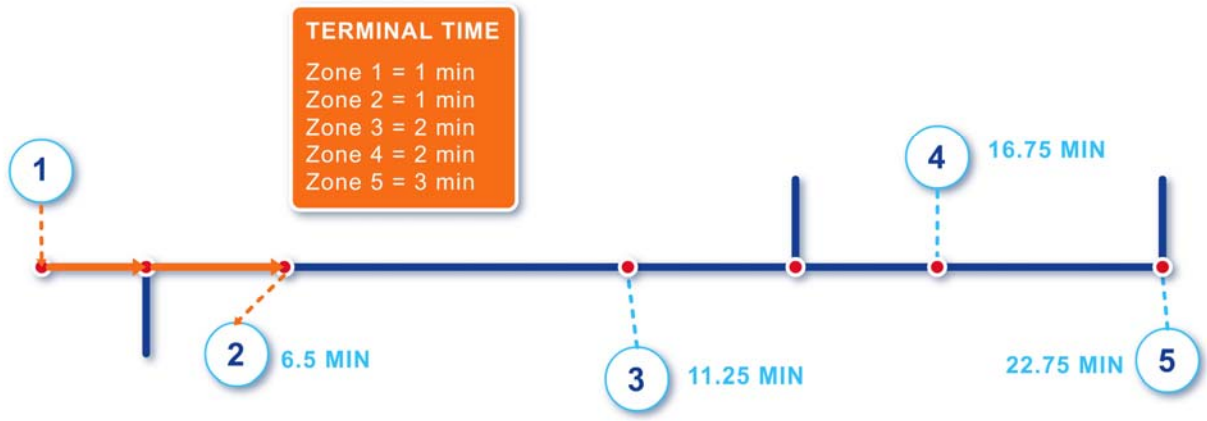
Zones	1	2	3	4	5
1	0	6.5	11.25	16.75	22.75
2					
3					
4					
5					

Compute Total Impedance

The skim matrix given in the previous slide includes only the driving times. To compute the total impedance, we need to add the terminal times and the intrazonal times. Terminal times include the time it takes to walk from the trip origin to the parking location and the time it takes to walk from a parking location to the final destination. In the catalog key, suggested terminal times by area type are 5 minutes in C-B-D areas, 2 to 3 minutes in C-B-D fringe and O-B-D areas, and 1 minute in residential and rural areas. Intrazonal time represents the driving time required to travel across a given zone. The nearest-neighbor method is commonly used to estimate the intrazonal time. Two alternatives based on this method can be used. The first alternative is to calculate the time as half of the driving time to the nearest zone. The second alternative is to calculate it as half of the average driving time to each surrounding zone.

Update Skims to Include Terminal Times

Assume that the terminal time for zones 1 to 5 are 1 minute, 1 minute, 2 minutes, 2 minutes, and 3 minutes, respectively. For example, the total terminal time for a trip from zone 1 to zone 2 would be 2 minutes, which includes 1 minute in zone 1 and one minute in zone 2. These additional 2 minutes are added to the driving time of 6.5 minutes for a total of 8.5 minutes. The same is done for all zone pairs, including for the intrazonal trips, which in this case is two minutes, including 1 minute to walk to a destination in the zone and another minute to walk back.



DRIVING TIME SKIMS

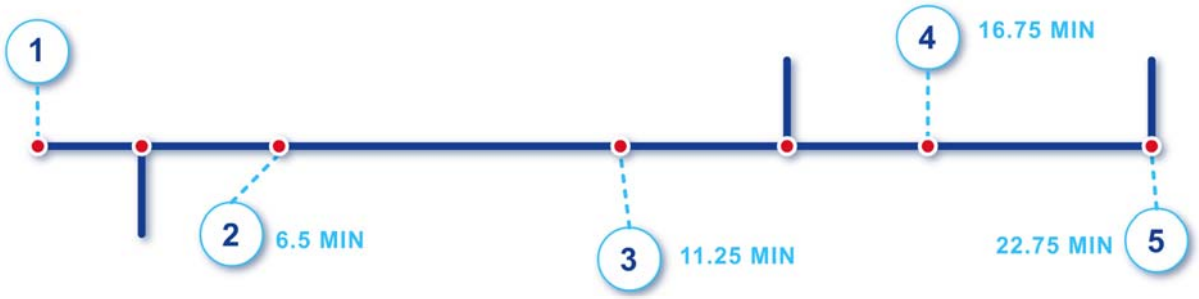
Zones	1	2	3	4	5
1	0	6.5	11.25	16.75	22.75
2					
3					
4					
5					

UPDATED WITH TERMINAL TIMES

Zones	1	2	3	4	5
1	0	8.5	14.25	19.75	26.75
2					
3					
4					
5					

Update Skims to Include Intrazonal Times

As we mentioned earlier, intrazonal time is the driving time required to travel across a given zone. You may recall that one of the two alternative methods for calculating intrazonal times is half of the average driving time to each surrounding zone. Assuming that zone 1 is surrounded by zones 2, 3, and 4. The average driving time will be calculated as the summation of three driving times divided by 3, i.e., 6.5 minutes for zone 2 plus 11.25 minutes for zone 3 plus 16.75 minutes for zone 4, for a total of 34.5 minutes. Dividing this total by 3 will get us 11.5 minutes. Now, multiply it by half to get the final intrazonal time of 5.75 minutes for zone 1. This time can then be added directly to the skim matrix for zone 1. The total impedance for zone 1 is thus 7.75 minutes, including 2 minutes of terminal time and 5.75 minutes of intrazonal time.



INTRAZONAL TIME OF ZONE 1 =
[(6.5 + 11.25 + 16.75)/3] x 0.5 = **5.75** minutes

UPDATED WITH TERMINAL TIMES

Zones	1	2	3	4	5
1	2	8.5	14.25	19.75	26.75
2					
3					
4					
5					

UPDATED WITH INTRAZONAL TIMES

Zones	1	2	3	4	5
1	7.75	8.5	14.25	19.75	26.75
2					
3					
4					
5					

Exercises

For Part II of this lesson, we will complete two exercises. For the first exercise we will display the highway paths created by the Highway Network model. We will learn to display them in different graphic representations. For the second exercise, we will modify a TOLLLINK attribute to examine the impact of the modification.

We will start the first exercise by opening the Unloaded Highway Network. By now we assume that you already know how to open the Olympus model. If you need help on this, you may go back to Part I of this lesson and review the first exercise. We are now in Cube with the Olympus model opened. To open the Unloaded Highway Network, double-click on Outputs in the Data window, then double-click on Network, and then double click on Unloaded Highway Network.

This will display the unloaded highway network. Click on the Path drop-down menu and then select Build. This will display the Path Cost Calculation dialog box. In the Specifications block, right-click on the mouse button. Look for the TIME attribute on the attribute list and click it. Click on the Done button.

On the Path Building (Time) dialog box displayed on top of the map, you will see that the default origin zone number is 1. Replace origin zone 1 with 523 by first highlighting it and then type in 523. Similarly, highlight the destination zone and then type in 277. Click on the Display button. This will display the minimum path between Zone 523 and Zone 277. Click on the Clear button to clear the path. Cube also allows you to enter multiple origin and destination nodes at the same time. Now, enter a range of origin nodes, from node 277 to node 400. Similarly, enter a range of destination nodes, from node 277 to node 330. On the top right corner, check the Single Color box. This opens the Color Selection box. Select a color and then click OK. Click Display. This will display all the minimum paths between all combinations of the origin and destination zones. Click Clear to clear all paths.

Now, check the List Path Traces box and enter a pair of origin and destination zones. We will enter 6 for the origin zone. For the destination zone we will enter 198. Click Display. This will not only display the minimum path, but also the minimum time between the two nodes. The time is displayed in parentheses in minutes in the Traces box. Click Clear to clear the path and the trace. Now, check the Isochromes box. This will bring up the Isochromes Display dialog box. Enter a Cost Increment. For this example, enter 10 and click on OK. In the origin zone, enter 388. In the destination zone, enter ALL. Click on the Display button. This will display an Isochromes map for zone 388 to each of the other zones. You can see that in this map a different color is shown for every 10 minute intervals of travel time.

Click on the Close button to clear the paths and exit the Path Building dialog box. Close Cube by clicking on the outside X at the top of the screen. Click Yes to close all windows. Click Yes again to save the changes. This concludes the first exercise.

For the second exercise, we will practice modifying a TOLLINK attribute. Because we will want to compare between two scenarios at the end of this exercise, we need to create a new scenario.

Click the Cube icon on your desktop to start Cube. Click OK to load the default Olympus model. We will create a new scenario that is a child of the Base scenario. Right click on Base and select Add Child. We will call it Toll. Hit Enter when you have entered the scenario name. The Scenario Properties dialog box will pop up. Click OK. This opens the Scenario dialog box. Check all the model steps one at a time. On the Alternative Letter drop-down list, select alternative C. On the Application field on top, select the option called Create New Scenario Inputs. Click Yes to save scenario when prompted. Click Run. Click OK. Click Close and click Yes to create the new scenario.

We will now try to open the TOLLLINK file. In the Data window, double-click on Inputs. Double-click on Network, and double-click on Toll Link File to open the file. Now, change the toll from 1.00 to 2.00 for the EB Western Barrier mainline toll links. Do the same again for the

WB Western Barrier. Click the X button to close the TOLLLINK file. Click Yes to save the changes.

We will now execute the model you have just created. Click on Toll on the Scenario window. Make sure all steps are checked under "Please Select Model Steps". Click on Run to run the model steps. Click OK when the run is completed. Click Close to close the scenario. We will now check the results from the changes. Go to the Data window. Double-click on Outputs, double-click on Assignment, and double-click on Loaded Daily Net. This displays the loaded daily network. Click on the View drop-down menu and select Center on Nodes. Enter node 5429 and click OK. Enter a window width of 5000 and click OK.

We will now try to post the total volume on the links. With the network displayed, click on the Post drop-down menu and select All Links. This will display the Posting Selection dialog box. Look for TOTALVOL from the drop down box and click to select it. Click OK. This will display the total volume on all links on the map. We will now examine the impact of the modification to the tolls by comparing the results with those before the modification.

In order to do this, first click on Base on the Scenario window. Double-click Loaded Daily Net in the Data window. This opens and displays the loaded daily network for the Base scenario. Again, click on the View drop-down menu and select Center on Nodes. Enter node 5429 and click OK. Enter a window width of 5000 and click OK.

We are now ready to compare the two displays which is on top of one another. Click the Window drop-down menu on top and select Tile Horizontal. This will display the output total volumes from the two scenarios side-by-side. The top window shows the results for the Toll scenario and the bottom window shows the results for the Base scenario. You can see that the change in tolls resulted in a redistribution of trips surrounding the toll links. This concludes the second exercise.

Summary

This concludes Part II of Lesson 5. In this lesson, we covered the following major topics:

- Overview of the highway path model
- Minimum path building process
- Model input and output files,
- Time penalties and turn prohibitors
- CTOLL parameter
- Toll model and toll link coding
- Terminal times
- Intrazonal times

We also completed two exercises, one to display the minimum paths in different graphic representations and a second to modify the TOLLLINK file to examine its impact on traffic patterns.

LESSON 6: TRIP DISTRIBUTION

Lesson Goals

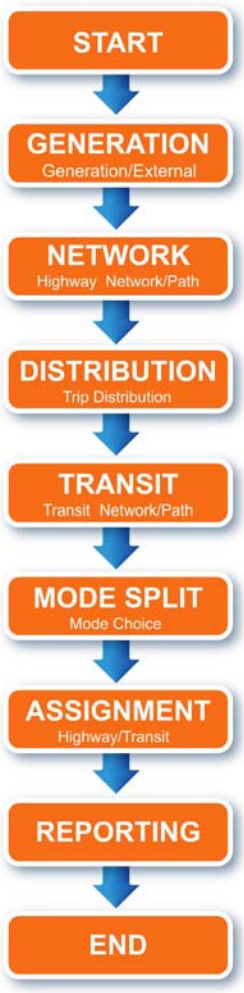
Welcome to Lesson 6. In this lesson, we will first provide an overview on the trip distribution methodology used in FSUTMS. We will then discuss the specific components of methodology, which includes:

- Gravity model
- Friction factors
- K-factors
- Subarea balancing scheme
- Development of congested or restrained highway skims
- Input and output files for the trip distribution step in the context of the Olympus model

Finally, we will complete a series of five short exercises.

Overview

Trip distribution is the third step in the FSUTMS model chain. The purpose of this step is to determine where the trips produced in each zone will go. In other words, it is to predict how the trips produced from each zone will be divided among all other zones in the study area.



As will be described in greater detail later in this lesson, the method used in FSUTMS to distribute trips is by matching the production trip ends to the attraction trip ends based on the relative attractiveness and accessibility of each attraction zone. The attractiveness of a zone in this case is measured in terms of the relative amount of trips attracted to the zone. The accessibility of a zone, on the other hand, is measured based on the level of separation between two zones in relative to the separations among the different pairs of zones.

The output from the trip distribution step is trip tables for different trip purposes. Each trip table lists the number of person trips that travel between each pair of zones. For this reason, these trips are also called "trip interchanges". Remember, trip interchanges are not directional, meaning that from the amount of trip interchanges we know only the number of trips that travel between Zone A and Zone B, but we don't know how many of these trips actually travel from Zone A to Zone B and how many from Zone B to Zone A.

The input to the trip distribution step include the highway skims produced by the network and path models discussed in the previous lesson, the trip productions and trip attractions produced by the trip generation models,

and a set of friction factors that attempts to measure the level of separation between zones as a function of the travel time between each pair of zones.

Before being input to the trip distribution step, the free-flow skims are revised or updated to include both intrazonal and terminal times:

- Intrazonal time is an estimate of the time required to travel within a given traffic zone when the trip origin and the trip destination are both in the same zone.
- Terminal time refers to the walk time required to travel from trip origin to auto and from auto to final destination

Gravity Model

The gravity model is the method used to distribute trips in FSUTMS. The gravity model assumes that all trips starting from a given zone are attracted to other zones in direct proportion to the relative attraction of each zone and in inverse proportion to the separation between the zones.

As mentioned, attractiveness is measured by the number of attraction trip ends in every zone for each purpose analyzed, and accessibility is measured by the degree of separation between zones. This relationship is expressed in the formula below:

$$Tij = \frac{AjFijKij}{\sum_{j=1}^{n} AjFijKij} \times Pi$$

In this equation:

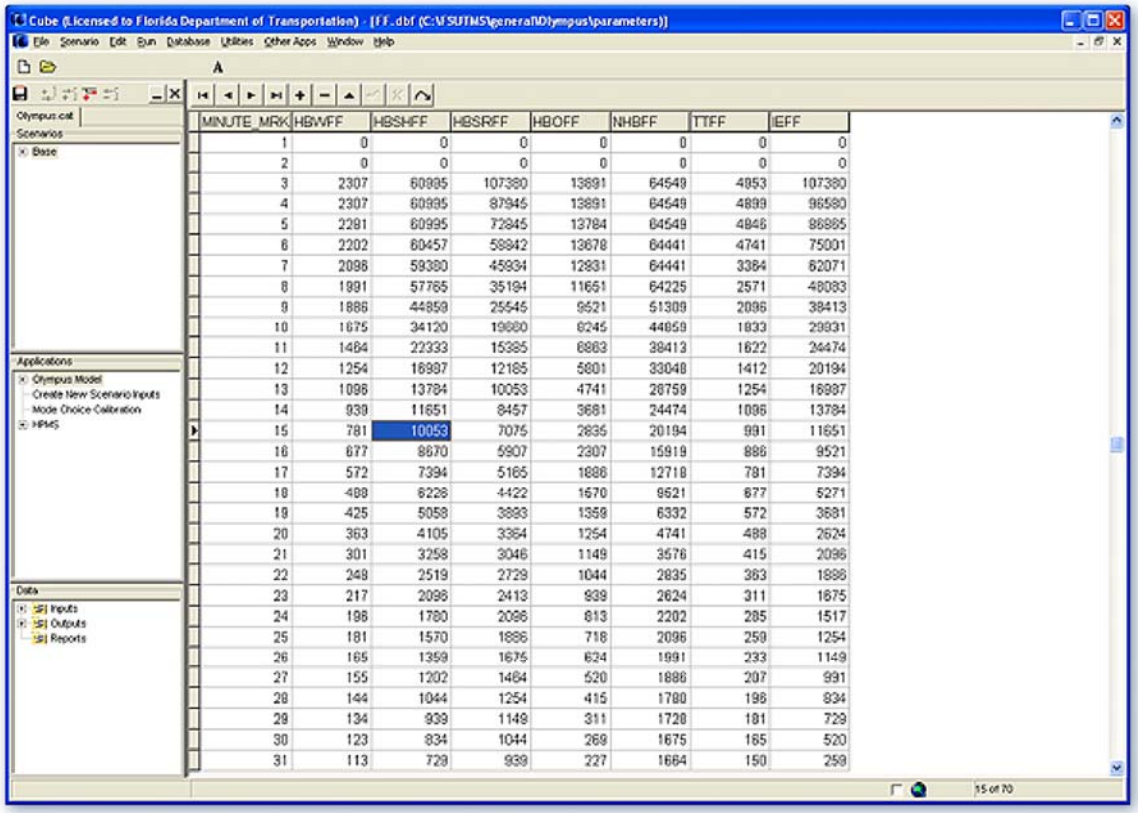
- T_{ij} is the trips produced in zone i and attracted to zone j;
- P_i is the total trip production at zone i;
- A_j is the total trip attraction at zone j;
- F_{ij} is the separation between zones i and j, commonly known as the friction factor;
- K_{ij} is a socioeconomic adjustment factor for zones i and j, commonly known as the K-factor; and
- n is the total number of zones.

Next, we will explain the friction factors and the K factors in greater detail.

Friction Factors

As previously explained, friction factors, also known as "FF" factors or travel time factors, are used by the gravity model as a measure of accessibility between production and attraction zones. They express the effect that spatial separation exerts on trip interchange. In effect, these factors measure the probability that a traveler will make a trip at one-minute increments of travel time. The gravity model is used to replicate the attractiveness of a zone through the use of friction factors, which represent travel time impedances between origins and destinations.

This screen shows the lists of friction factors from the FF.DBF file. As you can see, it lists the friction factors for each trip purpose as a function of time in minutes of travel.



MINUTE_MRK	HBWFF	HBSHFF	HBSRFF	HBOFF	NHBFF	TTFF	IEFF
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	2307	60995	107380	13891	64549	4853	107380
4	2307	60995	87945	13891	64549	4899	96580
5	2281	60995	72845	13784	64549	4846	86985
6	2202	60457	58942	13678	64441	4741	75001
7	2098	59380	45934	12831	64441	3384	62071
8	1991	57765	35194	11651	64225	2571	48083
9	1886	44859	25545	9521	51309	2096	38413
10	1675	34120	19680	8245	44859	1833	29931
11	1464	22333	15385	6863	38413	1622	24474
12	1254	16997	12185	5801	33048	1412	20194
13	1096	13784	10053	4741	28759	1254	16997
14	939	11651	8457	3681	24474	1096	13784
15	781	10053	7075	2835	20194	991	11651
16	677	8870	5907	2307	15919	886	9521
17	572	7394	5165	1886	12718	781	7394
18	488	6228	4422	1670	9521	677	5271
19	425	5058	3893	1359	6332	572	3681
20	363	4105	3364	1254	4741	488	2624
21	301	3258	3046	1149	3576	415	2096
22	248	2519	2729	1044	2835	363	1886
23	217	2096	2413	939	2624	311	1675
24	196	1780	2096	813	2202	285	1517
25	181	1570	1886	718	2096	259	1254
26	165	1359	1675	624	1991	233	1149
27	155	1202	1464	520	1886	207	991
28	144	1044	1254	415	1780	196	834
29	134	939	1149	311	1728	181	729
30	123	834	1044	269	1675	165	520
31	113	729	939	227	1664	150	259

Friction factors are usually obtained either by generating from local survey data such as those from a household survey, or by borrowing from another study that is believed to hold the same local characteristics. Many urban areas do not have calibrated friction factors for all trip purposes. These areas must, therefore, borrow factors from other urban areas. Note that the friction factors for work-related trips can be derived from the Census Journey-to-Work data, and roadside surveys can be used to generate the friction factors for internal-external trips.

K-Factors

K-Factors are often called the socioeconomic correction factors. K-Factors are normally used in urban areas where friction factors alone do not accurately measure the separation between production and attraction zones and, therefore, require additional impedance measures. Such cases may include:

- Too many rural-area trips attracted to an urban core
- Low-income resident trips attracted to suburban office locations

When using K-Factors, you must proceed with caution. These factors should be used as a last resort if no other adjustment methods can improve the distribution results.

Subarea Balancing

Subarea balancing is an alternative to using the K-Factors. A subarea could be a county or a planning district that is identified to balance productions and attractions. Subarea balancing has been successfully employed in the Northeast Florida Regional Planning Model and Tampa Bay Regional Planning Model. Subarea balancing must be used with caution. One reason is that there is not as much history available for subarea balancing as there is for the K-factor approach.

Congested Skims

Congested skims are not used in highway-only models, but they are required for nested logit mode choice models. Congested skims are simulated by running pre-mode choice and pre-highway assignment prior to transit network building process. Some models use congested skims as input to distribution for home-based work trips. Some models go one step further and compute composite skims that include weighted highway and transit travel times as input to the final trip distribution

Olympus Trip Distribution Input and Output Files

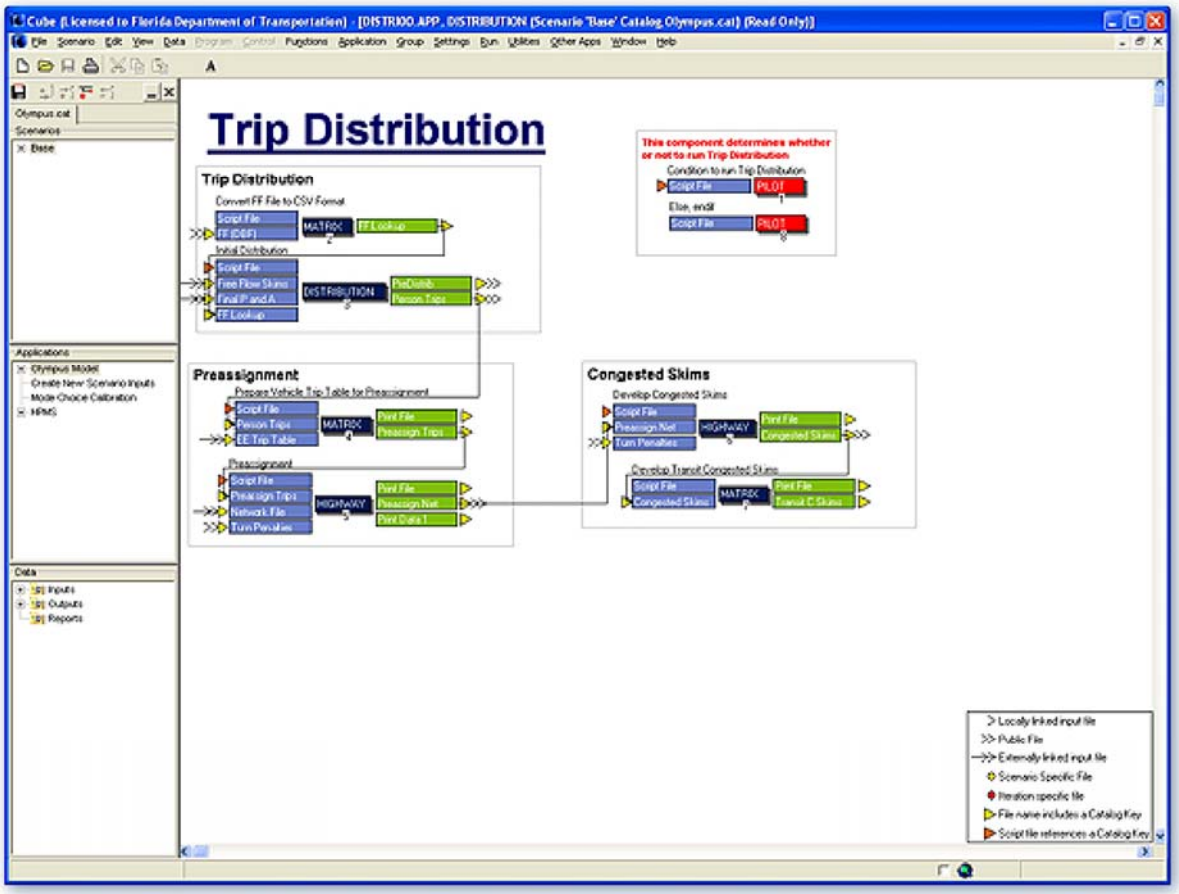
The Olympus model requires the following input files:

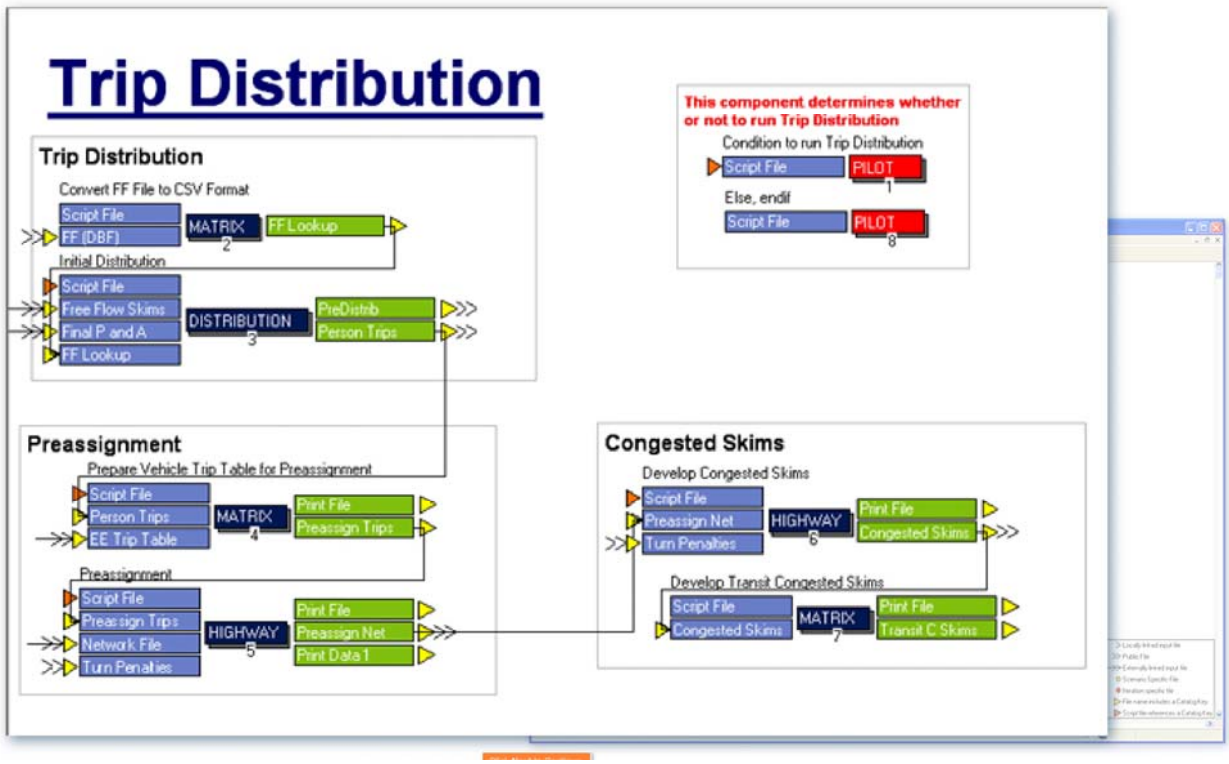
- freeskim_ayy.mat, which is the free-flow skims matrix,
- panda_ayy.dbf, which stores the trip production and attraction information,
- unloaded_ayy.net, which stores the highway network and is used only for pre-assignment
- ff.dbf, which stores the friction factors, and
- turn_yya.pen, which is used to specify turn penalties or turn prohibitors for pre-assignment

The Olympus model will generate the following output files:

- psntrips_ayy.mat, which contains person trip table matrices by trip purposes,
- congskim_ayy.mat, which contains the restrained skim matrix, and
- preassign_ayy.net, which stores the preassignment network

The trip distribution step for the Olympus model is highlighted here on the overall Cube flow chart. Clicking on the Distribution yellow box will take you to the screen that shows the detailed components of the step. Click Next when you finish viewing the flow charts.


