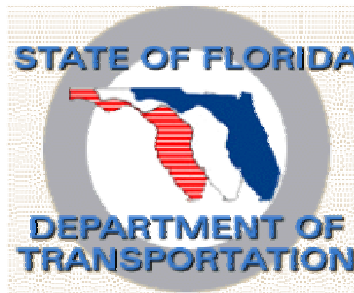


**PHASED IMPLEMENTATION OF A MULTIMODAL
ACTIVITY-BASED TRAVEL DEMAND
MODELING SYSTEM IN FLORIDA
FINAL REPORT
Vol II: FAMOS USERS GUIDE**

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Disclaimer

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TABLE OF CONTENTS

1. GETTING STARTED	1.1
1.1 What is FAMOS?	1.1
1.2 Structure of FAMOS	1.2
1.3 Using FAMOS in Conjunction with FSUTMS	1.4
1.4 Installing FAMOS	1.6
1.5 Hardware Requirements	1.7
1.6 Software Requirements	1.7
1.7 Starting FAMOS	1.8
1.8 FAMOS Main Window	1.8
1.9 Create/Open a Scenario	1.9
2. DATABASE DEFINITION	2.1
2.1 Data Requirements	2.1
2.2 Zonal Socio-economic Data	2.1
2.3 Network Level-of-Service Data	2.5
2.4 Person and Fixed Activity Data	2.6
2.5 Activity and Travel Records Data File	2.7
2.6 Structure of the Output Database: FAMOS.MDB	2.10
3. HOUSEHOLD ATTRIBUTES GENERATION SYSTEM (HAGS)	3.1
3.1 What is HAGS?	3.1
3.2 HAGS Methodology	3.2
3.2.1 Iterative Proportional Fitting (IPF) Method	3.3
3.3 Running HAGS	3.5
3.4 Viewing HAGS Output at Individual-Level	3.8
3.5 Viewing HAGS Input at Aggregate Zone Level	3.11
4. PRISM-CONSTRAINED ACTIVITY TRAVEL SIMULATOR (PCATS)	4.1
4.1 What is PCATS?	4.1
4.1.1 Generation of Activities	4.4
4.1.2 Activity Type Choice Models	4.6
4.1.3 Destination-Mode Choice Models	4.6
4.1.4 Activity Duration Models	4.7
4.2 Running PCATS	4.9
4.3 Viewing PCATS Output at the Individual-Level	4.11
4.4 Viewing PCATS Output at the Aggregate Zone Level	4.12
4.5 Viewing PCATS Output in ArcView 3.x or Higher	4.14
5. ORIGIN-DESTINATION MATRIX CREATOR	5.1
5.1 Using the O-D Matrix Creator	5.1
6. MODEL SPECIFICATION AND ESTIMATION RESULTS	6.1
6.1 PCATS Submodels	6.1
6.1.1 Time-Space Prism Vertex Models	6.1
6.1.2 Activity Type Choice Models	6.4

TABLE OF CONTENTS (continued)

6.1.3	Split Population Survival Models of Activity Duration	6.8
6.1.4	Work and School Location Choice Model	6.13
6.1.5	Mode Choice Models for Fixed Activities	6.13
6.1.6	Mode Choice Models for In-Home Discretionary Activities.....	6.16
6.1.7	Joint Destination-Mode Choice Models for Out-of-Home Discretionary Activities	6.19
6.2	Validation Results	6.25
7.	ADDITIONAL READING	7.1

LIST OF TABLES

Table 2.1	Zonal Information Data	2.2
Table 2.2	Population Data	2.3
Table 2.3	Sample Data	2.4
Table 2.4	Network Level-of-Service Data	2.5
Table 2.5	Person and Fixed Activity Information Data File	2.8
Table 2.6	Activity and Travel Records Data File.....	2.9
Table 4.1	Segmentation Adopted in Model Development	4.6
Table 4.2	Explanatory Variables of Destination-Mode Choice Model: For Workers, Non-Work Activities.....	4.7
Table 4.3	Example Explanatory Variables of Split Population Survival Models: For Workers, Shopping	4.8
Table 6.1	Stochastic Frontier Model of the Worker’s Morning Prism Origin Vertex.....	6.2
Table 6.2	Stochastic Frontier Model of the Worker’s Evening Prism Terminal Vertex.....	6.2
Table 6.3	Stochastic Frontier Model of the Student’s Morning Prism Origin Vertex.....	6.3
Table 6.4	Stochastic Frontier Model of the Student’s Evening Prism Terminal Vertex	6.3
Table 6.5	Stochastic Frontier Model of the Other’s Morning Prism Origin Vertex	6.4
Table 6.6	Linear Regression (OLS) Estimates of the Other’s Final Arrival at Home	6.4
Table 6.7	Nested Logit Model of Worker’s Activity Type Choice	6.5
Table 6.8	Nested Logit Model of Student’s Activity Type Choice	6.6
Table 6.9	Nested Logit Model of Other’s Activity Type Choice	6.7
Table 6.10	Split Population Survival Model: At-Home Non-Fixed Activity	6.9
Table 6.11	Split Population Survival Model: Out-of-Home Non-Fixed Shopping Activity.....	6.10
Table 6.12	Split Population Survival Model: Out-of-Home Non-Fixed Social-Recreational Activity	6.11
Table 6.13	Split Population Survival Model: Out-of-Home Non-Fixed Other Activity	6.12
Table 6.14	Multinomial Logit Model of Work/School Location Choice	6.13
Table 6.15	Multinomial Logit Model of Worker’s Mode Choice for Fixed Activity.....	6.14
Table 6.16	Multinomial Logit Model of Student’s Mode Choice for Fixed Activity	6.15
Table 6.17	Multinomial Logit Model of Other’s Mode Choice for Fixed Activity	6.16
Table 6.18	Multinomial Logit Model of Worker’s Mode Choice for In-Home Discretionary Activity	6.17
Table 6.19	Multinomial Logit Model of Student’s Mode Choice for In-Home Discretionary Activity	6.18
Table 6.20	Multinomial Logit Model of Other’s Mode Choice for In-Home Discretionary Activity	6.19

LIST OF TABLES (continued)

Table 6.21	Multinomial Logit Model of Worker’s Destination and Mode Joint Choice For Out-of-Home Discretionary Activity	6.20
Table 6.22	Multinomial Logit Model of Student’s Destination and Mode Joint Choice For Out-of-Home Discretionary Activity	6.22
Table 6.23	Multinomial Logit Model of Other’s Destination and Mode Joint Choice For Out-of-Home Discretionary Activity	6.23
Table 6.24	Comparison of Observed and Predicted Average Daily Trip Rates	6.25
Table 6.25	Comparison of Observed and Predicted Average Daily Fixed and Flexible Activities.....	6.25
Table 6.26	Comparison of Observed and Predicted First Home Departure Time And Final Home Arrival Time.....	6.26
Table 6.27	Mode Split Validation Results by Market Segment.....	6.26

LIST OF FIGURES

Figure 1.1	Structure and Logic of FAMOS	1.3
Figure 1.2	Using FAMOS in Conjunction with FSUTMS	1.5
Figure 1.3	FAMOS Main Window	1.9
Figure 1.4	Scenario Manager: Create and Open a Scenario	1.11
Figure 2.1	Schematic of Data Flow in FAMOS.....	2.11
Figure 3.1	HAGS Window	3.6
Figure 3.2	Zone Information Database Viewing Window	3.7
Figure 3.3	Screen Showing HAGS in Progress	3.9
Figure 3.4	Household and Person-Level HAGS Output Visualizer	3.10
Figure 3.5	HAGS Output Visualizer Window Showing Fixed Activities	3.10
Figure 3.6	Screen Showing Input Zone Data Analyzer	3.11
Figure 3.7	Screen Showing HAGS Input in Aggregate Table Format	3.12
Figure 3.8	Screen Showing Dialog Box for Choosing Variable to Display in ArcView	3.13
Figure 3.9	ArcView Display of Zonal Input Data for a Selected Variable	3.14
Figure 4.1	Example Daily Activity-Travel Pattern of an Individual Simulated by PCATS.....	4.2
Figure 4.2	Hagerstrand’s Prism	4.3
Figure 4.3	Typical Worker’s Prisms.....	4.4
Figure 4.4	Structure of PCATS.....	4.5
Figure 4.5	PCATS Main Window	4.9
Figure 4.6	Screen Showing PCATS Running	4.11
Figure 4.7	Screen Showing PCATS Individual-Level Output Visualizer	4.12
Figure 4.8	Screen Showing PCATS Output Trip Length Distribution Analyzer	4.14
Figure 4.9	Screen Showing Results of Zone Query in Table Form	4.16
Figure 4.10	ArcView Visual Display of Daily Trip Exchange Output by PCATS	4.17
Figure 5.1	O-D Matrix Creator Window	5.2

1. GETTING STARTED

This chapter helps the user get started with FAMOS version 2004.01. The chapter provides an overview of the structure and logic of FAMOS, a brief description of the capabilities of FAMOS, and instructions for installation.

1.1 What is FAMOS?

FAMOS stands for The Florida Activity Mobility Simulator.

Over the past few decades, great strides have been made in understanding the derived nature of travel demand. Travel demand is derived from the human need to participate in activities that are distributed in time and space. Models that simulate travel demand using an activity-based approach have been gaining increasing attention in recent times due to their strong behavioral foundation and intuitive theoretical appeal.

FAMOS simulates activity-travel patterns at the level of the individual decision-maker. Thus, not only is it an activity-based model system, but it is also a “microsimulation” model system. This is because activity-travel patterns are simulated at the “micro” level, i.e., at the most disaggregate level possible. By simulating activity-travel patterns at the level of the individual decision-maker, the model intends to provide a strong platform for modeling travel demand in a region along a continuous time axis.

FAMOS has been designed to work with readily available databases. The data sets needed to get started with FAMOS are the following:

- Zonal socio-economic data (commonly available with all traditional four-step models)
- Zonal-level network level of service (LOS) data (commonly available with all traditional four-step models)
- Household travel survey data set

If a household travel survey data set is not available, this users manual provides possible alternative strategies that may be used to successfully run FAMOS. These strategies are described in appropriate places within the manual.

FAMOS is a powerful activity-based microsimulation model system that simulates activity and travel patterns of individual travelers within a population along the continuous time axis. The output of FAMOS is essentially a series of activity-travel records for all people in the simulation.

These activity-travel records can be aggregated both spatially and temporally to obtain zone-level origin-destination matrices by trip purpose and time of day. These OD matrices may then be fed into any traditional travel demand modeling system for performing traffic assignment and obtaining link volumes.

Although FAMOS is quite comprehensive in its treatment of activity-travel patterns, it does not currently model:

- Freight and goods travel
- Taxi travel
- E-I and E-E travel
- Visitor/tourist travel

Information about these trips should be obtained from the traditional four-step model to augment the output obtained from FAMOS.

The current version of FAMOS has been estimated and calibrated using the 2000 Southeast Florida Household Travel Survey data set. Model estimation results and coefficients are provided in the last chapter of this users manual. Users who desire to use models customized to their own area will need to re-estimate and re-calibrate the various components of FAMOS using travel survey data collected in their own area. The modeling methodologies and estimation procedures are described in a separate set of documentation in an accompanying CD.

1.2 Structure of FAMOS

Figure 1.1 provides a broad schematic of the structure and logic of FAMOS. FAMOS includes two primary components. They are as follows:

1. *Household Attributes Generation System (HAGS)*: The Household Attributes Generation System (HAGS) is primarily a population synthesizer. Using zonal socio-economic data and household travel survey data, HAGS generates (synthesizes) households and persons within households. In addition to generating household and person attributes, HAGS also generates the agenda of mandatory or fixed activities that must be accomplished by each individual. For example, workers have to engage in work activities that generally tend to be fixed in time and space. The mandatory fixed activities are generated for each individual within HAGS. Thus, a basic skeleton around which the complete activity-travel agenda of a person will be formed is generated within this step. HAGS also includes work and school location choice models to identify the spatial locations of the fixed activities.

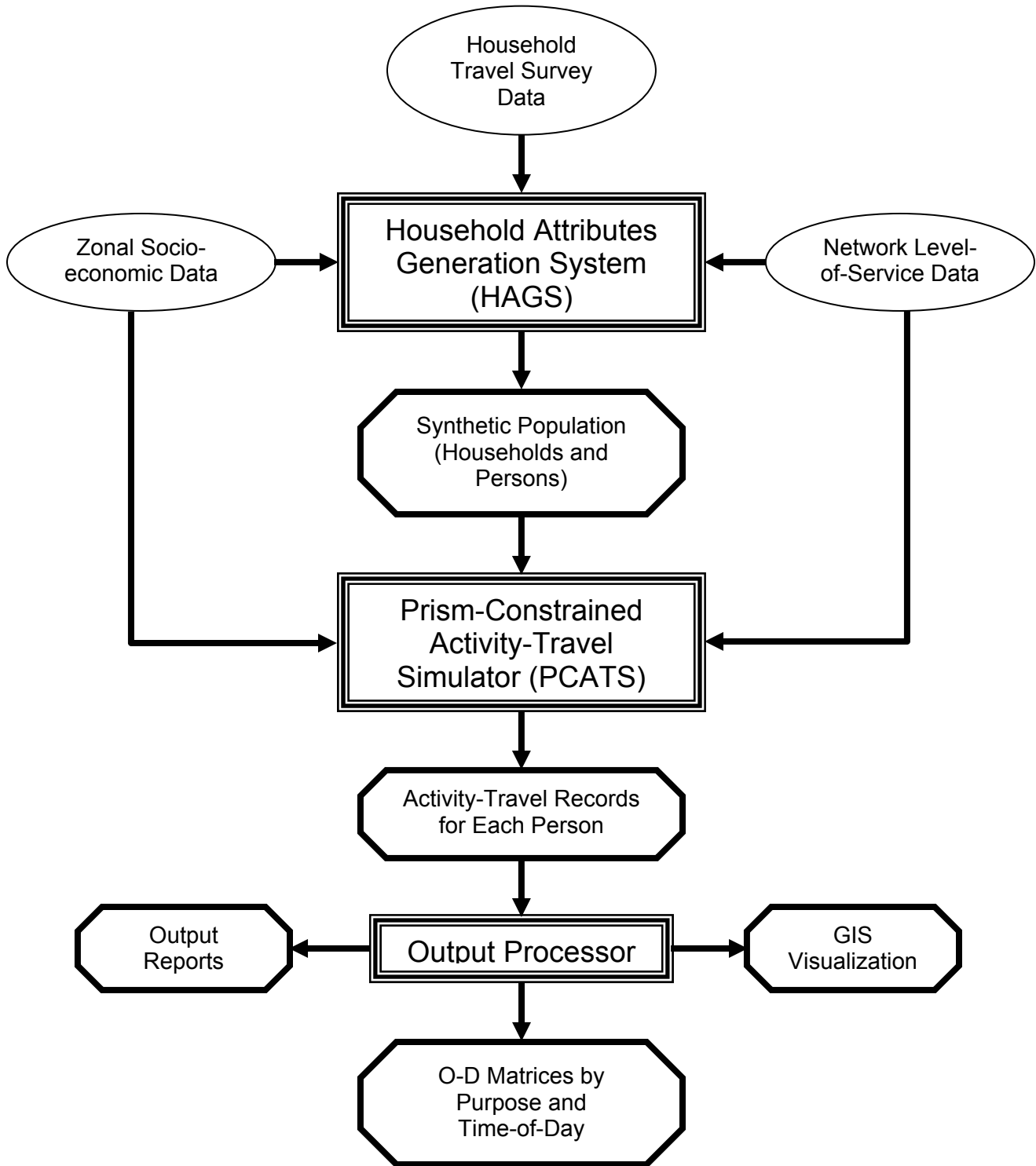


Figure 1.1 Structure and Logic of FAMOS

2. *Prism-Constrained Activity Travel Simulator (PCATS)*: The Prism-Constrained Activity Travel Simulator is a unique and comprehensive activity-based travel demand simulator that generates activity and travel records for each person synthesized by HAGS. The simulator utilizes the notion of Hagerstrand's time-space prisms to recognize the spatio-temporal constraints under which individuals must undertake their activities and trips. For each individual, PCATS determines the time-space prism boundaries and then simulates activity-travel records using a series of submodels that include activity type choice models, activity duration models, and destination and mode choice models.

Finally, FAMOS includes an output processor. The output processor is capable of aggregating the activity-travel records simulated by PCATS to generate origin-destination (OD) matrices by mode, trip purpose, and time of day. These matrices are then ready for network traffic assignment. In addition, the output processor includes a GIS visualization capability and a modest output reporter so that the user can examine trip length distributions by mode and purpose, aggregate trip rates, and overall modal splits. The output processor and report generator will be further enhanced in future versions of FAMOS.

1.3 Using FAMOS in Conjunction with FSUTMS

FAMOS is a comprehensive activity-travel simulator that can be used in a stand-alone context as long as the databases needed to run it are available. However, in order to maximize the utilization of databases currently available at most public agencies and to facilitate a seamless transition from the traditional four-step model to the new activity-based models, FAMOS takes advantage of FSUTMS databases, data preparation and computation capabilities, and network assignment routines. Figure 1.2 provides a broad schematic showing the relationship between FSUTMS and FAMOS.

To use FAMOS in conjunction with FSUTMS, the user may choose to utilize the zonal socio-economic data and the network level of service data (peak and off-peak modal LOS attributes) that is associated with the current FSUTMS model in the region. The user should prepare these databases using existing FSUTMS procedures outside of the FAMOS software environment. Thus, FAMOS has been set up to utilize existing FSUTMS databases to the extent possible. Similarly, on the output end, FAMOS is capable of providing OD matrices by mode, purpose, and time of day. These OD matrices may be fed directly to FSUTMS for network assignment. Thus, FAMOS version 2004.01 is capable of replacing the trip generation, trip distribution, and mode choice steps of FSUTMS (or any traditional four-step modeling process). In the future, a dynamic event-based network simulator will be added to FAMOS so that the network assignment step of the four-step modeling process can also be replaced by FAMOS. However,

it should be noted that the generation of network level-of-service data currently requires one to run various steps of FSUTMS including, but not limited to, HNET, TNET, DISTRIB, and MODE.