Cube (Licensed to Florida Department of Transportation) - [DISTR00.APP, DISTRIBUTION (Scenario 'Base' Catalog Olympus.cat) (Read Only)]
Trip Distribution
Trip Distribution
Convert FF File to CSV Format
Script File
FF (DBF)
MATRIX
2
FF Lookup
Initial Distribution
Script File
Free Flow Skims
Final P and A
FF Lookup
DISTRIBUTION
3
PreDistrib
Person Trips
This component determines whether or not to run Trip Distribution
Condition to run Trip Distribution
Script File
PILOT
1
Else, endif
Script File
PILOT
8
Preassignment
Prepare Vehicle Trip Table for Preassignment
Script File
Person Trips
EE Trip Table
MATRIX
4
Print File
Preassign Trips
Preassignment
Script File
Preassign Trips
Network File
Turn Penalties
HIGHWAY
5
Print File
Preassign Net
Print Data1
Congested Skims
Develop Congested Skims
Script File
Preassign Net
Turn Penalties
HIGHWAY
6
Print File
Congested Skims
Develop Transit Congested Skims
Script File
Congested Skims
MATRIX
7
Print File
Transit C Skims
Locally linked input file
Public File
Externally linked input file
Scenario Specific File
Iteration specific file
File name includes a Catalog Key
Script file references a Catalog Key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Prepare Vehicle Trip Table for Preassignment
Script File
Person Trips
EE Trip Table
MATRIX
4
Print File
Preassign Trips
Preassignment
Script File
Preassign Trips
Network File
Turn Penalties
HIGHWAY
5
Print File
Preassign Net
Print Data1
Congested Skims
Develop Congested Skims
Script File
Preassign Net
Turn Penalties
HIGHWAY
6
Print File
Congested Skims
Develop Transit Congested Skims
Script File
Congested Skims
MATRIX
7
Print File
Transit C Skims

Exercises

In this lesson we will do a total of five short exercises.

- Review the trip distribution inputs
- Execute the trip distribution model
- Review the results
- Review the node or point chart
- Create the desire line maps

For the first exercise, which is to review the trip distribution inputs, we will first navigate to the Olympus Model. Click on the FSUTMS Launcher icon. Select Statewide and Training Models on the FSUTMS Welcome Screen. Select the FSUTMS/CUBE Olympus Training Model.

Next, we will open one of the main input file for the trip distribution step, the friction factor file, called FF.DBF. To do this, in the Data window, simply double-click on the FF.DBF file under Inputs\Distribution.

For our next exercise, we will execute the trip distribution model. To do this, first, close FF.DBF and Open the Scenario Manager for Base. Click the box next to Trip Distribution under Please Select Model Steps…. Make sure that all other model steps are unchecked. Click on Run. This allows you to run only the trip distribution portion of the model. Click OK when the run has completed. Close the Scenario Manager.

The run is completed. Now we are ready to review the model output results. Double-click on the outputs files under Outputs\Distribution in the Data window to review and answer the questions to be posted next.

- What is the congested intrazonal time for zone 102? ____ (use Congested Skims file)
- How many purposes are shown in the Distribution Summary?_____ (use Distribution Summary file)
- How many iterations did the gravity model run? _____ (use Distribution Summary file)
- What is the friction factor value for home-based work for 25 minutes? _____ (use FF.DBF input file)
- What are the total trips for the home-based shop purpose? _____ (use Distribution Summary file)
- What is the average travel time in minutes for the home-based other purpose? _____ (use Distribution Summary file)
- How many intrazonal home-based work trips are there for zone 10?____ (use Person Trips file)

When you are done, click the "Answers" button to reveal the answers.

- What is the congested intrazonal time for zone 102?
  Open Congested Skims file and get the answer: 0.67
- How many purposes are shown in the Distribution Summary?

Open the Distribution Summary file: 7

- How many iterations did the gravity model run?
  Go to the Distribution Summary file and find the answer: 32
- What is the friction factor value for home-based work for 25 minutes?
  Go to the FF.DBF input file: 181
- What are the total trips for the home-based shop purpose?
  Use the Distribution Summary file: 191,932
- What is the average travel time in minutes for the home-based other purpose?
  Open the Distribution Summary file: 15.12
- How many intrazonal home-based work trips are there for zone 10?
  Use Person Trips file and get the number: 249.88

Click Next to continue. We will now review the Node/Point chart. We will first open the required data files. In the Data window, click the Input Network in the Network group under Inputs. In the Data window, click the Person Trips file in the Distribution group under Outputs.

We are now ready to link the network to the trip matrices. While viewing the model network, click on the Node option in the menu bar at the top of the page. Select the Link to Matrix option. Add the person trip matrix and close the Set Linkages to Matrices window. Select the Post option from the menu bar at the top of the page. Next, select Node/Point Chart from the menu and select five trip purposes

For the first attribute, select the option for home-based work, select Fix color and select red. You can now repeat the same for the other four trip purposes:

- Select home-based school trips, select Fix color and select green
- Select home-based social-recreational trips, select Fix color and select orange
- Select home-based other trips, select Fix color and select blue
- Finally, select non-home-based, select Fix color and select black.

We will now review a Production Node Chart. Set up the Highway Layer Node Chart Settings window to show the sum of the production trips for the first five purposes. Enter the following for the Radius Expression:

```
((M1.T1.P_SUM.HBW+M1.T2.P_SUM.HBSH+M1.T3.P_SUM.HBSR+
M1.T4.P_SUM.HBO+M1.T5.P_SUM.NHB)^0.5)/5
```

Name it Productions and Click OK when you are finished. Notice the distribution of productions throughout the model area. We can similarly review an Attraction Node Char. Set up the Highway Layer Node Chart Settings window to show the sum of the attraction trips for the first five purposes. Name it Attractions. Similar to before, input the information for the five trip purposes: For the first attribute, select the option for home-based work, select Fix color and select red. Repeat the same for the other four trip purposes:

- Select home-based school trips, select Fix color and select green
- Select home-based social-recreational trips, select Fix color and select orange

- Select home-based other trips, select Fix color and select blue
- Finally, select non-home-based, select Fix color and select black.

Next, enter the following for the Radius Expression:

((M1.T1.A_SUM.HBW+M1.T2.A_SUM.HBSH+
M1.T3.A_SUM.HBSR+M1.T4.A_SUM.HBO+M1.T5.A_SUM.NHB)^0.5)/5

Click OK when you are finished. Notice the distribution of attractions throughout the model area. When you are finished, you may close the network and matrix files without saving any changes.

For the last exercise, we are to create some desire line maps. First, we will open a person trip table and the unloaded network. Double-click on the Person Trips table under Outputs\Distribution in the Data window. Double-click on the Input Network under Inputs/Network in the Data window. We will next link the vehicle trip table to the loaded network. Select Link to Matrix from the Node menu at the top of the screen. Select the person trips table from the Available Linkage area in the Set Linkage to Matrices window. Click the Add button. Click the Close button.

Now we are ready to create desire lines. Select Desire Lines from the Post menu at the top of the screen. To specify the desire line settings and display, Fill in the Matrix Table to represent Home Based Work trips (M1.T1.HBW = Matrix 2, Table 1, Home Based Work). Set the Scale to 1. Set the Origin Zones to 1-653. Set the Destination Zone to 142. Click on Display to view trips by bandwidth from zones 1-653 to zone 142.

To clear the desire lines and close the network, close the desire lines by selecting Close from the Desire Lines menu. Clear the desire lines by selecting Clear All Postings from the Post menu. Close out FSUTMS by clicking on the "x" button at the top right corner of the window.

Summary

This is the end of Lesson 6. In this lesson, we covered for the trip distribution module of FSUTMS

- Gravity model
- Friction factors
- K-factors
- Subarea balancing scheme
- Development of congested or restrained highway skims
- Input and output files for the trip distribution step in the context of the Olympus model

We also completed a series of five short exercises.

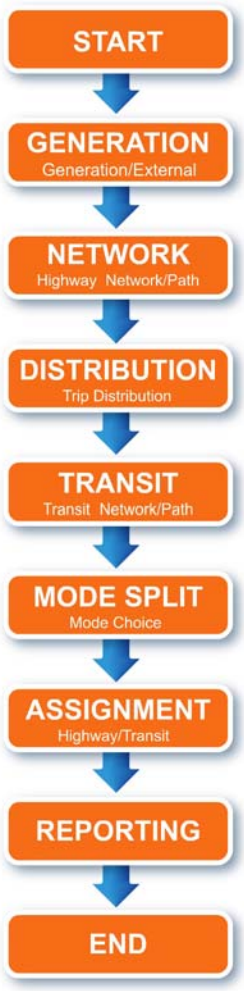
LESSON 7, PART I: TRANSIT NETWORKS

Lesson Goals

Welcome to Part I of Lesson 7 on Transit Networks. In this lesson, we will cover the following topics:

- Overview of transit networks, transit stops, and transit stations
- Transit network coding
- Transit headway
- Transit network input and data sources
- Non-transit modes and access links
- Percent walks
- Transit network model structure
- Transit network model input and output files
- Required fields in highway network for transit

Finally, we will complete an exercise to create a transit line and build transit network paths. In part II of the lesson, we will learn about the process of transit path building in Cube Voyager.



Transit Networks

Transit is the fourth step of the FSUTMS model chain. We will start by defining what a transit network is. In travel demand modeling, a transit network is one that represents a system of existing or proposed transit facilities in a format that the computer can process. A transit network may consist of one or more transit lines. A transit line is one that delineates the route that transit vehicles take during a particular scheduled time period. This route delineation is done by defining a series of nodes. A node can be a transit stop, a transit station, or a regular highway interruption such as an intersection. A transit network may also include links to provide access for pedestrians and vehicles. These are referred to as the access links and will be discussed in further later in this lesson.

Transit Stops vs. Transit Stations

In the previous slide, we mentioned both transit stops and transit stations. So, what is the difference between a transit stop and a transit station? A transit stop is one that occurs on the highway network, usually along a bus route, whereas a transit station is one that occurs OFF the highway network, usually along a light rail, a heavy rail, or a rapid rail transit facility. In transit line files, if a node is a transit stop or a transit station, it is assigned a positive node number. If a node is NOT a transit stop or a transit station, it is assigned a negative number.

Highway Network Modifications

There are three types of transit network elements that are coded in a highway network. The first is the transit-only links. This type of links has a facility type of 69 in a highway network. The second type of links involves micro-coded stations that are built to separate rail and bus platforms. In this case, individual links are coded to connect station nodes to network or bus stop nodes. The third transit network element coded in a highway network involves station data that are coded on the nodes for such facilities as park-and-ride and fixed-guideway stations.

Transit Headway

An important input to transit network modeling is transit headway. A transit headway is defined as the time difference between the scheduled arrivals of two successive transit vehicles at a particular stop for a particular route. For example, if a bus for Route A is scheduled to leave from a particular bus stop 30 minutes before the next bus is scheduled to arrive for also Route A at the same stop, Route A is said to have a headway of 30 minutes.

Transit Network Input and Data Sources

The file to store route lines includes information on transit headway, stop, and routing for each route. The main data sources for such information are the route maps and that route schedules that can both be obtained from transit agencies. Information on transit stations can also be obtained from transit agencies from their transit facility inventories. Note that the walk access time between a zone and a transit stop is calculated by Cube Voyager automatically.

Non-Transit Modes and Access Links

A non-transit mode could be for pedestrians or auto vehicles. Access to transit network for non-transit modes is made through the so-called access links. Access links are generated in the PT program and validated using the REWALK and AUTOCON third party programs to ensure that access links are logical. Several access links together may form a non-transit leg that represents a minimum-cost route between a zone centroid and the transit network. A non-transit leg can be an access leg, an egress leg, or a transfer leg. An access leg is one that connects a zone centroid to a transit stop. An egress leg is just the opposite. It connects a transit stop to a zone centroid. Finally, a transfer leg is one that connects two transit stops, such as a sidewalk.

Percent Walks

One input related to access links is “Percent Walks”. So what are they? “Percent walks” are defined as the proportion of a zone that is accessible to transit by walking. The information on percent walks are used in the model to control for over-estimation of trips. Three assumptions are made when estimating the percent walks. First, we assume that walk access is ubiquitous throughout a zone. Second, we assume that the spatial distribution of productions and attractions are uniform. Finally, we assume that there are no environmental or topological barriers that can impede walking

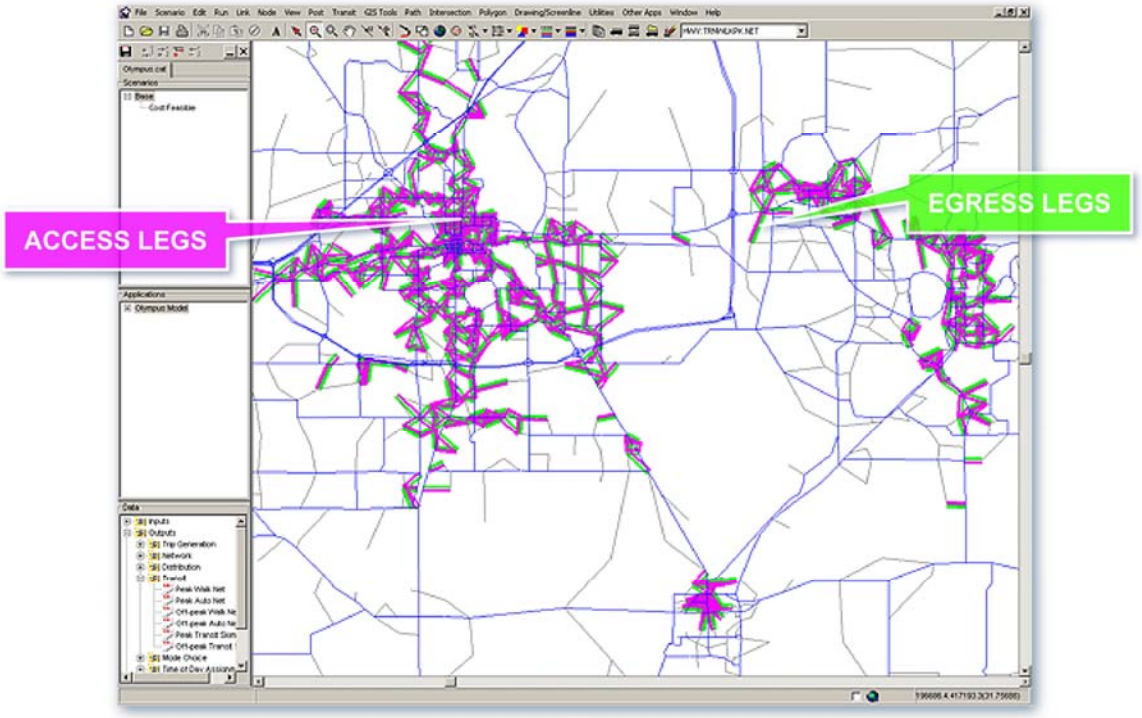
Access Modes

This table lists the name, the long name, and the corresponding mode and mode numbers for up to 20 different types of access modes. The access modes include both existing and other potential modes reserved for future uses. Click Next when you are done reading this table.

No.	NAME	LONGNAME	Mode
1	**WALKCON**	WALK ACCESS CONNECTOR	Walk access/egress (centroid-to-stop & vice-versa)
2	**AUTOCON**	AUTO ACCESS CONNECTOR	Auto access
4	**ALLWALKCON**	ALL WALK CONNECTORS	All walk access
3, 5-10	--	--	Other access connectors (for future uses)
11	**STATCON**	STATION CONNECTORS	Fixed-guideway platform to street connectors
12	**XFERCON**	TRANSFER CONNECTORS	Transfer connectors ("sidewalks")
13-20	--	--	Other non-centroid connectors (for future uses)

Example of Walk Access Links

This figure shows an example of walk access links in the Olympus model. The access legs are shown in purple and the egress legs are shown in green.



Problem with Large Zones for Access

As we have learned earlier, TAZs or zones are used to aggregate model input data. The size of a zone can make a difference in the accuracy of the model output. In general, large zones tend to reduce the forecasting accuracy because they can increase the aggregation errors for a number of model elements. For example, a large zone will tend to include a high level of land use activities that can cause the highway assignment to assign an unrealistic or overburdened amount of trips to the roadways surrounding the zone. In addition, large zones will increase the length of centroid connectors, resulting in over-estimation of zonal accessibility.

Required Highway Network Link Fields

This table shows the required fields for the highway network links for modeling transit. Click Next when you are done reading this table.

Field	Modes	Description
TBSDIST	Bus/mixed-flow	Distance (miles)
TBSTIME	"	Time (minutes)
TBSSPEED	"	Speed (mph)
TFGDIST	Fixed-guideway	Distance (miles)
TFGTIME	"	Time (minutes)
TFGSPEED	"	Speed (mph)
TFGMODE	"	Mode

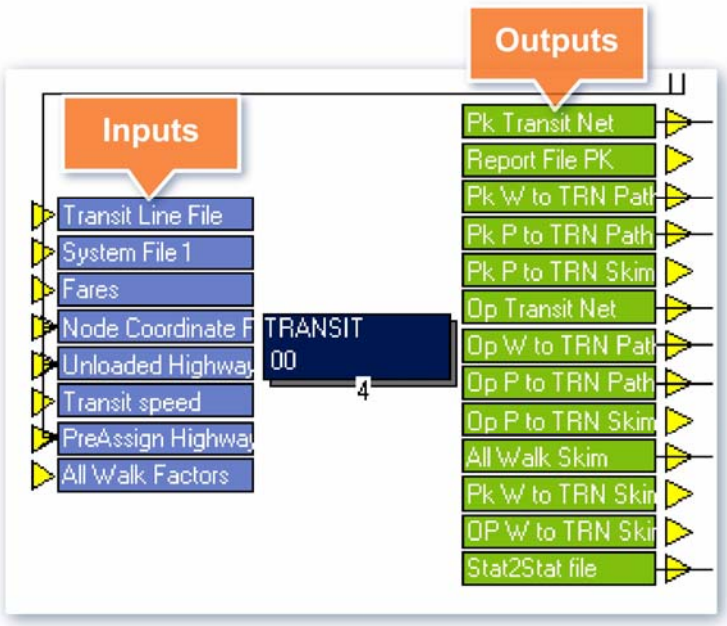
Required Highway Network Node Fields

Similarly, this table shows the mandatory fields for the highway network nodes for modeling transit. Again, click Next when you are done reading this table.

Field	Modes	Description
TSNAME	Station name	--
TSTYPE	Type of access	0 - not used 1 - Line-haul PNR 2 - Circulator and fringe parking
FAREZONE	Fare zone for zone-based fares	Coded on station nodes only
TSRANGE	Maximum roadway distance allowed for auto-access connector	Varies
TSPARK	Number of parking spaces	--
TSCOSTAM	Parking cost in peak period	--
TSCOSTMD	Parking cost in off-peak period	--
TSPNRTERM	PNR terminal time	2.0
TSKNRTERM	KNR terminal time	0.5

Transit Network Model Structure

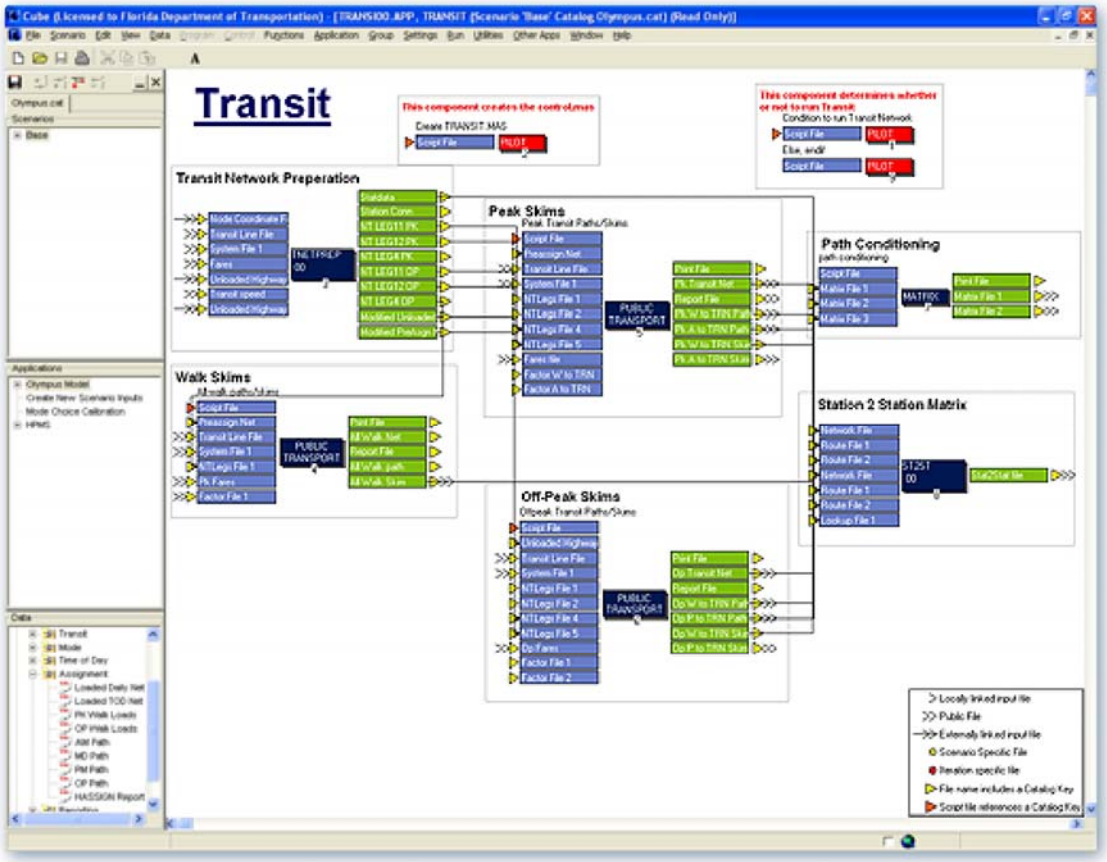
The transit network model is built during the fourth step in the FSUTMS model chain. The model utilizes Cube Voyager's Public Transport, or PT, program. The model first reads the input files to include highway network-related files, transit route files, transit system data, transit factors, and station data. Using this information, the model then outputs the appropriate transit networks. Any of the networks produced by this process can be displayed by opening a file with Cube and clicking the appropriate box on the model flow chart. The network can be edited either by modifying the route line files in a text editor or visually through the Cube interface similar to the highway network. This flow chart shows the input and output files of the Transit Network/Path application for the Olympus model. Clicking the TRANSIT box in the previous flow chart will open this flow chart (see next page). It shows the complete model structure of the Transit Network/Paths application for the Olympus model.



Model Input Files

The specific input files for transit modeling in the PT program include the following. Click Next when you are finished reading the list.

- TROUTE_yya.lin: Route definitions (details in next slide)
- STATDATA_CSV.dat: Stations (created in the model based on station data kept in the nodes of the highway network)
- UNLOADED_ayy.net: Unloaded highway network
- NODES.csv: Node coordinates
- TURN_yya.pen: Turn penalties/prohibitors

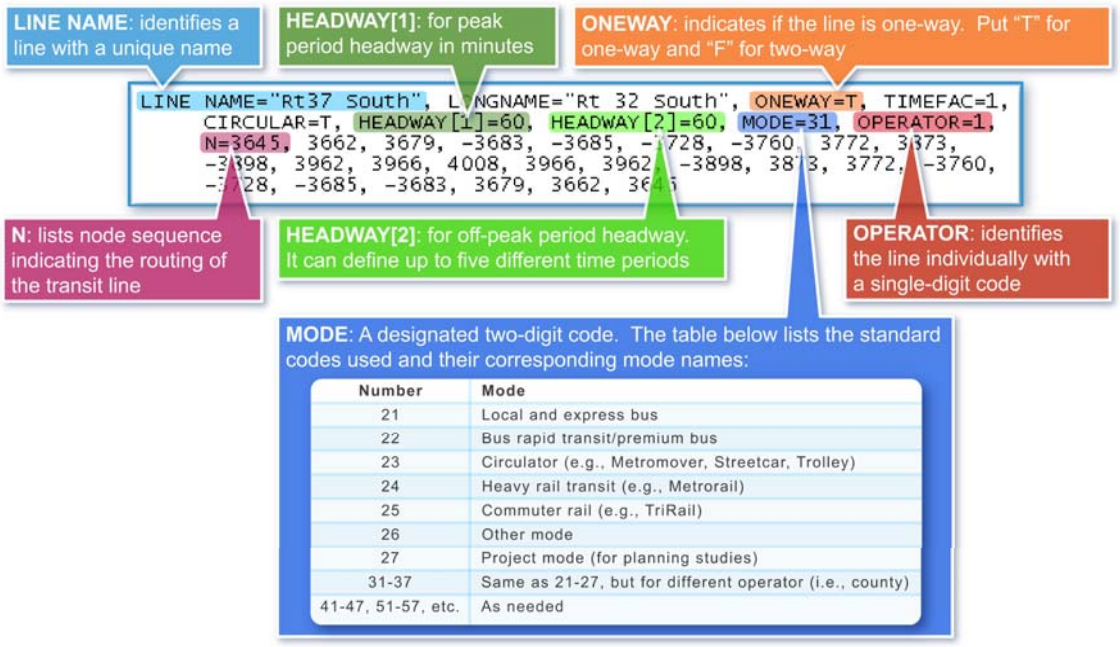


Transit Networks and Time Periods

Transit networks are typically generated for each specific period in the model. These typically include the peak and off-peak periods. Peak period transit networks are typically designated as the "PK" network. This includes both the morning and evening peak periods. Off-peak period transit networks are typically designated as the "OP" network. This includes all time periods not included in the peak periods. Input transit network data no longer require separate peak and off-peak files due to headway parameters.

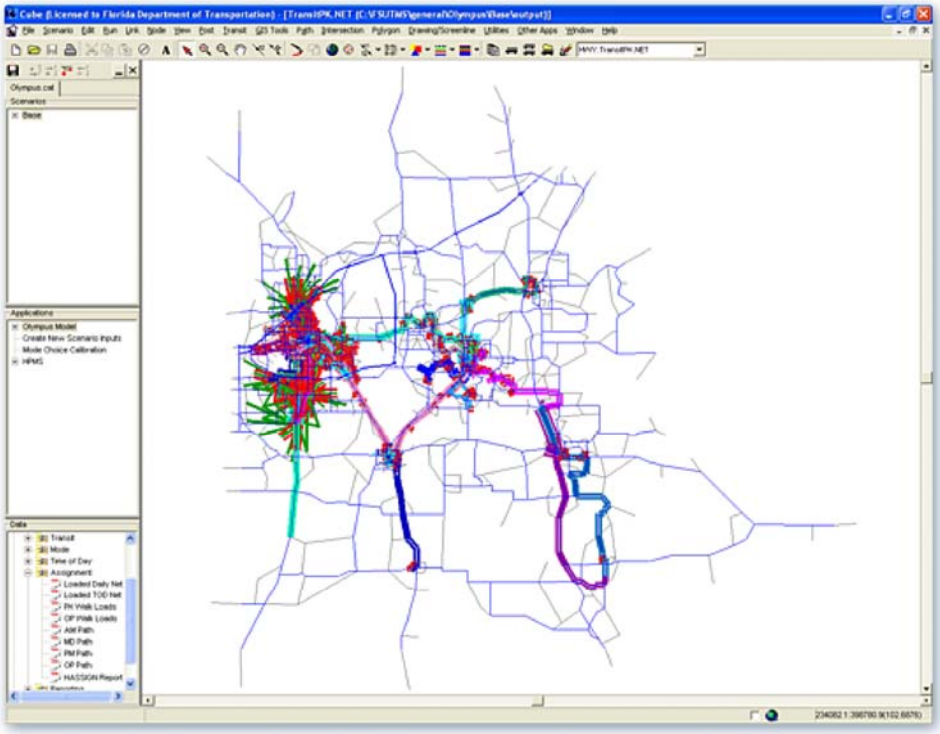
TROUTE _yya.lin

The TROUTE transit line file is used to store all the transit lines that form a transit network. This example shows how a transit line is defined in the file. Specifically, the "LINE NAME" field allows you to identify a line with a unique name. The ONEWAY field indicates if the line is one-way. Put "T" if it is one-way and "F" if it is two-way. HEADWAY[1] in this example is for peak period headway in minutes and HEADWAY[2] for off-peak period headway. You can define up to any five different time periods. The Modes field is a designated two-digit code. The Operator field identifies the line individually with a single-digit code. Finally, the N field lists the node sequence indicating the routing of the transit line. Click Next when you are ready to go to the next slide.



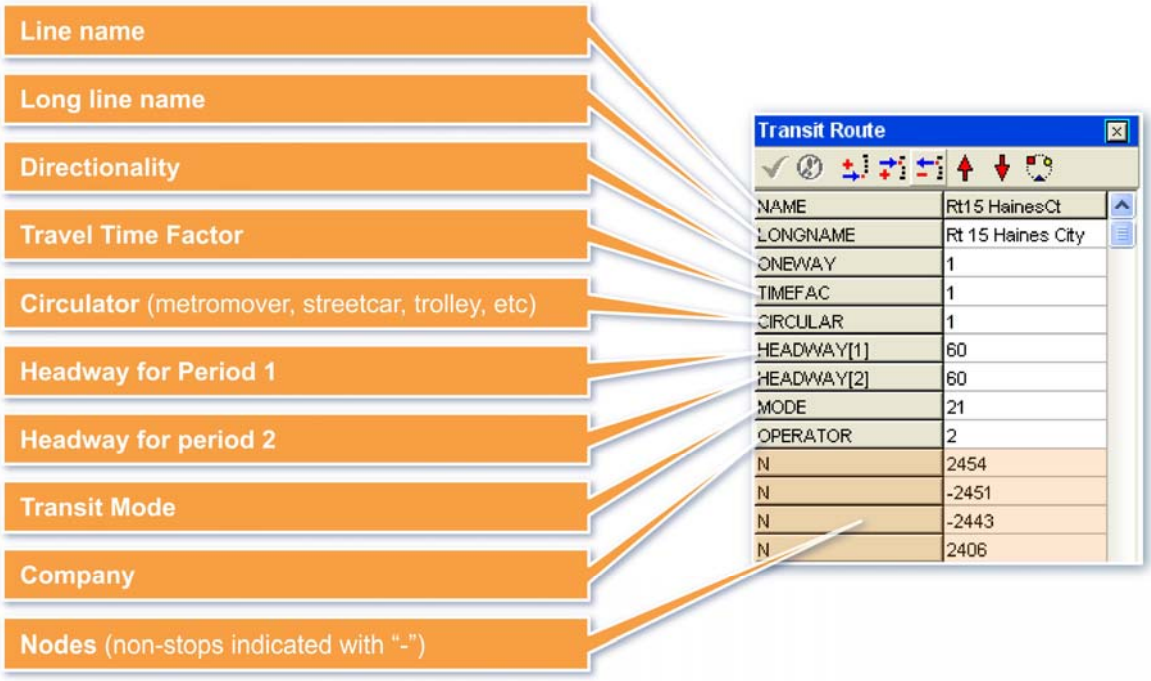
Model Output Files

Transit network model includes two main output files. The first is for the Peak Period Transit Network, called TransitPK.net. The second is for the Off-Peak Period Transit Network, called TransitOP.net. Clicking either of these files in the Data window for transit output will open a network map that looks like this.



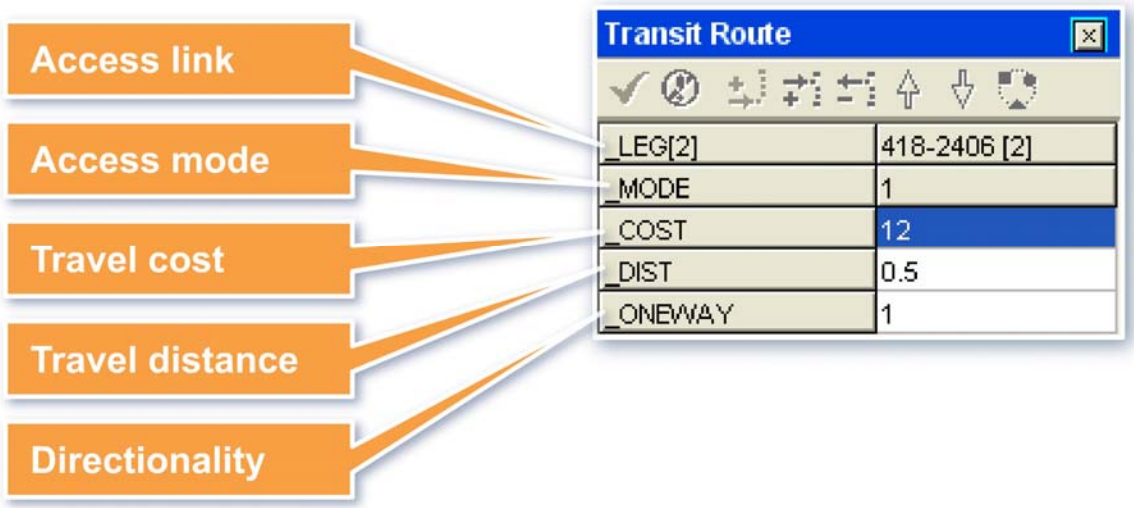
Transit Line Binary Network Fields

This table lists the fields in the transit network binary output file for transit lines. Click Next when you are done reading the fields.



Access Link Binary Network Fields

Similarly, this table lists the fields in the transit network binary output file for access links. When you are done reading the fields, click Next to start on the Exercise portion of this lesson.



Exercises

We will now start to complete two exercises. First, we will code a transit line. Then we will build transit network paths.

To get started, as usual, we first navigate to the Olympus Model. Click on the FSUTMS Launcher Icon, select Statewide and Training Models on the FSUTMS Welcome Screen, then select the FSUTMS/CUBE Olympus Training Model. Cube allows you to code all types of public transit (bus, tramway, heavy rail, etc.). For this exercise, we will code a bus line.

The first step is to create a new scenario that will include the new bus line. In order to do this, we will use the techniques learned earlier in this workshop. Right click Base and create a new scenario that is a child of the Base scenario. We will call it Transit, so type in Transit. We will now change the model year to 05 and the alternative letter to T.

We will create new inputs for the new scenario using the Create New Scenario Inputs application. On top of the screen, select Create New Scenario Inputs from the Application dropdown list. Click Yes to save changes to the Transit scenario. Click Run to run the scenario. Click OK when the run is completed. Click Close and click Yes. Next, we will open the Highway Network. In the Data window, double-click Inputs and then Network, and then "Input Network". This will open and display the transit network.

We will now open the transit network layer. Click the Layer Control tool button on top. This opens the Layer Control dialog box. Double-click on Transit to open the Layer Parameters dialog box for the transit layer. On top of this dialog box, click the Browse button to open the File Open dialog box. Browse to the C:\FSUTMS\general\Olympus\ base\Transit\Input folder. Locate the TROUTE_05T.LIN file. Click on the file to select it and then click Open. This will display the transit network layer. On the Layer Parameters dialog box, click All Done at the bottom.

We will now make the transit network layer active. In order to do this, go to the top and pull down the layer menu and select TRN: TROUTE_05T.LIN. This will make the public transit line layer the active layer. We now have a public transit layer, and it is now on top and ready for editing. We can now start to add a new bus line. On the main menu on top, click Transit. Click Line Manager. The public transit line manager dialog box will open. It shows the files that are available for editing as well as the transit lines that are currently in the file. Now, click New in the Line Options field. A dialog box will open and prompt you for the name of the line. Type in Red Flash. Click OK. We have just created and named a new transit line.

With the Red Flash highlighted, click on the Edit button. This opens the transit route coding dialog box. First click on the Route Edit tool button on the Transit Route dialog box. If you move the cursor over the map, you should now have a cross-hair. We are now ready to trace the line and locate the stops.

But before we do that, we want to zoom in to the area where we will add the transit line. Click on the View Center of Nodes tool button. Enter 2580 and then click OK. Next, set Window

Width to 7060. Click OK. The view is now zoomed to the intersection. Now we are ready to add a new bus line. Select the Post menu and then select All Nodes. This should post the node numbers on to the screen. Click OK. Now move the cross-hair cursor and click on node 2608. The node will flash. Click on node 2538. The route of the line is found via the minimum path. You now have coded a transit line starting at node 2608, traveling to node 2538, with stops located at these two nodes. Continue coding the line by clicking on node 2531. Hit the Escape key on your keyboard. This takes you out of the line coding mode. Now, click on the Green Check on the line coding dialog box. This will accept what you have just coded.

We will now specify the mode for this new line. Pull down on the Transit Route dialog box to make it longer. You can see the nodes that make up the line. A negative sign indicates that the node it is not a transit stop and no boardings or alightings will be allowed at this node. Type in "21" next to Mode to indicate that it is a local bus line.

There are still a few things we need to specify for the new line. Next we will specify the headway and the color for the line. Click on the Insert Row tool button. This opens a dialog box with a list of variables that may be added to the line. Now scroll and click on Headway [1]. Click OK. Headway for modeling period 1 will be added to the line. Next, click on Color and Click OK. Color is also added to the line. Click on Cancel to close the dialog box. In the Color box, type in 3. In the Headway [1] box, type in 10. Click on the Green Check Mark and close the dialog box. The line is now shown in red. Select the Transit Line Manager tool button and then select Save All to save edits. Click Exit.

Now we would like to show the stops. Select Transit on the Main Menu. Click on Show Stop/Non-Stop Nodes and then click the two check boxes and accept the default colors and sizes. Click OK. The transit line now shows where it runs, where it stops, and where it does not stop.

What if we want to delete a line? For example, if we will now delete the 'Red Flash' transit line we just created. Click on the Transit Line Manager tool button to open the dialog box. Make sure the 'Red Flash' line is highlighted. Click on the Delete button, select OK, and click on the Exit button. The 'Red Flash' transit line has now been deleted.

We have now completed the first of two exercises for this lesson. To close out the network, click the X button on the inside window to close the network. When prompted whether or not to save transit line file changes, select No. When prompted whether or not to save the project file, also select No. You are now returned to the Transit Network/Paths detailed flow chart.

In the second exercise, we will build the transit network paths for the model by simply executing the Transit Network/Paths model. In order to do this, we first open the Base scenario manager. Click the box next to Transit Network under Please Select Model Steps. Make sure all other steps are unchecked. Click Run in order to run the transit network. Once the run has completed, the Task Run Result window will be displayed. Click OK. The transit paths are now built and can be used for trip assignment purposes.

Summary

In Part I of this lesson, we have covered the following topics:

- Overview of transit networks, transit stops, and transit stations
- Transit network coding
- Transit headway
- Transit network input and data sources
- Non-transit modes and access links
- Percent walks
- Transit network model structure
- Transit network model input and output files
- Required fields in highway network for transit

We have also completed an exercise to create a transit line and build transit network paths. Please click the link for Part II of this lesson to learn more about the transit path building process of Cube Voyager.

LESSON 7, PART II: TRANSIT PATHS

Lesson Goals

Welcome to Part II of Lesson 7. In this lesson, we will first have an overview of the transit network paths. We will then talk about the data requirements, the generalized cost process, followed by the PT best path method, and finally the model input and output files.

Overview

The transit network path-building model uses the transit network information to calculate matrices of travel times, costs, and distances between each pair of traffic analysis zones in the network. These time, cost, and distance matrices, generally referred to as "skims", are accumulated over the best path between each origin and destination pair based on link lengths and travel speeds as indicated in the transit network database. Note that Cube Voyager is also capable of performing multi-path path building. However, this methodology is not endorsed in Florida due to concerns with meeting FTA criteria for transit modeling. For more information on multi-path, you may consult the software documentation that comes with Cube Voyager.

Data Requirements

Transit networks are created as part of the Transit Network Model process described in Part I of this Lesson. Other required data, including fares and average transit operating speeds, can be obtained from local transit agencies. In addition, auto/transit speed delay studies provide the basis for determining bus speeds based on automobile speeds in the model. For example, Jacksonville conducted such a study in 2005.

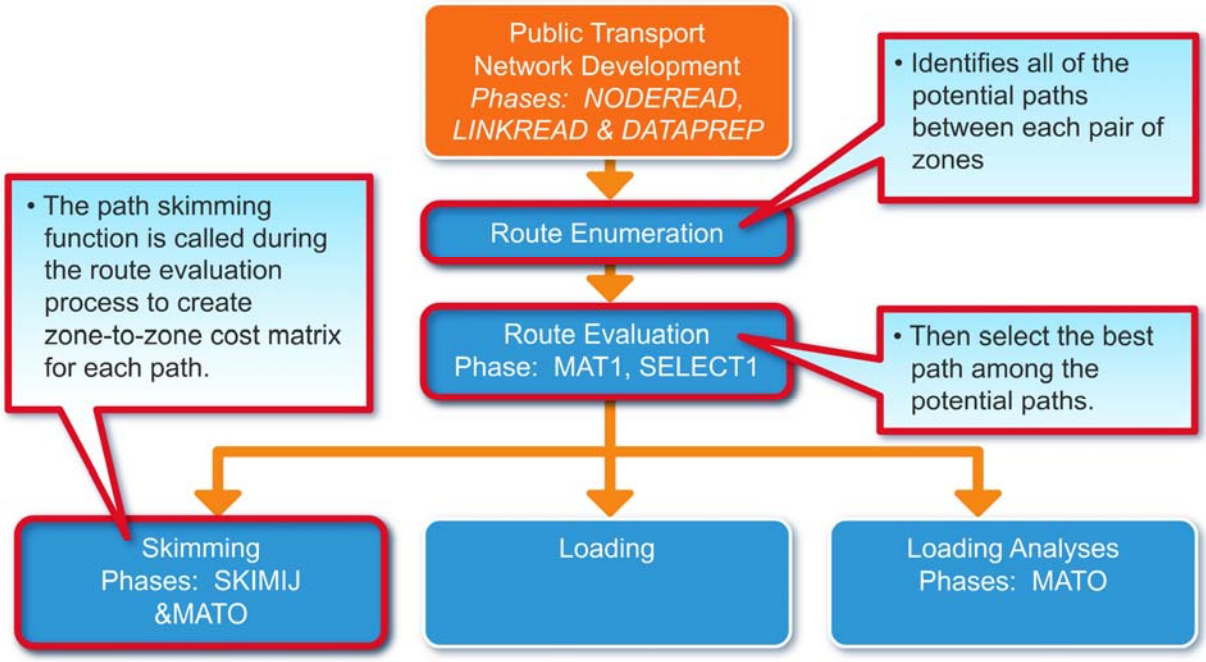
Model Structure and Procedures

The transit paths model is built during the fourth step in the FSUTMS model chain. The transit paths model uses Cube Voyager's PT and Matrix programs. The model first reads the input transit network and then enumerates, evaluates, and skims the routes. Finally, it outputs the appropriate skim matrices that are needed for transit assignment.

PT Processes and Functions

This flow chart shows the processes or functions of the PT program. The program employs a multi-routing process. The process first identifies all of the potential paths between each pair of zones and the select the best path among the potential paths. The path skimming function is called during the route evaluation process to create zone-to-zone cost matrix for each path.

The cost associated with each path is calculated through a generalized cost process that considers three cost components. This process will be discussed next. Note that the Loading and Loading Analyses functions will be discussed in Lesson 9 when we will talk about transit assignment. Click Next when you are ready to go to the next slide.



Generalized Cost Process

Generalized cost measures the main components of transit trips. There are three broad components of transit trips. The first is the time component. This includes the walk or non-transit time, wait time, and in-vehicle time. The second is the inconvenience component, which considers boardings and transfers. The third is the cost component, which considers fare. Generalized cost is measured in time in the PT program and is usually a linear function of these three components. Variables from the three components are weighted by coefficients, which incorporate the significance of time, inconvenience, and cost in the passengers' perception and convert the components to a common unit. We will discuss each of the three components next.

Time Components

As mentioned, three time components are considered by the PT program in the generalized cost process. The first is the walk time. Walking can occur at different parts of the PT journey.

- It can occur at the beginning and end of a journey (between stop node and zone centroid)
- It can also occurs when transferring services between two stop nodes
- Or it can occurs when not using any transit mode (between origin and destination zones)

The second time component is the wait time, which is derived using the combined headway of services available at the boarding point and calculated from user-supplied wait curves. This figure shows the default curve for the wait time. It describes the relationship between waiting time and transit headways. As you can see, the waiting time tends to increase with transit headway. You may overwrite this default curve with local data.

The third and last time component is the in-vehicle time. In-vehicle time represents the time spent in the transit vehicle for each transit leg. If the journey consists of more than one leg, the in-vehicle time represents the total of the transit legs. As we have defined earlier in Part I of this lesson, a leg is a segment of a transit journey along a route from one stop to the next or from stop to centroid.

Inconvenience Component

Two kinds of penalties are considered in the generalized cost.

The first is Boarding Penalty. This is the fixed penalty that is applied at each boarding. A boarding represents the start of a journey or an interchange. The default assumes no penalty. The second is Transfer Penalty. This represents the inconvenience of transferring between modes and is applied at transfer locations. Transfer penalties can be applied between the same mode or between different mode combinations.

Cost Component

The cost component considers only fares. Fares are used in three occasions in the PT modeling process. First, fares are considered in the selection of routes. Second, they are used skimming of each zone pair, and, third, they are used in the calculation and reporting of revenue

Best Path Process

The "best path" option was added to PT in response to concerns expressed by FTA for New Starts. PT finds the best path between each pair of zone in three steps: network simplification, route enumeration, and route evaluation. The purpose of network simplification is to minimize memory and storage requirements. In this step, the transit network is simplified to a set of intermediate data structures that includes transit legs, transit leg bundles, non-transit legs, line-

zone legs, and line-line legs. In bundling transit legs, those with the same boarding and alighting points are bundled together. The purpose of route enumeration is to identify all the potentially attractive routes and enumerates them.

The principles underlying this process include:

- Principle 1: The journey to move progressively from the origin to the destination.
- Principle 2: Travelers tend to select journeys that are simpler (that are direct or involve few transfers).
- Principle 3: Travelers are unwilling to walk very long distances.

Finally, the purpose of route evaluation is to determine which of the enumerated routes is the best path is. Passenger trips will be assigned to this best path in the assignment step. During the route evaluation step, the path skimming function is called to create a zone-to-zone matrix for each transit path. In selecting the best paths from the skim matrices, the following decision points are evaluated:

- Walk choices
- Transit choices
- Alternative alighting choices
- Transfer opportunities.

Model Parameters

The model parameters used in the PT program for the transit paths step include:

- Walk to local bus factors
- Walk to premium transit factors
- Fares
- Speed curves

Model Input and Output Files

For model input, in addition to the three files shown in the previous slides for four set of model parameters, the input file needed for transit path building is the transit line file, TROUTE_yya.lin. In terms of output files, they are generated in both of the route enumeration and skimming path-building steps. During the route enumeration step, the following output files are generated for the enumerated routes:

- TPATHPK1_AYY.rte: Peak walk-to-transit paths
- TPATHOP1_AYY.rte: Off-peak walk-to-transit paths
- AllWalk_AYY.rte: All-walk paths
- TPATHPK2_AYY.rte: Peak auto-to-transit paths
- TPATHOP2_AYY.rte: Off-peak auto-to-transit paths

During path skimming, the process generates the following matrix files

- TSKIMPK1_TEM.mat: Peak walk-to-transit skim
- TSKIMPK2_ayy.mat: Peak auto-to-transit skim
- TSKIMOP1_TEM.mat: Off-peak walk-to-transit skim
- TSKIMOP2_ayy.mat: Off-peak auto-to-transit skim

Off-Peak Period Walk-to-Transit Matrix

Below is a complete list of the variables in the walk-to-transit matrix. Click Next when you are done reading this list.

- Walktime: Walk Time
- AutoTime: Auto Time
- SidewalkTime: Sidewalk Time
- BUSTIME: Bus Time
- PBUSTIME: Premium Bus Time
- CIRCTIME: Circulator Time
- RAILTIME: Rail Time
- COMRLTIME: Commuter Rail Time
- OTHTIME: Other Transit Mode Time
- PRJTIME: Project Time
- XFER: Transfer
- IWAIT: Initial Wait Time
- XWAIT: Transfer Wait Time
- FARE: Cost
- TOTTIME: Total Time Between Zones

Summary

This concludes Part II of Lesson 7. In this part of Lesson 7, we covered:

- Overview of the transit network paths
- Data requirements
- Generalized cost process
- PT best path method
- Model input and output files

The next lesson is mode choice.

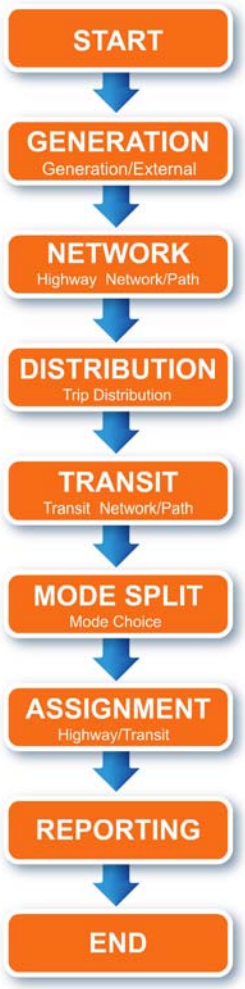
LESSON 8: MODE CHOICE

Lesson Goals

Welcome to Lesson 8. The focus of this lesson is on the FSUTMS mode choice module. We will first go through an overview of the mode choice models in FSUTMS. We will then learn about the FSUTMS model constants and coefficients, the input and output files, the auto occupancy model, the logit models, and finally, the desired result reporting for this FSUTMS module.

Overview

Mode choice is the fifth step in the FSUTMS model chain. The main purpose of mode choice models is to determine how many travelers will choose to use a particular mode of travel. In FSUTMS, this choice is a function of the characteristics of the travel modes, which include the travel times and travel costs associated with each mode.



The standard FSUTMS mode choice models include the highway-only models and the nested logit models. The highway-only mode choice models, also referred to as the non-transit mode choice models, simply converts auto person-trips to auto vehicle-trips by applying vehicle occupancy factors. The highway-only mode choice models are still applied in small-to-medium sized urban areas in Florida, where significant transit service expansion is not anticipated.

For other urban areas that model one or more transit modes, nested logit is now the standard model that is used to determine the split among the available highway and transit modes of travel. The majority of the FSUTMS models use one of the two standard models, with the Northeast Florida Regional Planning Model (NERPM) being the exception, which uses the XCHOICE model of Cube-Voyager.

When building the auto and transit vehicle trip tables, the mode choice module performs the following tasks:

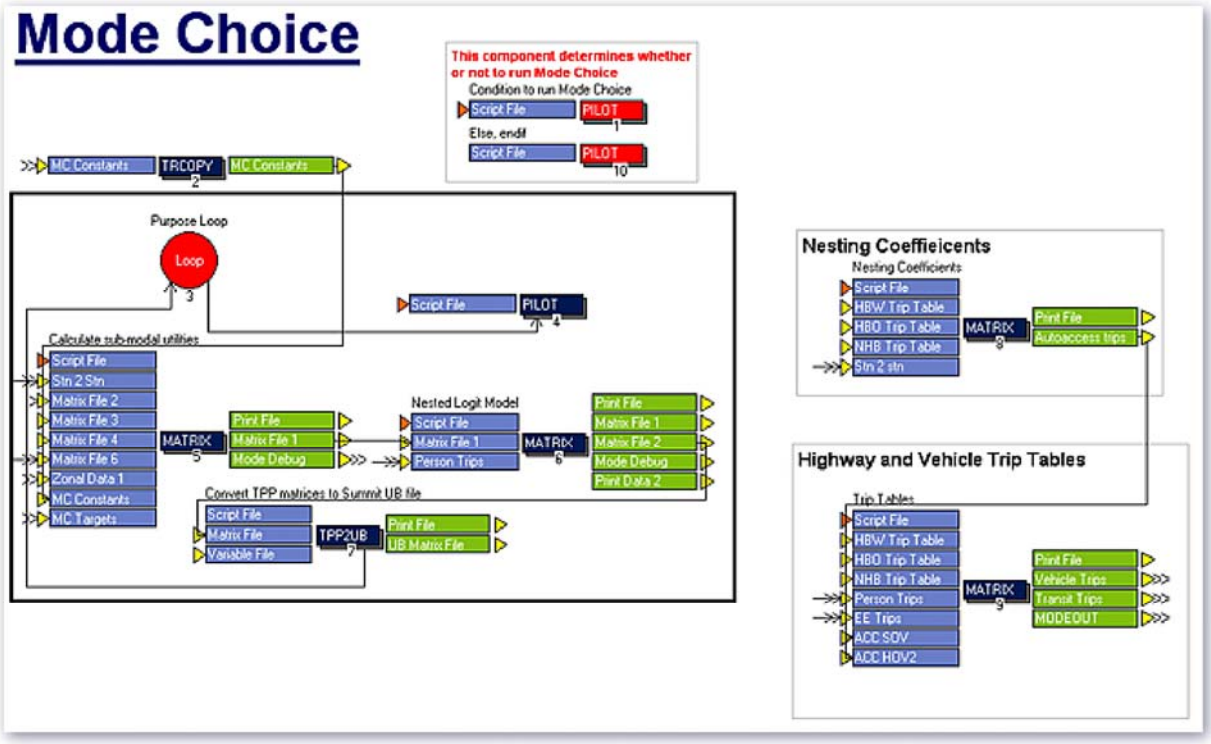
- It first performs a set of trip table manipulations.
- If the nested logit model is used, it allocates trips among the different highway and transit modes.
- Next, it applies the vehicle occupancy rates to convert from person trips to vehicle trips for the highway mode.
- It then factors and balances the highway trip tables.
- Finally, it combines all trip tables into one table.

The final step above is done for both non-transit and transit models:

- For non-transit models, it takes the typically seven-purpose person-trip table output from the trip distribution module and converts it into a single-purpose vehicle-trip table.

- For transit models, multi-purpose vehicle-trip tables are produced. These tables subdivide auto trips by vehicle occupancy category and transit trips by the type of transit service.

The figure below shows the mode choice flow chart for the Olympus model:



Model Parameters

The parameters for the mode choice models consist of coefficients and constants. These parameters are used in transit models only. They can be edited within the Scenario Manager when running the model. The constants are stored in an input file called MC_CONSTANTS.CSV and the coefficients are stored in another input file called MC_COEFFICIENTS.CSV. The constants for an alternative capture the average effect on utility of all factors that are not included in the model. The utility function represents how much value is associated with choosing a mode alternative. The coefficients for mode choice represent a contribution from an independent variable, which can be the number of workers or the availability of vehicles, to the utility function. Constants and coefficients can be developed from survey and census data; however, they are frequently borrowed from other comparable models. Because constants and coefficients can significantly change the number of transit trips, they should only be adjusted during the calibration and validation of a model.