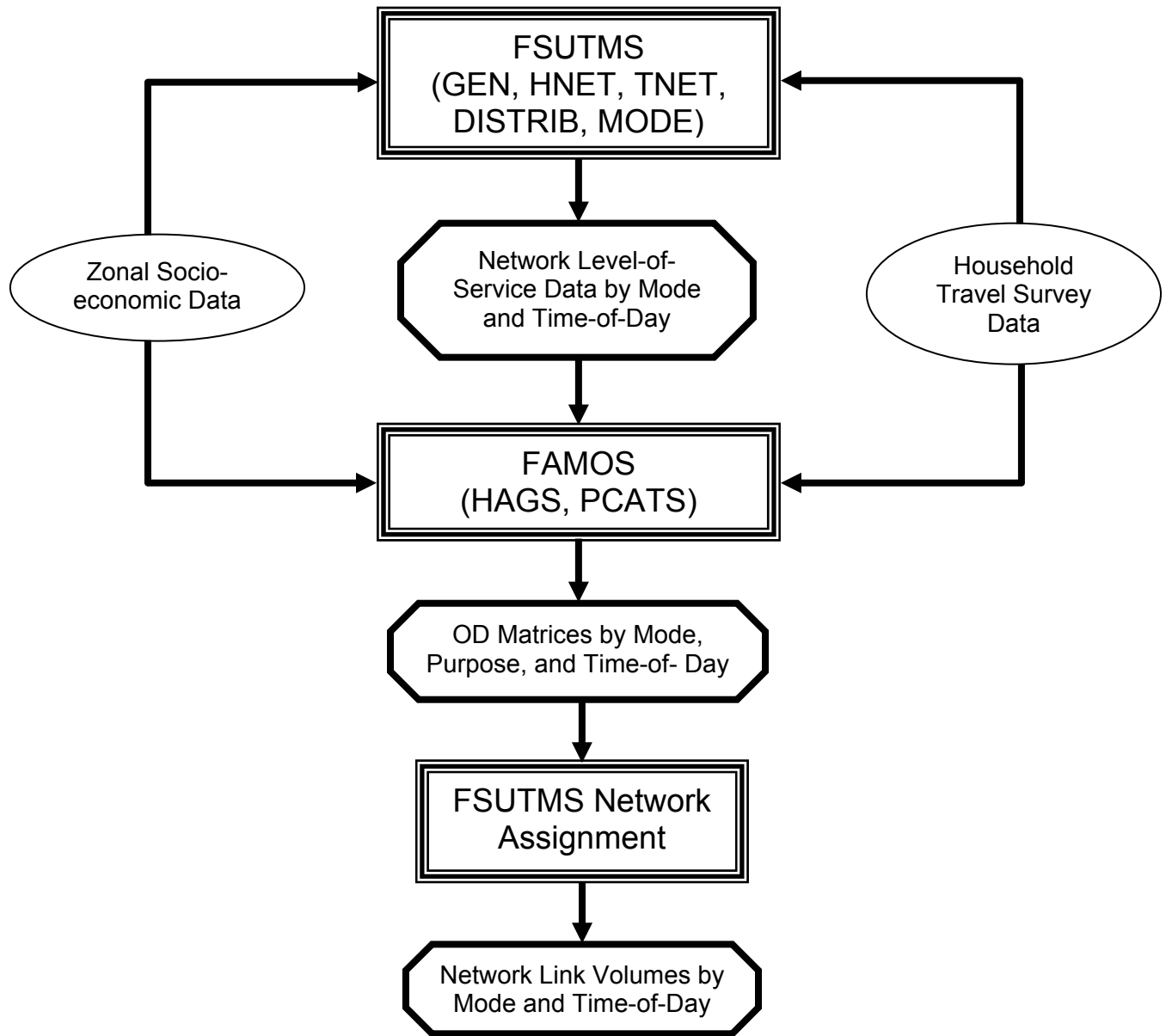


Figure 1.2 Using FAMOS in Conjunction with FSUTMS

Thus, the current version of FAMOS is complementary to, and is not a replacement for, FSUTMS. On the other hand, it should be noted that the PCATS component of FAMOS is capable of replacing the trip generation, trip distribution, and mode choice steps of FSUTMS.

FAMOS is able to simulate activity-travel patterns along the continuous time axis while accounting for the inter-dependency among trips due to trip chaining. It has been found in recent travel surveys that trip chaining (linking of trips) is very common among travelers and that trip chains are becoming increasingly complex over time. By accounting for trip chaining and recognizing the inter-dependency among trips that trip chaining entails, FAMOS is able to realistically simulate modes, destinations, and trips/activities while recognizing the spatio-temporal and modal constraints that exist in daily activity-travel patterns. The other major benefit of using FAMOS is its inherent time-of-day modeling capability. As activity-travel patterns are simulated along the continuous time axis, FAMOS is capable of providing time-of-day based origin-destination matrices by mode and purpose suitable for time-of-day based traffic assignment and policy analysis.

1.4. Installing FAMOS

FAMOS is distributed on CD. The installation process is similar to that of other Microsoft Windows® based software where the user follows the instructions on the screen. If one is using Microsoft Windows 2000® or XP®, then installation of FAMOS requires that the user have administrative access to the machine.

Installation of FAMOS requires running the *setup.exe* file that is on the CD. Before installing FAMOS, it is recommended that all other programs be closed.

Instructions for Installing FAMOS

- Step 1: From the desktop, click on *Start* and then *Run*.
- Step 2: Type **d:/setup** (or use the respective drive letter and directory location for the setup file and click **OK**. Use **Browse...** to locate the setup file, if necessary.
- Step 3: The installation process will commence. Follow the on-screen instructions. FAMOS may be installed on any drive. However, the name of the directory itself must be **FAMOS**.
- Step 4: During the installation, the user will be prompted to locate the ArcView Program file. After locating the ArcView Program file, click **Open** in the dialog box. Note that any change or re-installation of ArcView at a later time will not affect FAMOS in any way. If the location of the ArcView program file is changed at a later time, FAMOS will simply prompt the user to provide an updated location.

Step 5: The installation process should be completed. Usually, when FAMOS is installed for the first time on a machine, clicking the **Finish** button results in a prompt to restart the computer so that the configurations and settings can be updated and take effect. Allow the computer to restart itself. This will ensure that FAMOS runs correctly on the machine.

Step 6: Appropriate data files will be copied into subdirectories within the FAMOS directory.

It is not essential to have ArcView to run FAMOS. FAMOS is a stand-alone activity-based model system that can function without the GIS functionality of ArcView. However, the output visualization capability of FAMOS currently relies on the availability of ArcView on the resident machine. In the future, the output visualization capability of FAMOS will be made independent of ArcView.

1.5. Hardware Requirements

FAMOS does not have any special hardware requirements. As the input and output databases associated with FAMOS tend to be large and some of the simulation algorithms are complex and computationally intensive (particularly if one is dealing with a large region), it is recommended that FAMOS run on a high-end Pentium 4 machine. Hard disk space requirements are dependent on the size of the databases (region) and the extent to which multiple scenarios will be saved to the hard drive.

Minimum Recommended Hardware Specifications

- Pentium III 800 MHz
- 128 MB RAM
- 2 GB free disk space after installation of FAMOS (in the same drive where FAMOS has been installed)
- 17" SVGA monitor

While FAMOS will run on a machine whose hardware specifications are below those noted previously, it is likely to run slowly.

1.6. Software Requirements

FAMOS is a Microsoft Windows® based software package that involves complex computations, intensive database handling, and output visualization using GIS. As such, FAMOS comes with some specific software requirements so that all of its features will function properly.

Minimum Preferred Software Specifications

- ArcView 3.2 or higher
- Microsoft Excel® and Microsoft Access®
- Microsoft Windows® 2000 or XP

1.7. Starting FAMOS

The FAMOS installation process will make the program accessible via the *Programs* menu in Windows®. Users may choose to create a desktop shortcut if desired. The installation process will not create a desktop shortcut automatically.

Accessing and Starting FAMOS

- Step 1: From the Windows® desktop, click on *Start* and then *Programs*.
- Step 2: From the menu of available programs, choose *FAMOS* and select *FAMOS 2004.01*.
- Step 3: FAMOS 2004.01 will open with a welcome screen.
- Step 4: Click on **Enter** to go to the main FAMOS window.

1.8. FAMOS Main Window

The FAMOS Main Window serves as the central command for the software operations. The FAMOS main window is as shown in Figure 1.3.

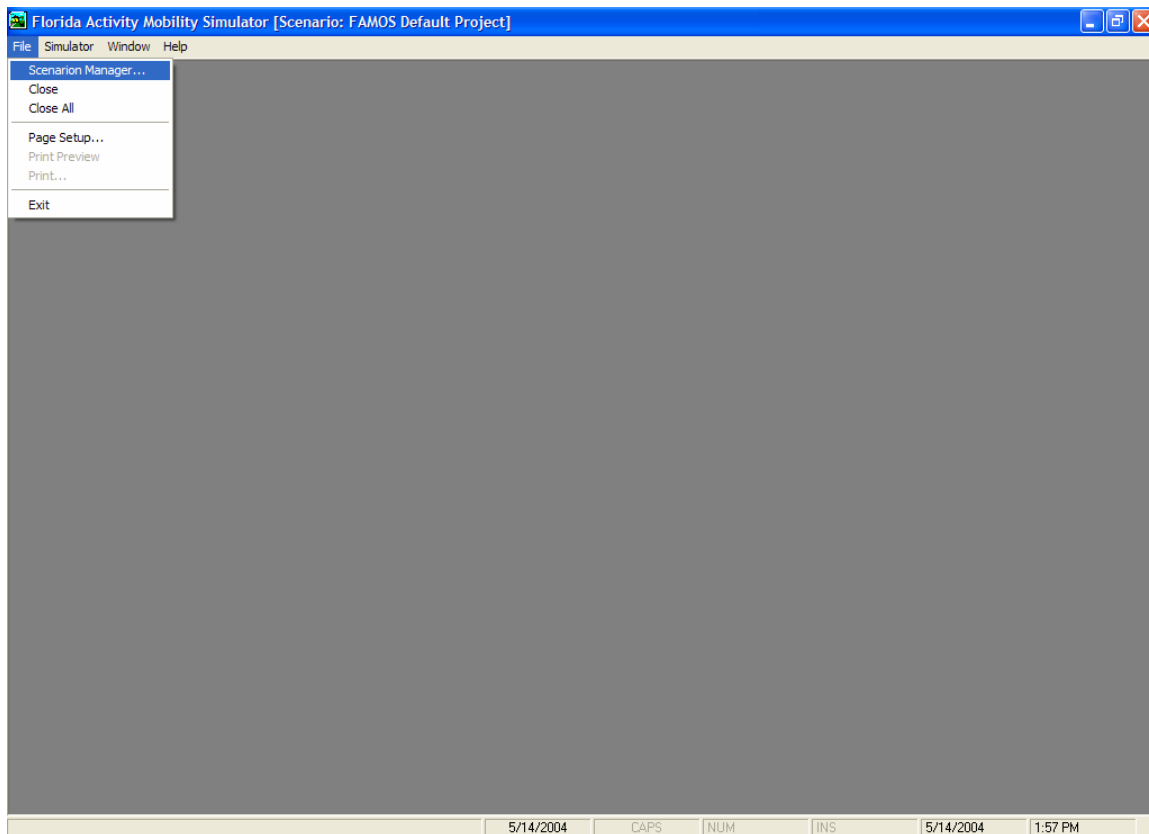


Figure 1.3 FAMOS Main Window

From this command center, one can begin the simulation process, manage databases, and set up scenarios.

1.9. Create/Open a Scenario

When FAMOS is installed, a directory called *Scenarios* is created within the FAMOS directory. This subdirectory will contain all of the various scenarios and alternatives that a user may be interested in analyzing. Every scenario or alternative will have its own subdirectory within the *Scenarios* directory. FAMOS software comes with a sample scenario pertaining to the Southeast Florida region covering Broward, Miami, and Palm Beach counties. The directory containing the base or master databases for a region will be placed in a subdirectory called *Default Scenario*. At a minimum, three MS Access® databases will be present in this directory:

- MODALLOS.MDB: This database includes all of the network level of service variables (skims) for every origin-destination pair in the region.

- PERSON.MDB: This database includes the household, person, and travel characteristics from a regional household travel survey data set.
- ZONEINFO.MDB: This database includes the zonal socio-economic characteristics such as population and employment totals by market segment.

The exact structure of these databases will be described in detail in the ensuing chapter that focuses on setting up and defining databases.

A user would place the three databases corresponding to the base case (base alternative) into the default directory. It is recommended that these databases be preserved in the default directory so that they are never altered or lost. Every time a user wishes to run a scenario or alternative, then a new scenario needs to be created and opened. In other words, a new subdirectory pertaining to a scenario needs to be created with the relevant databases.

Create/Open Scenario

- Step 1: From the FAMOS main window, choose the *File* menu and then *Scenario Manager*.
- Step 2: The *Scenario Manager* dialog box will appear on the screen. When this is launched the first time after installing FAMOS, only the default scenario or project will be listed. In all subsequent times, all of the scenarios created and saved by the user will appear in the dialog box.
- Step 3: Click on **Create New** at the bottom of the dialog box. An hour-glass will appear as the software copies all of the files from the default scenario subdirectory into a new scenario subdirectory. Note that this process may take several minutes as the software is copying large databases between subdirectories.
- Step 4: When the process is completed, a new scenario will appear in the dialog box. Click on the Scenario Name and the Scenario Description to edit and customize the name and description of the scenario.
- Step 5: Choose the desired scenario (highlight it to make it blue) and then click **Open** to make the selected scenario the active scenario or project.

After the desired scenario has been selected and activated/opened, a user has the ability to modify the databases within FAMOS or provide MS Access® databases externally to that scenario subdirectory (by overwriting the files that were copied from the default scenario directory). In any case, FAMOS requires person, modal LOS, and zone information databases in a scenario subdirectory (within the *Scenarios* directory) to perform a successful run. The structure of these databases is defined in the next chapter.

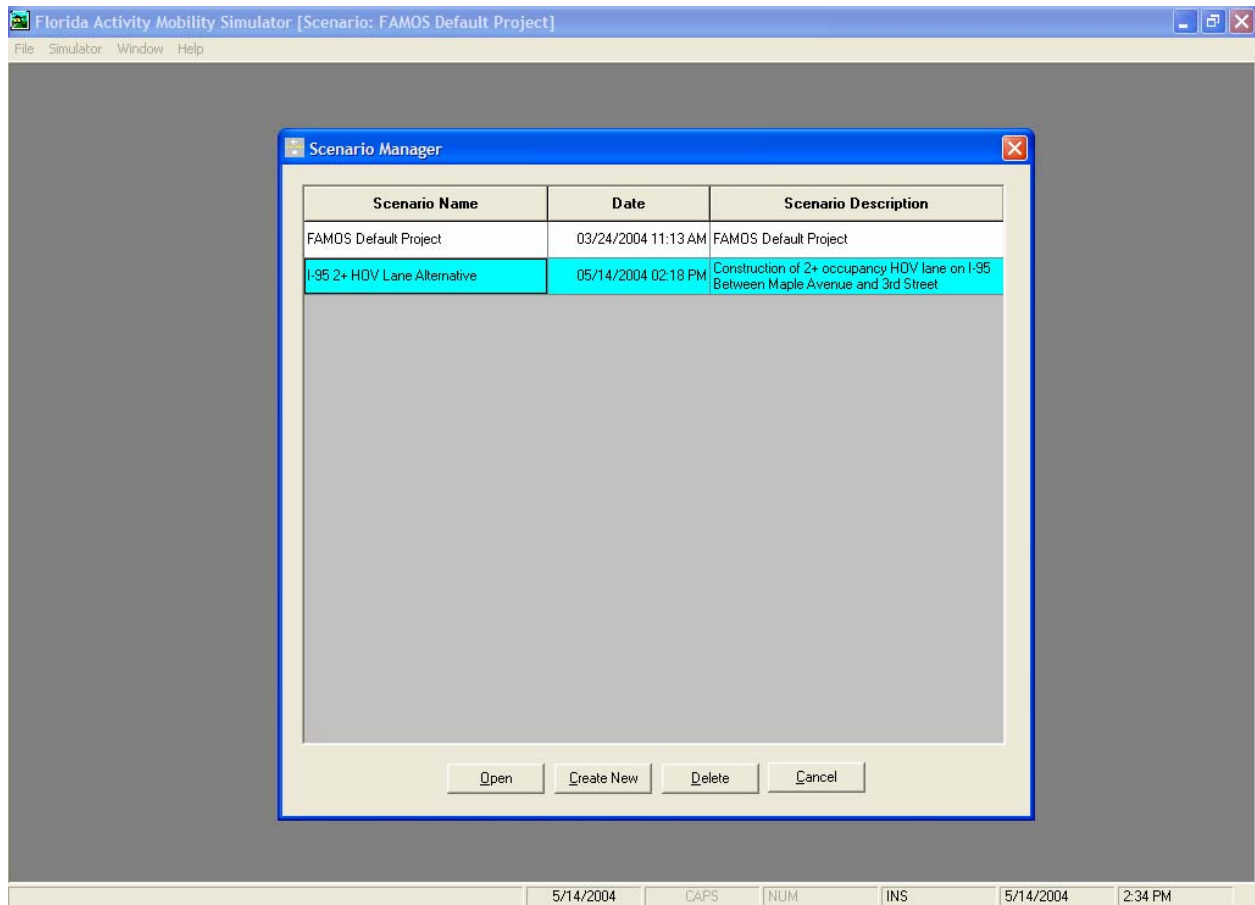


Figure 1.4 Scenario Manager: Create and Open a Scenario

2. DATABASE DEFINITION

This chapter provides an overview of the database definitions and formats used in FAMOS. As mentioned previously, FAMOS makes maximum use of existing model databases that are commonly employed in the context of traditional four-step modeling procedures. At this time, FAMOS has been developed with a view to keeping input and output database formats simple and easy to use. Future versions of FAMOS will incorporate added flexibility, complexity, and detail in database definitions and formats. Microsoft Access[®] is used extensively for database management and handling in FAMOS.

2.1 Data Requirements

The file formats and descriptions provided in this section are derived from the Southeast Florida Regional Planning Model (SERPM) file formats. Although the variables and file formats that are present in FAMOS on a default basis pertain to SERPM, it is theoretically possible to use any regional model database formats and variable fields within FAMOS. However, it is required that file formats and variable fields currently available in FAMOS be used to the extent possible because all submodels (model coefficients and specification) are based on SERPM databases. The use of completely different database formats and variable fields would necessitate the re-estimation and re-specification of various model components. This is a complex and computationally intensive effort that must be undertaken outside of the FAMOS software environment.

This chapter describes the various databases and variable fields needed to run FAMOS without having to undertake a large amount of work to completely re-specify, re-estimate, and re-calibrate model components. The user must set up and define databases exactly as defined in this chapter in order to use FAMOS “out-of-the-box”. Any deviation from the database definitions provided in this chapter will result in FAMOS returning error messages indicating database – model incompatibility.

2.2 Zonal Socio-economic Data

The zonal socio-economic data includes both population and employment characteristics for the traffic analysis zones (TAZ) of the region. Additional variables representing school enrollment and parking costs may also be included, depending on the availability of such information. In the Florida context, the FSUTMS ZDATA1 and ZDATA2 files are combined to form the zonal

information database (called ZONEINFO.MDB). This access database contains several different tables pertaining to the socio-economic profile of the region that is being simulated.

First, there is a ZONEINFO table that contains the basic population and employment information for the region. This file includes the variables that measure the attractiveness of a zone and is largely used in the context of location (destination) choice modeling. Table 2.1 provides the format of this table.

Table 2.1 Zonal Information Data

Variable No.	Variable Name	Variable Description
1	STAZ	TAZ
2	POPINSF	Population in single-family dwelling units
3	POPINMF	Population in multi-family dwelling units
4	INDEMPPW	Industrial employment by place of work (SIC 01-39)
5	COMEMPPW	Commercial employment by place of work (SIC 50-59)
6	SEREMPPW	Service employment by place of work (SIC 40-49 and 60-69)
7	SCHENRL	School enrollment (school totals by TAZ)
8	SHTMPC	Short term parking costs (cents)
9	LOTMPC	Long term parking costs (cents)
10	AREA DUMMY	1 if this TAZ is used, 0 otherwise

Second, there is a POPULATION characteristics table that describes the target population by market segment for each zone. This database contains the population totals for each zone (by market segment) that HAGS must replicate during the population synthesis procedure. Table 2.2 provides the format of this table.

Table 2.2 Population Data

Variable No.	Variable Name	Variable Description
1	REG_TAZ	Regional TAZ
2	SFU0VEH	Zero vehicle single family units
3	SFU1VEH	One vehicle single family units
4	SFUMVEH	Multi vehicle single family units
5	MFU0VEH	Zero vehicle multi-family units
6	MFU1VEH	One vehicle multi-family units
7	MFUMVEH	Multi vehicle multi-family units
8	CTY_CODE	County Code 1 Palm Beach 2 Broward 3 Miami-Dade
9	CTY_TAZ	County TAZ
10	DIST	District number
11	SECTNUM	Sector number
12	TOTSFUTS	Total number of single family dwelling units
13	P0VEHSF	Percentage of zero vehicle single family units
14	P1VEHSF	Percentage of one vehicle single family units
15	P2VEHSF	Percentage of multi vehicle single family units
16	TOTMFUTS	Total number multi-family units
17	P0VEHMF	Percentage of zero vehicle multi-family units
18	P1VEHMF	Percentage of one vehicle multi-family units
19	P2MVEHMF	Percentage of multi vehicle multi-family units

Finally, there is the SAMPLE table that is a subset of the household travel survey database. This subset includes household level records with information about the market segmentation variables for each household in the data file. Table 2.3 provides the format for this table.

Table 2.3 Sample Data

Variable No.	Variable Name	Variable Description
1	HHID	Household ID
2	VEHS	Number of vehicles (0, 1, 2)
3	SFU	1: Single-family home, 0: Other
4	HVEHICLE	Number of vehicles available for the household
5	DU_TYPE	Dwelling Unit type 1 Single-family home 2 Duplex 3 Apartment 4 Townhouse 5 Condo 6 Mobile home 7 Villa 8 Retirement home 9 Detached studio garage apt 10 Rectory 11 Boat 12 Triplex 13 Quadraplex 98 Don't know 99 Refused
6	H_CO	County of home location 1 Broward 2 Dade 3 Palm Beach
7	RTZ_H	Regional survey TAZ number for home location
8	CSTZ_H	County survey TAZ number for home location
9	STZ_H	SERPM TAZ number for home location
10	PBTZ_H	Palm Beach TAZ number for home location
11	BOTZ_H	Broward TAZ number for home location
12	MITZ_H	Miami TAZ number for home location

The joint distribution of dwelling unit type and vehicle ownership used in the simulation is obtained from the Southeast Florida Regional Planning Model (SERPM) databases. The zonal database for SERPM includes the joint distribution of dwelling unit by vehicle ownership, thus making it very convenient to simulate households in the region. In the absence of information about the joint distribution of these variables, one would have to apply the iterative proportional

fitting (IPF) algorithm on the marginal distributions of these variables to derive the joint distribution of these variables. HAGS includes a routine that automatically checks for the availability of the joint distribution in the zonal information database. If the joint distribution is available, then the IPF algorithm is skipped; otherwise, the IPF algorithm is applied and the joint distribution is derived.

2.3 Network Level-of-Service Data

The network level-of-service data is derived from FSUTMS skim files for the simulation region. The network level-of-service data is an extremely large database as it includes skim variables (values) for all zone-to-zone combinations. For the SERPM region which includes about 3000 traffic analysis zones, a series of skim values are derived for each of the 3000 x 3000 origin-destination pairs (cells). Table 2.4 provides the format and variables included in the network level-of-service database. It should be noted that this file (MODALLOS.MDB) is derived from FSUTMS and converted to Microsoft Access outside of the FAMOS software environment.

Table 2.4 Network Level-of-Service Data

Variable No.	Variable Name	Variable Description
1	ORG_TAZ	Origin TAZ
2	DES_TAZ	Destination TAZ
3	AHDWHLOS	Peak highway distance with HOV
4	AHDNHLOS	Peak highway distance without HOV
5	AHRWHLOS	Peak highway run-time with HOV
6	AHRNHLOS	Peak highway run-time without HOV
7	AHTWHLOS	Peak highway toll with HOV
8	AHTNHLOS	Peak highway toll without HOV
9	ATRRTLOS	Peak transit run-time
10	ATRTRLOS	Peak transit transfer
11	ATRTWTLOS	Peak transit walk-time
12	MHDWHLOS	Off-peak highway distance with HOV
13	MHDNHLOS	Off-peak highway distance without HOV
14	MHRWHLOS	Off-peak highway run-time with HOV
15	MHRNHLOS	Off-peak highway run-time without HOV
16	MHTWHLOS	Off-peak highway toll with HOV
17	MHTNHLOS	Off-peak highway toll without HOV
18	MTRRTLOS	Off-peak transit run time
19	MTRTRLOS	Off-peak transit transfer
20	MTRWTLOS	Off-peak transit walk time

The network level-of-service data is used extensively within FAMOS for work location choice, school location choice, and destination choice modeling. Thus, it is very important to have high quality level-of-service data. Given that traditional four-step modeling procedures have evolved over the years to include high quality level-of-service data, it is recommended that network level-of-service data from the existing FSUTMS model be used as a starting point for FAMOS. As improved data become available, the existing level of service data can be further enhanced.

Creating the Modal Level of Service Database: MODALLOS.MDB

- Step 1: The modal level of service database (MODALLOS.MDB) must be created outside the FAMOS software environment.
- Step 2: At the end of a complete FSUTMS run, one will obtain a set of binary files that include the freeflow and congested skim tables. These binary files appear in the FSUTMS directory as *FHSKIMS.Ayy* and *RHSKIMS.Ayy* where the former corresponds to freeflow skims while the latter corresponds to congested skims.
- Step 3: Run FSUTMS matrix manipulation routines to obtain/separate skim variable tables in binary tranplan format.
- Step 4: Run FSUTMS *tpcard* utility on each trip table to obtain an ASCII text version of each table.
- Step 5: Save all ASCII text tables to a central location. Note that, depending on the size of the region under consideration and the number of TAZ's, these files can be extremely large (in the hundreds of MB).
- Step 6: Import the ASCII text tables into MS Access®. All all skim variable tables into a single MS Access® database. Save the database with the name MODALLOS.MDB in the appropriate scenario subdirectory.
- Step 7: Note that edits may be made to the MODALLOS.MDB file from within FAMOS. Thus, after the MS Access® database has been set up for the first time, one does not need to use MS Access® again for editing the database.

A similar procedure can be employed in conjunction with a four-step model that runs in FSUTMS-TransCAD. As FSUTMS-TransCAD is inherently database driven, it is easier and more convenient to create the MS Access® database that FAMOS needs in a FSUTMS-TransCAD environment. The same basic procedure applies, i.e., save the skim tables in ASCII text format (from the FSUTMS-TransCAD environment) and then merge and save the tables in MS Access®.

In the rare instance that a four-step model does not exist, then a modal level of service database would have to be created from scratch using a GIS-based network basemap and a zonal geography. The network would have to be robust in terms of network connectivity and

should have basic attributes including freeflow and congested speed, number of lanes, area type and facility type, and so on. In an appropriate GIS environment such as ArcGIS or TransCAD, a user can derive the lengths and travel times on each segment of the network and consequently compute the shortest paths between origin-destination pairs. These distances and travel times can then be used as skim variables in the modal level of service database.

2.4 Person and Fixed Activity Data

The Household Attributes Generation System (HAGS) produces a synthetic population of households and persons together with their attributes and fixed activities. Associated with these fixed activities are time points indicating their beginning and ending times. These fixed activities and their associated time periods are considered locked, closed, or unavailable time periods within which other activities and trips can not be undertaken. Thus, FAMOS takes into account spatio-temporal constraints associated with activity-travel engagement; i.e., people need to be at certain locations at certain times to pursue certain mandatory activities. Table 2.5 shows the format of the person and fixed activity information file generated by HAGS.

At this time, the information that can be generated by HAGS is limited to that contained in the 2000 Southeast Florida Regional Travel Survey characteristics data set. For example, that data set does not contain information on the sex of the person. Thus, HAGS can not simulate the sex of the synthesized person. Information is generated for all variables where the original survey data set had reasonably large sample sizes from which households and persons may be synthesized. Thus, standard socio-economic characteristics such as household size, number of workers, number of vehicles, number of licensed drivers, age, income, and employment type/status can be simulated within the current scope of FAMOS. In applying FAMOS to a particular region, a user may choose to synthesize and simulate additional variables or a different set of variables. The set of variables simulated depends on the availability of information in a travel survey data set and the need for such variables in PCATS submodels.

When HAGS is run, FAMOS produces an output database called FAMOS.MDB. All of the information generated by HAGS and specified in Table 2.5 is saved in FAMOS.MDB. Subsequently, when PCATS (the Prism Constrained Activity Travel Simulator) is run, the output of PCATS is appended to FAMOS.MDB to form an integrated and comprehensive output database from which origin-destination (O-D) trip tables can be generated.

Table 2.5 Person and Fixed Activity Information Data File

Variable No.	Variable Name	Variable Description
1	ID	Person ID
2	HHLDSIZE	Number of persons in the household
3	HHLDEMP	Number of workers in the household
4	NUMCHILD	Number of children in the household
5	NUM_LIC	Number of licensed drivers in the household
6	NUMVISIT	Number of out of town visitors in the HH on the survey day
7	HVEHICLE	Number of vehicles available for the household
8	HHINC	Annual income of the household
9	MEM_INC	Annual income of the person
10	MEM_AGE	Age of the person (continuous variable)
11	CAT_AGE	Age of the person (categorized)
12	MEM_COUN	County of the member residence
13	EMP_STAT	Employment Status (whether part time or full time)
14	EMP_TYPE	Type of work
15	EMP_RET	Whether the person is retired or unemployed?
16	ACT_NUM	Number of fixed activities
17	ACT_TYPE	Fixed activity type
18	BEG_TIME	Beginning time of the activity in minutes
19	END_TIME	End time of the activity in minutes
20	COUN_ACT	County of the activity location
21	STZ_ACT	TAZ for the activity location
22	CATEGORY	1:Worker; 2:Student; 3:Other

2.5 Activity and Travel Records Data File

PCATS simulates activity and travel records for each synthesized person in the population. The activity-travel records appear similar to those typically obtained from household travel surveys. For each trip, a purpose, beginning and ending time, location, and mode are determined and written to a final population database containing all activity-travel records. At this time, FAMOS simulates modal options and trip purposes that could be supported by the 2000 Southeast Florida Household Travel Survey data set. Some modal options and trip purposes could not be included in this version of FAMOS due to very small samples in the survey data set. Table 2.6 shows the structure of the PCATS output data that has been incorporated into FAMOS at this time.

Table 2.6 Activity and Travel Records Data File

Variable No.	Variable Name	Variable Description
1	COUNT	Iteration count
2	ID	Person ID
3	ACT_NO	Activity number
4	FACILITY	Activity location 1: Home 2: Work 3: School 100: Other
5	TAZ	Geographic location of activity (TAZ)
6	ACTIVITY TYPE	Activity type (purpose) 1: Home 2: Work 3: Shopping/Personal Business 4: Social Recreation 5: School 6 or 7: Other
7	FIX_DUMMY	1:if this activity is fixed activity; 0:non-fixed activity
8	BEG_TIME	Beginning time of this activity
9	END_TIME	End Time of this activity
10	TRAVEL DUMMY	1:if trip is needed after this activity; 0:otherwise
11	BEG_TIME_TRIP	Beginning time of trip (=End_Time of previous activity)
12	END_TIME_TRIP	End Time of Trip (=Beg_Time of next activity)
13	MODE	1:SOV(Driver) 2:HOV (Driver) 3:HOV (Non-driver) 4:Transit 5:Other (Bike and Walk) 100: Non-trip
14	CATEGORY	1:Worker; 2:Student; 3:Other

For FAMOS version 2004.01, it is recommended that databases be maintained in a format as close to that described in this section as possible. Future versions of FAMOS will include greater flexibility to accommodate databases of different formats with a variety of different variables and field names. It is to be noted that the use of alternative databases and variables/fields entails re-estimation and re-specification of submodels within PCATS.

2.6 Structure of the Output Database: FAMOS.MDB

Upon a complete run of FAMOS, an output database called FAMOS.MDB is created. This database is saved within the same scenario subdirectory as the input files. This database is in MS Access® format and contains four distinct tables. They are:

- *Household*: The household table includes all household-level information for the synthesized households and persons.
- *Person*: The person table includes all person-specific information for the synthesized persons.
- *Activity*: The activity table includes activity records generated by HAGS and PCATS and provides a basic activity schedule for each person in the simulation.
- *Trips*: The trip table includes trip records with all related trip information corresponding to the activity schedule pursued by an individual in the simulation.

Thus, FAMOS produces a comprehensive MS Access® database with detailed information about the socio-economic and activity-travel characteristics of each person in the simulation. For each and every table included in the MS Access® database, FAMOS produces an equivalent ASCII text data file that is saved in a working data directory. While each scenario subdirectory will have its own FAMOS.MDB output database, the files in the working data directory are overwritten every time a FAMOS model run is performed. Figure 2.1 provides a schematic showing the flow of data in FAMOS.

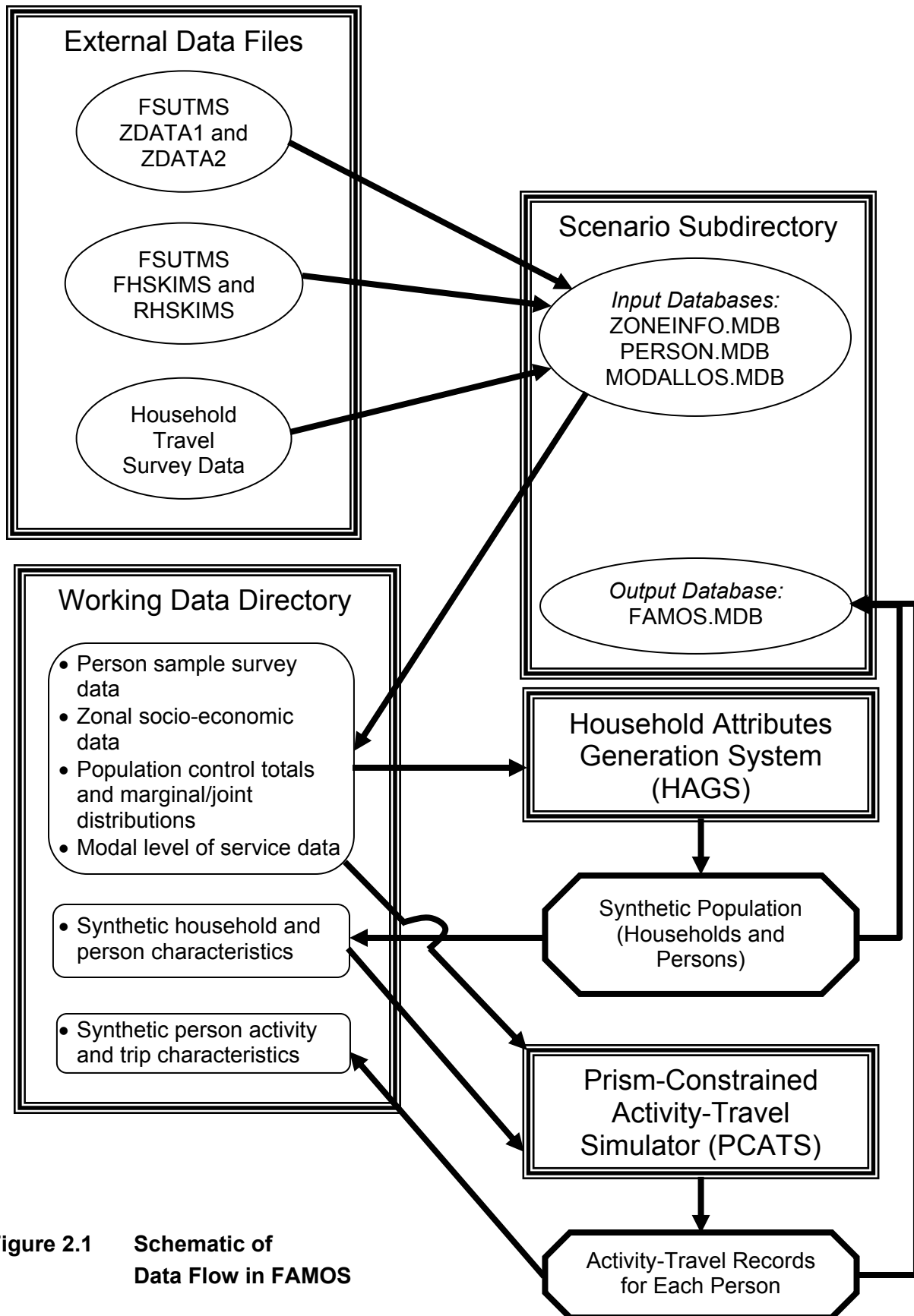


Figure 2.1 Schematic of Data Flow in FAMOS

3. HOUSEHOLD ATTRIBUTES GENERATION SYSTEM (HAGS)

This chapter of the users guide provides instructions for running the Household Attributes Generation System (HAGS).

3.1 What is HAGS?

The Household Attributes Generation System (HAGS) is a model system developed to generate synthetic households. HAGS populates each geographical zone with synthetic households while observing marginal distributions of pertinent variables in census or zonal data. The current version of HAGS consists of two components: Household Distributor and Fixed Activity Generator.

Household Distributor determines the distribution of attributes of households in the respective zones based on data from the census, travel surveys and other sources. An iterative proportional fitting (IPF) method (Beckman et al., 1996) is applied to base-year marginal distributions of pertinent household and person attributes in each zone and their area-wide joint distribution, to yield a frequency distribution of households by their attributes for each zone. The base-year marginal distributions are obtained from the census and other data, while their area-wide joint distribution is obtained from base-year travel survey data. Each zone is then populated by cloning households from the travel survey data according to the distribution obtained for the zone.

Fixed Activity Generator determines the beginning vertex of the morning prism, the ending vertex of the evening prism, the beginning and ending times of fixed activities, for each household member generated by the Household Distributor. For non-workers without any fixed activities, there will be just one prism for the entire day, and the Generator determines the beginning and ending vertices for this prism. The location of prism vertices are estimated using the stochastic frontier models developed by Kitamura et al. (2000) and Pendyala et al. (2000). These models incorporate as explanatory variables: person attributes, household attributes, land use characteristics, and attributes of commute trips. Since only work (including work-related business) and school activities will be considered as fixed activities in the Florida implementation effort, work/school starting and ending times are generated probabilistically for each worker or student based on their distributions observed in the base-year travel survey data. Work/school zones are determined for respective workers/students using multinomial logit models of work/school location choice. The models may be viewed as a version of production-

constrained gravity models. Their explanatory variables include land use characteristics, measures of separation between zones, and some of the variables used in the stochastic frontier models.

3.2 HAGS Methodology

This section briefly describes the methodology underlying the Household Attributes Generation System (HAGS). HAGS provides a means by which synthetic households can be generated and located, persons in each synthesized household can be simulated, and person work/school locations and schedules can be probabilistically determined.

First, a joint distribution of selected population segment variables is developed for each zone. In the current implementation of FAMOS, vehicle ownership and dwelling unit type are used as the segmentation variables. Vehicle ownership categories are zero, one, and two or more cars while dwelling unit type categories are single family dwelling unit and multi family dwelling unit. Using marginal distributions available for these variables at the regional and zonal level, the joint distribution of these segmentation variables can be developed using the iterative proportional fitting (IPF) method. If a joint distribution is already available at the zonal level, then the IPF method does not need to be applied. The IPF method is described in detail in the next subsection and closely follows that proposed by Beckman, et. al. (1996) for use in TRANSIMS.

Once the joint distribution of the market segmentation variables is ascertained for each zone, the synthetic households and personal attributes can be simulated.

- Step 1:* Draw households from the sample (sample data) with replacement to match the target population by segment for each zone (population data). At this step, the residential location of the sample draw is ignored, and changed to match the target population at each draw.
- Step 2:* The person records corresponding to the identical household identification number drawn in step 1 are extracted from the survey sample data, and the residential location is changed to that of the zone determined in step 1.
- Step 3:* For workers and students, the work/school location is determined using a multinomial logit model of work/school location choice. As the number of alternatives is large, the Monte Carlo Markov Chain (MCMC) algorithm is used to simulate choice sets for each individual with explicit consideration of time-space prism constraints (thus zones that are very far away are not drawn).
- Step 4:* The work/school beginning and ending times are preserved from the original sample data to be consistent with the observed distribution of work/school beginning and

ending times. However, a small value of less than or equal to +/- 5 minutes is randomly added to reported start and end times to avoid round off problems that might lead to a large number of trips starting exactly at the same instant.

3.2.1 Iterative Proportional Fitting (IPF) Method

It is often the case that the joint distribution of the variables of interest is available with the desired level of geographical aggregation. For example, the joint distribution of age, sex, and driver's license holding may be available for an entire metropolitan area, but not for each traffic zone. Even in such cases, it is possible to infer the joint distribution for each traffic zone if the marginal distributions of the respective variables are known at the zone level. The iterative proportional fitting (IPF) procedure is applicable to such cases.

The basic concept underlying the IPF method is illustrated first for the case where a joint distribution of the variables of interest is available from a survey sample. This sample joint distribution in general does not have marginal distributions that agree with the population marginal distributions, however. This implies that the sample joint distribution does not coincide with the (unknown) population joint distribution either. The IPF method can be applied here to correct the sample joint distribution when population marginal distributions are given.