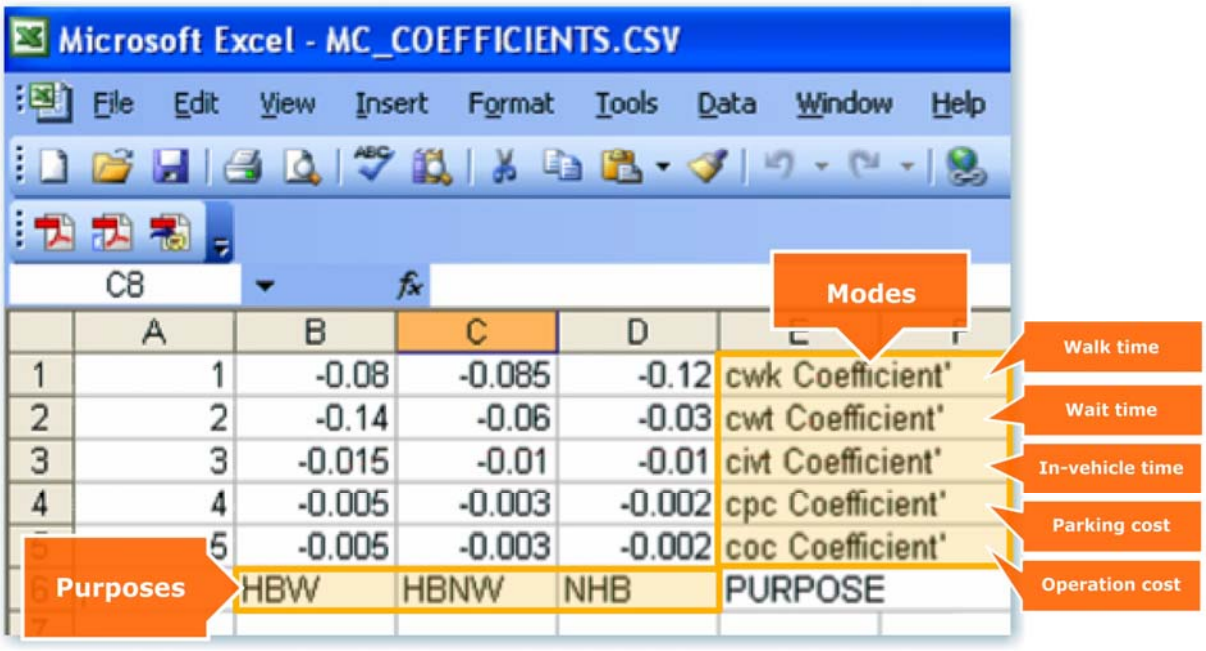
Mode Choice Input Files

The following is a list of the mode-choice input files for the Olympus model. Click Next when you are done reading the list.

- PSNTRIPS_ayy.mat : Person Trips
- FREESKIM_ayy.mat : Free-Flow Highway Skims
- CONGSKIM_ayy.mat : Restrained Highway Skims
- TSKIMOP_ayy.mat : Off-Peak Transit Skims
- TSKIMPK_ayy.mat : Peak Transit Skims
- ZONEDATA_yya.dbf : Parking Cost
- MC_COEFFICIENTS.CSV : Mode Choice Coefficients
- MC_TARGETS.CSV : Mode Choice Targets
- MC_CONSTANTS.CSV : Mode Choice Constants
- EETABLE_ayy.mat : External Trip Table

Mode Choice Model Coefficients

We mentioned earlier that the coefficients for the mode choice models are stored in a file called MC_COEFFICIENTS.CSV. The figure below shows a sample set of mode choice coefficients for the nested logit models. You can see that the coefficients are given for five modes and three trip purposes.

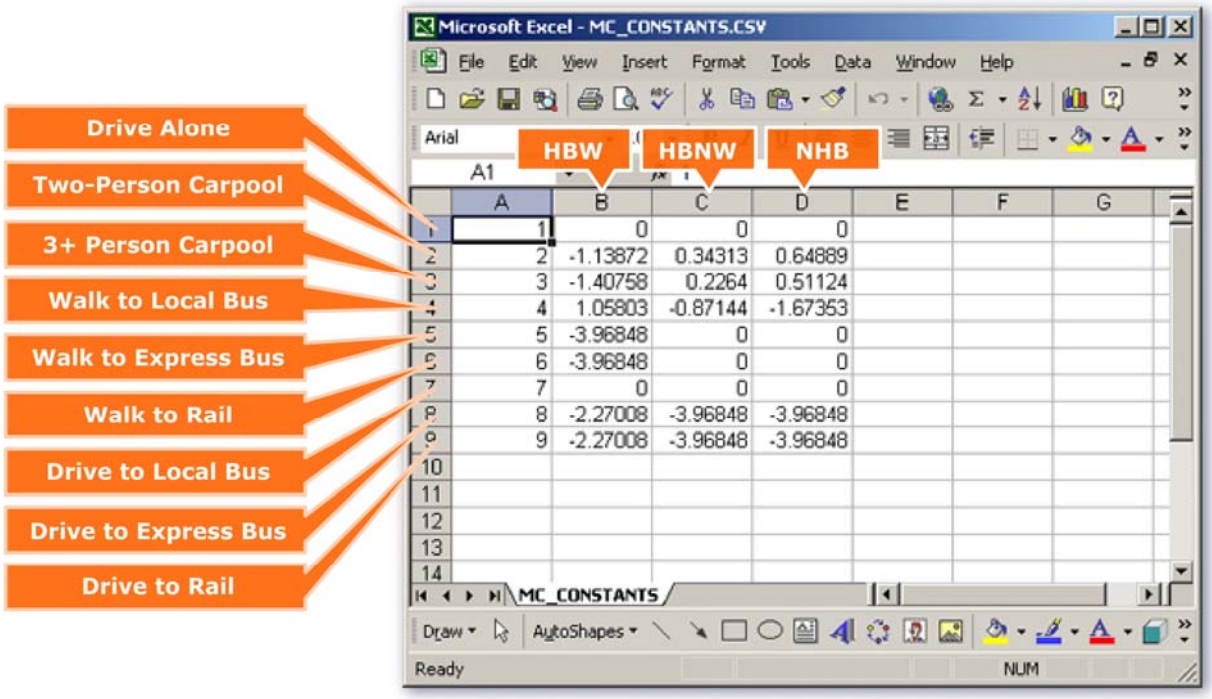


Mode Choice Model Constants

Earlier we also mentioned that the constants for the mode choice models are stored in a file called MC_CONSTANTS.CSV. There are nine modes in the Olympus model. Some urban models may contain up to the following 12 standard modes:

1. Drive Alone
2. Two-Person Carpool
3. 3+ Person Carpool
4. Local Bus
5. Line-Haul, Walk/Local Access – Metrorail
6. Line-Haul, Walk/Local Access – Express Bus
7. Line-Haul, Park&Ride, Metrorail, Drive Alone
8. Line-Haul, Park&Ride, Metrorail, Shared Ride
9. Line-Haul, Park&Ride, Express Bus, Drive Alone
10. Line-Haul, Park&Ride, Express Bus, Shared Ride
11. Line-Haul, Kiss&Ride, Metrorail
12. Line-Haul, Kiss&Ride, Express Bus

Below you can see a sample set of mode choice constants that are stratified by mode and trip purpose:

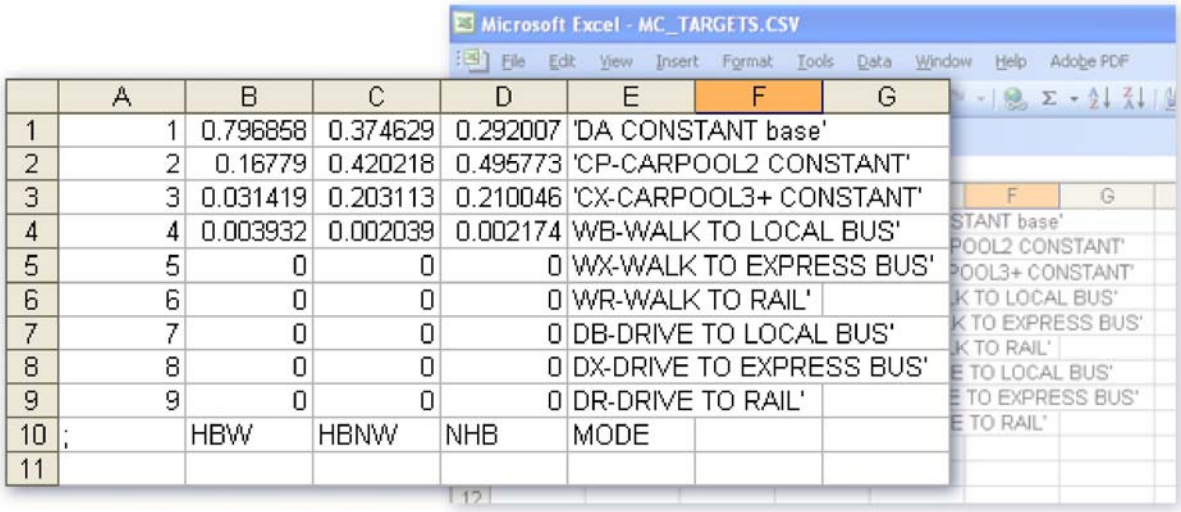


	A	B	C	D
1	1	0	0	0
2	2	-1.13872	0.34313	0.64889
3	3	-1.40758	0.2264	0.51124
4	4	1.05803	-0.87144	-1.67353
5	5	-3.96848	0	0
6	6	-3.96848	0	0
7	7	0	0	0
8	8	-2.27008	-3.96848	-3.96848
9	9	-2.27008	-3.96848	-3.96848

Mode Choice Model Bias Constant Targets

There is another set of constants called the bias constant targets. These constants are stored in a file called MC_TARGETS.CSV. The constant targets represent the target shares for the

different modes. Mode choice constants are often adjusted during the mode choice calibration and validation process to simulate reasonable mode share targets. Below is a sample set of constant targets that are stratified by mode and trip purpose. Notice that the constant targets for each trip purpose sum up to one.



	A	B	C	D	E	F	G
1	1	0.796858	0.374629	0.292007	'DA CONSTANT base'		
2	2	0.16779	0.420218	0.495773	'CP-CARPOOL2 CONSTANT'		
3	3	0.031419	0.203113	0.210046	'CX-CARPOOL3+ CONSTANT'		
4	4	0.003932	0.002039	0.002174	WB-WALK TO LOCAL BUS'		
5	5	0	0	0	WX-WALK TO EXPRESS BUS'		
6	6	0	0	0	WR-WALK TO RAIL'		
7	7	0	0	0	DB-DRIVE TO LOCAL BUS'		
8	8	0	0	0	DX-DRIVE TO EXPRESS BUS'		
9	9	0	0	0	DR-DRIVE TO RAIL'		
10	;	HBW	HBNW	NHB	MODE		
11							

Mode Choice Output Files

The output files generated by the mode choice model include:

- A print file called FINALTABLES.PRN;
- A vehicle trips matrix file in this file naming format: HWYTRIPS_ayy.MAT; and
- A transit trips matrix file in this file naming format: TRNTRIPS_ayy.MAT.

Types of Mode Choice Models

As mentioned earlier, FSUTMS has used two categories of mode choice models, i.e., non-transit and transit. Again, non-transit models are what we refer to as the highway-only mode choice models. They are used in urban areas where there is not a transit system or significant transit service expansion is not anticipated. This type of models applies an occupancy model to convert person trips to vehicle trips by applying a set of auto occupancy factors. Transit mode choice models, on the other hand, include multinomial and nested logit models. They are used when the models consider major transit capacity options such as fixed-guideways or Bus Rapid Transit (BRT). Multinomial logit models split trips among a variety of auto and transit modes. Both nested logit and multinomial logit models split trips among different auto and transit modes. However, only nested logit models use the mode and submode structure.

Auto Occupancy Factors

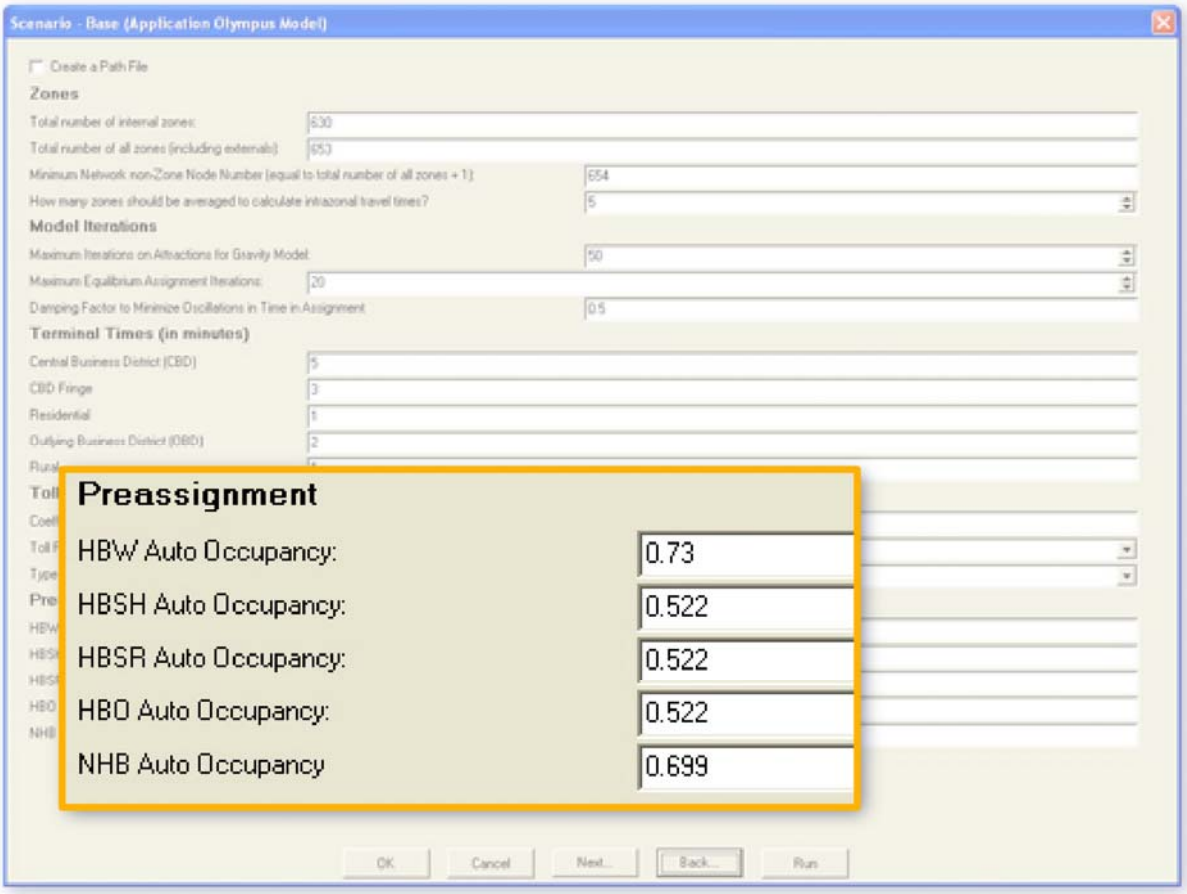
Auto occupancy factors, or AOFAC, are used in FSUTMS to convert person trips to vehicle trips. An occupancy factor is defined as the inverse of the corresponding auto occupancy rate (AOR), as follows:

$$AOFAC = \frac{1}{AOR}$$

An auto occupancy rate, or AOR, counts the average number of people in a vehicle, i.e., the total number of persons divided by the total numbers of total vehicles involved.

Entering Auto Occupancy Factors in Cube Voyager

Auto occupancy factors can generally be designated in the Scenario Manager Catalog Keys for Cube models.



Sources for Occupancy Data

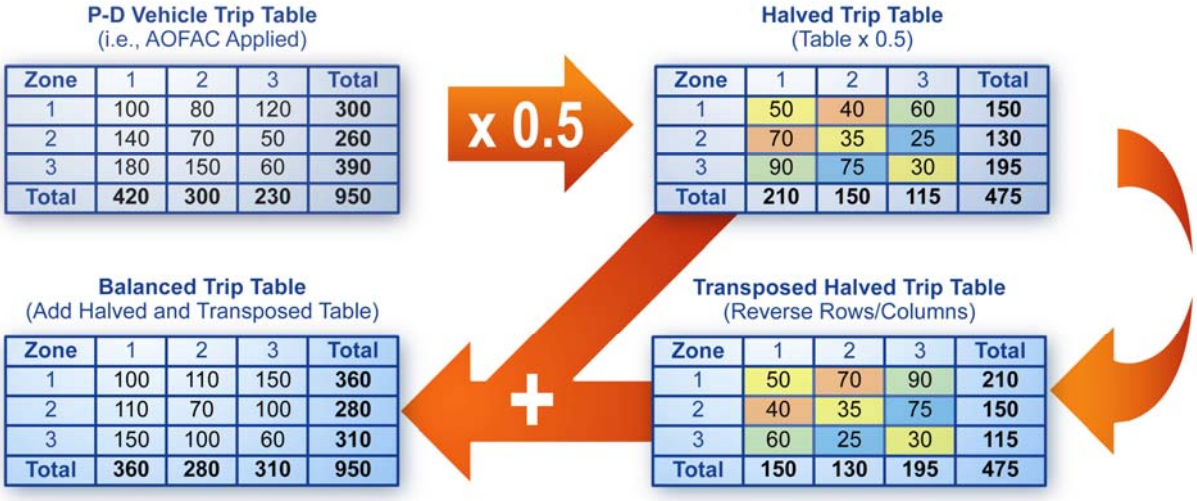
The most accurate data set for vehicle occupancy would include separate occupancy rates for each trip purpose using data from a recently conducted origin/destination survey. In low growth urban areas, it is acceptable to borrow these rates from other studies or to consolidate multiple rates of similar trip purposes. Other potential sources of occupancy data include the National Household Travel Survey, or NHTS, and the NCHRP 365 Report.

Conversion of Production-Attraction Trips to Origin-Destination Trips

After person trips are converted to vehicle trips, they must further be converted from trips that are expressed in productions and attractions to trips in origins and destinations. This conversion can be accomplished in the following steps:

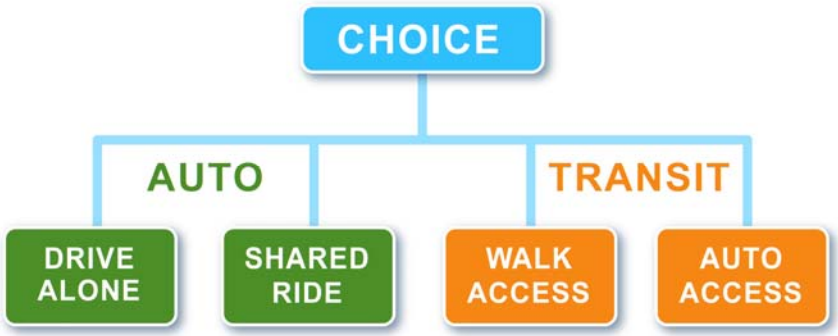
1. All trips in the vehicle trip table are halved to create a temporary trip table
2. Temporary trip table is transposed
3. Temporary and transposed tables are added together

The example below illustrates how to apply these steps. First, production-attraction trip table that has been multiplied by the auto occupancy factor is halved by multiplying the table with a factor of 0.5. A third table is then created by transposing the halved table. The halved and transposed tables are then added together to get the final balanced origin-destination trip table.



Multinomial Logit Mode Choice Models

Multinomial logit mode choice models allocate trips among a mixture of competing auto and transit modes. The figure below shows a sample structure of a multinomial mode choice model.



The equation below shows a simplified representation of the multinomial logit formula for determining mode shares:

$$Ms_t = A + \frac{1 - A - B}{1 + e^{C(\Delta u + D)}}$$

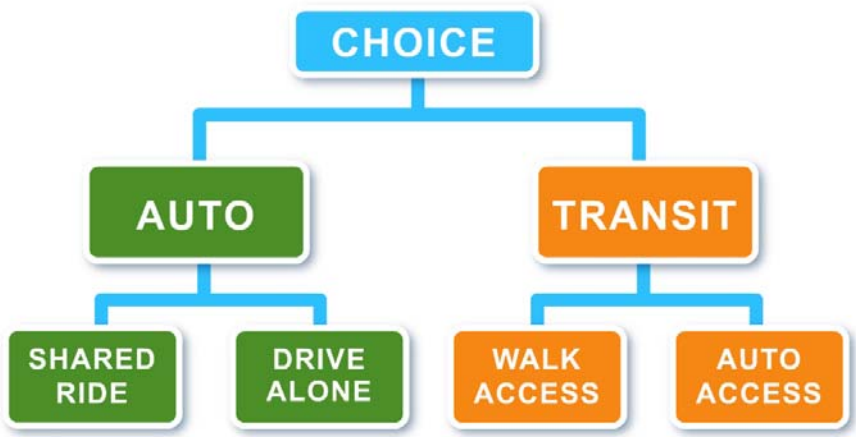
In this equation:

- Ms_t is the mode split to transit mode,
- A is the transit captives fraction,
- B is the highway captives fraction,
- C is the slope parameter which determines elasticity of the LOGIT curve,
- D is the point of symmetry of the LOGIT curve, and
- Δu is the difference between transit and auto impedance, also referred to as the disutility term.

Calibration of this mode choice model would involve determining the values for the terms A, B, C, and D. The FDOT has phased out the multinomial models because the outcomes from these models may violate the "Independence of Irrelevant Alternatives" property, or IIA. The IIA property assures that if mode A is preferred to mode B, then introducing a third mode X, will not make mode B preferred to mode A. In other words, whether mode A or mode B is better should not be changed by the availability of mode X, which is irrelevant to the choice between A and B.

Nested Logit Mode Choice Models

Nested logit mode choice models represent the current state-of-the-art in mode choice modeling. They overcome the IIA problem associated with the multinomial logit models. Nested logit models first allocate trips to primary modes (transit, auto), and then allocate these primary mode shares to submodes. Auto submodes may include ride sharing and driving alone, while transit submodes may include walking and auto access to transit. This type of model provides a more realistic modeling of the relationship among the possible modes as compared to multinomial logit models.



Desired Reporting for Mode Choice Models

For mode choice models, the desired reporting includes the following:

- Formatted listing of all model coefficients and constants
- Diagram of the nesting structure
- Number and percent of trips divided by mode, sub-mode, and purpose
- Mode share for major activity centers
- Estimated auto occupancy by purpose

Exercises

In this exercise you will first run the mode choice model and then retrieve the transit ridership by mode share. To run the Mode Choice Model, we first navigate to the Olympus Model by first clicking on the FSUTMS Launcher icon, then selecting Statewide and Training Models on the FSUTMS Welcome Screen, and finally selecting the FSUTMS/CUBE Olympus Training Model.

To execute the Mode Choice Model, we first open the Scenario Manager for Base. We then click the box next to Mode Choice under Please Select Model Steps. Make sure all other steps are unchecked. Now, click Run to run the mode choice model. Once the run has completed, the Task Run Result window will be displayed. Click OK to return to the scenario manager for Base. Then click Ok to return to the parent flowchart.

We can now try to retrieve the transit ridership by mode share. To do this, first double-click on the Mode Out file under Outputs/Mode Choice in the Data window. Now, this will open the Mode Summary file that lists the different mode shares for the three trip purposes: Home-Based Work, Home-Based Other, and Non-Home Based.

You can now try to answer the following questions:

- How many Drive-Alone trips are there for HBW? 244,534
- How many Carpool 3+ trips are there for HBO? 173,334
- How many Walk-to-Transit trips are there for NHB? 1,018

To close out the Mode Summary file, simply click on the "x" close button in the inside top right hand corner. To close FSUTMS completely, click on the X close button in the outside top right hand corner.

Summary

This is the end of Lesson 8. In this lesson we first went through an overview of mode choice models. We then learned about the model constants and coefficients as well as the model input and output files. We also learned about how production and attraction trips are converted to origin and destination trips. We then learned about the different types of mode choice models, which include the highway-only models, the multinomial logit models, and the nested logit models. Finally, we learned about desired types of reports for mode choice module.

LESSON 9, PART I: HIGHWAY ASSIGNMENT

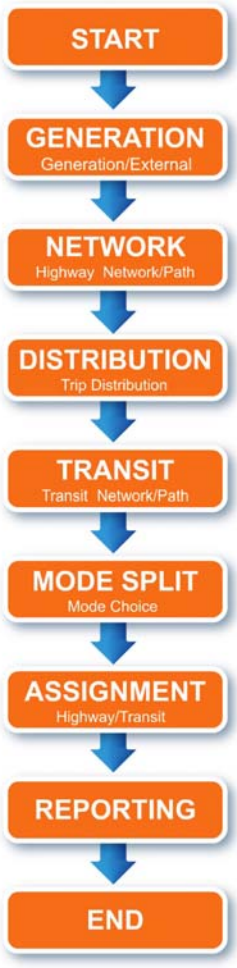
Lesson Goals

Welcome to Part I of Lesson 9 on Highway Assignment. This lesson includes:

- Overview on trip assignment and its applications
- Equilibrium assignment method
- Highway assignment model parameters
- Model input and output files
- Time-of-day assignment
- Calculation of Model Output Conversion Factors (MOCF)
- Reporting and display of highway assignment results

Overview

Assignment is the sixth step in the model chain. Trip assignment is the process that assigns trips to available paths or routes in a network according to an assignment model. The highway assignment model, HASSIGN, assigns vehicle trips to highway routes between each pair of zones, while another model, TASSIGN, assigns person trips to transit routes. The results from trip assignment include the number of daily trips on each link in the network. They may also include the number of trips per period on each link in the network if the Time-of-Day (TOD) assignment is performed. In Part I of this lesson we will cover highway assignment. Transit assignment will be covered in Part II of this lesson.



Trip Assignment Applications

Some of the common applications of trip assignment include:

- Comparing traffic counts with model estimates for model validation.
- Developing and testing alternative transportation systems or projects.
- Establishing short-range priorities for implementing transportation facilities.
- Analyzing alternative locations for facilities.
- Providing the necessary input and feedback for other planning tools.
- Providing design volumes for facility sizing.

Equilibrium Assignment

The trip assignment procedure used in HASSIGN is based on the equilibrium assignment method. By definition, equilibrium occurs when no trips can take an alternate path without increasing the total travel time of all trips on the network. The implementation of the equilibrium assignment method involves running several iterations of the "All-or-Nothing Capacity Restraint"

assignment with an adjustment for travel time in each iteration. In each iteration, the procedure assigns all selected interzonal highway trips to minimum-impedance paths on the highway network.

After the first iteration, the assigned trips are combined with those of the previous iterations using a weight between 0 and 1.

The iteration process continues until it reaches a user-specified closure value, or until the maximum number of specified iterations is achieved. It is through this equilibrium assignment process that trips are assigned to multiple paths between each pair of zones.

BPR Volume-Delay Function

The adjustments to travel time during the equilibrium iterative process are based on the combined link volume to reflect delays associated with each iteration. The effect of roadway capacity on travel times is specified by a volume-delay function, which is used to express the amount of time needed to travel on a roadway link as a function of travel volume. The volume-delay functional relationship used in FSUTMS is based on the Bureau of Public Roads (BPR) formula, expressed as follows:

$$T = T_0 \times \left[1 + \text{BPRLOS} \times \left(v / c \right)^{\text{BPREXP}} \right]$$

In this equation:

- T_n is the adjusted time for the current iteration,
- T_{n-1} is the travel time from the previous iteration,
- BPRLOS is the BPR level-of-service (LOS) value, defaults to 0.15,
- v/c is the ratio of assigned volume-to-practical capacity, and
- BPREXP is the BPR exponent, defaults to 4.0.