Consider an m -dimensional joint distribution. Define the proportion of the sample observations that belong to category i_j ($i_j = 1, 2, \dots, n_j$) of variable j ($j = 1, 2, \dots, m$) as

$$p_{i_1, i_2, \dots, i_m} = \frac{n_{i_1, i_2, \dots, i_m}}{n} \quad (3.1)$$

where

n = the total number of observations, and
 n_{i_1, i_2, \dots, i_m} = the number of observations that belong to cell (i_1, i_2, \dots, i_m) .

The iteration in the IPF method progresses as follows. Let the estimate of the proportion of cell (i_1, i_2, \dots, i_m) in the t -th iteration be $p_{i_1, i_2, \dots, i_m}^{(t)}$. Then the proportion of the k -th category of variable j can be estimated as

$$p_{i_j=k}^{(t)} = \sum_{p \neq j} \sum_{i_p=1}^{n_p} p_{i_1, i_2, \dots, i_j=k, \dots, i_m}^{(t)} \quad (3.2)$$

Letting the initial value be

$$p_{i_1, i_2, \dots, i_m}^{(0)} = p_{i_1, i_2, \dots, i_m}, \quad (3.3)$$

and as defined in Eq. (3.1), let the proportion estimate at the t -th iteration be

$$p_{i_1, i_2, \dots, i_j = k, \dots, i_m}^{(t)} = \frac{p_{i_1, i_2, \dots, i_j = k, \dots, i_m}^{(t-1)}}{p_{i_j = k}^{(t-1)}} \left(\frac{T_k^{(j)}}{n} \right), \quad (3.4)$$

where

$T_k^{(j)}$ = the number of observations which fall in the k -th category of variable j .

Note that $\sum_{k=1}^{n_j} T_k^{(j)} = n$. It can be seen that $p_{i_1, i_2, \dots, i_j = k, \dots, i_m}^{(t)}$ is obtained by multiplying to the estimate from the previous iteration, $p_{i_1, i_2, \dots, i_j = k, \dots, i_m}^{(t-1)}$, the ratio of the observed proportion of the k -th category of variable j ($T_k^{(j)} / n$) to the estimated proportion ($p_{i_j = k}^{(t-1)}$).

This process is repeated for the respective cells. For example, the proportion estimates are updated for all cells in the m -dimensional table that belong to the first category of the first variable, then for the cells that belong to the second category of the first variable, and so on. After proportion estimates are updated for all categories for the first variable, the same procedure is repeated for the respective categories of the second variables. This is repeated until estimates are updated for all m variables. This process is repeated until the proportion estimates converge for the respective cells. It is known that the iterative process converges after 10 to 20 iterations (Beckman et al., 1996).

The IPF method has been applied in the transportation planning field in Beckman et al. (1996) and Nishida et al. (2000). In these studies, the population joint distribution is estimated by holding constant the odds ratios in a sample joint distribution, given the population marginal distributions. This approach, however, may not work well when the sample joint distribution obtained from a survey is not reliable.

Suppose the population joint distribution is available for the entire metropolitan area, but not for traffic zones. If population marginal distributions are available for the respective traffic zones, then a possible approach to the estimation of the population joint distribution for each traffic zone is to apply the area-wide population joint distribution to traffic zones. Estimated joint distributions at the zone level thus produced, however, do not add up to the area-wide population joint distribution, even when the zonal joint distributions are appropriately weighted using zonal populations.

Another approach is to view the area-wide population joint distribution as a marginal distribution obtained by collapsing over traffic zones, and to estimate the $(m + 1)$ -dimensional joint distribution where the $(m + 1)$ th dimension is defined by the traffic zones. In this method, the weighted average of the zonal joint distributions coincides with the area-wide population joint distribution.

Let traffic zone be the $(m + 1)$ th variable, and let n_{m+1} be the number of traffic zones. For each of the first through m -th variables, redefine its marginal distribution as the distribution of its categories by zone. And let the $(m + 1)$ th marginal distribution be the population joint distribution. For example, suppose $m = 2$ and the first variable is sex, the second variable is age, and the population joint distribution of sex and age is given. In this case, the first marginal distribution will be given as the distribution of sex by zone, the second marginal distribution will be that of age by zone, and the third marginal distribution will be that of sex by age, which is the population joint distribution.

In this approach, the number of categories in the marginal distribution of variable j becomes $n_j \times n_{m+1}$, and that for variable $(m + 1)$ is $\prod_{j=1}^m n_j$.

As the initial value of cell proportion, let

$$p_{i_1, i_2, \dots, i_m, i_{m+1}}^{(0)} = \frac{1}{\prod_{j=1}^{m+1} n_j} \quad (3.5)$$

Thus, all cells have the same proportion. With these initial values, the procedure described above can be applied to estimate joint distributions by traffic zone that is consistent with the area-wide population joint distribution.

3.3 Running HAGS

HAGS may be launched from the FAMOS main window. The HAGS window allows the user to specify and view the input and output databases, identify the variables or attributes that need to be generated or synthesized, and run the program. In addition, the HAGS window includes options to view the output in both summary and graphical formats.

Launching HAGS

Step 1: From the FAMOS main window, click on *Simulator* and then *Household Attributes Generation System*. The HAGS window should appear as in Figure 3.1.

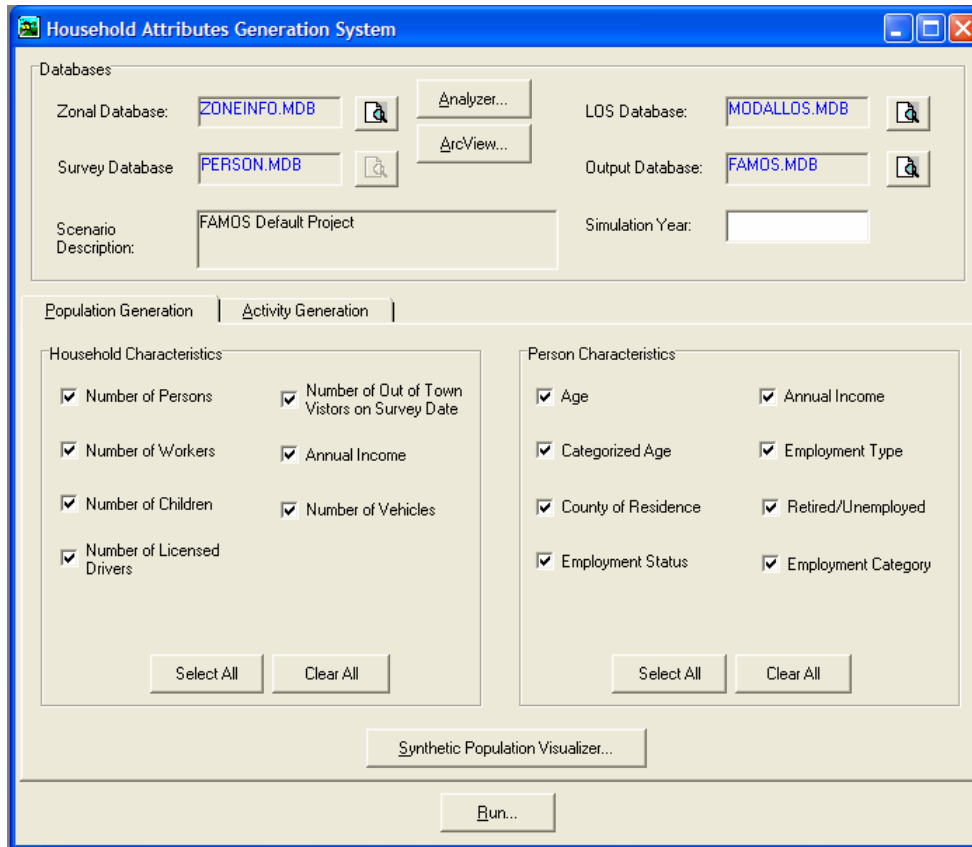



Figure 3.1 HAGS Window

The databases that pertain to the chosen active scenario will automatically appear in the database fields of the window. If a user wishes to use different databases, then a different scenario needs to be created and opened using the *Scenario Manager...* menu option under *File* in the FAMOS main window. The user may view and edit the input zonal database and the modal level-of-service database by clicking on the little buttons next to the file names.

Viewing and Editing Databases

- Step 1: In the HAGS window, click on the button  next to the database name.
- Step 2: A data viewing window showing the entire database will appear on the screen as shown in Figure 3.2.
- Step 3: The user may click in any field within this table and edit values. Note that all edits are permanent. Changes made to the field values can not be canceled.
- Step 4: When finished viewing and editing the data, click **Exit** to close the data viewing window. FAMOS automatically saves the changes/edits to the corresponding MS Access® database.

Zone Info								
Origin TAZ	Population in Single Family	Population in Multi-Famil	Industrial Employment by Place of	Commercial Employment by Place of	Service Employment by Place of	School Enrollment	Short Term Parking Costs	Long Term Parking Costs
1	1274	0	0	0	130	0	0	0
2	1165	852	0	0	0	0	0	0
3	2007	124	11	5	55	0	0	0
4	1351	527	182	161	255	0	0	0
5	1863	827	183	113	197	0	0	0
6	0	308	0	172	83	0	0	0
7	0	0	0	101	87	0	0	0
8	109	499	0	272	47	0	0	0
9	180	0	10	121	62	0	0	0
10	2	439	0	2	15	0	0	0
11	385	35	0	0	9	0	0	0
12	0	0	0	6	22	0	0	0
13	0	0	45	304	367	0	0	0
14	0	123	5	8	56	0	0	0
15	596	0	8	0	141	0	0	0
16	720	0	0	1	1	0	0	0
17	2625	0	14	7	77	994	0	0
18	105	348	0	0	0	0	0	0
19	709	46	52	91	99	0	0	0

Figure 3.2 Zone Information Database Viewing Window

The current version of FAMOS allows the user to edit the data from within this window. This has been done with the intent of providing a user-friendly environment in which users can create alternative scenarios and test their impacts on the transportation system. Future versions of FAMOS will include a more extensive scenario manager and database setup system to help users create and manage alternative scenarios and associated databases.

FAMOS has the ability to automatically read the input databases and detect the attributes and fields available for population synthesis. These fields will automatically appear under *Household Characteristics* and *Person Characteristics* under the *Population Generation* tab. By default, all attributes available in the input databases will be checked. At this time, HAGS automatically lists and checks (selects) all of the variables that are present in the PERSON.MDB file. The user is not allowed to uncheck (deselect) any of the variables. In other words, FAMOS automatically generates all of the attributes that are present in the household travel survey database (PERSON.MDB). Also, HAGS identifies the trip purposes (activity types) that will be included in the simulation. Once again, in this version of FAMOS, the activity types

and trip purposes are pre-identified and selected for the user. The list of trip purposes or activity types can be seen by choosing the *Activity Generation* tab in the HAGS main window. However, the user should note that only fixed activities of work, school, and home (and their associated temporal and spatial characteristics) are simulated by HAGS. Thus HAGS will simulate the location and timing of all fixed (mandatory) activities in the schedule of a person. Other activity types and their associated attributes are simulated in PCATS.

Running HAGS

- Step 1: Click **Run...** to run HAGS. A small dialog box showing the progress of the simulation should appear on the HAGS window. Figure 3.3 shows this screen.
- Step 3: When the simulation is complete, a message denoting successful completion of the population synthesis will appear.

When HAGS is run, the MS Access® databases corresponding to the zonal data and the modal level of service data are written out in ASCII form into the working data directory. Following this, the actual synthesis of households and persons will begin. As the network modal level of service database is likely to be very big, it may take about 20-30 minutes to write out a working data file corresponding to this database.

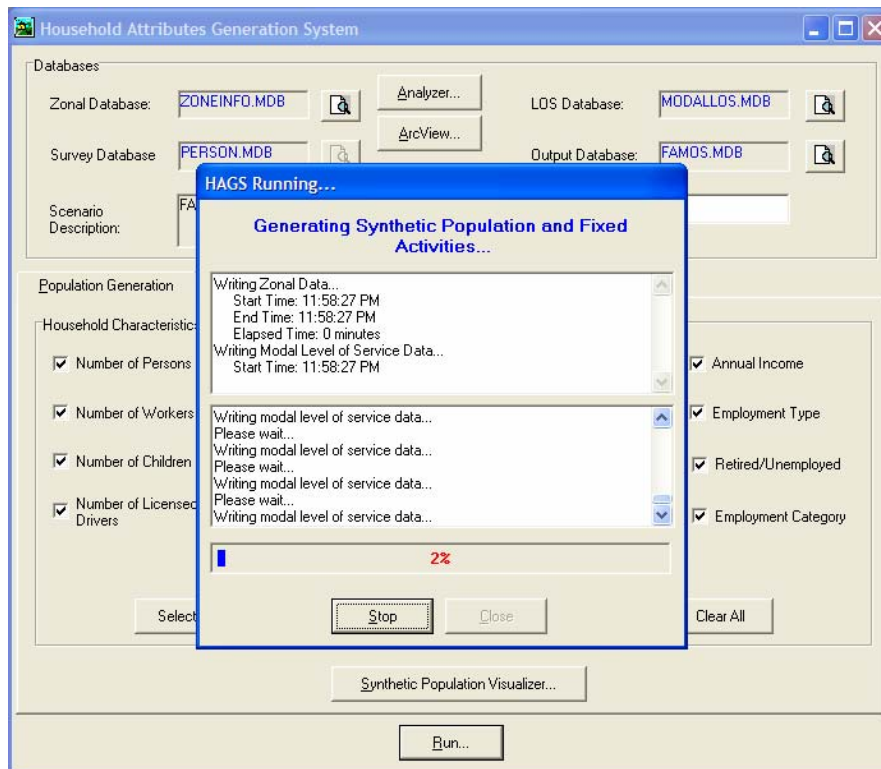


Figure 3.3 Screen Showing HAGS in Progress

3.4 Viewing HAGS Output at Individual-Level

FAMOS software incorporates numerous ways in which the user can view the output of HAGS. All of the output gets saved to the MS Access® database named FAMOS.MDB (located within the scenario subdirectory). The output of HAGS can be viewed in a disaggregate individual-level format or in more aggregate graphical formats.

Viewing Individual-Level HAGS Output

- Step 1: After a successful HAGS run, click on **Synthetic Population Visualizer...** to launch the individual-level HAGS output viewer.
- Step 2: A screen similar to that shown in Figure 3.4 will appear. The screen shows both household characteristics and person characteristics.
- Step 3: Click **Exit** to close this viewer window.

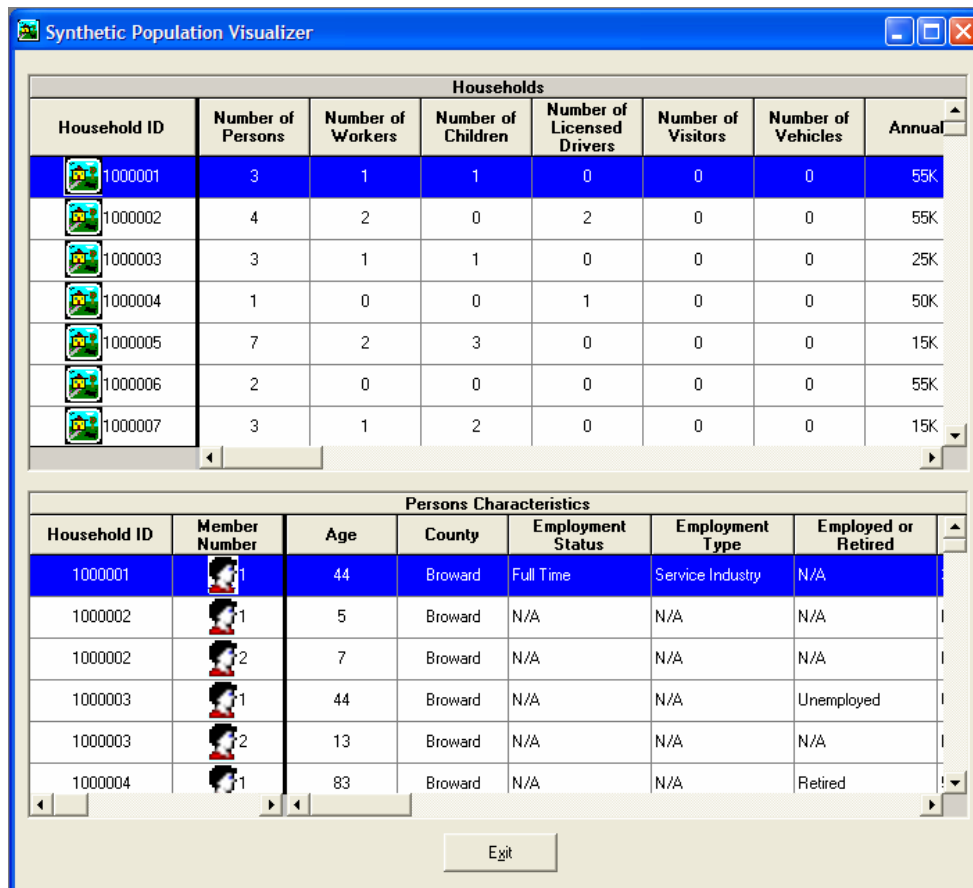


Figure 3.4 Household and Person-level HAGS Output Visualizer

In addition to viewing the household and personal characteristics generated by HAPS, one can also view the fixed activities identified by HAPS for each individual. These fixed activities constitute an activity agenda skeleton around which PCATS will build and simulate a full activity-travel pattern for each individual.

Viewing Fixed Activity Agenda

- Step 1: Choose the **Activity Generation** tab from the HAPS main window.
- Step 2: Click on **Synthetic Population Activity Visualizer...** to view the individual-level output window. A screen similar to that shown in Figure 3.5 will appear. The screen shows the fixed activity agenda in addition to both household characteristics and person characteristics. The fixed activity agenda can be seen in the bottom right portion of the visualizer window.
- Step 3: Click **Exit** to close this visualizer window.

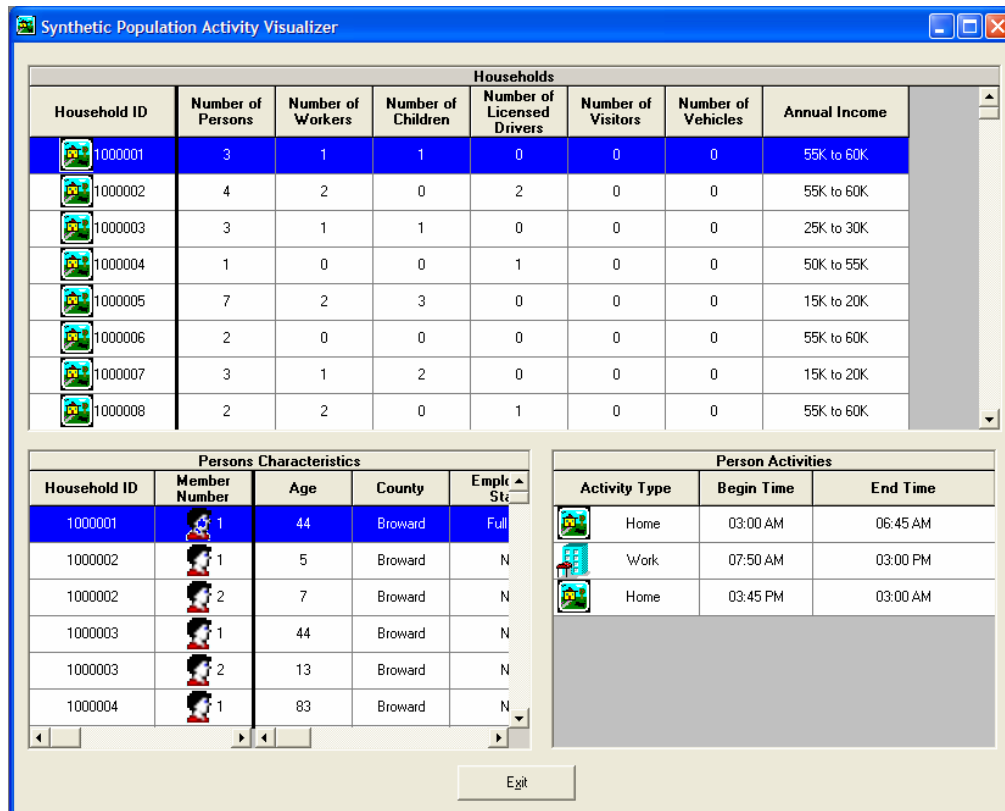


Figure 3.5 HAPS Output Visualizer Window Showing Fixed Activities

3.5 Viewing HAGS Input at Aggregate Zone Level

HAGS provides a means of reviewing input zonal data using aggregate statistics and measures. The user can view the aggregate level input data in a variety of forms. This feature allows the user to quickly check whether the zonal data is robust and accurate as it is very critical to have accurate zonal data for the population synthesizer. If the zonal data is not accurate, the population synthesizer will produce results inconsistent with the spatial distribution of population and employment in the region.