BPR Function with Damping Factor

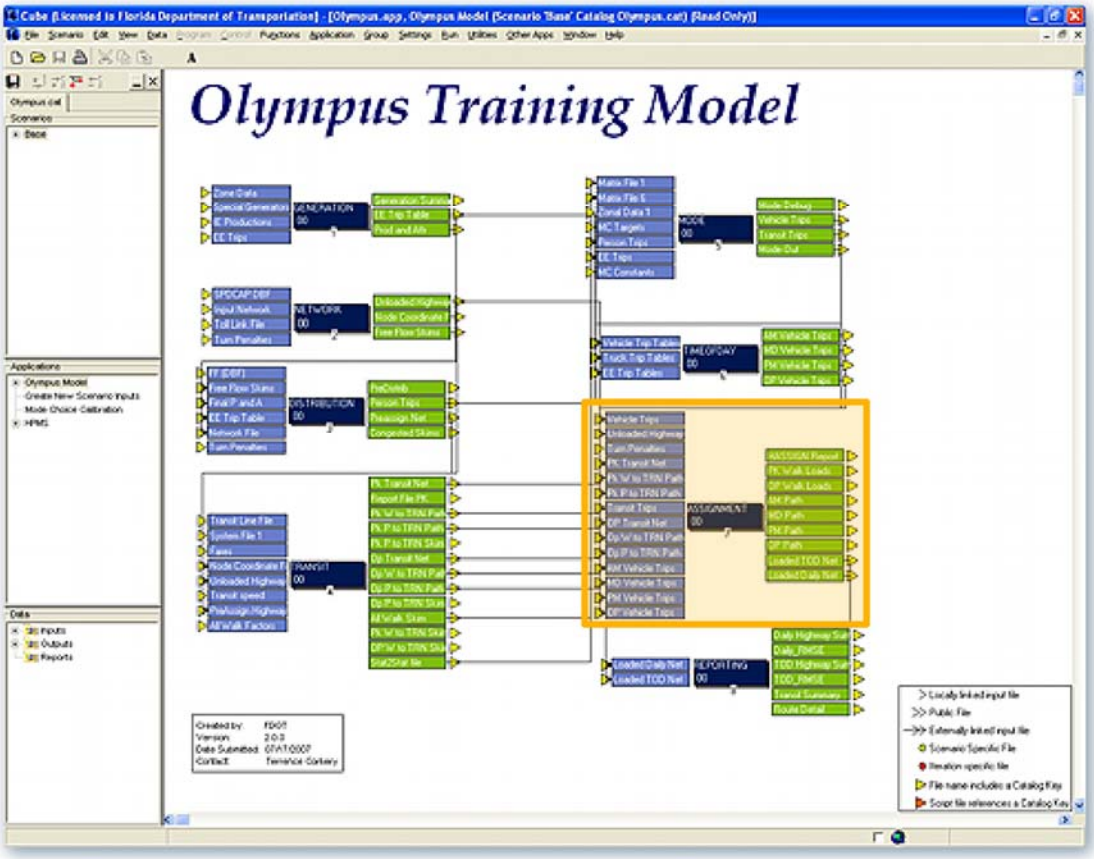
An available option in the application of BPR formula is to include a so-called damping factor to "dampen" the new time by a user-specified factor, as follows:

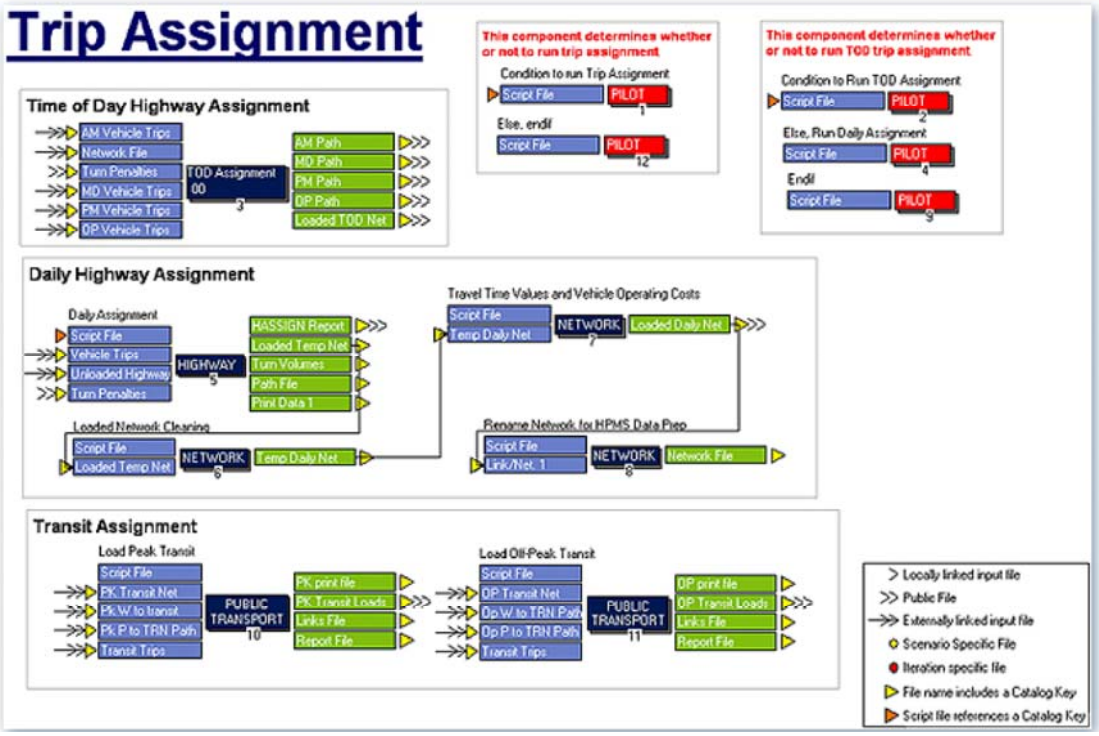
$$T = T_0 \times \left[1 + \text{BPRLOS} \times \text{Damping Factor} \times \left(v / c \right)^{\text{BPREXP}} \right]$$

The damping factor adjusts the time difference between the current iteration and the previous iteration. This helps to lessen the oscillation of loadings from one iteration to the next.

Olympus Highway Assignment Step

The parent flow chart for the assignment step is highlighted. Clicking on the ASSIGNMENT box in this flow chart will open a flow chart that shows all of the components of the trip assignment model, which include those for both highway and transit assignments.


Olympus Training Model


Trip Assignment
This component determines whether or not to run trip assignment
Condition to run Trip Assignment
Script File
PILOT
Else, endif
This component determines whether or not to run TOD trip assignment
Condition to Run TOD Assignment
Else, Run Daily Assignment
Endif
Time of Day Highway Assignment
AM Vehicle Trips
Network File
Turn Penalties
MD Vehicle Trips
PM Vehicle Trips
OP Vehicle Trips
TOD Assignment
AM Path
MD Path
PM Path
OP Path
Loaded TOD Net
Daily Highway Assignment
Daily Assignment
Vehicle Trips
Unloaded Highway
HIGHWAY
HASSIGN Report
Loaded Temp Net
Turn Volumes
Path File
Print Data 1
Travel Time Values and Vehicle Operating Costs
Temp Daily Net
NETWORK
Loaded Daily Net
Loaded Network Clearing
Loaded Temp Net
Rename Network for HPMS Data Prep
Link/Net: 1
Network File
Transit Assignment
Load Peak Transit
PK Transit Net
Pk W to transit
PK P to TRN Path
Transit Trips
PUBLIC TRANSPORT
PK print file
PK Transit Loads
Links File
Report File
Load Off-Peak Transit
OP Transit Net
Op W to TRN Path
Op P to TRN Path
OP print file
OP Transit Loads
Locally linked input file
Public File
Externally linked input file
Scenario Specific File
Iteration specific file
File name includes a Catalog Key
Script file references a Catalog Key

Model Parameters

For equilibrium assignment, the model parameters include:

- Number of equilibrium iterations
- Damping factor
- Three VFACTORS parameters to be explained later in this lesson

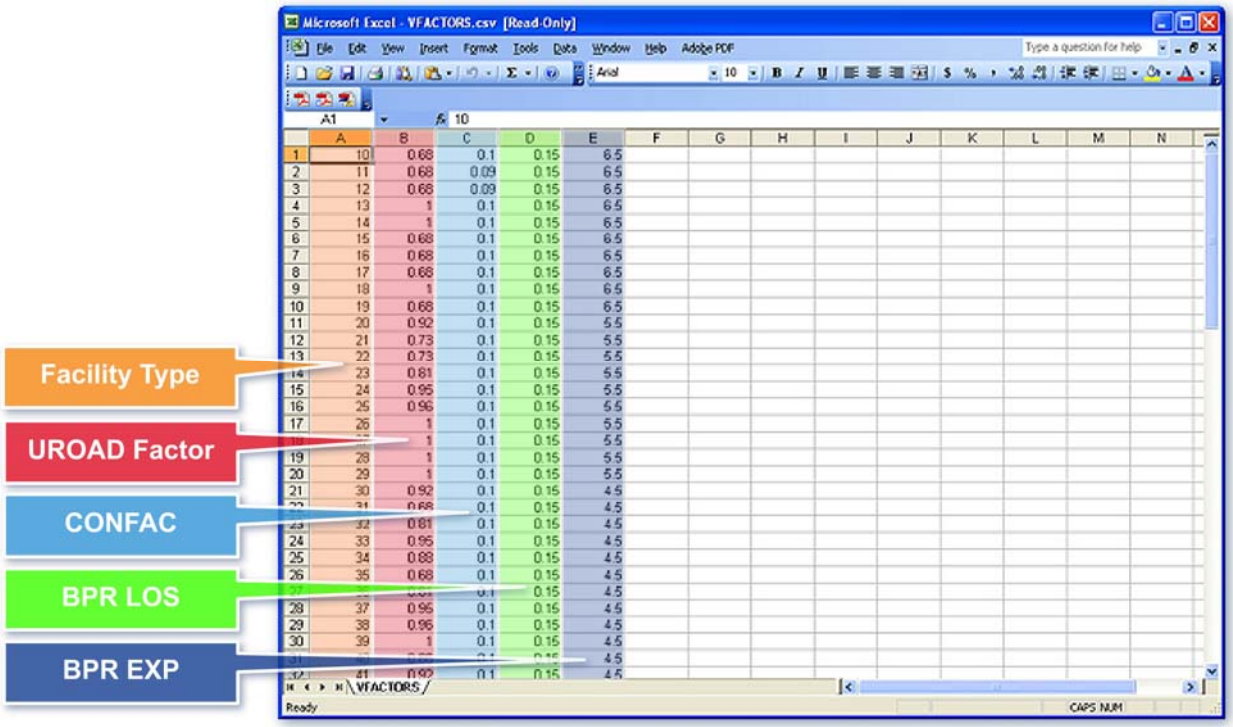
If you are modeling toll facilities, the following additional parameters are required:

- CTOLL, which is used to specify the impedance of a toll in terms of hour per dollar
- SERVT, which is used to specify the service time, or time to get through a toll facility
- TOLLS, which is used to specify the average toll rates

VFACTORS File

The VFACTORS file is used to store the following three VFACTORS parameters for different facility types:

1. UROAD factors
2. Peak-to-daily ratios, or commonly referred to as CONFAC
3. BPRLOS and BPREXP parameters as defined earlier



UROAD Factors

So what are the UROAD Factors? UROAD factors are used to adjust level-of-service (LOS) "E" capacities to represent practical capacity. Capacities in the highway network model are usually based on LOS "E". Application of UROAD factors allows capacity restraint to begin at LOS "C", or another desired LOS. A UROAD factor of 0.75 has previously been used as a default value. Current procedures call for UROAD factors to be based on a ratio between LOS "C" and "E" capacities specified in the FDOT 2002 LOS Manual.

Peak-to-Daily Ratios

The peak-to-daily ratios, or CONFACs, are used in the assignment process to convert the hourly capacities into the daily capacities. This conversion is needed in order to calculate the volume-to-capacity ratios when the assigned volumes are for 24 hours. Many areas use a default CONFAC value of 0.1, meaning that approximately 10 percent of daily trips occurred during the peak hour.

Model Input Files

The following model input data files are required for the highway assignment model:

- UNLOADED_ayy.net: The highway network
- HWYTRIPS_ayy.mat: Vehicle trip tables
- TURN_yya.pen: Turn penalties/prohibitors
- TOLLLINK_yya.dat: Toll links (for toll roads)
- VFACTORS.csv: BPR curves, CONFAC, and UROAD factors

Note that TOLLLINK and VFACTORS are also used during the Network step and thus are specified before rather than during the Assignment step.

Model Output Files

The model output files for highway assignment include:

- HWYLOAD_ayy.net: Loaded highway network
- HIGHWAY.pth: Restrained highway skims
- TURNS.TRN: Turn volumes
- HASSIGN.prn: Highway assignment print file

Output Network Field Names

The field names for the output network may include:

- CGSTD_SPEED: Congested speed
- CGSTD_TIME: Congested time
- TOTALVOL: Total vehicles

- LTRKVOL: Light-duty truck volume
- MTRKVOL: Medium-duty truck volume
- HTRKVOL: Heavy-duty truck volume
- TRUCK_TAXI: Truck-taxi vehicle trips
- DRIVEALONE: Single Occupancy vehicles
- HOV_VOL: Total daily HOV volume
- VMT: Vehicle Miles Traveled
- VHT: Vehicle Hours Traveled

Note that not all models produce separate assignment volumes for trucks and high-occupancy vehicles, or HOVs. Click Next when you are finished reading this slide.

Time-of-Day Assignment

Time-of-Day, or TOD, assignments involve separate assignments for each time period modeled. After that, the loaded networks are combined into a single loaded network. The period trips from a time-of-day assignment are summed to generate daily trips. A typical four-period model is divided into morning peak, mid-day, evening peak, and overnight periods. In a time-of-day assignment, trips are modeled directionally according to time period. Using statistically derived time-of-day factors, period and directional counts are needed to validate time-of-day assignments. Time-of-day assignments allow for a more detailed analysis of congestion to be derived during peak periods.

Seasonal Factors

The Monthly Seasonal Factor (MSF) is derived using the Annual Average Daily Traffic (AADT) for a count site divided by the Monthly Average Daily Traffic (MADT) for a specific month at that count site. Weekly Seasonal Factors (SF) are derived by interpolation between monthly factors for two consecutive months. Peak Season Weekday Average Daily Traffic (PSWADT) is derived by multiplying short-term traffic counts by the Peak Season Conversion Factor (PSCF) for modeling purposes.

Model Output Conversion Factors (MOCF)

The Model Output Conversion Factors (MOCF) are used to convert Peak Season Weekday Average Daily Traffic (PSWADT) to Annual Average Daily Traffic (AADT). Since traffic models output Peak Season Weekday Average Daily Traffic (PSWADT), then Model Output Conversion Factors (MOCF) is also based on the peak season. The peak season is the 13 consecutive weeks during which the highest weekday volumes occur. The 13 week highest weekday volume occurs when the sum of seasonal factors for those 13 weeks is at its lowest. The Model Output Conversion Factors (MOCF) is calculated as the average of the 13 weekly seasonal factors during the peak season.

Reporting Highway Assignment

The standard reporting from highway assignment includes:

- Vehicle Miles Traveled, or VMT, and the Vehicle Hours Traveled, or VHT
- Number of trips loaded and counted
- Volume/capacity ratios, including those by VMT, VHT, and Peak Season Weekday Average Daily Traffic (PSWADT) and summarized by
  - Screenline, cutline, cordon line, and significant corridors
  - Area type, facility type, and the number of lanes
  - Volume group
- Free-flow and congested speeds and the percent difference between them
- For validation purposes, the Root Mean Square Error (RMSE) by volume group and volume-count ratios by area type and facility type

Display of Results

The following assignment output may be displayed on maps in Cube-Voyager:

- Loaded volumes
- Traffic flow (loaded volumes by band width)
- Volume-to-capacity ratios
- Volume-to-count ratios
- Speeds
- Congestion

Exercises

In this exercise we will run both highway and transit assignment, label traffic volumes on a map, and create traffic flow maps.

To run both highway and transit assignment, first navigate to the Olympus Model by clicking on the FSUTMS Launcher icon, and then Selecting Statewide and Training Models on the FSUTMS Welcome Screen. Finally, select the FSUTMS/CUBE Olympus Training Model.

We are now ready to execute the trip assignment model, open the Scenario Manager for Base. Click the box next to Trip Assignment under Please Select Model Steps. Make sure all other steps are unchecked. Click Run in order to run the trip assignment. Once the run has completed, the Task Run Result window will be displayed. Click OK and close the Scenario Manager to return to the parent flow chart

In the second exercise, we will label traffic volumes on a map. First, open the Loaded Highway Network by double-clicking on it. We can now click on any link in the network to view the attribute data for that link. In the Olympus model, the TOTALVOL field represents vehicles per day by direction. Close the attribute data table. To label the daily volumes by direction, First, click on the screen. Now, select All Links from the Post menu at the top of the screen. This will

open the Posting Selection screen. On this screen, select TOTALVOL field from the first drop-down box. Click OK. This will display the traffic volumes on the map. To clear the volume labels, simply select Clear All Postings from the Post menu at the top of the screen.

Finally, we will create a traffic flow map. To do this, first, select Multi Bandwidths from the Post menu at the top of the screen. Now, select the TOTALVOL field from the drop-down list in the Highway Layer Link Band Width Settings window. Click OK. This will display different bandwidths on the links. The thicker the link lines, the higher the volumes. To clear the traffic flow bandwidth lines, simply select the Post menu and click on Clear All Postings.

Summary

This concludes Part I of Lesson 9. In this part of Lesson 9, we have covered:

- Overview on trip assignment and its applications
- Equilibrium assignment method
- Highway assignment model parameters
- Model input and output files
- Time-of-day assignment
- Calculation of Model Output Conversion Factors (MOCF)
- Reporting and display of highway assignment results

Next, please click on the link for Part II of Lesson 9 to learn about transit assignment.

LESSON 9, PART II: TRANSIT ASSIGNMENT

Lesson Goals

Welcome to the Part II of Lesson 9 on transit assignment. This lesson includes:

- Overview of transit assignment
- Review of the major functions in Public Transport Module of Cube Voyager
- Model parameters
- Model input and output files
- Reporting and displaying of transit assignment results

Overview

The purpose of transit assignment is to load transit trips to the route between each pair of zones. There may be more than one route between each pair of zones. The route that is selected will be one that has the lowest cost. For Highway-Only models, obviously transit assignment will not be executed.

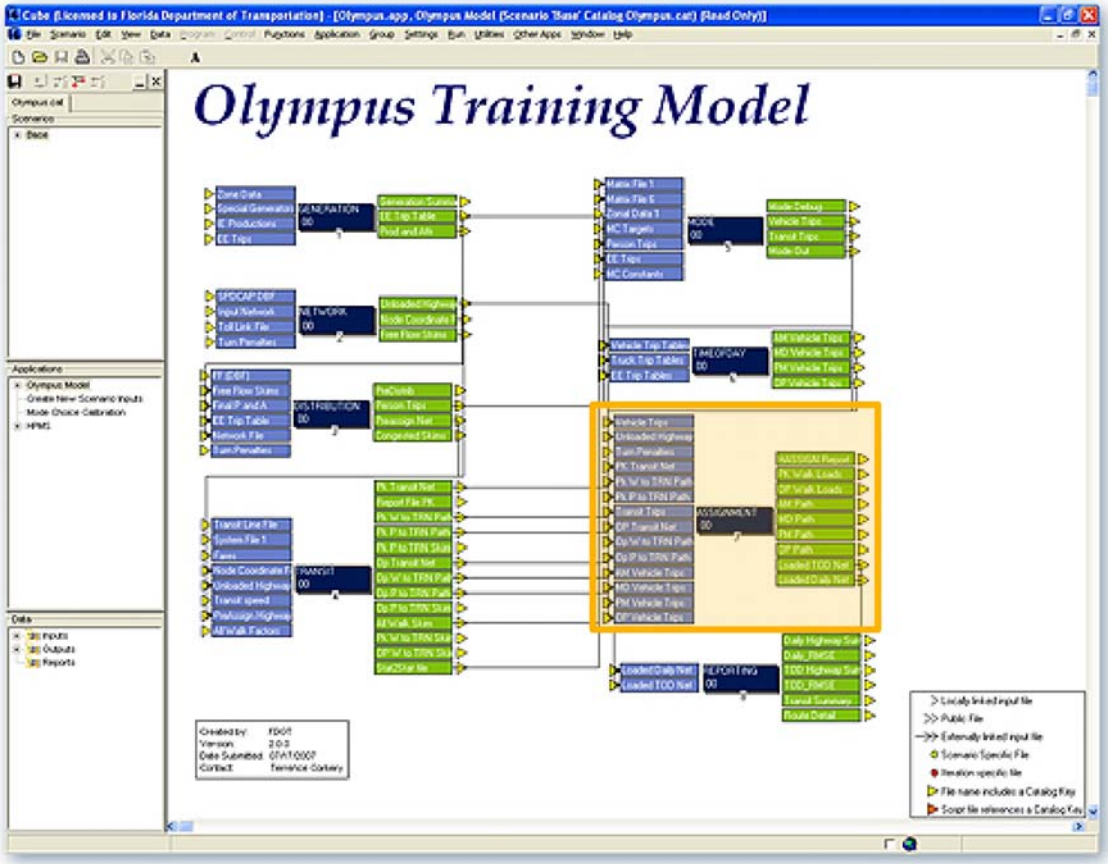
The transit assignment models in FSUTMS are based on the Public Transport Preparation and Modeling module from Cube Voyager. From here we will refer to this module as the Public Transport module, or simply the PT module.

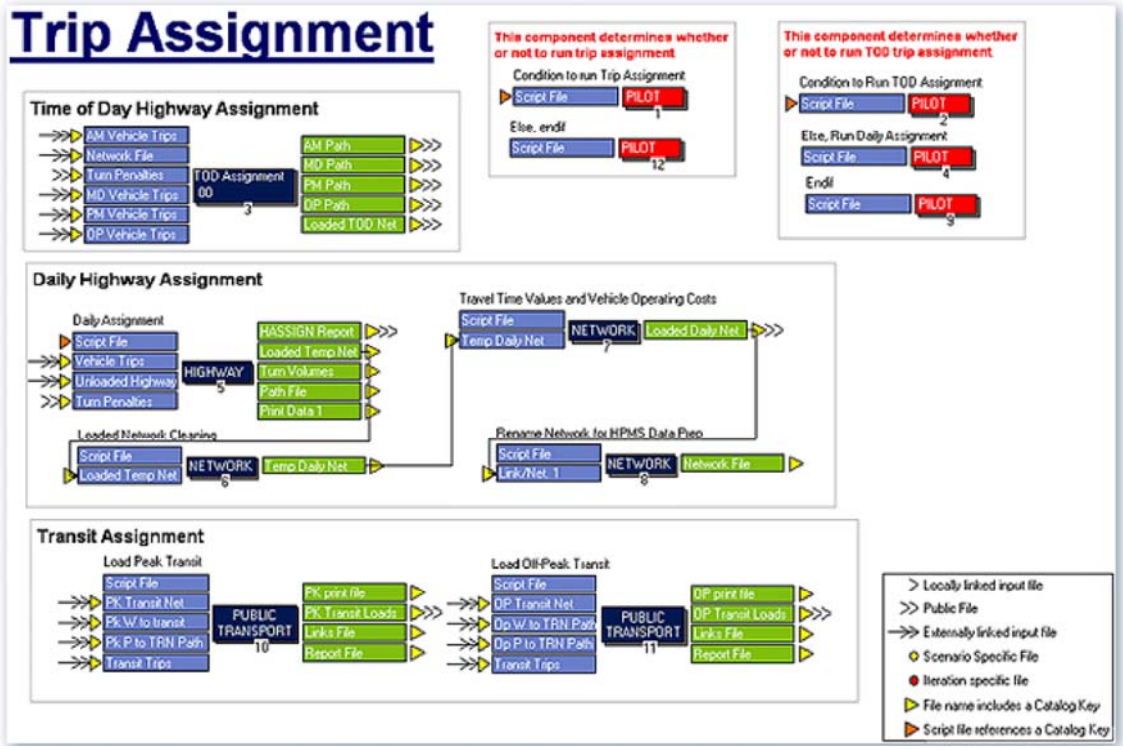
In the Olympus model, the Transit Assignment module includes two steps:

1. Load the peak transit trips
2. Load the off-peak transit trips

Olympus Assignment Step

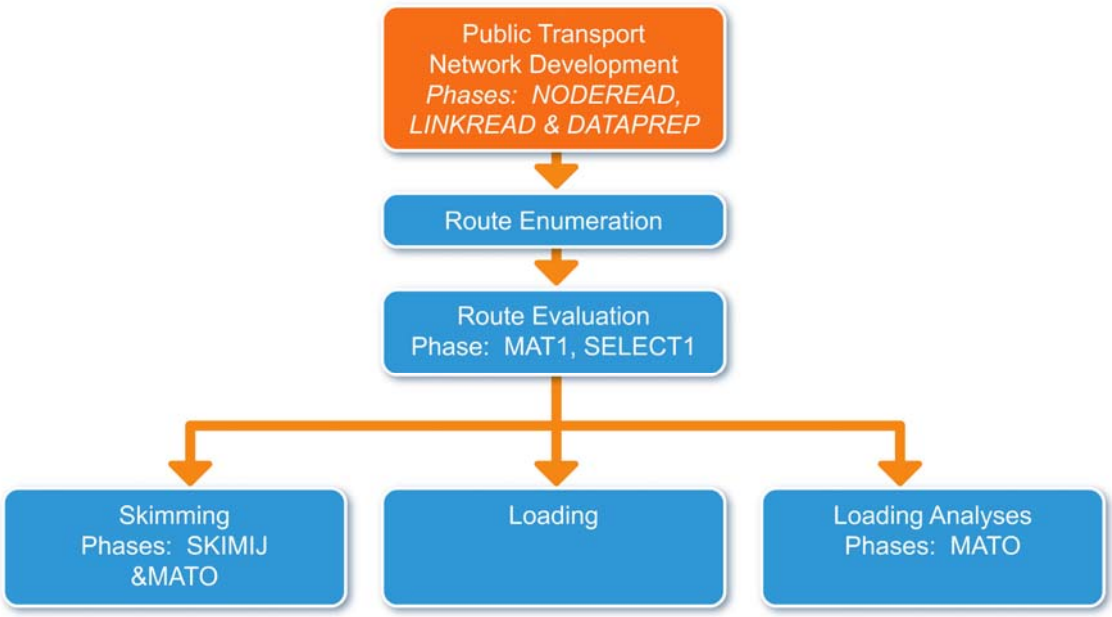
This figure shows the parent flow chart for the assignment step. Clicking on the ASSIGNMENT box in this flow chart will open a flow chart that shows all of the components of the trip assignment model. It includes those for both highway and transit assignments.


Olympus Training Model


Trip Assignment
This component determines whether or not to run trip assignment
Condition to run Trip Assignment
Script File
PILOT
Else, endif
This component determines whether or not to run TOD trip assignment
Condition to Run TOD Assignment
Else, Run Daily Assignment
Endif
Time of Day Highway Assignment
AM Vehicle Trips
Network File
Turn Penalties
MD Vehicle Trips
PM Vehicle Trips
OP Vehicle Trips
TOD Assignment
AM Path
MD Path
PM Path
OP Path
Loaded TOD Net
Daily Highway Assignment
Daily Assignment
Vehicle Trips
Unloaded Highway
HIGHWAY
HASSIGN Report
Loaded Temp Net
Turn Volumes
Path File
Print Data 1
Travel Time Values and Vehicle Operating Costs
Temp Daily Net
NETWORK
Loaded Daily Net
Loaded Network Cleaning
Rename Network for HPMS Data Prep
Link/Net 1
Network File
Transit Assignment
Load Peak Transit
PK Transit Net
Pk W to transit
Pk P to TRN Path
Transit Trips
PUBLIC TRANSPORT
PK print file
PK Transit Loads
Links File
Report File
Load Off-Peak Transit
OP Transit Net
Op W to TRN Path
Op P to TRN Path
OP print file
OP Transit Loads
Locally linked input file
Public File
Externally linked input file
Scenario Specific File
Iteration specific file
File name includes a Catalog Key
Script file references a Catalog Key

Public Transit Functions

This figure shows the functional hierarchy of the PT module in Cube Voyager.



In this hierarchy, the Loading function is the one that assigns transit trips to the minimum-cost route between each zone pair. The cost associated with each route is calculated in the Route Evaluation function. The output of the Loading function may include:

- Loaded transit network loaded with transit and non-transit loads
- Loaded non-transit legs in an ASCII format
- Loaded lines in an ASCII format
- Link attributes, including loads in a DBF format

The Loading Analyses function can create additional reports of transit and non-transit passenger loadings. If demand is divided up by User Class in the Loading function, it will also be divided up during this step. The Loading Analyses function can report:

- Transfers between modes
- Transfers between operators
- Stop-to-stop movements

A third party software program can provide line summaries and detailed route reports. The executable file for the program is called TAREPORT.EXE.