Viewing HAGS Input in Aggregate Form

- Step 1: Choose the **Population Generation** tab in the HAGS main window.
- Step 2: Click on **Analyzer...** and a new screen will appear. In the top half of the screen, selected zonal aggregate socio-economic measures will appear.
- Step 3: Click and choose any desired variable/measure. Then click **Plot**. For the chosen measure, the frequency distribution or histogram of the variable will appear in the bottom half of the screen. The histogram shows the number of zones in the region that fall within a certain value range for the chosen variable. This is shown in Figure 3.6.

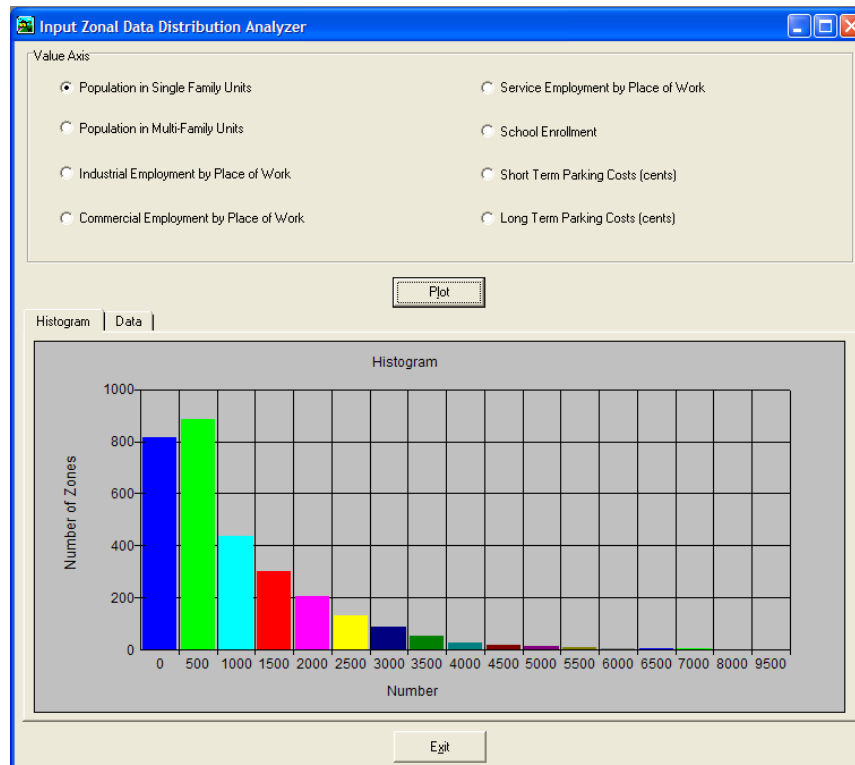


Figure 3.6 Screen Showing Input Zone Data Analyzer

In addition to viewing a graphical distribution of the variables, one can also view the aggregate measures in a tabular format directly. Within the window shown in Figure 3.6, select the *Data* tab instead of the *Histogram* tab. The complete zone-level aggregate data appears as shown in Figure 3.7.

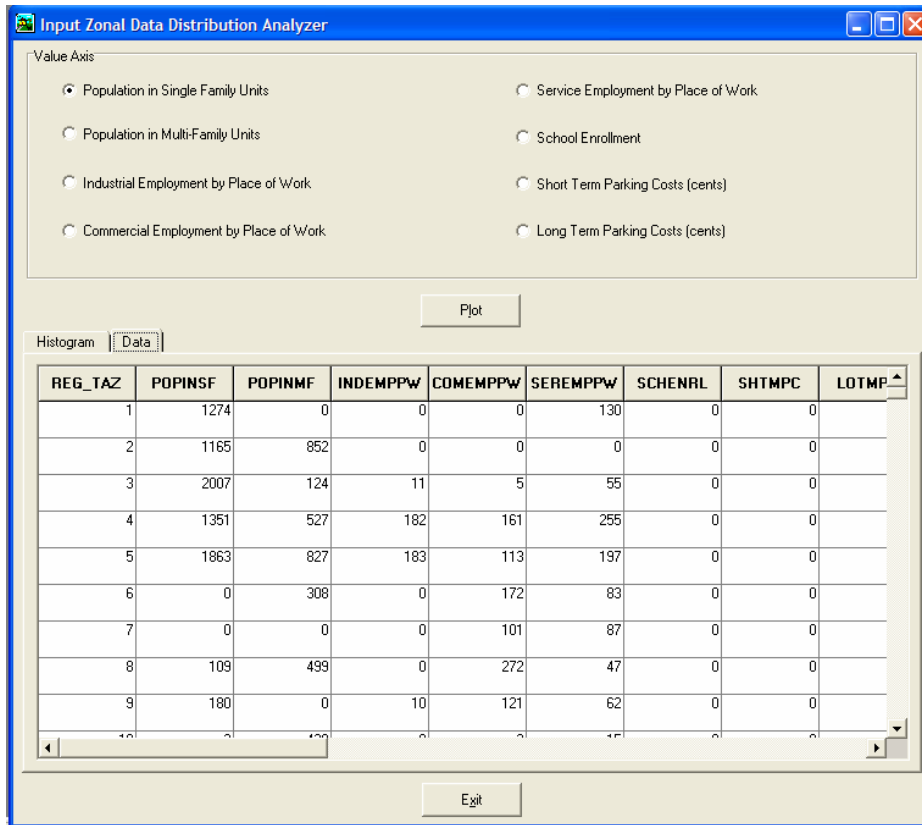


Figure 3.7 Screen Showing HAGS Input in Aggregate Table Format

While the graphical and table formats provide a powerful means of viewing the input zonal data at an aggregate level, HAGS also provides an interface to ArcView 3.2 or later so that the data can also be seen in a visual map format. One must have ArcView 3.2 or later in order to use this capability of FAMOS. Although FAMOS is a stand-alone package that will run without any problems even in the absence of ArcView, users will not be able to utilize the ArcView visualization capability without the ArcView package resident on the machine. One should also note that there are a host of visualization tools within the ArcView software package than can be utilized to further enhance and customize the views. Future versions of FAMOS will be interfaced with TransCAD so that there is stronger compatibility between FAMOS and FSUTMS-TransCAD.

Viewing HAGS Input Zone Data in ArcView

- Step 1: Choose the **Population Generation** tab in the HAGS main window.
- Step 2: Click on **ArcView...** and a new dialog box will appear. This dialog box includes selected aggregate zone-level socio-economic measures or variables used by HAGS. The user should select one variable for ArcView display purposes. The screen showing this dialog box is as shown in Figure 3.8.
- Step 3: Click and choose any desired variable/measure. Then click **ArcView...**. FAMOS will now launch the ArcView program/software resident on the machine. For the chosen input variable, a thematic map will be automatically generated by ArcView and displayed on the screen. This is shown in Figure 3.9.
- Step 4: One can exit from ArcView at any time. Also, one can keep ArcView running in the background and switch back to FAMOS at any time.

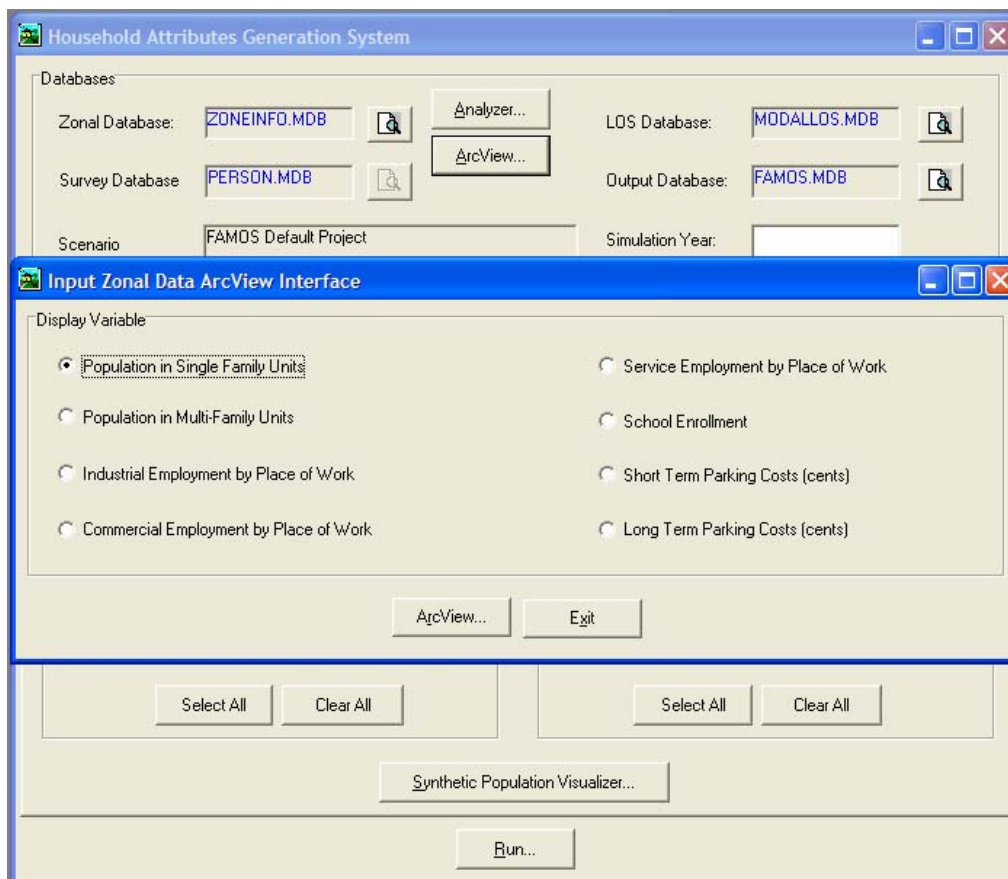


Figure 3.8 Screen Showing Dialog Box for Choosing Variable to Display in ArcView

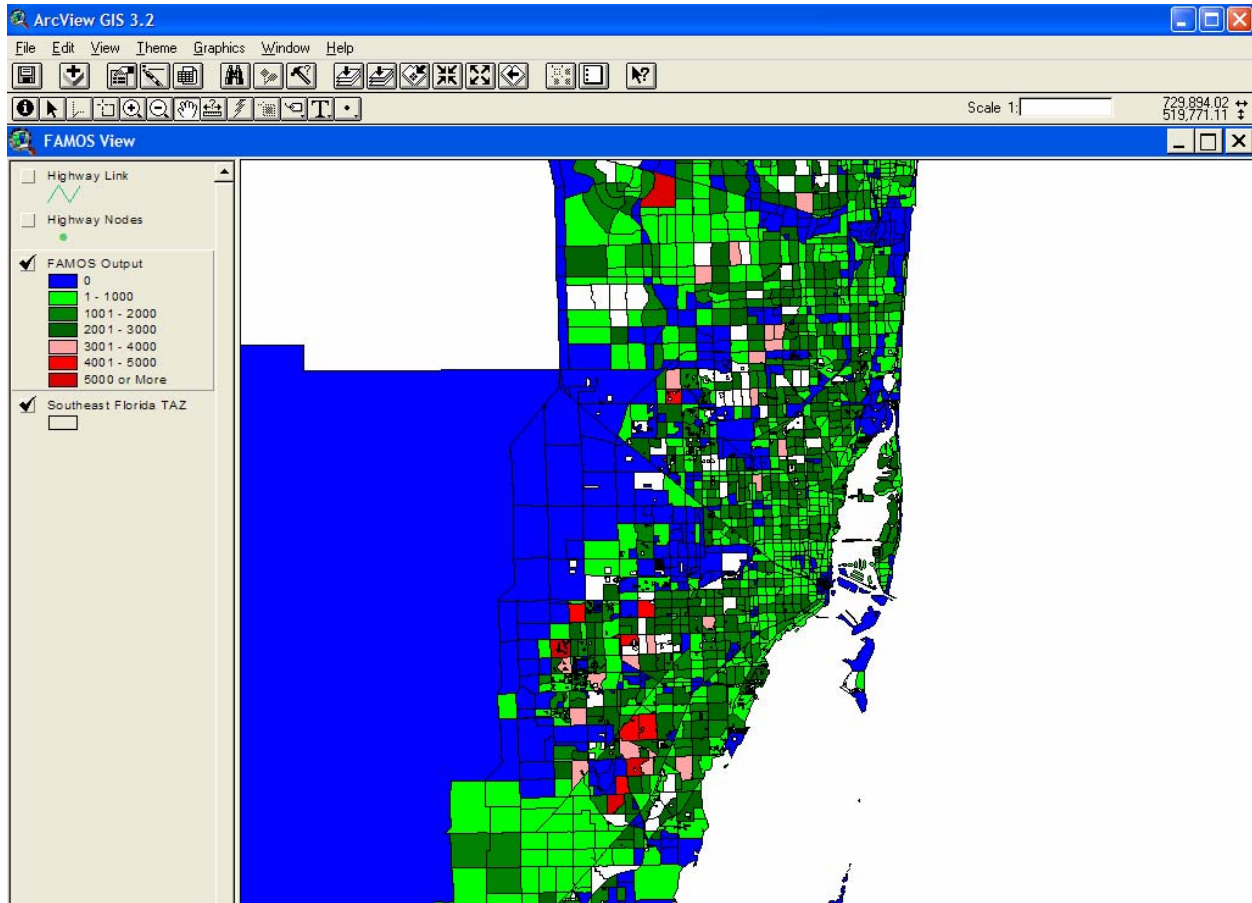


Figure 3.9 ArcView Display of Zonal Input Data for a Selected Variable

4. PRISM-CONSTRAINED ACTIVITY-TRAVEL SIMULATOR

This chapter of the users guide provides instructions for running the Prism-Constrained Activity-Travel Simulator (PCATS).

4.1 What is PCATS?

PCATS (Prism-Constrained Activity-Travel Simulator) is a system of behavioral models that together simulate individuals' activity and travel in urban space. All model components are statistically estimated and adjusted using household travel survey results. The PCATS within FAMOS is based on the 1999 Southeast Florida Household Travel Survey. It should be noted that the specification and estimation of PCATS submodels is limited by the availability of variables in the household travel survey. For example, the household travel survey does not include information about the sex of the person. Therefore, none of the models in PCATS include sex as an explanatory variable. The implementation of PCATS in other areas of the state may entail using the default models currently available within FAMOS or re-estimating PCATS submodels using locally available survey data. If local travel survey data is available, then one may develop and use very different model specifications and estimation results.

Although one would ideally like to develop PCATS submodels specific to a geographic area using locally available survey data, it may not be inappropriate to use the PCATS default activity-based submodels as a starting point when implementing FAMOS in a different area. In general, it is found that activity characteristics show lower variance across geographic areas indicating a greater possibility of transferability of activity-based models between areas. Activity-based models are considered to be more behavioral in nature and therefore fundamentally more transferable than traditional trip-based four-step models.

PCATS simulates behaviors of sample households in time and space over a one-day period. Results of the simulation may be visualized as a set of trip records for each household member, with information on trip purpose, starting and ending times, origin and destination zones, and travel mode. These data are accompanied by information on person and household attributes that are typically contained in travel survey data. An example of an individual's simulated daily travel pattern is shown in Figure 4.1.

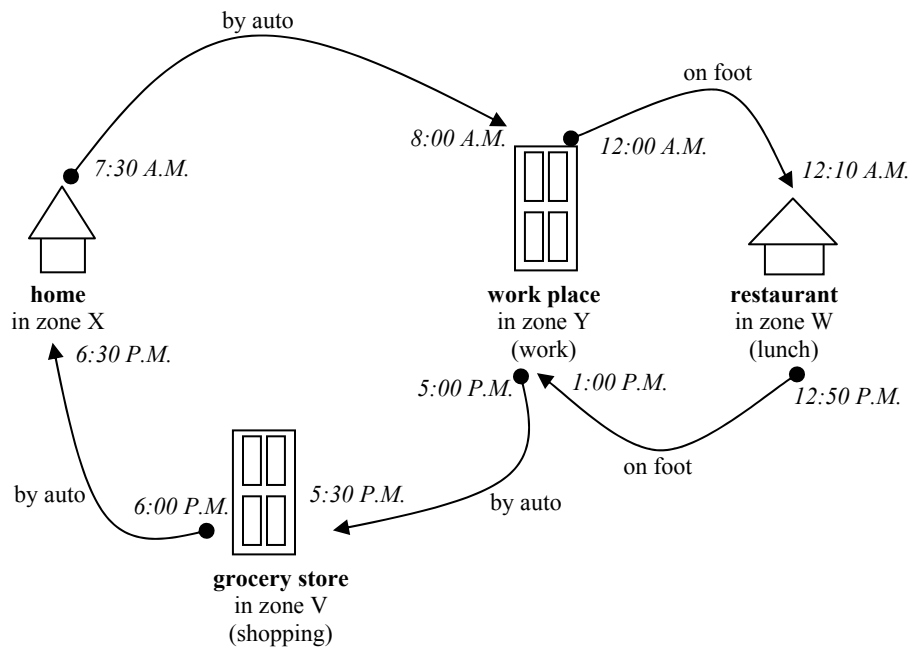


Figure 4.1 Example Daily Activity-Travel Pattern of an Individual Simulated by PCATS

Sample households may contain synthetic households, generated based on census data and travel survey results and distributed over the study area to represent its current, or future, population. The number of sample households can be adjusted to achieve desired levels of precision and spatial/temporal resolution in simulation results. In general, more precise results can be obtained by increasing the number of sample households by generating additional synthetic households. At this time, FAMOS simulates the entire population and thus provides a very high level of spatial and temporal resolution and accuracy. However, recognizing that full population simulation is computationally intensive and time-consuming, future versions of FAMOS will incorporate the ability to undertake sample-based simulation where the user can specify the size of the sample desired and then weight and expand the results to obtain regional origin-destination matrices. However, the user should recognize that sample-based simulation comes at the expense of accuracy and precision.

The development of PCATS was motivated by the recognition that various constraints imposed on individuals' activity and travel are not well represented in conventional models of travel behavior. Emphasized in PCATS, therefore, are the constraints imposed on the individual's movement in geographical space along time. Because the speed of travel is finite while the time available for travel and activity is limited, the individual's trajectory in time and space is necessarily confined within "Hägerstrand's prism." This is shown in Figure 4.2. In the figure, point A represents the time point through which the individual must stay at location H. For example, this may be the earliest possible time that a commuter can leave home. Point B

represents the time point by which the individual must be at location W. This may be the time by which the commuter must report at his or her work place. If urban space can be represented one dimensionally as in the figure, and if the commuter can travel at speed v , then the domain in time and space that the commuter can occupy can be represented by the parallelogram as shown in the figure. This parallelogram is representative of Hägerstrand's prism.

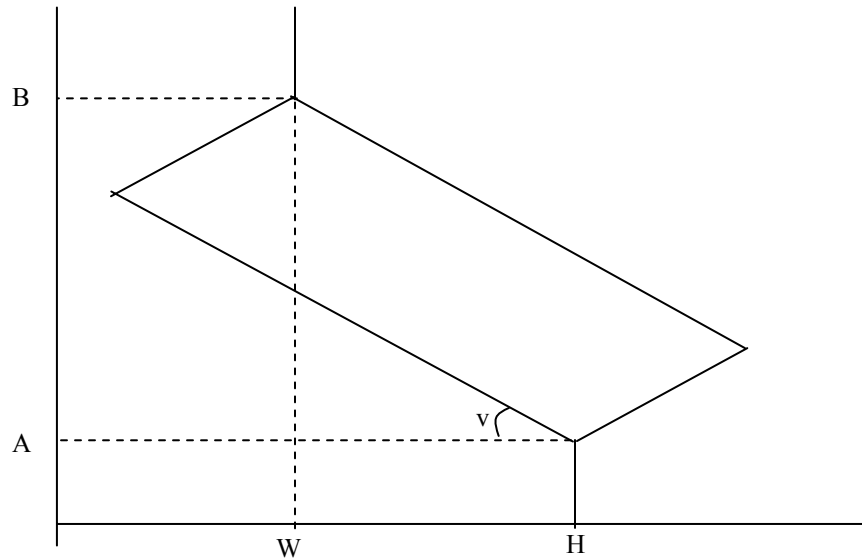


Figure 4.2 Hägerstrand's Prism

Prior to the simulation of activity-travel behavior, PCATS identifies the set of prisms that govern an individual's behavior, then generates activities and trips within each prism while observing constraints involving private travel modes and operating hours of public transit. Prisms are defined over a system of traffic zones (TAZs). PCATS first determines for each individual the periods in which the individual is committed to engage in a certain activity, or a bundle of activities, at a predetermined location. These periods are called "blocked periods". For example, a worker's work hours may constitute blocked periods.

The complement of a set of blocked periods for an individual is a set of "open periods." For example, the lunch break of a worker constitutes an open period. A Hägerstrand's prism is established for each open period that an individual has. This is done through the following procedure. Given the mode of travel being used, it is determined for each zone whether the zone can be visited within the open period and, if so, how much time can be spent in the zone before starting to move to the location of the next committed activity. This is repeated for all zones to identify the earliest possible arrival time at, and the latest possible departure time from, each zone. These arrival times and departure times comprise a prism for the open period.

Blocked periods for workers are typically determined by work schedules, e.g., between 8:00 A.M. and 12:00 noon and between 1:00 P.M. and 5:00 P.M. would be typical blocked periods (see Figure 4.3). Then, a worker's day may be assumed to include three prisms: one before work, one during the lunch break, and one after work (Figure 4.3). The beginning time of the first prism before work and the ending point of the last prism after work are not well defined. In FAMOS, models have been developed to estimate such unobserved prism vertices or end points.

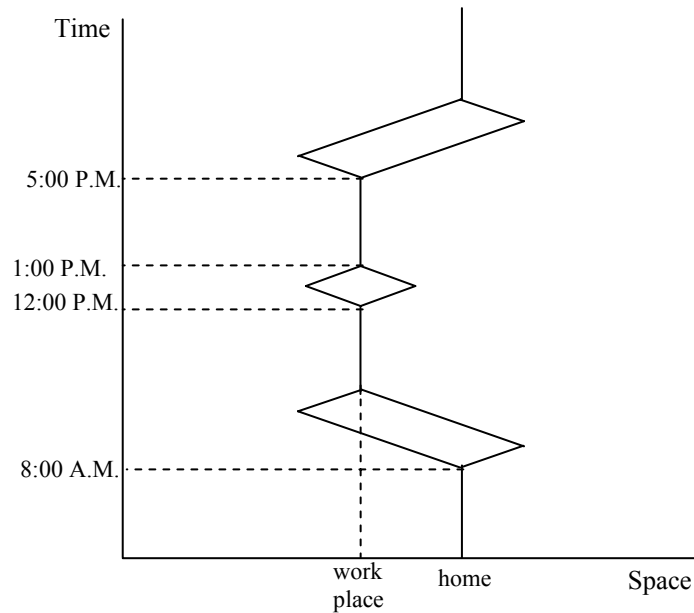


Figure 4.3 Typical Worker's Prisms

Another set of constraints incorporated into PCATS is concerned with the availability of travel modes. As noted earlier, the availability of public transit is determined by its operating hours. Outside the operating hours, public transit is eliminated from the choice set of the destination-mode choice models. PCATS also tracks the location of private travel modes such as the automobile and bicycle. For example, if a private automobile is not located at the origin of a trip, then it will be eliminated from the choice set of the destination-mode choice models.

4.1.1 Generation of Activities

In PCATS, the probability that a particular daily activity-travel pattern will be made is decomposed into a series of conditional probabilities, each associated with one activity bundle and the trip to reach the location where it is pursued. The conditional probability of an activity bundle is further decomposed to yield the following three sets of model components: 1) activity type choice models, 2) destination and mode choice models, and 3) activity duration models.

These models are applied repeatedly to simulate activities and trips one by one within each open period. This is shown in Figure 4.4.

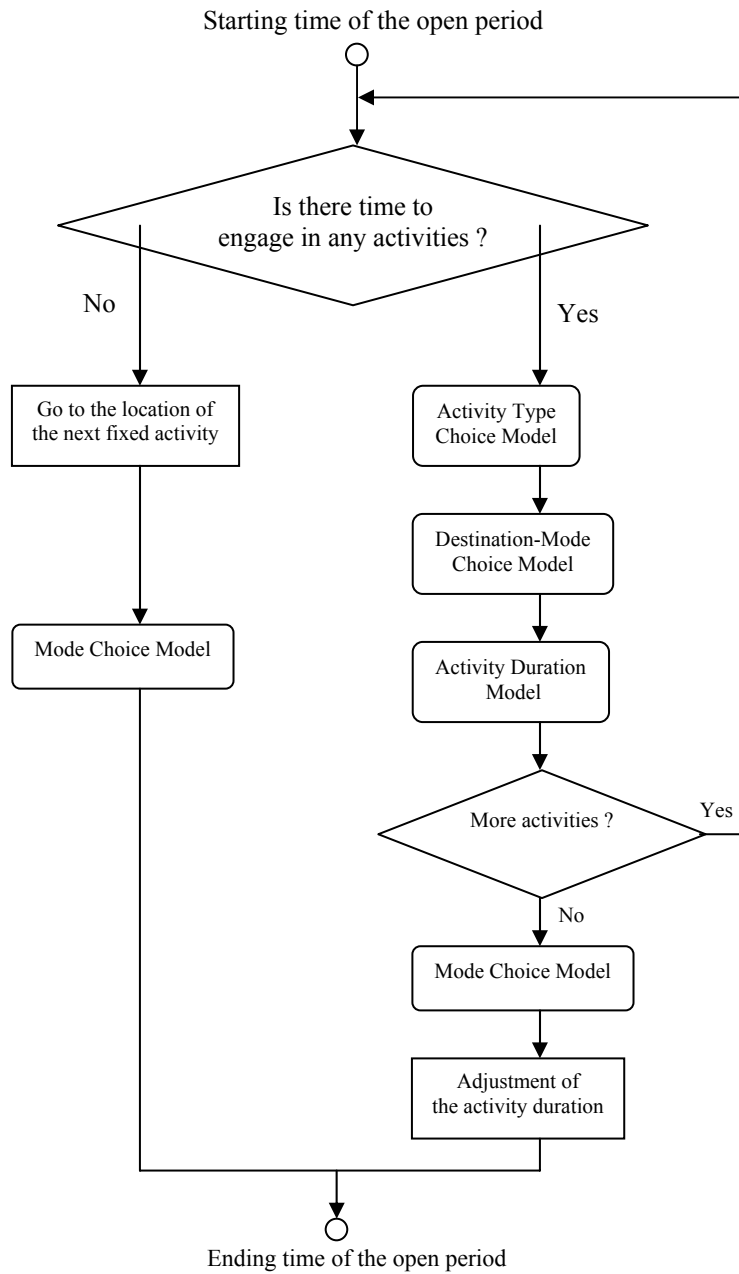


Figure 4.4 Structure of PCATS

Table 4.1 shows the segments on which these models were developed in the FAMOS version of PCATS.

Table 4.1 Segmentation Adopted in Model Development

Models	FAMOS Segmentation
Activity Type Choice Models	{Workers, Students, Others}
Destination-Mode Choice Models	{Work, Non-work} × {Workers, Students, Others}
Activity Duration Models	{Social-Recreational, Shopping, Other Non-work} × {Workers, Students, Others}

4.1.2 Activity Type Choice Models

The activity type choice models are two-tier nested logit models. The upper tier comprises two categories of activity bundles: (A) in-home activities, and (B) out-of-home activities. The alternatives nested under (B) may include the following activity types: social-recreational and shopping. These are defined in terms of the trip purposes defined in the travel diary data used for model specification and estimation.

The type of the first activity bundle in an open period is determined using an activity type choice model. In the models, the probability that a given activity type will be selected decreases as the time available in the prism becomes shorter relative to the distribution of activity durations for that type of activity. In other words, the models reflect the tendency that activities tend not to be pursued if there is not enough time for them. The time of day is another important factor that affects the choice of activity type. The explanatory variables used in the activity type choice models in the FAMOS implementation of PCATS are: age, sex, household auto ownership, household size, and the time of day.

Given the activity type, a destination-mode pair is next determined using a destination and mode choice model. Following this, the duration of the activity at the destination is determined. At this point, the time of day when, and the location where, the next activity ends can be determined. The activity type choice model is applied again to simulate activity engagement in the remainder of the open period, using updated amount of time available. This process is repeated until all available time is exhausted in the open period.

4.1.3 Destination-Mode Choice Models

The destination and mode choice models are also nested logit models. Alternative destinations constitute the upper-level alternatives, and available travel modes are nested under each destination alternative. An example set of explanatory variables is presented in Table 4.2.

**Table 4.2 Explanatory Variables of Destination-Mode Choice Model:
For Workers, Non-work Activities**

Zone Attributes zone size population density commercial employment Household/Person Attributes age auto ownership Trip Attributes travel cost travel time number of transfers Activity Attributes current time of day location type of current activity location type of next fixed activity
--

Geographical zones are used in the current version of PCATS to represent location. As noted earlier, the geographical extension of the prism is evaluated for each travel mode, and destination-mode pairs are excluded from the choice set if they do not fall in the prism. The amount of time available at the destination is one of the determinants of the choice probability along with the attributes of the destination zone and the trip to the destination by respective travel modes. Travel modes are classified into auto drive alone, auto multi-occupant vehicle (driver and non-driver), public transit, and walk and bicycle.

Given a travel mode, PCATS evaluates travel time to the destination zone. If the automobile or public transit is used, a zone-to-zone travel time is obtained from the modal level-of-service database depending on the time of day (peak or off-peak). Travel times by bicycle or walking are computed using an assumed mean speed of travel (12.0 mph for bicycle and 4.0 mph for walking) and the zone-to-zone distance. Given a travel time, the starting time of the activity at the destination is determined.

4.1.4 Activity Duration Models

Following these, the duration of the activity at the destination is determined using the activity duration model corresponding to the activity type. The activity duration models in PCATS are hazard-based, split population survival models. In these models, the maximum possible activity duration is first determined based on the size of the prism, which is a function of the speed of travel, the location of the trip origin, the location of the current activity, and the location of the next fixed activity. Then, an individual is assumed to decide whether he or she allocates all the time available in the current open period to a single activity, or to two or more activities. Binary logit models are developed to represent this binary choice.

If a person chooses the former option, the activity duration is the maximum possible activity duration in the current open period. If the person chooses the latter option, the duration of the next activity is determined using a hazard-based duration model. A set of hazard-based duration models is deployed in PCATS. A model is developed for each activity type, and the parameters of the distribution (the mean and a shape parameter) are formulated as functions of personal attributes and other explanatory variables. Weibull distributions are exclusively used in the current version of PCATS. The examples of explanatory variables used in the duration models are person and household attributes, time of day, time availability, location type indicator (see Table 4.3). The distribution as given by the duration model for the activity type is right truncated, i.e., a probability mass equaling to the probability that the activity duration will exceed the maximum available time is placed at the maximum. The resulting mix distribution is used to generate activity durations in the simulation. The two sub-models, the binary logit model and hazard-based duration model, are estimated simultaneously for each activity type.

**Table 4.3 Example Explanatory Variables of Split Population Survival Models:
For Workers, Shopping**

Household/Person Attributes
age
license
household size
car ownership
Activity/Prism Attributes
current time of day
the possible maximum activity duration
location type of current activity
location type of next fixed activity

As noted earlier, once the attributes of an activity bundle are all determined, the procedure is repeated for the next activity bundle in the same prism. Activity and travel in each open period is thus simulated by recursively applying these model components, while considering the history of past activity engagement. Activity starting and ending times are determined based on simulated activity durations and travel times (from the modal level-of-service tables). The procedure is repeated until each open period is filled with activities.

Estimating the components of PCATS and simulating an individual's activity-travel pattern in the target area, requires the following data:

- Household/person attributes (e.g., age, sex, license, household size, car-ownership) usually obtained from running HAGS
- Attributes of blocked periods (e.g., the beginning time, ending time, type, and location of each fixed activity within each blocked period) usually obtained from running HAGS

- Level of service data by mode for each zone pair in the study area (e.g., travel time, travel cost, and number of transfers) usually obtained from a traditional four-step model (FSUTMS)
- Zone characteristics (e.g., area, population, population density, number of employees, and number of commercial establishments) usually associated with current four-step models (FSUTMS).

4.2 Running PCATS

PCATS (Prism-Constrained Activity-Travel Simulator) may be accessed from the *Simulator* menu of the FAMOS main window. The PCATS window may be launched while keeping the HAGS window open. One can switch back and forth between these windows during a FAMOS session.

Launching PCATS

Step 1: From the FAMOS main window, click on *Simulator* and then *Prism Constrained Activity Travel Simulator*. The PCATS window should appear as in Figure 4.5.

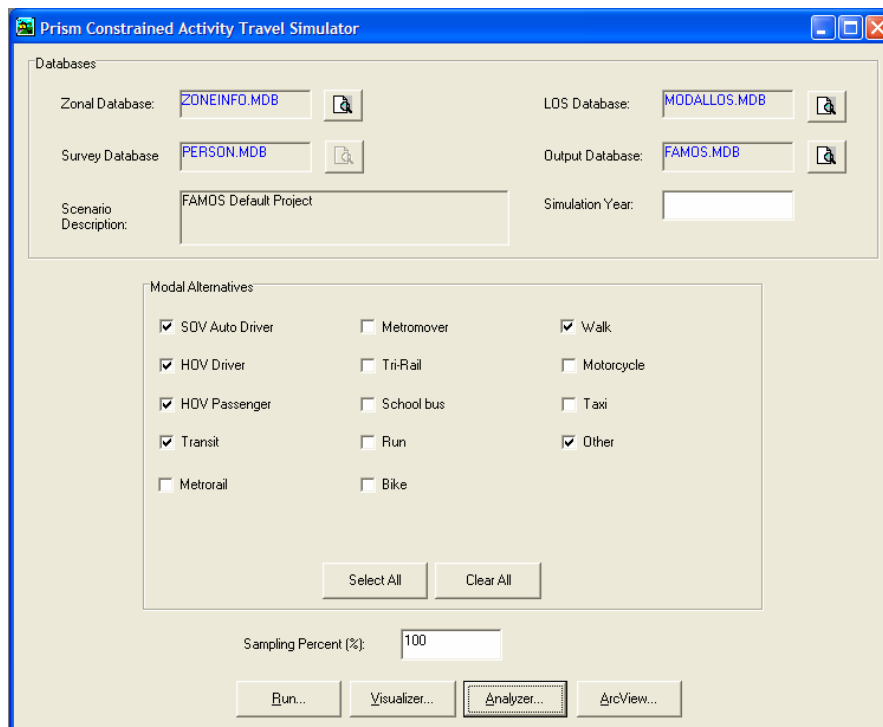


Figure 4.5 PCATS Main Window

Within this window, the user can view the databases (zonal and modal level-of-service databases) as described previously in Chapter 3. At this time, the simulator accommodates modes of transportation that are commonly encountered in transportation planning applications.

These include:

- SOV driver
- HOV driver
- HOV non-driver
- Public Transit
- Bike or Walk

Due to the limited household travel survey data available, mode choice model utility equations could not be estimated for other modes of transportation appearing in the PCATS window. Depending on the mode choice model specified and estimated by the user, the appropriate modes of transportation need to be selected within this screen. At this time, FAMOS automatically selects all modes of transportation for which utility equations have been estimated in the mode choice models of PCATS. The user is not allowed to deselect any mode for which a utility equation exists. Similarly, a user can not select a mode for which a utility equation does not exist. After selecting the appropriate modes of transportation, PCATS may be run.

While HAGS simulates the entire population of a region, PCATS provides the user the flexibility to perform the simulation on a random sample of the synthetic population generated by HAGS. The user can specify a sampling rate between 5 and 100 percent. A smaller sampling fraction will reduce run times substantially, but this comes at the cost of prediction accuracy. At the end of the simulation, the current version of FAMOS simply expands the resulting trip tables using the inverse of the sampling rate as a multiplying factor. This expansion method is rather simplistic and constitutes an approximation that may not be acceptable in all applications. The user should be cautious when running a small sample-based simulation to estimate regional trip tables.

Executing PCATS

Step 1: In the PCATS main window, enter a sampling fraction. The smallest allowable value is 5 and the maximum value is 100. The system default is 100 (which corresponds to a full population-based simulation).

Step 2: Click the **Run** button. The simulation process will start. The simulation will generate activity-travel patterns for each and every person included in the simulation. A screen similar to that shown in Figure 4.6 will appear.

Step 3: When the execution is complete, a message indicating successful completion of the simulation will appear. Close this dialog box if it does not close automatically.

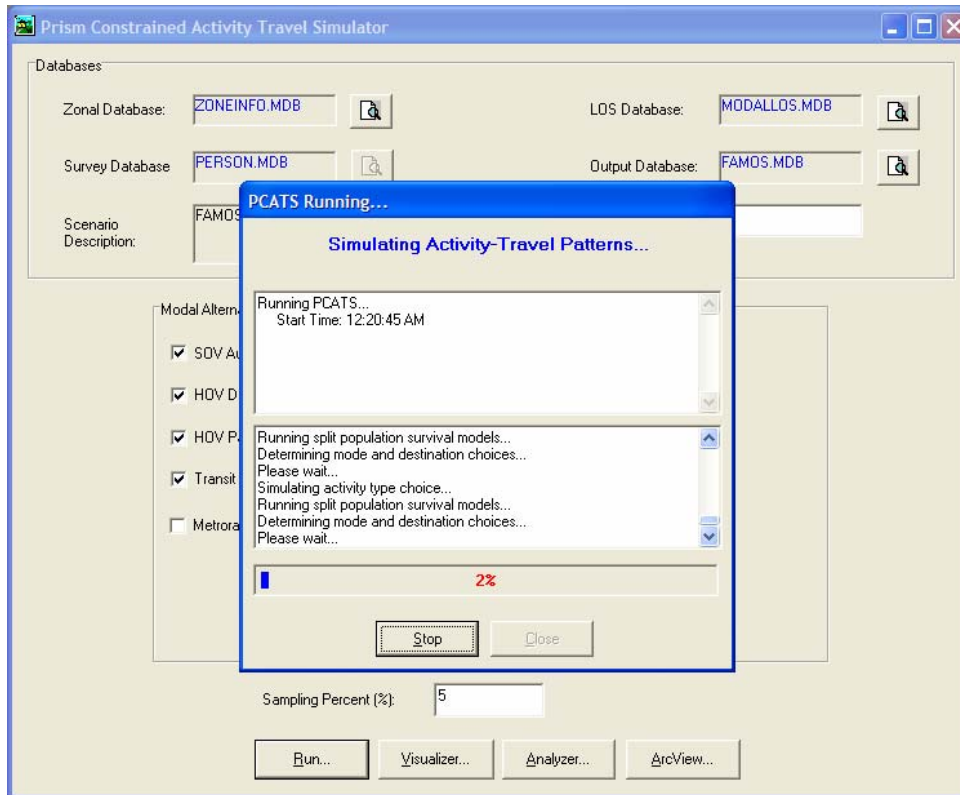


Figure 4.6 Screen Showing PCATS Running

4.3 Viewing PCATS Output at the Individual-Level

As with HAGS, PCATS allows the user to view the output both at the individual level and at the aggregate level. At the individual-level, PCATS allows the user to view individual persons and their activity-travel records. At this time, a rather simple graphic depicting the major aspects of the activity-travel pattern appears in the output viewer screen. In future versions, more sophisticated graphics clearly depicting the trip chaining pattern followed by the individual will be incorporated.