Model Parameters

The model parameters that were used in the TRANPLAN version of TASSIGN are no longer required for PT in Cube Voyager. PT provides a parameter called USERCLASSES that you can specify to stratify the transit demand by such variables as fare type and trip purpose.

Model Input and Output Files

The PT model includes the following input and output files to store various input data needed for transit assignment. The input files for this step are generated from the transit network and path building step covered in Lesson 5. Click Next when you finish reading the list of input and output files below.

Input Files:

- TransitPK.net: Peak period transit network
- TransitOP.net: Off-peak period transit network
- TRNTRIPS_ayy.mat: Transit trip table
- TPATHPK1_ayy.rte: Peak period walk-to-transit paths
- TPATHPK2_ayy.rte: Peak period parking-to-transit paths
- TPATHOP1_ayy.rte: Off-peak period walk-to-transit paths
- TPATHOP2_ayy.rte: Off-peak period parking-to-transit paths

Output Files:

- TRNWLKPK_ayy.net: Loaded peak period transit network
- TRNWLKOP_ayy.net: Loaded off-peak period transit network

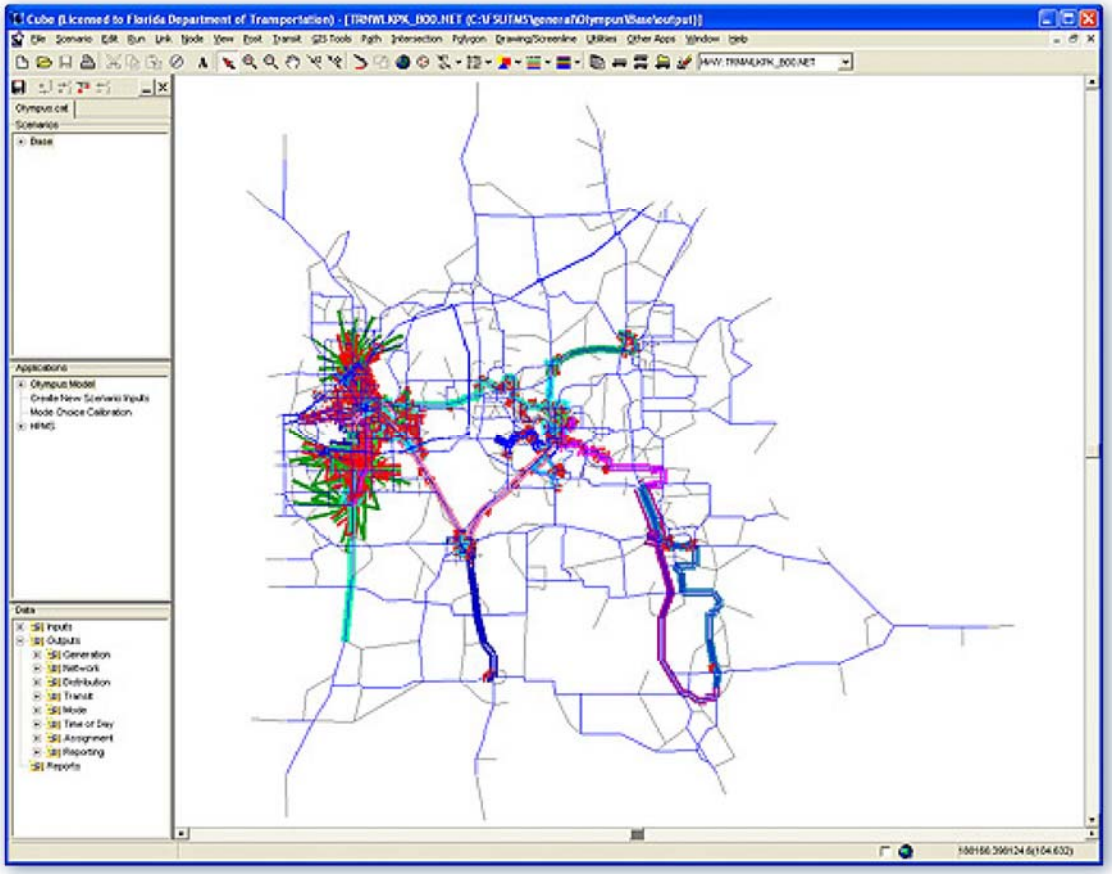
Loaded Transit Network Map

This map displays a loaded transit network for the peak period for the Olympus model (see next page).

Reporting Transit Assignment Results

The output reports from transit assignment include:

- Boardings and alightings by transit stop and direction
- Estimated number of transfers by mode and route
- Peak period vehicle requirements
- Transit station loading report in both tabular and graphic formats
- Estimated transit ridership by mode and route compared to observed values



Displaying Transit Assignment Results

The results from transit assignment that are displayed in tabular form include:

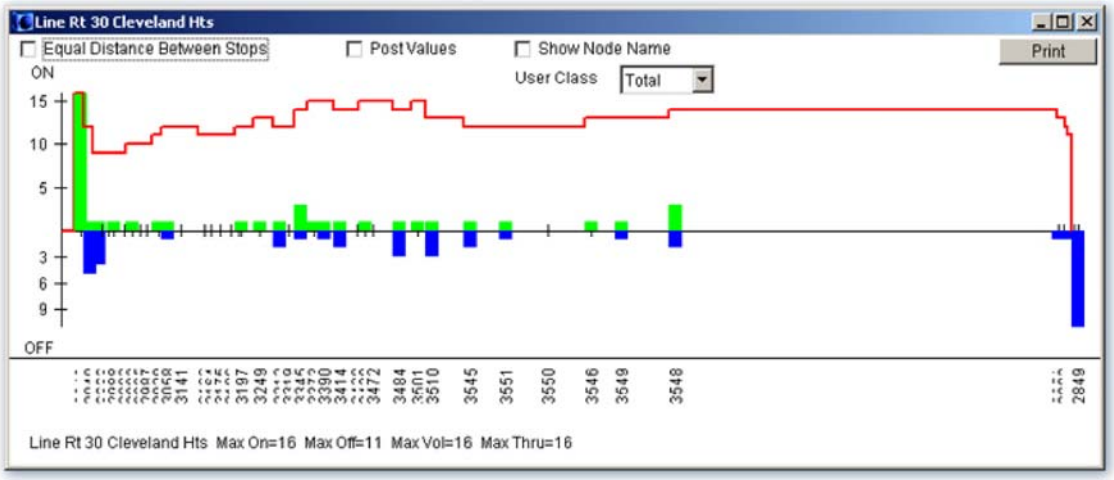
- Transit ridership by bus route
- Transit ridership by mode
- Total transit ridership

The results that can be mapped include:

- Transit ridership flow
- Transit boardings and alightings

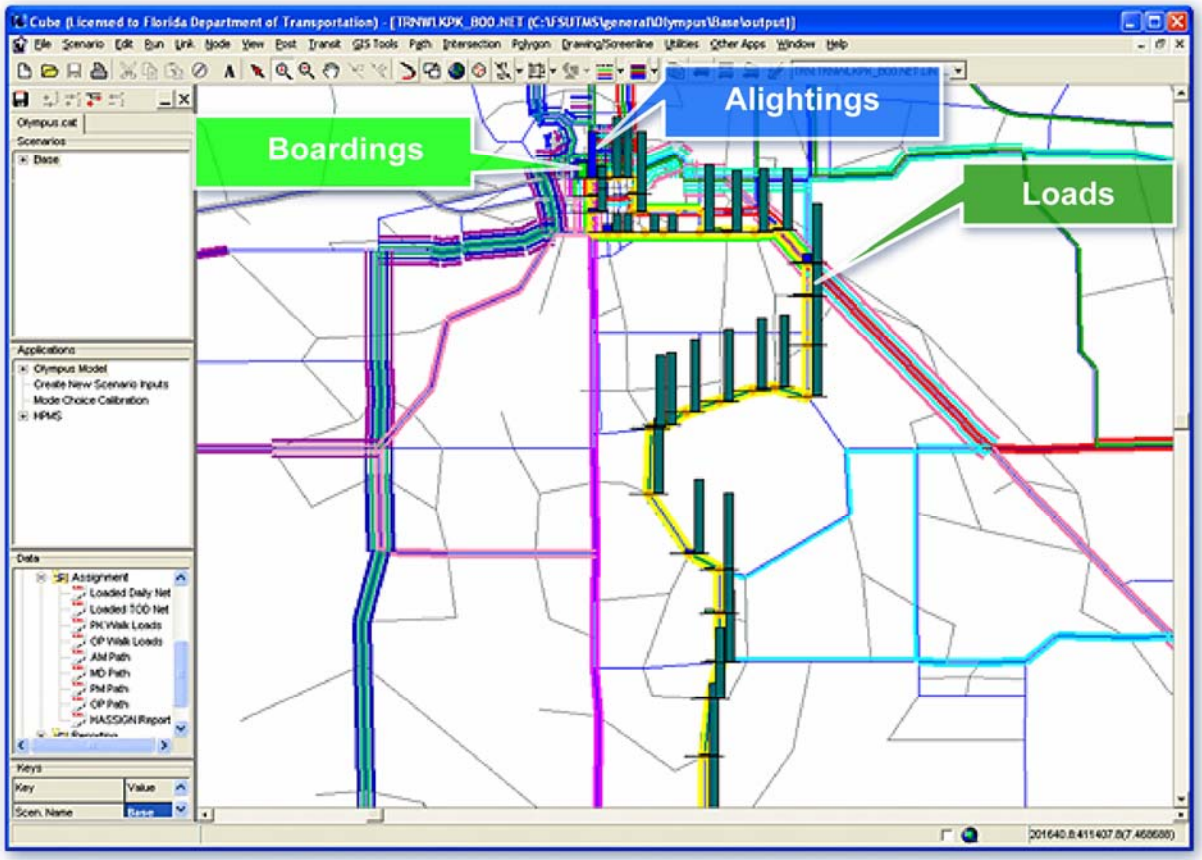
Sample Chart Display

This figure shows a chart that displays the total boardings and alightings at each transit station of a particular route. Boardings are shown in green and alightings in blue. The red line gives the transit loads between transit stops.



Sample Map Display

This map displays the same information for a particular route on a map. Pay attention to the yellow route. You can see that vertical bars are used to indicate the number of boardings, alightings, and loads at each transit stop along the route.



Exercises

For part II of this lesson, we will complete the following two exercises:

- Retrieve the transit ridership results
- Map the transit boardings

For the first exercise, as usual, we will first navigate to the Olympus model.

1. First, click on the FSUTMS Launcher icon
2. Then select Statewide and Training Models on the FSUTMS Welcome screen.
3. Finally, select the FSUTMS/CUBE Olympus Training Model.

This opens the Olympus model. Now, in the Data window, double-click on Outputs, and then Reporting, and then Transit Summary. This opens the Transit Summary report, which gives the ridership results for each route. For example, this column gives the transit passengers for the peak period for each bus route. You can scroll down to also get the total ridership for all routes. To close this report, click on the inside X close button.

We will now do the second exercise. As you might recall, it is to map the transit boardings. In the Data window, double-click on Outputs, and then Assignments, and then PK Walk Loads. This opens a map that displays the peak transit walk loaded network. We will now zoom in on a target route. We will do this by first selecting Center on Node from the View menu, and then entering node 2580 and setting the scale to 7060. Next we set the peak walk layer to the top by selecting the transit layer called TRNWLKPK_B00.NET from the layer drop down menu.

Now, click on the Display Transit Line icon on the toolbar. This opens the Transit Display Selection window. Click the Clear All button. Scroll the list to find RT 12/50 LLWH. Click to select it. Click OK. Now select Show Transit On/Off from the Transit menu. Click OK in the Maximum On/Off Bar Height window. Click OK in the Select User Class window. This will display the transit information in vertical bars. The green bar represents boardings. The blue bar represents alightings. The teal bar represents through volumes. You can close this map by clicking on the X inside close button.

Summary

This is the end of Lesson 9. In this lesson, we covered:

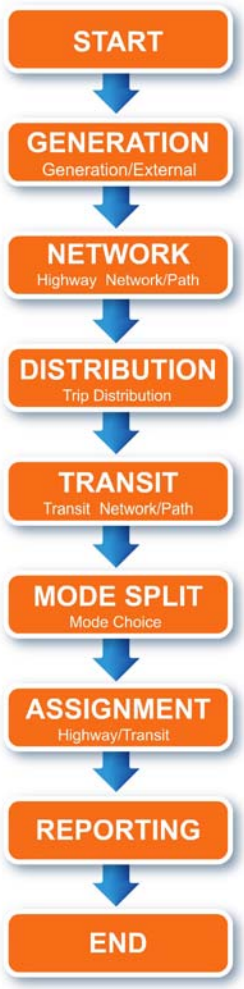
- Overview of transit assignment
- Review of the major functions in Public Transport Module of Cube Voyager
- Model parameters
- Model input and output files
- Reporting and displaying of transit assignment results

LESSON 10: POST PROCESSING

Lesson Goals

Welcome to Lesson 10 on Post Processing. FSUTMS reports the output data at the end of each step in the FSUTMS model chain. Post processing consists of reporting and adjusting the output data, usually in either a report or a map format. The main focus of this lesson is to use an example to show you how to set up your own map layouts for printing. Future versions of Cube will interface directly with ESRI GIS to provide more mapping flexibility. A program that can help generate a predefined set of FSUTMS standard reports and maps are currently being developed and will be available in early 2009.

Examples of Map Data



Some examples of the map data from FSUTMS include:

- Network characteristics. These include area type, facility type, number of lanes, etc.
- Volume-to-count ratios that can be used during validation
- Loaded volumes that give the magnitude of trips
- Traffic flow, including loaded volumes by bandwidth, which also gives the magnitude of trips
- Volume-to-capacity ratios, which measure the level of congestion
- Desire lines, which show the travel patterns

Exercises

Next, we will show you an example on how to do a map layout for printing in Cube. The first step is to navigate to the Olympus Model by clicking on the FSUTMS Launcher icon and then selecting the Statewide and Training Models on the FSUTMS Welcome Screen and then the FSUTMS/CUBE Olympus Training Model. Next we open up the loaded highway network by double-clicking on the Loaded Daily Network file under Outputs/Assignment in the Data window. For this example, we are to display the volume-to-capacity ratios to illustrate the congestion levels. To do this, click on the **Layer Control** button. Double-click on the **HWY: HWYLOAD_B00.NET** layer. Select **VolCap** from the link legend pull-down menu. The legend settings for the volume-to-capacity ratios have already been defined. Click on the **All Done** button. The most congested roads are shown in thick red.

Now we are ready to set up the header in the map layout. To do this, we first select Page Setup from the File menu at the top of the screen. Then we click on the Printer Setup button to select the respective printer and page size. We then click on the Header Area with the mouse. Now, type in 'Olympus Volume-to-Capacity Ratios' on the first line. And type in 'Base Year' on the second line. To include the file name, right-click on the third line and select [hwyfile]. Select

Center for the Alignment of the header. Click on the Change Font button to change the font size or style of the header. Select Bold for the Font Style. Select 12 for the Size. Click on OK in the Font window. Click on OK on the Enter Header Title window. If desired, a footer can also be included the same way as the header by clicking on the Footer part of the Page Setup window.

Now we will set up the legend in the map layout. To place the legend at the bottom right of the layout, click on the Legend 4(1) area in the Page Setup window. Select Manual Legend under Legend Items in the Edit Legend window. Click on the Edit Item button. Type 'Volume-to-Capacity Ratios' in the Title bar of the Edit Legend Item window. Click on the Modify Manual Legend Items button. Click Append to enter the color and size options, or you can just click on the Copy Legend menu and select Highway and then Link. This will copy the legend settings from the highway network. You can add descriptor to the legend to describe the selection criteria.

For example: For the first one, enter: VOLCAP<.75; V/C less than 0.75
For the second one, enter: VOLCAP=.75-.90; V/C between 0.75 to 0.90
For the third one, enter: VOLCAP>.90; V/C between 0.90 to1.00
For the fourth one, enter: VOLCAP>1; V/C between 1.00 to1.25
For the first one, enter: VOLCAP>1.25; V/C greater than 1.25

After you have finished entering your descriptor, select Close from the menu and then click on OK and then OK again. We will now include a scale in the map layout. Click on Legend 2(1) to include a scale at the bottom left of the map. Select Manual Legend under the Legend Items. Click on the arrow button to remove Manual Legend from Legend 2(1). Click on Scale Bar 1 under Available Legend Items to add a scale bar. Click on the Edit Item button. Type '4' in the Width bar. Type '0.5' in the Height bar. Type '1600' in the Coord /Scale Unit bar. Type 'Miles' in the Scale Unit bar. Click OK. Click OK again.

To include a north arrow in the map layout, click on Legend 2(1) to include a North Arrow at the bottom left of the map with the scale. Select North Arrow 1 from the Available Legend Items. Click on the arrow button to add North Arrow 1 to the Legend Items list. Select North Arrow 1 from the Legend Items list. Click on Edit Item. Type '0.5' for the Width. Type '0.5' for the Height. Select Center for the Alignment. Click on the OK button. Click on OK again.

Once we are done with setting up the print layout, we can preview the map to make sure that it looks the way we want it. To preview the map, click on the Preview button in the Page Setup window. Click on the X at the top right of the Print Preview window to close out the preview. Click on Print in the Page Setup window to send the map to the printer. Click on the Close button to close out the Page Setup window.

Summary

This is the end of Lesson 10. In this lesson we covered:

- Examples of map data
- Setting up map layouts for printing

LESSON 11: ADVANCED TOOLS

Lesson Goals

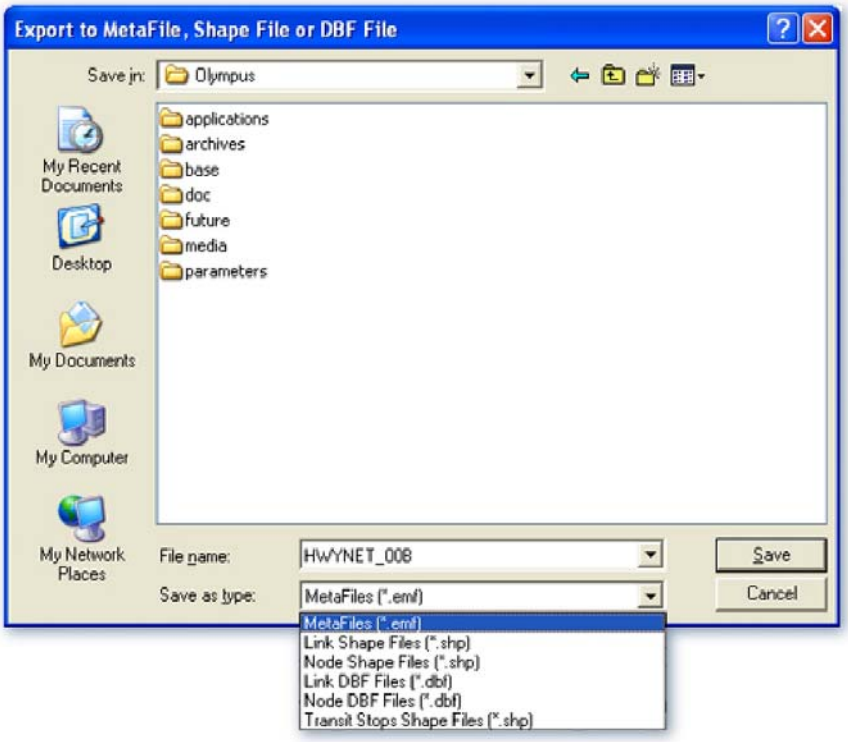
Welcome to Lesson 11 of this workshop on Advanced Tools. In this lesson we will cover the following four major topics:

- Exporting files
- GIS tools
- Selected link and selected zone analyses
- Scripting

At the end of this lesson, we will complete a total of five exercises.

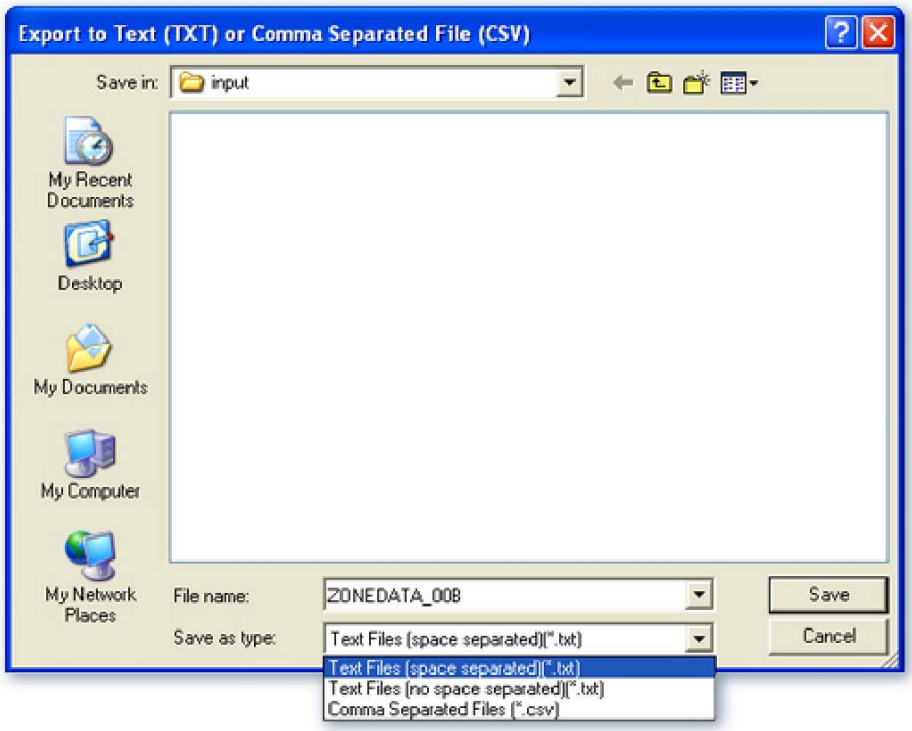
Exporting Files

Cube provides a comprehensive export function that allows the users to save networks, databases, and matrices in different file formats. To export a file, simply click on the File drop-down menu and then select Export. Depending on the current type of file on display, Cube will list the available file formats where you can export your data. Highway and transit networks can be exported in the windows Enhanced Metafile (EMF) format. EMF is a generic vector graphics format that is recognized by several image-editing applications. The networks can also be exported to point and line shape files, which are referred to as Node and Link shape files in Cube, respectively. A special type of shape files called Transit Stops Point Shape Files is also available for creating shape files for your transit stops point layers.



Most other database files, other than the matrix files, can be exported to one of the following file formats:

- Space Separated Text Files, with a TXT file extension
- No Space Separated Text Files, also with a TXT file extension
- Comma Separated Values Text Files, with a CSV file extension



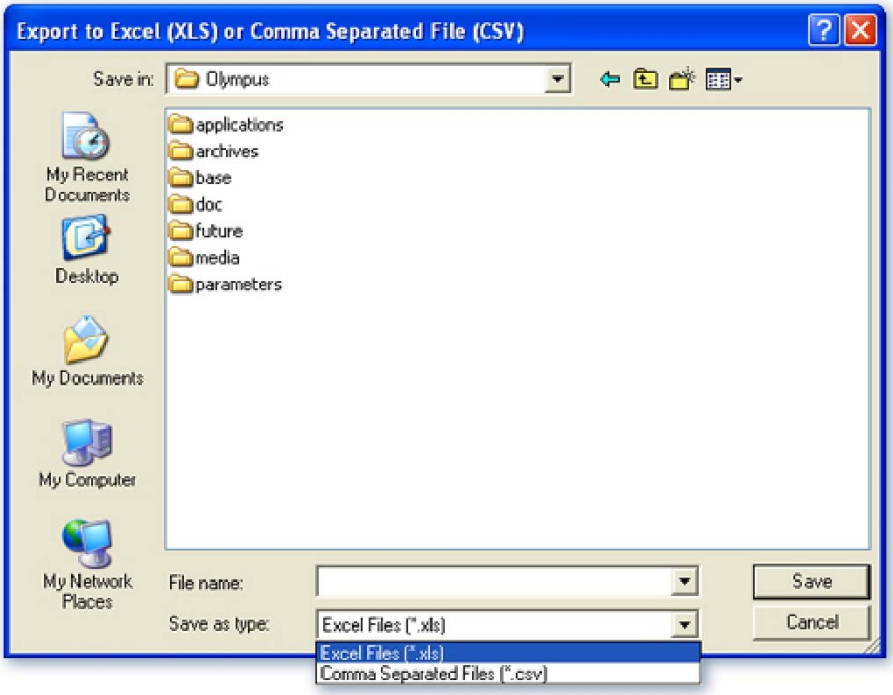
A matrix file can be exported to either an Excel Spreadsheet Format, with an XLS file extension, or a Comma Separated Values, with a CSV file extension.

GIS Tools

The GIS Tools module is an optional add-on for Cube Base within FSUTMS. You can access the GIS Tools functions by selecting the GIS Tools menu at the top of the network screen. Some of the main GIS functions included are:

- Layer Alignment
- Rubber Sheeting
- Network Conflation
- True Shape Display
- Build Network from Shapefile
- Reverse Line Shape

We will introduce each of these functions in the next few slides.



Layer Alignment

The purpose of Layer Alignment is to shift and scale a layer in order to align it with other layers. During the process, the layer coordinates being shifted or scaled are not actually changed. Only the base point and scale settings are. The base point and scale settings are not saved with the network file. They are stored in the network project file. However, you also have the option to permanently change coordinates in a network file. This is done by using the Node Attribute Compute option to recalculate the X and Y coordinates of the whole network.

The Automatic Distance Recalculation option should be disabled before recalculating the coordinates and enabled afterwards. The Distance Scale for the highway network will need to be changed after scaling the coordinates.

Rubber Sheeting

The Rubber Sheeting function is similar to Layer Alignment in that it also tries to align one layer with other layers. However, instead of shifting and scaling the layer, the Rubber Sheeting function stretches or compresses part of the highway network to make them aligned. In addition, the process also changes the node coordinates within the rubber sheeting box. Once these new coordinates are saved, the changes become a permanent part of the highway network.

Network Conflation

The purpose of Network Conflation is to snap the highway nodes to an end point of the underlying GIS line shapes so they have the same coordinates. Cube offers four options for snapping nodes:

- Snap node
- Snap all node
- Snap all nodes in view
- Snap all nodes in polygon

True Shape Display

The True Shape Display function changes the network link display to show the true shape of a link based on one or more shapes in the shape file instead of a straight line. For this function, the Line shape DBF database file must include an A node field and a B node field. For links with more than one shape, the DBF file must include a sequence field indicating the sequence of the line shapes.

Build Network from Shapefiles

The Build Network from Shapefiles function can generate a corresponding highway network from a line shape file with automatic node numbering. As for the True Shape Display function, the shape DBF file must also have an A node field and a B node field. The shapes in a shape file can be treated as all one-way links or all two-way links. Alternatively, a field in the shape file can be used to indicate one-way and two-way shapes. If line shapes were not digitized in the direction of travel, one-way links will be created in the wrong direction. To correct this, the Reverse Line Shape function can be used.

Reverse Line Shape

As the name implies, the purpose of the Reverse Line Shape function is to reverse the digitized direction of a line shape to correct for directional error in one-way streets. The digitized direction of a line shape is important if the line shape file will be used to build a network or as a base for true shape display. During the Reverse Line Shape process, changes to the shape file are saved automatically and therefore cannot be undone without reversing the direction again.

Statewide GIS Data Sources

The Florida Department of Transportation purchased the following statewide data sets:

- InfoUSA Employment Data Files that are needed for input to the trip attraction models.

- The GDT DYNAMAP mapping files that provides detailed street networks needed for building highway networks.

In addition, the GEOPLAN center at the University of Florida also provide free downloads for over 300 data layers at both county and statewide levels.