Viewing PCATS Output at Individual-Level

Step 1: After a successful PCATS simulation run, click on **Visualizer...**

- Step 2: A screen similar to that shown in Figure 4.7 will appear. A user may select any individual of the simulation to view the activity-travel records and activity-travel agenda for the selected individual.
- Step 3: Click on any travel record to view the details about the trip in the bottom right portion of the screen. A simple graphic depicting the highlights of the activity-travel patterns is shown in the bottom left portion of the screen.
- Step 4: Click **Exit** to return to the PCATS main window.

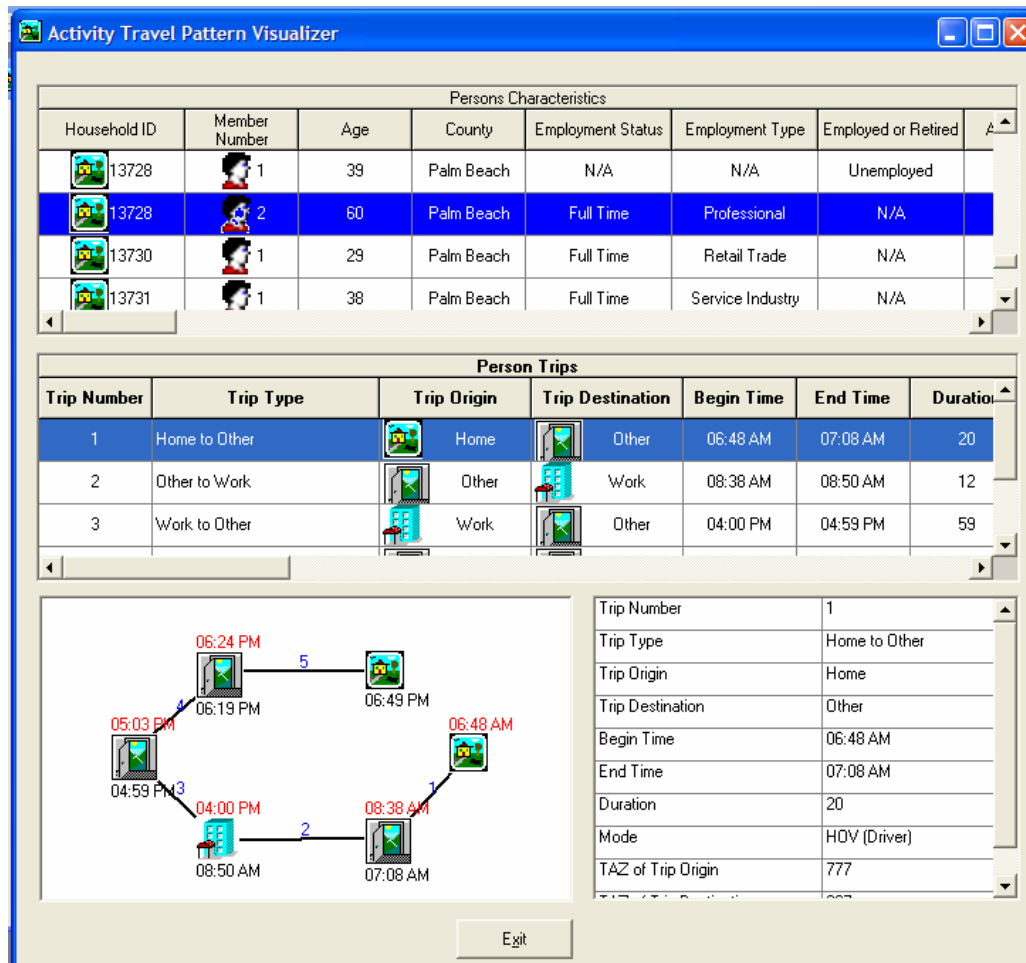


Figure 4.7 Screen Showing PCATS Individual-Level Output Visualizer

4.4 Viewing PCATS Output at the Aggregate Zone Level

As with HAGS, PCATS allows the user to view the output at the aggregate or zone level so that the user may view reports, perform reasonableness checks, and obtain aggregate measures of travel demand in the region.

Viewing PCATS Output using the PCATS Analyzer

- Step 1: After a successful PCATS simulation run, click on **Aalyzer...** in the PCATS main window.
- Step 2: A screen similar to that shown in Figure 4.8 will appear. A user may view trip length distributions for various trip types by purpose (origin-destination combination) and mode using the PCATS analyzer.
- Step 3: Select one or more trip origin, destination, and mode combinations to view a trip length distribution. Select the impedance measure that will be used for the x-axis of the trip length distribution. The impedance measures include distance and travel time. The plots may be viewed in raw distribution form or in cumulative form.
- Step 4: Click **Plot...** to obtain the desired trip length distribution. A user may generate as many plots as desired.
- Step 5: The data underlying the plot may be seen in tabular form. Click on the *Data* tab (next to the *Histogram* tab). A table will appear. This table shows the number of trips of the type chosen by the user that fall within each impedance measure bin (interval).
- Step 5: Click on **Exit** to return to the PCATS main window.

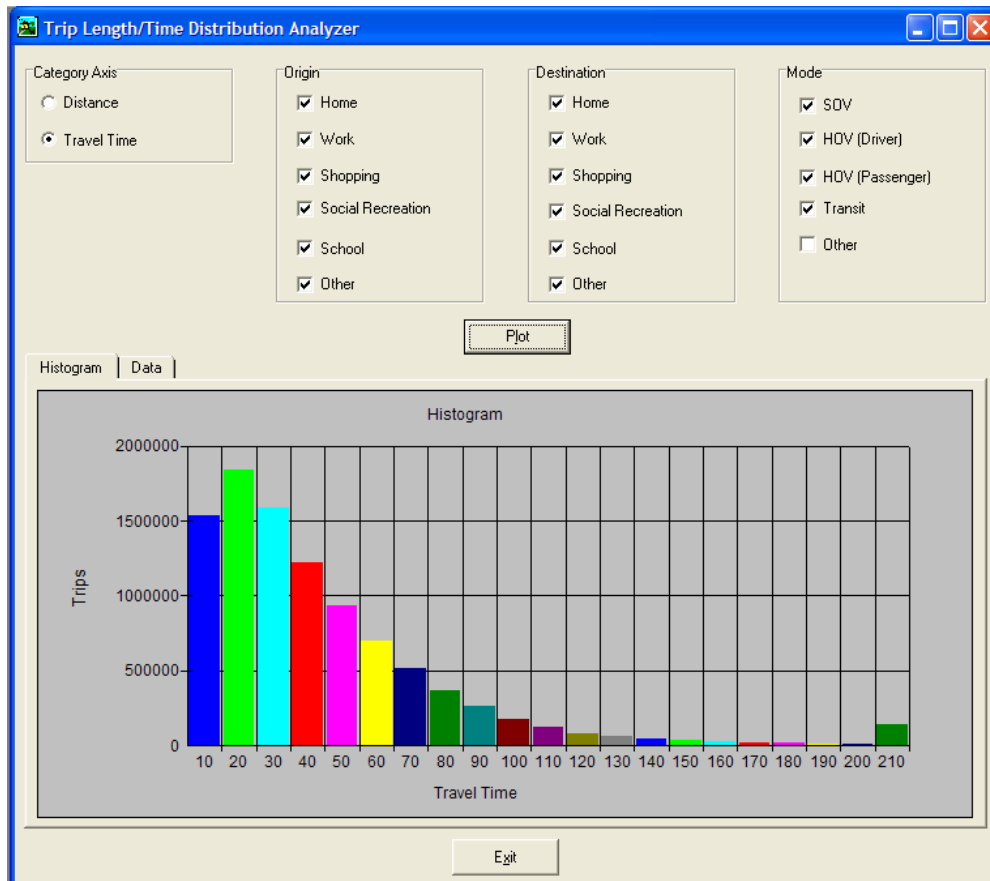


Figure 4.8 Screen Showing PCATS Output Trip Length Distribution Analyzer

4.5 Viewing PCATS Output in ArcView 3.x or Higher

PCATS also provides the ability to view the output in aggregate form within a GIS environment. Currently, FAMOS provides an interface to ArcView 3.2 or higher. If a user has ArcView 3.2 or higher on the resident machine, then this feature can be activated. If ArcView 3.2 or higher is not available, then all features of PCATS except for the GIS interface are available to the user.

The GIS output viewer allows the user to visually display a thematic map showing the density of trip exchange from an origin zone to all possible destination zones or vice versa. Thus, the thematic display can show daily trip exchanges from an origin zone to all possible destination zones or show daily trip exchanges from all possible origin zones to a destination zone.

The GIS interface requires the user to have a zonal shape file in an ArcView subdirectory within the FAMOS directory. The zonal shape file is a standard ArcView shape file that has the map of the TAZ structure. The associated DBF file should contain the zone IDs and any other zonal attributes that the user wishes to have in the ArcView DBF file. Whenever the user requests an

ArcView display of a particular piece of information, FAMOS will automatically (dynamically) append information to the zonal DBF file in the ArcView subdirectory and produce the desired display.

Viewing PCATS Output using the ArcView Interface

- Step 1: After a successful PCATS simulation run, click on **ArcView...** in the PCATS main window.
- Step 2: A screen similar to that shown in Figure 4.9 will appear. The user can select one or more combinations of trip types (origin-destination combinations) and modes for viewing trip exchanges between selected zones.
- Step 3: Choose a zone number that will serve as the origin zone or the destination zone for analysis purposes. Click on **Query**.
- Step 4: The PCATS output analyzer will run and query the database to isolate the trip exchanges involving the chosen zone. The query results are displayed in a table format in the screen similar to that seen in Figure 4.9. The table shows the total daily trips between the origin-destination zone pairs for the chosen trip types and modes. The average travel time between the zone pairs for the trips shown in the table is a weighted average of the peak and off-peak travel times where the weights are equal to the trip share in each time period.
- Step 5: Click **ArcView...** to launch the ArcView display of the chosen trip exchanges. A map similar to that seen in Figure 4.10 will appear.
- Step 6: Within the ArcView display, a user can use the many features of ArcView to further enhance or manipulate the visual display.
- Step 7: Exit from ArcView in the usual way to return to the PCATS ArcView analyzer interface. Alternatively, one can switch to this screen while keeping ArcView open and active. A different query can be run and the results can be displayed in ArcView.
- Step 8: Click **Exit** to return to the PCATS main window.

It is envisioned that future versions of FAMOS will have enhanced visual display capabilities, possibly via an interface with TransCAD[®] or by developing ArcObjects based display systems that are resident within FAMOS and not dependent on any third party software.

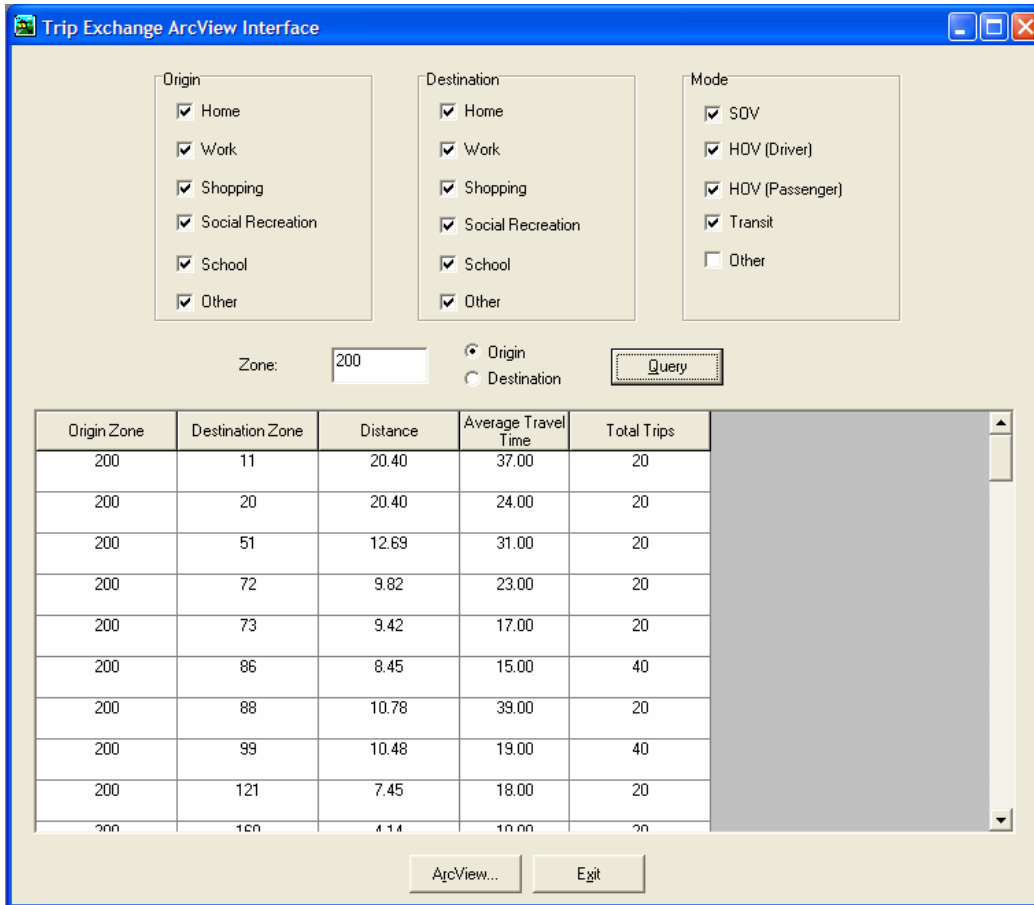


Figure 4.9 Screen Showing Results of Zone Query in Table Form

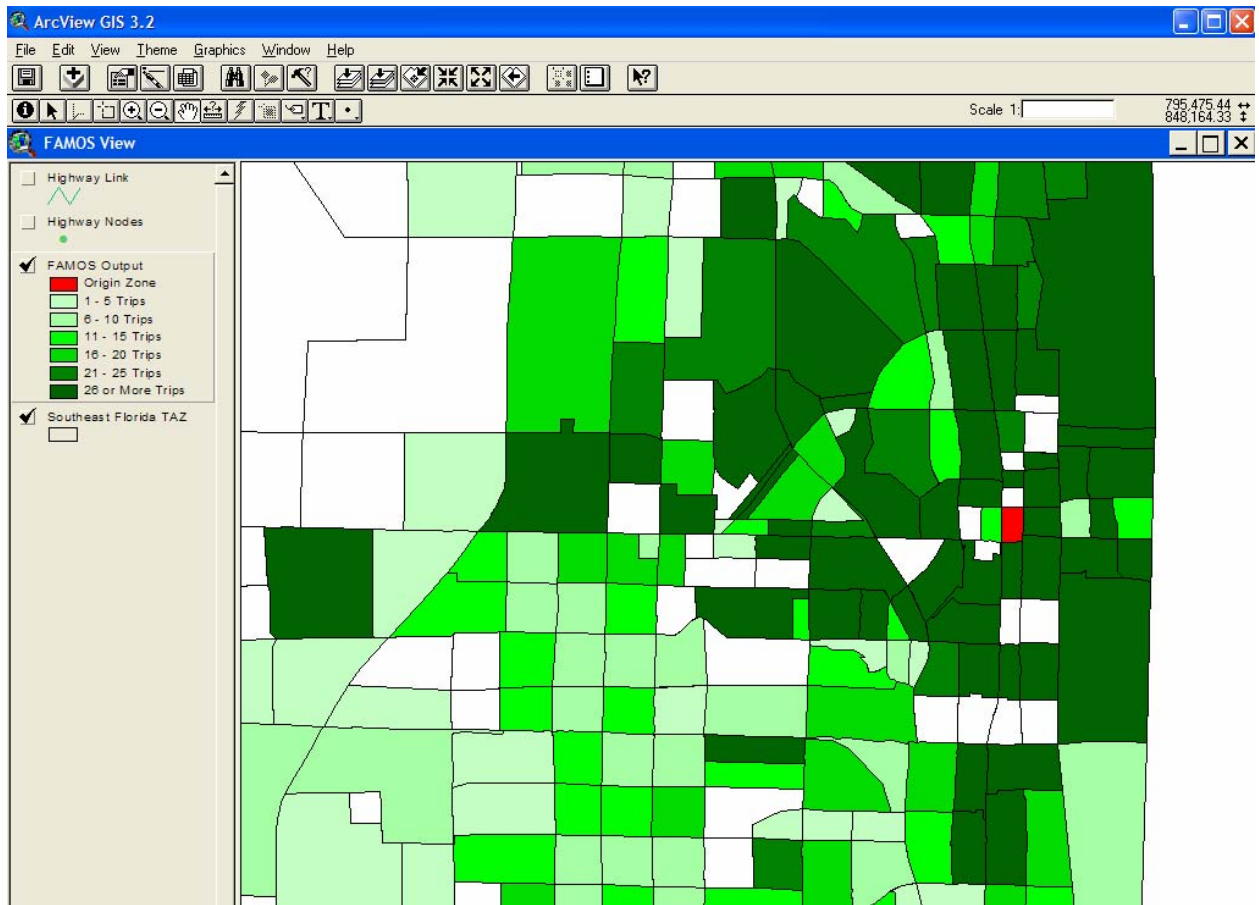


Figure 4.10 ArcView Visual Display of Daily Trip Exchanges Output by PCATS

5. O-D MATRIX CREATOR

This chapter of the users guide describes the operation and use of the O-D matrix creator. The O-D matrix creator allows the user to generate custom O-D matrices suitable for traffic assignment in any transportation modeling software package.

5.1 Using the O-D Matrix Creator

FAMOS produces individual activity-travel records for each person in the simulation region. In order to generate origin-destination matrices suitable for traffic assignment in FSUTMS, one needs to aggregate across the individual activity-travel records according to selected criteria. FAMOS incorporates an O-D matrix creator to allow the user to generate custom O-D matrices on the fly.

One of the most powerful aspects of FAMOS is its simulation of activity-travel patterns along the continuous time axis. Thus, it offers a powerful time-of-day modeling capability that has been missing in traditional trip-based travel demand models. Coupled with a robust activity-based simulation model system that is behavioral in nature, the time-of-day modeling capability makes FAMOS a powerful policy analysis tool for addressing such issues as induced demand, trip re-scheduling, trip chaining, and changes in destination choice.

O-D Matrix Creation

- Step 1: After a successful PCATS simulation run, click on the *Simulator* menu of the FAMOS main window. Choose *O-D Matrix Creator*.
- Step 2: A screen similar to that shown in Figure 5.1 will appear. This screen allows the user to generate custom O-D matrices on the fly according to selected criteria. A total of up to 12 matrices can be defined at any one time. Additional runs of the O-D matrix creator can be executed if more than 12 O-D matrices are desired.
- Step 3: For each desired matrix, define the time slice by entering, or choosing from the drop-down menu, the beginning and ending hours for which trips should be included in the O-D matrix. Select a trip type and mode from the respective menus. For each matrix, enter an output table name where the matrix will be saved. Each matrix will be saved in a different table within the FAMOS.MDB database using the name specified by the user.

- Step 4: After defining the desired matrices, click **Create** to save the matrices. This is an extremely computationally intensive exercise; as such the process may take quite a bit of time and require large amounts of hard disk space. The O-D matrices are saved in tables within a Microsoft Access® format database.
- Step 5: After the creation process is finished, click **Exit** to quit the O-D matrix creator or define new matrices to generate more than 12 matrices.