Selected Link and Selected Zone Analysis

Selected link and selected zone analysis is used to determine the origin and destination of trips traversing a specific link, zone, or node. They are typically used in identifying travel patterns or major movements and traffic impact analyses. Selected link and selected zone analysis is performed during the assignment step using a PATHLOAD statement. The procedure outputs an additional volume set that provides the number of trips on each link that traverse the selected link, zone, or node. The procedure can also output a matrix of volumes for the zones that traversed the selected link, zone, or node.

Scripting Overview

In the next few slides, we will give a general overview of the scripting function in Cube. FDOT offers a live workshop that goes into scripting in depth. The workshop is called FSUTMS/Voyager Scripting Workshop. You can learn more about this workshop and its availability by clicking the following link: http://www.fsutmsonline.net/modeling_training.aspx.

So, what is scripting? Cube Voyager operates by reading control statements from a script (job) file. So scripting is just the process of adding new control statements or making changes to existing control statements in the script files in order to accomplish a certain task. The scripting language used for Cube Voyager is called Cube Power Scripts (CPS).

Module Functions Available for Scripting

Below is a list of the functions associated with each of the eight FSUTMS modules for which scripting is available to manipulate the modeling process.

- NETWORK: Building, comparing, and manipulating highway networks
- HIGHWAY: Pathbuilding, skimming, and assignment of highway networks
- PT: All Public Transport functions
- GENERATION: Trip Generation
- DISTRIBUTION: Trip Distribution
- FRATAR: Matrix growth factoring
- MATRIX: Demand modeling and matrix manipulations
- PILOT: Special module which controls model flow

General Script Syntax

All control statements have the following general syntax:

COMMAND keyword=value

As you can see, the statement begins with a control word to tell the module what type of statement it is. Following the control word and one, or more, spaces, are keywords and their values. A keyword is always followed by an equals (=) sign, and then the value(s) to be

associated with the keyword. There may be as many keywords as are applicable to the control type.

Control Statement Continuation

A statement can be continued onto the next line by breaking it after a valid operator for the statement. If the last character on the statement (prior to any comments) is a valid operator for the statement, the statement MUST continue onto the next line. Valid continuation characters are: comma and mathematical and logical operators: (, + - / * ^ & | =); the character must be one that is in a proper context for the statement. For example:

```
COMP a = b + c =
```

This control statement is not valid because = is not in a proper context. On the other hand, the following two control statements are valid because in the first statement, + is logical at this point and the second line is also valid as a continuation of the first line.

```
COMP a = b + c +
d + e / f
```

Comments Format

There may be comments appended to any control statement or line. Comments are very helpful and should be used whenever it helps to clarify the application. Comments must be preceded by a semi-colon (;). There may be any number of spaces before and/or after the semi-colon; they are ignored. If a statement is continued onto subsequent lines, each line may have comments. A semicolon (;) as the first character of a statement sets the entire statement as a comment. Three example comments are shown below:

```
FILEI NETI=myfile.nam, ; I/P network
ZDATI=zonal.dat ; Zonal data
; this entire line is a comment
```

In the first example, the FILEI control statement is continued because a comma follows the network filename. The statement could also have been coded as:

```
FILEI NETI=myfile.nam, ZDATI=zonal.dat ; I/P network, Zonal data
```

To comment out a block of scripts, put /* and */ at the beginning and end of block to be commented out.

Keywords

All control information is entered by coding a keyword followed by an equals sign (=) and then the value(s) to be entered for the keyword. Keywords may sometimes specify vector data, i.e., multiple values for successive entries in a curve or array. When a vector keyword is specified,

the data is entered beginning at the first location in the array. Optionally, the vector keyword may be subscripted, so that the values are loaded into the array beginning at a specified location.

A subscript is specified by enclosing it within square brackets []. Some keywords allow double subscripts to indicate a matrix of rows and columns. In such cases, there are two sets of brackets [row][column]. For example: capacity stratified by lanes (row) and spdclass (column). The row index sets the row where the data is to load and the column index sets where in the row the data loading is to begin. If there is no column designation, it is assumed to be one. One is the minimum value for rows and columns. If there is more input data than is allowed in a row, the data spills into the next row (beginning at that row's column 1), but it will not fill beyond the end of the array. In certain cases, three-dimensional arrays are allowed, however they are rare. They will be more fully defined in the specific module documentation. Some valid keyword statements are given below:

LINKI= LINKI[3]= NOX[2][7]= NOX[3]= ; single value format
VAL=10,20,30,35,40,50 ; VAL[1]=10, VAL[2]=20, …, VAL[6]=50
VAL[55]=770, VAL[83]=1200,1250 ; VAL[83]=1200, VAL[84]=1250

VAL(2), for example, is not a valid statement because the subscript must be in brackets rather than parentheses:

Keywords for Input and Output files

Some of the most commonly used keywords are for specifying the model input and output files.

The command, FILEI (pronounced File-i) tells the module which input files to process. Following this command, a keyword could be one of the following:

- NETI (pronounced net-i), for input network
- MATI (pronounced mat-i), for input matrix
- ZDATI(pronounced z-dat-i), for input zonal data
- LINKI (pronounced link-i), for input link data

Similarly, FILEO tells the module which files to output. Following this command, a keyword could be one of the following:

- NETO, for output network
- MATO, for output matrix
- ZDATO, for output zonal data
- LINKO, for output link data

Example Script

Below is a simple example script.

```
RUN PGM=NETWORK
FILEI NETI=MY2000.ALT.NET
FILEO NETO=TOTVOL.ALT.NET
COMP TOTVOL =  V1_1 * 1.0 + ; Passenger Vehicles
               V2_1 * 1.2 + ; Small Trucks
               V3_1 * 2.5   ; Large Trucks
ENDRUN
```

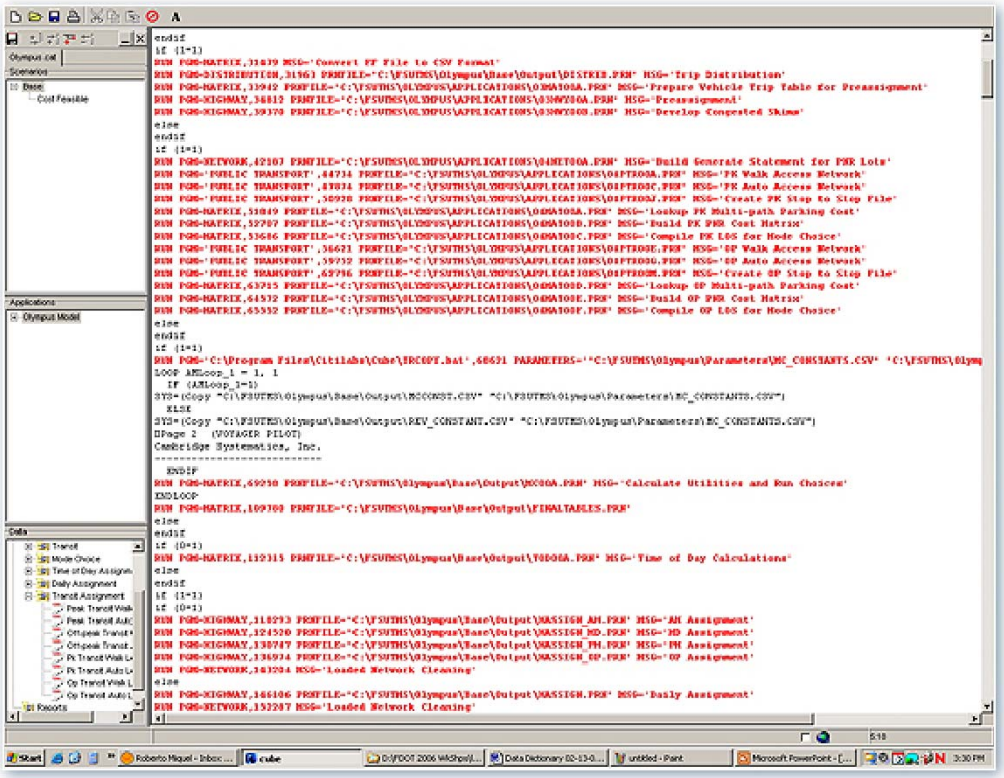
Notice that the script starts with the RUN control statement. It indicates that this script is to run the NETWORK model. The second control statement indicates that the input network file is MY2000.ALT.NET. The third control statement tells the program to send the network output data to a network output file called TOTALVOL.ALT.NET. The last statement performs a formula calculation for total volume. Notice that the statement is broken down into three lines in order to make it easy to add comments for the variables. The statement could have been written in one line as specified below:

COMP TOTVOL=V1_1 * 1.0 + V2_1 * 1.2 + V3_1 * 2.5

Finally, the last line is always ENDRUN to indicate the end of the script.

Report Files

A report file is generated for every model run. Upon completion of a model run, the Task Run Result window will give you an option to view the report file. By clicking on the View Run Report File button, a report file is shown which can assist in troubleshooting failed runs.



Exercises

For this lesson, we will complete the following five exercises:

- Export a loaded highway network to a link shape file
- Conduct a selected link analysis using the Scenario Manager
- Conduct a selected link analysis by using a path file instead of the Scenario Manager
- Review turn volumes at intersections
- Create a New Application

We will now start the first exercise. Again, it is to export a network to a link shape file. As usual, our first step is to navigate to the Olympus Model. In order to do this, click on the FSUTMS Launcher Icon on the desktop. Select Statewide and Training Models on the FSUTMS Welcome screen. Select the FSUTMS/CUBE Olympus Training Model.

We are now in Cube with the Olympus Model opened. We will now open the loaded highway network by going to the Data window, double-clicking on Outputs, double-clicking on Assignment and, finally, double-clicking on the Loaded Daily Network file to open it.

We will now export the network to a link shape file. In order to do this, click the File drop-down menu. Go down the menu list to select the Export menu. This will open a file export dialog box. We would like to save the exported files to the Media file folder under the Olympus folder. We will navigate to this folder by going up one level to the Base folder and then going up one more level to the Olympus folder. Now, double-click the Media folder. Select Link Shape Files from the Save as Type window. We will use the same name from the original network file. Click on Save to save the link shape file.

We will now check to make sure that the link shape file has been created. We will do this by using Windows Explorer. Press the Windows key and the E key simultaneously to activate Windows Explorer. Now, we will navigate to the Media folder where you have saved the files. Select drive C, select FSUTMS, select General, select Olympus and then select Media. You should see three files for the link shape file layer.

To close out the Loaded Network file, click on the Close button in the inside top right-hand corner. Click on the Close button in the outside top right-hand corner. Click Yes to close all

windows. Finally, close the FSUTMS Launcher by clicking the Close button in the top right corner. This completes the first exercise.

We will now start the second exercise. The objective is to learn to conduct a Selected Link Analysis using the Scenario Manager.

Just like in the first exercise, we will open the Olympus Model. Click on the FSUTMS Launcher icon on the desktop. Now select Statewide and Training Models on the FSUTMS Welcome screen. Finally, select the FSUTMS/CUBE Olympus Training Model.

We are now in Cube with the Olympus Model opened. Open the Scenario Manager for Base by double-clicking on it. Click the box next to Trip Assignment under Please Select Model Steps. Make sure all other steps are unchecked.

Click the box next to Conduct a Select Link Analysis under Special Applications. For this exercise, we will use the default link of 2103-2105*. Note that the asterisk after the link number is to indicate to Cube that we want to include both directions of the link. Click Run to run the selected link analysis.

Next, we will open the loaded network. After the task run is completed, click OK in the Task Run Result window. Then click on Close to close the scenario manager.

We will now open the loaded highway network in the Data window. Double-click on Outputs. Double-click on Assignment. Double-click on the Loaded Daily Network file to open it. The Network file is open. Now, we will create a multi-bandwidth map to show the selected link results. With the loaded network opened, click on the Post drop-down menu. Go down the menu list to select the Multi-Bandwidth menu item.

Select the SELECT_LINK variable from the Attributes pull-down menu. This represents the selected link volumes by direction. Click OK in the Highway Layer Link Band Width Settings window. This will display bandwidths which show the amount of trips on each link that go through to the selected link. The thicker the bandwidth, the higher the volumes.

To view the link that was selected, click on the Layer Control button. Double-click on the highway load layer in the Layer Control window. Make sure the check box for link Color is checked. Select 3 from the drop-down list next to Color. Click the Change button next to it. This opens the Link Color Specification dialog box. Click Append on top. Type in A=2103 && B=2105 in the Criteria box. Click on All Done. The selected link is now highlighted in red.

To close out the Loaded Network file, click on the Close button in the inside top right-hand corner. Click yes to save changes. Click on the Close button in the outside top right-hand corner. Click Yes to close all windows. Click Yes again to save changes. Close the FSUTMS Launcher by clicking the Close button in the top right corner. This completes the second exercise.

We will now start the third exercise. In this exercise, we will again perform a Selected Link Analysis. But instead of using the Scenario Manager, we will use the Path File.

Again, we will use the Olympus Model. Click on the FSUTMS Launcher icon on the desktop. Now select Statewide and Training Models on the FSUTMS Welcome screen. Finally, select the FSUTMS/CUBE Olympus Training Model.

We are now in Cube with the Olympus Model opened. Now, open the Scenario Manager for Base by double-clicking on it. Make sure only the Trip Assignment model step is checked. Next, uncheck the box for Conduct a Select Link Analysis. Click Next to go to the next page of the Scenario Manager dialog box.

Click the box next to Create a Path File under Path File. To save disk space, the path file is normally not created. Click Run to run the selected link analysis.

Once the model run has successfully completed, click OK in the Task Run Result window. Close the Scenario Manager.

We will now open the loaded daily network in the Data window. Double-click on Outputs. Double-click on Assignment. Double-click on the Loaded Daily Network file to open it. The next step is to open the Path File. In order to do this, click the Path drop-down menu and select the Use Path File menu item.

This will open the Open Highway Path File dialog box. Navigate to the Base\Output folder. Select the HIGHWAY.PTH file and then click Open to open it. Click OK in the Information window.

We will now display the bandwidths for volumes. On the top of the map, choose Selected Links from the Mode drop-down list in the Path File interface. Type in L=3355-3377* in the Selected Links/Nodes edit box. Click on the Display button. This will take a little while to run. After some time, the bandwidths will be displayed on the screen.

To close out the Loaded Network file, click on the Close button in the inside top right-hand corner. Click on the Close button in the outside top right-hand corner. Click Yes to close all windows. Click Yes again to save changes. Close the FSUTMS Launcher by clicking the Close button in the top right-hand corner. This completes the third exercise.

We will now start the fourth exercise. The purpose of this exercise is to learn how to view the turn volumes at an intersection. We will again do this exercise using the Olympus Model. As usual, click on the FSUTMS Launcher icon on the desktop. Select Statewide and Training Models on the FSUTMS Welcome screen. Select the FSUTMS/CUBE Olympus Training Model. We are now in Cube with the Olympus Model opened. In the Data window, double-click on Outputs. Double-click on Assignment. Double-click on the Loaded Daily Network file to open it.

We will now try to view the turning volumes at a particular intersection. In order to do this, click on the Intersection drop-down menu and select the menu item called Open Voyager/TP+ Turning Volume File. This will open the Open Turn Volume File dialog box. In this dialog box, navigate to the Base\Output folder. In the Output folder, look for the TURNS.TRN file. Click it.

Click Open. This will close the dialog box. Now, click on an intersection for which you want to view the turning volumes. This will bring up a Highway Nodes window showing the node attributes.

Next, click on the Intersection drop-down menu again. This time, select the View Voyager/TP+ Turning Volumes menu item. This will open a dialog box that shows all the turning volumes at the intersection in a from-node-to-node table. Each table cell gives the turning volume for a particular movement. Click on each cell to see the links and nodes that make up the turning movement. Click Close when done.

To close out the Loaded Network file, click on the Close button in the inside top right-hand corner. Click on the Close button in the outside top right-hand corner. Click Yes to close all windows. Click Yes again to save changes. Close the FSUTMS Launcher by clicking the Close button in the top right corner. This completes the fourth exercise.

In the last exercise, we will create a new model application. On the desktop, click the Cube icon. Click the Cancel button to start a new application. You are now in Cube. Click the New File icon on top and select New Catalog. This will open the New Catalog File dialog box. Navigate to the C:\FSUTMS\Test Model folder. Enter TestModel as the name for the new catalog file. Click Save. Note that all input files for this exercise can be found in the C:\FSUTMS\Test Model folder.

Click the New File icon again. This time, select New Application. This will open the Application Information dialog box. Name the application Test1 in the Application Group Name edit box. Give the application an Application Group Code of 01. Make sure Voyager is the Application Group Type. Click OK.

Navigate to the C:\FSUTMS\Test Model folder and save the application as Test100.app Notice that the base year "00" is automatically added to the application name that you just entered. Next, we will set up the Highway step. Click on the Program drop-down menu. Select Passenger Forecasting. Select Voyager and then Highway. Click the Cancel button on the Select an Item dialog box. Right-click on the Network File input box and select Link to and then Link to File. This opens the Link to File dialog box. Click the UNLOADED_00A.NET file and click Open.

We will now repeat the same to open two more files. First, right-click on the Turn Penalties input box and select Link to and then Link to File. Click the TURN.PEN file and click Open. Next, right-click on the Script File input box and select Link to and then Link to File. Click the HWYPATH.S file and click Open. Next, we will start to link some output files. Right-click on the Matrix File 1 output box and select Link to and then Link to Catalog Key. Select Scenario Directory for file location. Rename the default file name to FreeSkim.MAT. Click OK. Next, we will set up the Distribution step. Click on the Program drop-down menu. Select Passenger Forecasting, and then Voyager, and then Distribution. Click the Cancel button on the Select an Item dialog box. Move the Distribution flow chart to the right of the Highway flow chart. Now, right-click on the Zonal Data 1 File input box and select Link to and then Link to File. Click the PANDA_00A.DBF file and click Open. Similarly, right-click on the Lookup File 1 input box

and select Link to and then select Link to File. Click the FF.CSV file and click Open. Again, right-click on the Script File 1 input box and select Link to and then Link to File. Click the DISTRIB.S file and click Open.

For Distribution output files, first, right-click on the Matrix File 1 output box and then select Link to and then Link to Catalog Key. Select Scenario Directory for file location. Name the file PSNTRIPS.MAT. Click OK. Next, we will link the two matrix files in the Highway and Distribution steps. In order to do this, click on the Matrix File 1 output box for the Highway step, drag the cursor to the Matrix File 1 input box for the Distribution step. The skim file output from the Highway step should now be connected to the skim file input for the Distribution step.

Next, we will set up a File Conversion step. Click on the Program drop-down menu, select Passenger Forecasting, and then Voyager, and then Matrix. Click the Cancel button on the Select an Item dialog box. This adds the Matrix flow chart. Now, click on the Matrix File 1 output box from the Distribution step and drag it to the Matrix File 1 input box from Matrix. The trip table file output from Distribution should now be connected to the trip table file input for Matrix. Next, right-click on the Matrix File 1 output box for Matrix and select Link to and then Link to Catalog Key. Select Scenario Directory for file location. Name the file PSNTRIPS.DBF. Click OK.

Next, double-click on the Script File input box for Matrix. Add a comma at the end of the file output line and then hit Enter on your keyboard. Now, we will add a line as follows:

```
MAXFIELDS=3, MO=1, FORMAT=DBF, PATTERN=IJ:VM, FIELDS=4,4,6,0
```

Next, we will add another line below the file input line, as follows:

```
FILLMW MW[1]=mi.1.1
```

Click the inside Close button to close the script file. Click Yes to save the changes.
Next we will add the new application to the catalog. In order to do this, first click save. Then right-click within the Applications window and select Add Application from the menu. Click the Test100.app file, click Save.

Now, click on the Test-1-0-0 application within the Applications window. Click on Base to open the Scenario Manager. This opens the Scenario dialog box. Enter C:\FSUTMS\Test Model\Base for OUTDIR. Enter 653 for ZONESA (read as ZONES-A)

- 5 for TERM10
- 3 for TERM20
- 1 for TERM30
- 2 for TERM40
- 1 for TERM50
- 0.05 for C-TOLL
- 1 for PEN-SET
- 3 for AVEZONE, and

- 99 for ATITER
- Click Run to run the Test Model. Click OK when the run is completed.

You may review any of the outputs by clicking on any of the output boxes in the application manager. For example, clicking on the Matrix File 1 output box will open the free-flow skim matrix file. This completes the fifth and last exercise of this lesson.

Summary

This is the end of Lesson 11. In this lesson, we covered the following four major topics:

- Exporting files
- GIS Tools
- Selected Link and Selected Zone Analyses,
- Scripting

We have completed a total of five exercises. The next and final lesson of this workshop will be on traffic impact analysis.

LESSON 12: TRAFFIC IMPACT ANALYSIS

Lesson Goals

Welcome to Lesson 12. In this lesson we will learn what traffic impact analysis is and why it is conducted. We will introduce the different methods of trip generations in FSUTMS and ITE Trip Generation manual. We will also discuss alternate methodologies associated with performing a traffic impact analysis, and the advantages and disadvantages of each methodology. Finally, we will complete a series of six exercises.

Traffic Impact Analysis

What is Traffic Impact Analysis? Traffic impact analysis is a process used to measure the potential burden of a proposed development on the affected transportation infrastructure. Because new development can severely impair the performance of the transportation network, a traffic impact analysis is needed to facilitate planning efforts and to ensure that growth does not exceed the ability of the transportation network to serve such growth. In Florida, a traffic impact analysis may be performed under one or more of the following three processes:

- Proportionate share
- Concurrency, and
- Developments of Regional Impact, or DRI.

Proportionate Share

The purpose of proportionate share is to assess the impact of a proposed DRI to the region's infrastructure in order to identify the amount to be paid to mitigate that impact. Proportionate Fair Share is a separate designation applicable to sub-DRI developments that fail concurrency.

A sub-DRI here is defined as a development under a larger DRI development. Proportionate Fair Share enables the development to continue by allowing the developer an opportunity to offset the impact of the development by contributing to the improvement of the affected infrastructure. All local jurisdictions were required to adopt ordinances governing the Proportionate Fair Share process by December 1st, 2006.

It should be noted that proportionate fair share payments ate separate payments from impact fee payments. Impact fees are imposed to replace capacity utilized by growth and to provide funding for long-range transportation plans. Some jurisdictions allow reduced impact fees if a developer is already assessed a proportionate fair share.

Concurrency

The purpose of concurrency is to ensure that there is sufficient capacity to meet new growth. Concurrency became law in Florida in 1985 through Florida Statute 163.3180. The law requires that local governments define adequate levels-of-service and that a permit cannot be issued if a new development fails to meet concurrency. Special exceptions may be made to this

requirement for certain areas that have been designated as "Transportation Concurrency Exemption Areas" or through proportionate fair share as described above.

Developments of Regional Impact (DRI)

A DRI study is needed when a development surpasses a certain threshold of intensity that is considered to have an impact at a regional level. DRI thresholds for residences are established based on county population. DRI thresholds for other land uses differ based on land use. A DRI study must undergo review by Regional Planning Councils and other local and regional agencies.

Internal Project Trips

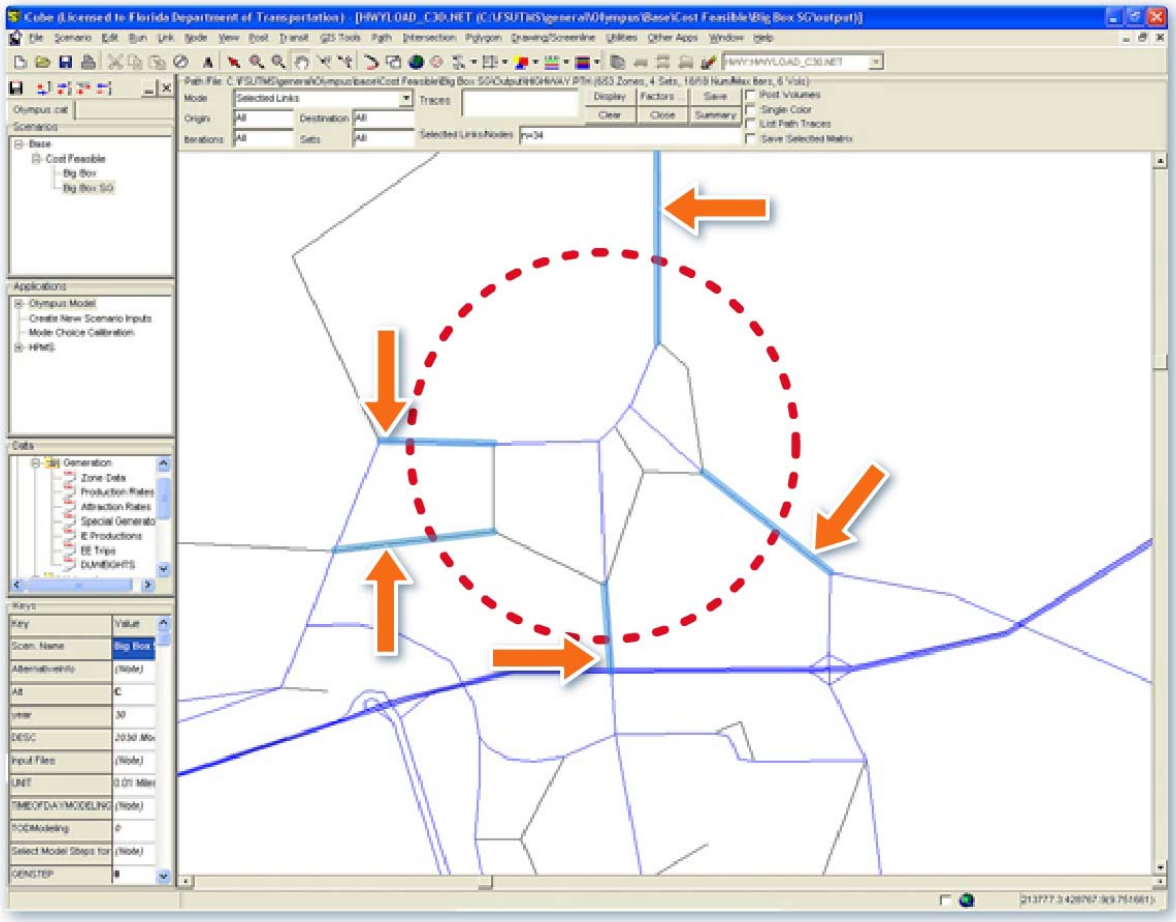
In traffic impact analysis, trips are divided into internal and external project trips. Internal project trips are trips that have both of their origin and destination within the zones that represent the project site. These trips travel on facilities within the zones to serve the internal needs of the project site. They are generally referred to as internal capture. The internal capture should be calculated using ITE methodologies to be explained later this lesson. They are not the focus of modeling efforts for analyzing traffic impact.

External Project Trips

What about external project trips? External project trips are trips that have one "trip end" inside a zone that represents the project site, and one trip end in a zone outside of the project site. These trips travel on facilities that serve travel needs outside of the project area. They can be identified by using a cordon line to select roadway segments/highway links that enter and leave the project site. Modeling efforts to analyze traffic impact should focus on replicating ITE external project trips.

Cordon Lines

As mentioned, cordon lines are used to define the area of a project site. They are imaginary lines that cordon around the site intersecting all facilities entering and leaving the site. A project area must be defined to identify the external trips. The total number of external trips involved in a project site can be obtained by summing the number of trips generated by the project site traveling on each of the links intersecting the cordon. In this example, the dashed circle represents a cordon around a proposed development site. The arrows point to the links that intersect the cordon.



Why Use Models for Traffic Impact Analysis?

There are several reasons why it will be advantageous to use a model to perform a traffic impact analysis. First and foremost, the use of a model allows the impacts of the proposed development to be placed in the context of an integrated transportation network. This allows traffic from the proposed site to be measured against traffic generated from developments all throughout the region covered by the model. The distribution and assignment of trips are then carried out on an integrated model network. This process minimizes any potential bias that may result from a manual procedure. Using a model also reduces the level of effort involved in tracing the site's impact beyond the immediate area of the site. In addition, because the datasets used in a model are either developed or adopted by the local MPO, they can better reflect the level of growth in the region and include the planned improvements to the transportation network.

Differences between ITE and FSUTMS

There are significant differences in the methodologies proposed by ITE for calculating trips and those used with FSUTMS models. In the next few slides, we will discuss these differences in terms of their trip rates, trip calculations, and land uses.

ITE Trip Rates

ITE trip rates are published in the Trip Generation manual. ITE trip rates are provided in vehicle trips for daily and various peak-hour conditions. These rates are derived from counting vehicles entering and leaving a particular land use. The traffic counts for each individual land use were collected at multiple locations throughout the country. The counts from different locations were then averaged to get the average trip rates for each land use. Where the number of locations for a land use is sufficiently large, a regression equation that expresses the average number of trips as a function of the land use intensity is also provided. Depending on the land use type, the intensity can be expressed in terms of number of dwelling units, number of persons, number of employees, number of acres, number of vehicles, and so on.

FSUTMS Trip Rates

In contrast to ITE trip rates, trip rates in FSUTMS are provided in person trips instead of vehicle trips. Trip rates in FSUTMS are commonly derived from household travel surveys and personal trip diaries. These rates are a function of socioeconomic variables, which may include:

- Population, dwelling units, vacancy rates, and lifestyle cohorts
- Income, automobile ownership
- Employment, schools, and special land use

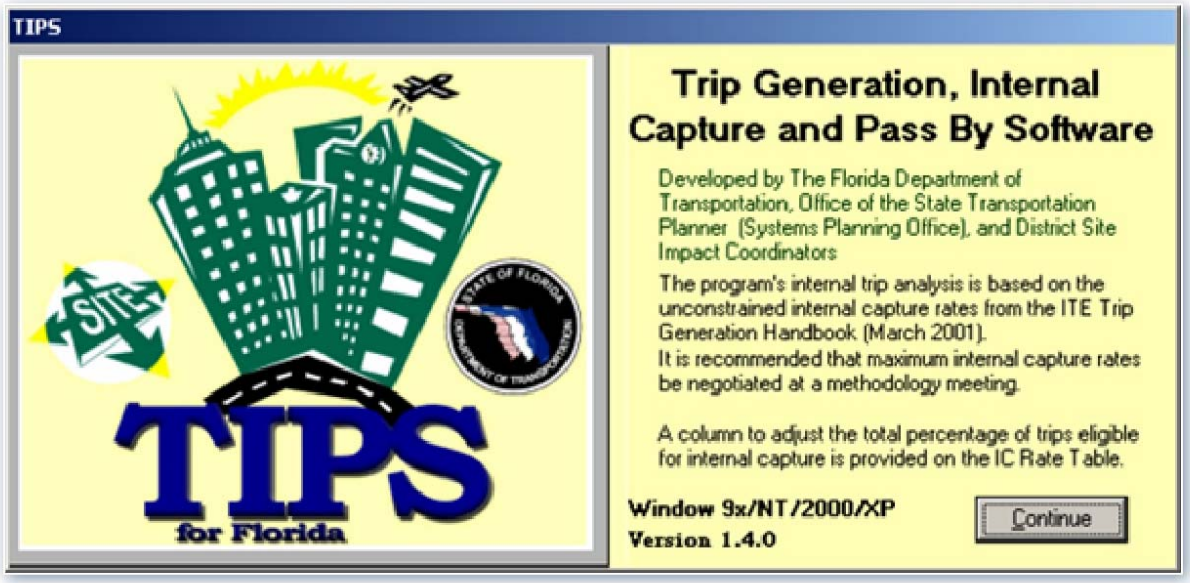
ITE Trip Calculations

With the ITE Trip Generation manual, the trips for a proposed land development are either obtained by multiplying the level of land use intensity with the average trip rate or by entering the level of land use intensity in an equation, if one is provided. Simple trip calculations may be done with a calculator or pen and paper, but more complex projects may require a spreadsheet or some Trip Generation software. As part of the trip calculations, internal capture is estimated if multiple land uses are being considered for a project.

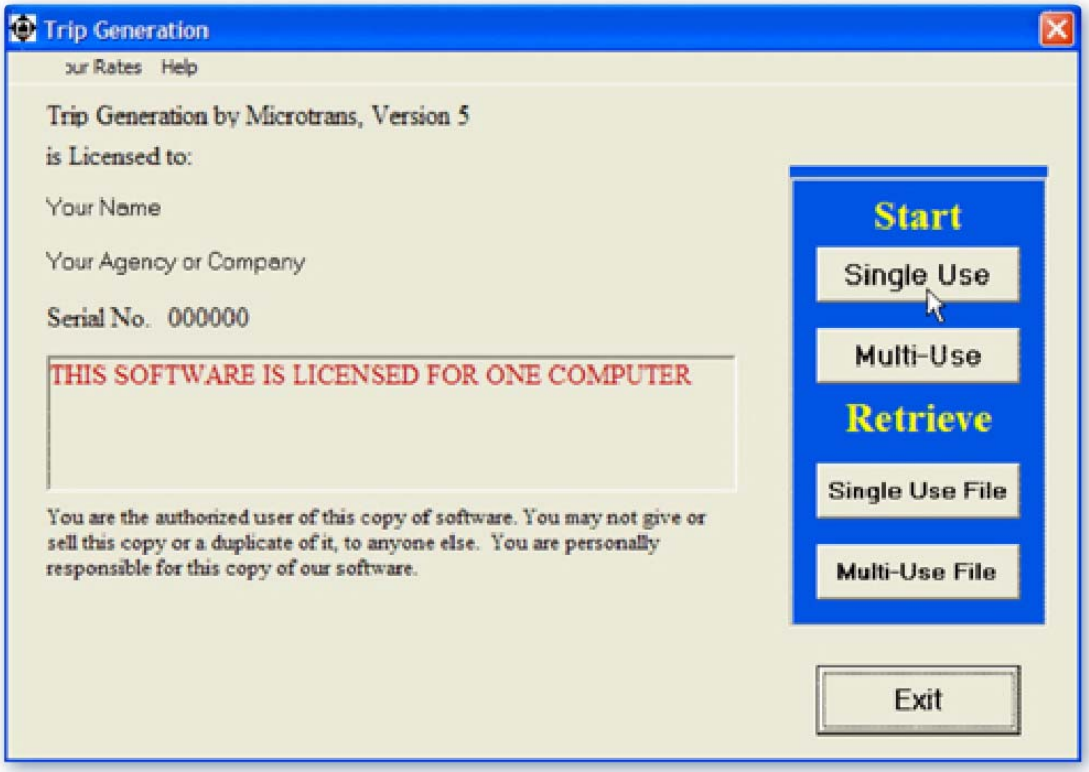
ITE Trip Calculation Software Packages

Some software packages are available to perform trip calculations based on ITE Trip Generation manual. One of these packages is the TIPS program developed by the Florida Department of Transportation.

TIPS is an acronym for Trip generation, Internal capture, and Pass-by Software. The install package can be downloaded from the following page:
http://www.dot.state.fl.us/planning/systems/sm/siteimp/tips.shtm



You may click on the link to open the page. Click Next to go to the next slide. Another software package is called Trip Generation, developed by Microtrans. This software is available for purchase at: http://www.tripgeneration.com/about.htm. Again, you may click on the links above to visit the page. Click Next to go to the next slide.



FSUTMS Trip Calculations

In FSUTMS, trip generation, along with trip distribution and trip assignment, is conducted automatically using the modeling software. The model uses a set of specialized mathematical models for trip calculation. Trip generation is based on both cross-classification with calibrated trip rates for trip productions and regression equations for trip attractions. The studied site is impacted by the trip-making behavior of all other land uses in the model

Land Uses

ITE includes dozens of distinct land use categories. These land uses are organized according to their intensity and function. FSUTMS, on the other hand, typically includes only three production land uses and four attraction land uses. The three production land uses are single-family dwelling, multi-family dwelling, hotel-motel units, and the four attraction land uses are industrial employment, service employment, commercial employment, and school enrollment. Also, in FSUTMS land uses are aggregated and combined into zones.

FSUTMS Methods for Traffic Impact Analysis

Two general methodologies can be used in FSUTMS to perform traffic impact analysis. They are the special generator method and the link volume factor method. Each method has its advantages and disadvantages. Both methods require a combination of ITE and FSUTMS methodologies in order to conduct a traffic impact analysis. We will look at each of these methods in the next few slides.

Special Generator Method

The special generator method works as follows. Step 1 is to calculate ITE external trip generation outside the model. In step 2, input the ITE trips into the special generator file in FSUTMS for the zone(s) corresponding to the development site. Step 3 is to allocate trip percentages into the trip purpose categories in the special generator file. In step 4, you factor the ITE vehicle trips to the person trips. Step 5 is to run the model. Step 6 is to compare ITE trips to the loaded network link volumes corresponding to the links at the site cordon. In step 7, we adjust the trips in the special generator file as necessary and rerun the model. This may involve increasing the number of trips if the model trip volumes at the site cordon are lower than the ITE trips, or decreasing the number of trips if the model trip volumes at the site cordon are higher than the ITE trips. This step is repeated until the model volumes are greater than or equal to the ITE trips. The next step, step 8, is to conduct a selected zone analysis of the zone(s) corresponding to the development site in order to trace trips throughout the network. Finally, the final step is to take the results from the model and continue with the analysis using established practices.

Advantages of Using Special Generator Method

The main advantage of using the special generator method is that it simplifies the analysis process because the appropriate number of ITE trips interacts dynamically with the background

traffic generated by the model. Also, because special generators are a direct input for the number of trips, there is no need to develop socio-economic data to represent the site. Note that these trips will still need to be split into the appropriate trip purpose categories by the analyst

Disadvantages of Using Special Generator Method

The main disadvantage of using the special generator method is that it will bias the trip distribution because of the uneven nature of FSUTMS and ITE trip generation methods. Another disadvantage is that sites being studied may produce or attract significantly more or fewer trips than similar land uses of similar intensity in the modeled study area. Also, larger models will take more time to run, which make iterating special generator trips more difficult and time consuming.

Link Volume Factor Method

The link volume factor method involves the following steps. The first step is to estimate the socioeconomic data based on the developer specifications of the project. In this step, for persons per dwelling units and employees per 1,000 square feet, use only the rates that are acceptable to the reviewers. In step 2 we input the socioeconomic data that represent the project into the zonal data file. The next step is to run the model. In step 4, we conduct a selected zone analysis of the zone(s) corresponding to the site and then save the resulting data to the loaded network. These are the project trips. In Step 5 we identify an external cordon around the development site. Any project trip that passes through a link that intersects with the external cordon is an external project trip. In Step 6, we calculate the total number of external project trips. In Step 7 we calculate the percent distribution of external project trips by dividing the number of project trips on each link of the network by the total number of external project trips. Use an off-model technique to calculate the total number of ITE external project trips for the site. In Step 8, we factor the total number of ITE external project trips by the link distribution percentages calculated earlier for each link in the loaded network. In step 9, we subtract the project trips (selected zone trips) from the total volume to derive the background traffic. Finally, we take the results from the model and continue with the analysis using established practices.

Advantages of Link Volume Factor Method

The main advantage of using the link volume factor method is that the trip generation will be consistent among all zones throughout the model. This eliminates any biases in trip distribution. In addition, sites being studied will produce or attract a similar amount of trips as similar land uses of similar intensity in the modeled study area. This removes the need to conduct iterative adjustments to the model's trip generation, saving time and effort with larger models.

Disadvantages of Link Volume Factor Method

The disadvantage of the link volume factor method is that the final project trips, after the ITE trips have been factored by the link distribution percentages, may not be consistent with the modeled trip generation. Accordingly, the resulting trip tables will not match the ITE trips. Also, modeled capacity constraints may not be consistent with ITE project trips. This means that

project traffic may not be accurately impacted by congestion during highway assignment. Another disadvantage is that the socioeconomic data must be estimated by applying rates to data, that are typically provided by the developer. These estimates may not accurately reflect the real development pattern of the site. One of the reasons is that data provided by developers are typically not complete from a modeling perspective. As such, the analyst is required to make assumptions based on existing model data.

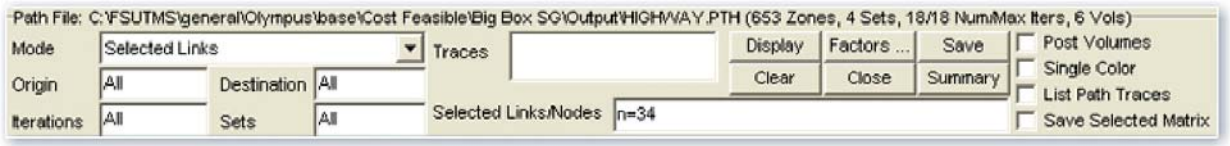
Land Use Conversion Rates for Traffic Impacts

Data for coding a site into the model may not be available in a format relevant to the model's structure. Developers typically provide data on proposed developments in terms of dwelling units for residences and square footage for employment centers. Local sources, such as MPOs, may have developed conversion rates for their areas in terms of persons per dwelling unit for residences or number of employees per square footage for commercial properties. If local data are not available, the following rates may be used. Click Next when you are ready to go to the next slide.

- Single-Family Dwelling Units: 3 persons per DU
- Multi-Family Dwelling Units: 2 persons per DU
- Office: 4 service employees per 1,000 sq ft
- Hospital: 3 service employees per 1,000 sq ft
- Retail <200K sq ft: 3 commercial employees per 1,000 sq ft
- Large Retail: 2 commercial employees per 1,000 sq ft
- Industrial: 2 industrial employees per 1,000 sq ft
- Warehousing: 1 industrial employee per 1,000 sq ft
- Hotel: 1 service employee per room

Computing a Link Volume Factor

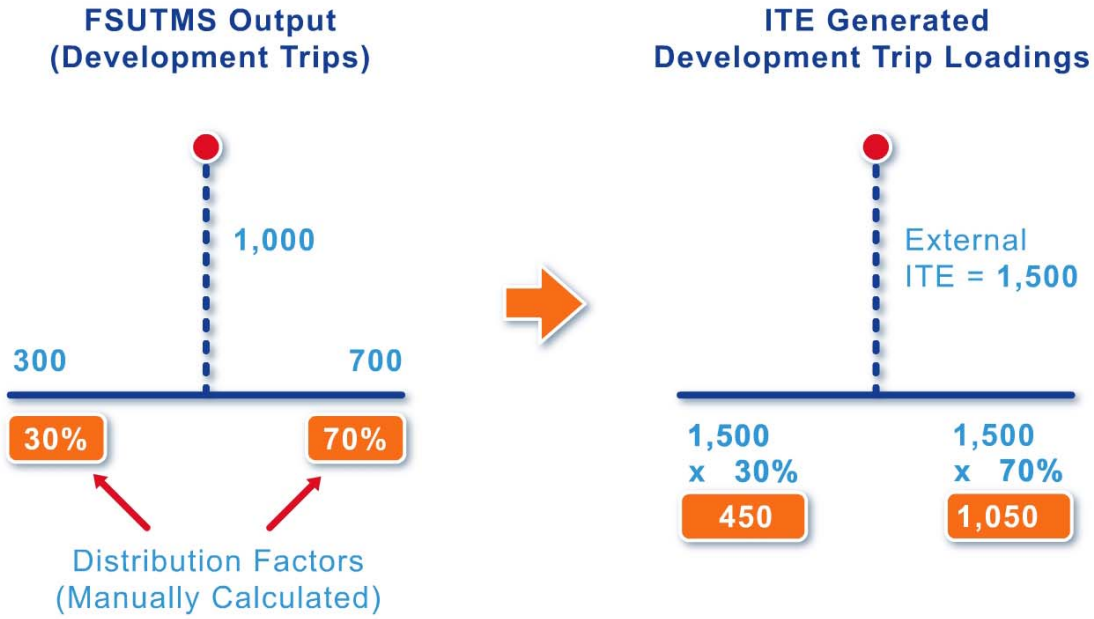
In order to calculate a link volume factor, it is necessary to first conduct a selected zone analysis using either a path file generated by the model or by modifying the assignment script.



Once the selected zone volumes for the site have been saved to the loaded network it will be necessary to divide the selected zone volume by the total external volume for the site. To calculate the link volume factor per link, you can use the following formula using the Link Attribute Calculator in Cube:

$$\text{Link Volume Factor} = \frac{\text{Selected Link Volume}}{\text{Total External Project Trips}}$$

Once the link volume factor has been calculated, it is used to factor the ITE trip generation volume for the site. In this example, a total of 1000 external project trips are generated by the FSUTMS model. We found in the FSUTMS assignment output that 300 of these trips turn right and 700 turn left. Using the link volume factor equation, we can determine that 30% and 70% as the percentages of trips turning right and left. We can then apply these factors to the ITE generated trips. In this particular example, we have a total of 1500 ITE generated trips. Applying the two calculated factors will give 450 of right-turning trips and 1050 of left-turning trips. Next, we will complete an exercise that involves a DRI project.



Exercises

This exercise will demonstrate the use of a FSUTMS model as it relates to a traffic impact analysis. This exercise will consist of adding three new TAZs to the model with a supporting roadway system. These TAZs will represent the development of an apartment complex, an office park, and a shopping center. Once the TAZs with their accompanying data and supporting network are added to the model, we will run the model and conduct a selected zone analysis to measure the impact to the study area.

Specifically, we will be completing the following exercises:

- Create a new scenario
- Edit the network
- Update the socioeconomic data
- Run the model
- Use the path file to conduct a selected zone analysis
- Calculate percent link distribution of project trips

As usual, we first navigate to the Olympus Model. Click on the FSUTMS Launcher icon. Select Statewide and Training Models on the FSUTMS Welcome screen. Select the FSUTMS/CUBE Olympus Training Model.

Next, we will create a new scenario for this exercise. In order to do this, right-click on the catalog file name tab and select Properties. This will open the Catalog Properties dialog box. Click the Model User tab. Select Model Applier and click OK.

Under the Scenario box click the "+" sign next to Base and right-click the mouse on Cost Feasible. Click on Add Child and type DRI and then hit enter. This will display the Scenario Properties dialog box. In the description box, type in "This is a DRI exercise". Click OK. This will open the Scenario - Cost Feasible.DRI dialog box. Change the alternative letter to B. Change the description to DRI Scenario. The model year will remain 30. Click Save at the bottom of the screen. Change the application to Create New Scenario Inputs. Click Run. Click OK. Click Close. This completes our first exercise to create a new scenario. Next we will start to edit the network.

Since for this exercise we will be adding new TAZs and their supporting highway facilities, we will need to start by editing the highway network. Go to the Data window. Double-click Inputs. Double-click Network. Double-click Input Network. This opens and displays the highway network. Check the file name at the top of the screen and make sure that the file path reads as C:\FSUTMS\general\Olympus\Base\Cost Feasible\DRI\Input.

Once we are certain that the network file is the copy that we just created for this scenario, we are ready to add our new TAZs. We will need to first add the nodes for the TAZ centroids. Click the Zoom-in tool button. Zoom into the area where you need to add the zones.

To make this process easier, we can change the symbols for the nodes to make the nodes easier to see. In order to do this, first, click on the Node/Point Color icon on the toolbar. This opens the Highway Network Node Color Specification dialog box. Click Append on top of the dialog box. Next, change the symbol for the node to a black circle by clicking on the symbol scroll menu. Choose a symbol. Choose the black color. Change the size to 3. Click Append again and change the new symbol to a red triangle. Next, type in n<=653 under Criteria. This will limit the use of the red triangles for our centroid nodes. Click on Close. The centroid node now appears as red triangles and all the non-centroid nodes appear as black dots.

We will now begin to add our new centroid nodes. These nodes will represent TAZs 280, 281, and 282. Click on the Node drop down menu at the top and select Add. Now move the cross-hairs to the area for our new node. Left-click it. The Add New Node dialog box appears. Type in 280 for the new node number. Click OK. Node 280 now appears on the screen.

We will repeat the same process for TAZs 281 and 282. First repeat for TAZ 281. Again, repeat the same for TAZ 282. We have just added three centroid nodes. Next we will include additional highway links to represent the infrastructural support these new TAZs will require. In other words, the developer will extend currently existing facilities.

First, change your cursor back into a pointer by clicking the Arrow icon at the top of the screen. Left-click on a link from which we will extend a new link. The link should start flashing. Right click on the link. A menu should appear. Select Copy from the menu. Next, right-click again and the menu should reappear. Select Paste. The mouse cursor now turns into a cross-hair. Move the cross-hair over the southern-most node of the link we are copying. This is node 3655. Left-click and drag up toward the area. Release the left mouse button. A window will appear asking if you would like to add a new B node. Click Yes. The Add New Node dialog box appears. Type in 7004. Click OK. Repeat the same to add node 7005. Repeat the same again to add 7006. Connect node 7006 to an existing node to complete the new roadway.

We are now almost ready to add centroid connectors and attach our TAZs to the highway network. But first, we have to split some links to provide suitable locations for our centroids to connect to. We will split the links in two locations. In order to do this, left-click on link 3655-3656 north of the new zones. Next, right-click on the same link and select Split from the menu. The Split Link dialog box appears. Click OK. The cursor should now turn into a cross-hair. Move the cursor over the location where you want to split. Left-click on the location. We are asked to confirm if we want to add a new middle node. Click Yes. Type in 7007 for the new node number. Click OK.

You should now see a new node number 7007 appear on your screen along the link we just split. We will now repeat the same process to split another link south of the new zones. Again, right-click on the same link and select Split from the menu. Click OK. Left-click on the location to split. Click Yes. Type in 7008 for the new node number. Click OK.

Now that the links have been split, it is time to attach the new centroids to the highway network. In order to do this, first, close the Highway Link attribute table. Left-click on an existing centroid connector. Next, right-click on the same centroid connector and select Copy. Right-click against the background and select Paste. Now, paste the centroid connectors so that they connect the new centroids to the nodes. We will add two connectors for centroid 280. We will also add two for centroid 281. We will add just one for centroid 282.

The editing of the highway network is now complete and we can save the network by clicking on the Save icon from the toolbar at the top of the screen. Now close the network but not the program by clicking on the inside X close button in the upper right corner of the screen. Click No to choose not to save the project. This completes our second exercise on editing the network.

Now that we are done with editing the highway network, it is time to update the socioeconomic data for our three new zones. We will enter the following socioeconomic data:

Zone	Use	Rate
280	200K sq ft Shopping	2 employees/1,000 sq ft
281	120K sq ft Office	4 employees/1,000 sq ft
282	400 Units of Apartments	1.8 persons/dwelling unit

In order to do this, first go to the Data window. Double-click on Generation. Double-click on Zone Data to open the file.

Now, click the "+" icon at the top of the table to insert a record. You can use the Tab, Left Arrow, or Right Arrow keys on your keyboard to move from cell to cell.

We will now start to enter data for zone 280. For zone 280, we will enter zero for all variables other than commercial employment and total employment. The number for commercial employment should be 400. The total employment is also 400. This is calculated by multiplying the floor space of 200,000 square feet by rate of 0.002 employees per square foot. When you are done entering the data, the new row will automatically be placed at the bottom of the table.

Now we will repeat the same process for zones 281 and 282. For zone 281, the number of service employment is 480 based on the information given. The total employment number is the same. For zone 282, we assume for this example that the developer has stated that the general characteristics for the new apartments are similar to the multi-family units found in zone 77. Assume the same vacancy and auto-ownership percentages. The number of multi-family units should be 400 and the total population is 720.

Close the file by clicking the inner X close button and click Yes to save the changes. This completes our third exercise for entering the socioeconomic data for the three new zones.

In this next exercise, we will run the model with the three new zones. First, go back to the Scenario Manager window. Click the DRI scenario. Select the Olympus Model application. Click Save at the bottom of the screen. Make sure that all model steps have been selected. Click Next. Check the box for Create a Path File. Click Run at the bottom of the screen. This will run the model from beginning to end with the exception of Time-of-Day, Special Applications, and Turning Volumes. When the model has finished running, click OK. This completes this exercise, which is to run the model with the new zones.

In this exercise, we will learn to use the path file to conduct a selected zone analysis. In order to do this, first, we will open the network file by going to the Data window. Look for the Outputs folder and double-click on it. Double-click on Assignment. Double-click on Loaded Daily Net to open the loaded network file.

We will now add a link attribute where you will save the project trips. Click the Link drop-down menu. Select Attribute from the menu and select Add. Name the new attribute DRI_TRIPS. This will be a numeric attribute.

Now, we will conduct a Selected Zone analysis interactively using the Path File. Click on the Path drop-down menu. Select Use Path File. This will open the Open Highway Path File dialog box. Navigate to the folder C:\FSUTMS\general\Olympus\Base\Cost Feasible \DRI\Output. Select the file called HIGHWAY.PTH. Click Open to open the file. A small window will appear showing the information on the contents of the path file. Click OK.

Notice that a new interface has opened up at the top of the screen. This interface allows us to use the path file to conduct various analyses. Go to the area next to Mode and click Selected Links from the drop down menu.

Note that even though we are conducting a selected zone analysis, you would only be able to look at volumes from the origin to the destination if you were to choose Selected Zones. By choosing Selected Links, we will still be able to conduct a selected zone analysis and look at volume from the destination to the origin as well as from the origin to the destination.

In the area called Selected Links/Nodes type in n=280, 281, 282. This indicates that we want to see all trips going from all zones to all zones and that specifically pass through the indicated nodes. Because these nodes are also centroids, this has a similar effect to a selected zone analysis. Now click on Display. The computer will take a few minutes to process the data. Click Save to store our project volumes. Go down the list and select the attribute called DRI_TRIPS. Click OK. Click Close. Note that the numbers that are posted are the volumes throughout the network that satisfy our selection criteria. The bandwidth is scaled to provide a meaningful visual in the context of the posted volumes. This completes the fifth exercise on Selected Zone analysis using the Path File. We will start for our next exercise by continuing from here to calculate the percent link distributions of project trips.

In the final exercise, we will calculate the percent link distributions of project trips. We will need to total our project external trips. Imagine a cordon line surrounding the site. Click on the links intersecting the cordon line and check the volume. We will need to manually total the volumes found in the DRI_TRIPS attribute. We will need to total the volume in both directions and for all links that intersect the cordon line. For this example, the total project external trip number is equal to 8992.69. Due to slight differences in how we edited our network, we may arrive at a slightly different number, but the value should be similar to this. If we find that our total project external trips deviate by more than a couple of hundred trips, we may have made an error in our calculations or in your socio-economic data.

Now click the inner X close button to close the attribute table. We will need to add two more numeric link attributes: PCT_DIST and ITE_TRIPS. In order to do this, click the Link dropdown menu. Select Attribute. Click Add. Click on the link to add the attributes. Enter PCT_DIST. Select “N” for numeric attribute. Enter ITE_TRIPS. Select “N”

After the new attributes have been added, click on the Link drop down menu. Select Compute. This opens the Link Attribute Calculation dialog box. We will assume that after a thorough analysis of the ITE trip generation for this DRI that the project external trips based on ITE rates is 14,845. Click on the big box under Name field. Right-click and select Append. This opens the Insert Equation dialog box. Enter “PCT_DIST=DRI_TRIPS/8992.69”. Click OK. Click on the big box again. Enter “ITE_TRIPS=PCT_DIST*14845”. Click OK.

Click Apply. Cube will update the network and tell you the number of links that have been updated with the new attribute information. Click OK. Click the inner X close button. Click Yes to save changes to the network file. Click No to choose not to save the project file.

We now have link distribution percentages for our project external trips on our loaded network. Furthermore, we have applied our ITE generated trips to these percentages. From here you

would continue on with your traffic impact study using appropriate practices. This concludes the last and final exercise of the lesson.

Summary

This concludes Lesson 12, the final lesson of this workshop. In this lesson, we covered

- What traffic impact is and why it is analyzed
- Internal and external trips
- Differences between ITE and FSUTMS trip generations
- Different methodologies for conducting a traffic impact analysis
- Computation of Link Volume Factors

We also completed a total of six exercises.

We thank you for taking this workshop and would appreciate it if you would complete the workshop evaluation and provide your feedback to help us improve this workshop. You can access the evaluation page by clicking on the next link on the main page of this workshop.