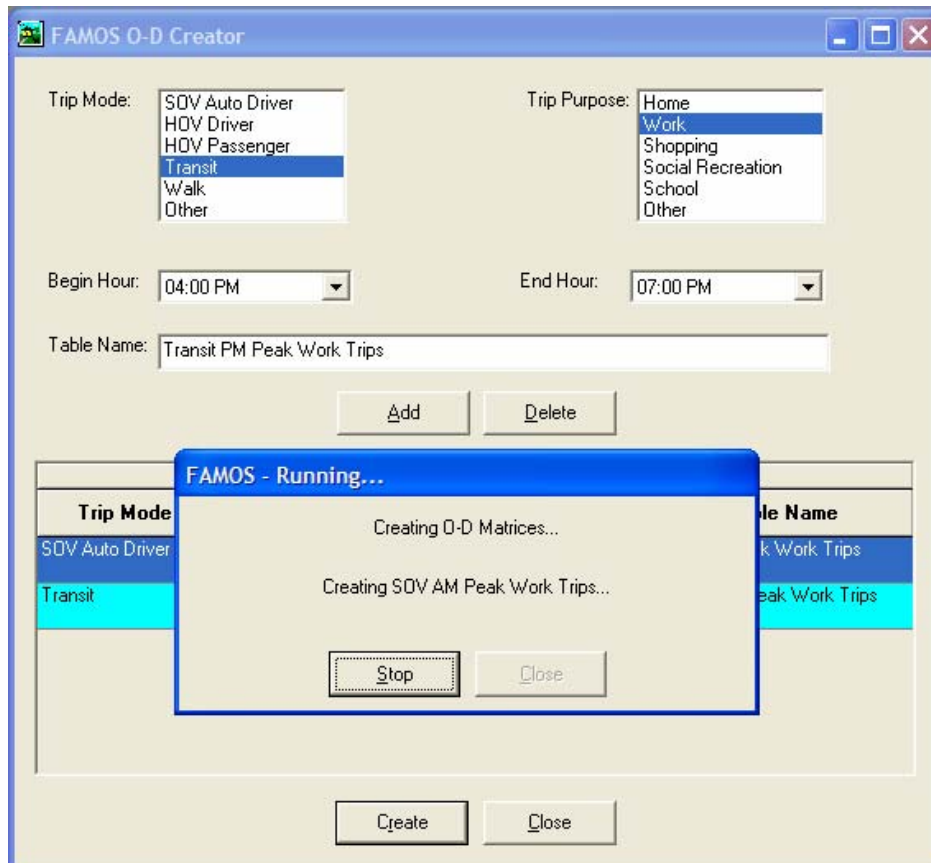


Figure 5.1 O-D Matrix Creator Window

The O-D matrices created using this feature of FAMOS are now ready to be imported in FSUTMS for performing time-of-day based traffic assignment. In addition, FSUTMS-TransCAD offers a host of additional features for viewing, displaying, and managing the O-D matrices created by FAMOS. While FAMOS incorporates the ability to automatically create and view daily trip exchanges from an origin zone to all possible destination zones or from all possible origin zones to a destination zone, it does not provide the full range of readily-available GIS-based display capabilities available in TransCAD that a user could use to view origin-destination travel flows predicted by a travel demand forecasting model.

Using O-D Trip Tables Created by FAMOS in FSUTMS for Traffic Assignment

- Step 1: Open FAMOS.MDB in MS Access®. The O-D matrices created in FAMOS will appear as tables in the database.
- Step 2: Open the desired O-D matrices and convert them to ASCII format for FSUTMS-Tranplan or DBF format for FSUTMS-TransCAD.
- Step 3: Open FSUTMS-Tranplan or FSUTMS-TransCAD and import/read the O-D matrices saved from MS Access®.
- Step 4: Run traditional traffic assignment algorithms on these O-D matrices.

The user must have a robust network/base map with all link and node attributes that is typically available with all four-step models. This network will be used for assigning the traffic. In the absence of a four-step model, a user would have to create a network and associated databases within a four-step modeling package so that traffic assignment can be performed. Thus FAMOS is currently a strong compliment to four-step models that might already be in place in various areas. In the future, it is envisioned that FAMOS will become a more stand-alone and independent package through the integration of a dynamic network simulator. It is also planned to interface FAMOS with the dynamic network simulators that are becoming available with commercially available four-step modeling software. Interfacing FAMOS with these simulators would allow one to dynamically load trips onto the network and view them as they get executed in the space-time continuum.

6. MODEL SPECIFICATION AND ESTIMATION RESULTS

This chapter provides the specification and estimation results of the various submodels contained within FAMOS. These models are primarily those contained within PCATS and embody a series of activity type choice models, mode choice models, location choice models, prism vertex models, and activity duration models. In addition, this chapter includes some validation results from the Southeast Florida simulation region to illustrate the ability of FAMOS to replicate observed data.

6.1 PCATS Submodels

There are a series of PCATS submodels that were estimated as part of the FAMOS development effort. It should be noted that the development of the FAMOS methodology, the specification of the models, and the estimation model coefficients using maximum likelihood estimation (MLE) methods was a monumental effort requiring years of person-effort. It is envisioned, however, that users who wish to develop a new series of models for their own area (using travel survey data collected locally) will be able to do so with substantially less effort than that required during the FAMOS development process. This is because the FAMOS modeling methodology, logic, and submodel connections have now been established within the software and users do not have to re-create the FAMOS modeling structure. It is suggested that users specify and estimate models that are similar to those presented in this section to maintain consistency with the internal FAMOS structure. In general, however, users should be aware that the development, specification, and estimation of new models for FAMOS will entail substantial effort, time, resources, and expertise.

The remainder of this section presents model estimation results for the various submodels within FAMOS. The mathematical and econometric formulations underlying the modeling methodologies are not explained within this users manual. The user is referred to various references listed in Chapter 7 to obtain detailed information about the mathematical formulations and statistical/econometric estimation procedures.

6.1.1 Time-Space Prism Vertex Models

The time space prism vertex models are stochastic frontier models aimed at determining the time-space prism boundaries or edges within which a person must undertake activities and trips. Time-space prisms may shrink or expand depending on household, modal, commute, and institutional constraints faced by an individual. Thus, the explicit incorporation of time-space

prism constraints into FAMOS provides a powerful framework for performing transportation policy analysis and transportation investment impact studies. Expected locations of the prism vertices can be computed as $\beta'X$ where β represents a vector of model coefficients and X represents a matrix of explanatory variables. The expected vertex location is computed from the model in continuous clock minutes; for example, 600 represents 10:00 AM and 1200 represents 8:00 PM. Tables 6.1 through 6.6 present estimation results for these models.

Table 6.1 Stochastic Frontier Model of the Worker's Morning Prism Origin Vertex

Variable	Coef	t-stat
Constant	411	63.34
Age of individual in years	-0.375	-3.32
Part-time worker	31.6	6.99
Telecommuting on working day	22.9	3.89
Employed in service industry	-13.1	-4.01
Commute time (home-to-work travel time in minutes)	-0.485	-5.90
Population in residential zone	-0.00168	-2.60
L(C) ^a , L(β)	-28303,	-22678
χ^2_c (df)		11251 (6)
Var(v)		3733
E(u), Var(u)	105,	10983
Sample size		3700

^a L(C) is evaluated by setting all coefficients to 0, except the constant.

Table 6.2 Stochastic Frontier Model of the Worker's Evening Prism Terminal Vertex

Variable	Coef	t-stat
Constant	1198	77.78
No. of children	-13.6	-4.49
No. of drivers	7.60	2.54
Residing in Palm Beach County	-23.0	-3.22
Age of individual in years	-1.55	-6.50
Part-time worker	-62.8	-7.95
Commute time (home-to-work travel time in minutes)	0.957	5.56
L(C) ^a , L(β)	-19456,	-18155
χ^2_c (df)		2603 (6)
Var(v)		14426
E(u), Var(u)	125,	15705
Sample size		2774

^a L(C) is evaluated by setting all coefficients to 0, except the constant.

Table 6.3 Stochastic Frontier Model of the Student's Morning Prism Origin Vertex

Variable	Coef	t-stat
Constant	375	52.09
No. of drivers in household	6.16	3.15
No. of vehicles \geq No. of drivers in household	15.7	3.04
Retired individual	28.9	2.22
L(C) ^a , L(β)	-12795, -101068	
χ^2_c (df)	5377 (3)	
Var(v)		1290
E(u), Var(u)	106,	11180
Sample size		1696

^a L(C) is evaluated by setting all coefficients to 0, except the constant.

Table 6.4 Stochastic Frontier Model of the Student's Evening Prism Terminal Vertex

Variable	Coef	t-stat
Constant	1082	57.27
Household size	-22.9	-6.16
No. of workers in household	15.9	4.07
Residence in Miami County	25.4	3.03
Age of individual in years	-1.43	-4.38
Individual is <18 years of age	25.5	2.90
L(C) ^a , L(β)	-8085, -8057	
χ^2_c (df)	55.9 (5)	
Var(v)		13807
E(u), Var(u)	92.9,	8629
Sample size		1256

^a L(C) is evaluated by setting all coefficients to 0, except the constant.

Table 6.5 Stochastic Frontier Model of the Other's Morning Prism Origin Vertex

Variable	Coef	t-stat
Constant	453	65.01
No. of children in household	-16.2	-4.18
Age of individual is such that $18 \leq \text{age} < 25$ years	69.5	4.87
Retired individual	19.6	2.69
$L(C)^a$, $L(\beta)$	-13330, -13298	
χ^2_c (df)		64.1 (3)
$\text{Var}(v)$		6929
$E(u)$, $\text{Var}(u)$	177,	31315
Sample size		2026

^a $L(C)$ is evaluated by setting all coefficients to 0, except the constant.

Table 6.6 Linear Regression (OLS) Estimates of the Other's Final Arrival at Home^a

Variable	Coef	t-stat
Constant	944	29.04
No. of children	-32.4	-4.52
Residence in Miami County	36.4	2.74
Age of individual in years	-2.83	-4.03
Age of individual is such that $18 \leq \text{age} < 25$ years	76.9	2.49
Age of individual is ≥ 55 years	60.3	2.50
Individual employed in service industry	0.0156	2.16
R^2 , Adjusted R^2	0.0467, 0.0427	
Sample size		1456

^a The results of the OLS estimates are shown because the third moment of the OLS residuals turned out to be positive.

These models are applied in FAMOS to determine the prisms and open periods in which activity-travel patterns are to be simulated.

6.1.2 Activity Type Choice Models

Activity type choice models are a family of models that predict the type of activity or trip purpose that will be pursued by an individual subsequent to the activity being undertaken currently. The models take into account the history of activity engagement during the day and the time of day in determining the "next activity" that the individual will pursue. Thus, the models in FAMOS recognize the important role played by history dependence and time of day in activity engagement. All models are estimated at the level of the individual decision-maker. The models take the form of nested logit discrete choice models which can be used to calculate the probability that an individual will pursue a certain activity type after the current activity. Tables

6.7 through 6.9 present estimation results for the activity type choice models incorporated in FAMOS.

Table 6.7 Nested Logit Model of Worker's Activity Type Choice

Alternative	Variable	Coef	t-stat
Shopping	Time available until the next fixed activity start time < 2 hours	0.85	3.28
	Current time is between 5:00 and 7:00 PM	0.96	4.02
	Current time is between 7:00 and 9:00 PM	1.81	7.53
	Current time is after 9:00 PM	2.60	3.38
Social	Constant	0.90	3.39
	2 hours \leq time available until next fixed activity start time < 4 hours	0.72	2.81
	Age of individual > 60 years	1.00	2.90
	Current time is between 9:00 AM and 12 noon	-2.54	-3.50
	Current time is between 12 noon and 3:00 PM	-2.42	-4.01
	Current time is between 3:00 PM and 5:00 PM	-1.46	-3.82
Other	Constant	2.77	14.76
	Time available until the next fixed activity start time < 2 hours	1.05	5.89
	2 hours \leq time available until next fixed activity start time < 4 hours	0.53	3.31
	Current time is after 9:00 PM	1.29	2.04
Out-of-Home Discretionary Activities	Duration of previous activities (min)	0.004	-11.62
	Dummy (previous activity is out-of-home discretionary activity)	-1.87	-11.94
Inclusive value		0.76	12.82
Sample size		1,976	
L(C)		-3040.65	
L(β)		-1633.29	
L(β)-L(C)		1407.35	
ρ^2		0.46	

Table 6.8 Nested Logit Model of Student's Activity Type Choice

Alternative	Variable	Coef	t-stat
Shopping	Current time is between 9:00 AM and 12 noon	1.23	4.11
	Current time is between 12 noon and 3:00 PM	0.68	2.09
	Current time is between 5:00 and 7:00 PM	1.49	4.76
	Current time is between 7:00 and 9:00 PM	1.97	4.14
Social	$2 \text{ hours} \leq \text{time available until next fixed activity start time} < 4 \text{ hours}$	0.63	2.95
	Current time is between 12 noon and 3:00 PM	-1.09	-3.14
	Age of individual ≤ 15 years	0.99	4.19
Other	Constant	2.56	11.80
	Time available until the next fixed activity start time < 2 hours	0.61	2.79
Out-of-Home	Duration of the previous activity (min)	-0.004	-6.69
Discretionary	Previous activity is an out-of-home discretionary activity	-2.08	-9.13
Activities	No outside fixed activity during the day	1.43	7.60
Inclusive value		0.81	8.58
Sample size		1,029	
L(C)		-1617.41	
L(β)		-1006.53	
L(β)-L(C)		610.88	
ρ^2		0.38	

Table 6.9 Nested Logit Model of Other's Activity Type Choice

Alternative	Variable	Coef	t-stat
Shopping	Time available until the next fixed activity start time < 2 hours	1.56	3.81
	Time available until the next fixed activity start time > 6 hours	-1.88	-11.50
	Activity is the first activity of the day	1.99	17.50
	Current time is between 9:00 AM and 12 noon	0.69	4.62
	Current time is between 12 noon and 3:00 PM	0.87	6.00
	Current time is between 3:00 and 5:00 PM	0.89	4.83
	Current time is between 7:00 and 9:00 PM	1.09	3.41
	Current time is after 9:00 PM	1.50	2.15
Social	Time available until the next fixed activity start time > 6 hours	-1.14	-5.95
	Activity is the first activity of the day	1.87	12.62
	Current time is between 9:00 AM and 12 noon	-0.40	-2.49
	Current time is between 5:00 and 7:00 PM	0.78	3.08
	Current time is between 7:00 and 9:00 PM	1.67	4.73
	Age of individual is such that $18 \leq \text{age} \leq 40$ years	-0.68	-3.76
	Age of individual is such that $40 < \text{age} \leq 65$ years	-0.45	-3.03
Other	Constant	2.71	19.48
	Time available until the next fixed activity start time < 2 hours	1.59	4.43
	Time available until the next fixed activity start time > 6 hours	-1.36	-9.82
	Age of individual is such that $18 \leq \text{age} \leq 40$ years	-0.37	-3.50
	Number of persons in the household = 1	0.33	2.58
Out-of-Home Discretionary Activities	Total duration of out-of-home discretionary activities so far up to the current activity(min)	-0.006	-10.22
	Duration of the previous activity (min)	0.008	9.90
Inclusive value		0.71	13.15
Sample size		3,130	
L(C)		-5045.72	
L(β)		-2986.45	
L(β)-L(C)		2059.27	
ρ^2		0.41	

6.1.3 Split Population Survival Models of Activity Duration

PCATS includes a sophisticated set of split population survival models (SPSM) that provide a powerful means of determining whether an individual will pursue another activity within an open period and if so, what the duration of the activity will be. For each individual, the SPSM determines whether a person will continue the same activity or transition to a new activity within the open period. Thus, there is a split population effect where some individuals choose to pursue the same activity until the end of the open period and others choose to undertake a different activity prior to the end of the open period. The duration of the activity is determined in a simultaneous equation framework, thus providing a rigorous joint analytical framework for activity engagement and activity duration estimation. Every time a new activity is undertaken, the activity type choice models help determine the trip purpose or activity type that will be undertaken. Tables 6.10 through 6.13 provide estimation results of the SPSM estimation effort.

Table 6.10 Split Population Survival Model (At-Home Non-Fixed Activity; N=4654)

Variable	Exponential Distribution		Normal Distribution		Logistic Distribution		Weibull Distribution	
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
<i>Split Population Choice Model of Continuation/Termination of At-Home Non-Fixed Activity</i>								
Constant	-3.67	-4.11	1.48	5.46	3.55	13.07	3.91	15.56
Past-time outside fixed activity (hours)	-0.46	-5.70	-0.06	-2.19	-0.13	-6.56	-0.16	-7.99
Past-time at-home activity (hours)	0.17	2.25			-0.10	-2.40	-0.12	-3.07
Past-time outside non-fixed other activity (hours)					-0.21	-3.19	-0.21	-3.56
Current time is between 12 noon and 3:00 PM	2.25	4.70	0.73	3.10			-0.41	-1.91
Current time is before first outside fixed activity	2.43	4.28	-2.33	-2.40	-4.13	-1.75	-3.84	-4.43
<i>Hazard-Based Activity Duration Model</i>								
Constant	1.82	9.92	1.73	14.25	1.38	11.23	1.56	12.29
Age of individual <18 years of age	0.89	2.01	0.83	2.52	0.75	3.10	0.72	2.71
Number of persons in the household = 1	0.45	2.44	0.53	3.75	0.52	4.70	0.48	4.48
Number of persons in the household = 2	0.36	3.27	0.34	4.36	0.33	4.96	0.28	4.30
Number of vehicles available in the household	0.16	2.64	0.16	3.71	0.14	3.98	0.13	3.65
Previous activity is outside fixed activity					-0.66	-7.78	-0.48	-6.84
Current time is between 12 noon and 3:00 PM	-0.64	-3.23	-1.56	-11.20				
Current time is between 3:00 and 5:00 PM	-0.79	-4.27	-1.24	-10.44	-0.99	-8.59	-1.12	-10.58
Current time is between 5:00 and 7:00 PM	-1.88	-11.44	-2.09	-17.10	-1.56	-14.51	-1.55	-17.59
Current time is between 7:00 and 9:00 PM	-2.03	-8.03	-2.12	-9.21	-1.67	-8.96	-1.72	-10.78
Current time is between outside fixed activities					-1.80	-8.17	-1.87	-9.27
Travel time from the previous point (hours)					0.23	3.77	0.19	3.10
Time until the next fixed activity start time (hours)					0.03	2.21	0.05	4.13
Current time is before first outside fixed activity and the time until the next fixed activity start time ≥ 6hours	-0.77	-3.17						
Current time is after last outside fixed activity and the time until the next fixed activity start time < 2hours	2.93	13.85	0.98	7.37				
Current time is after last outside fixed activity and 2 hours ≤ the time until the next fixed activity start time < 4hours	0.95	6.76						
Shape Parameter	1.00	1E+10	1.17	44.65	0.54	33.05	0.64	32.03
L(c)	-2187.60		-2171.02		-2137.87		-2146.88	
L(β)	-1904.45		-1914.46		-1880.90		-1892.74	
L(β)-L(c)	283.15		256.56		256.97		254.14	

Table 6.11 Split Population Survival Model (Out-of-Home Non-Fixed Shopping Activity; N=106)

Variable	Exponential Distribution		Normal Distribution		Logistic Distribution		Weibull Distribution	
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
<i>Split Population Choice Model of Continuation/Termination of Out-of-Home Non-Fixed Shopping Activity</i>								
Constant	-7.65	0.00	-7.54	0.00	-7.71	0.00	-7.65	0.00
<i>Hazard-Based Activity Duration Model</i>								
Constant	-1.25	-4.52	-1.09	-6.08	-1.09	-6.33	-1.00	-5.29
Time traveled from the previous location (hours)	3.64	3.60	2.28	4.47	2.53	4.67	3.52	5.88
Current time is between 6:00 and 9:00 AM							0.69	2.33
Current time is before first outside fixed activity and the time until the next fixed activity start time < 2 hours			-0.51	-2.10	-0.47	-1.81	-0.73	-2.33
Current time is before first outside fixed activity and 4 hours ≤ the time until the next fixed activity start time < 6 hours			-0.97	-2.80	-1.05	-2.95	-0.93	-2.51
Current time is after last outside fixed activity and the time until the next fixed activity start time < 2 hours			-0.36	-1.90	-0.31	-1.74	-0.32	-1.90
Shape Parameter	1.00	1E+10	0.88	12.88	0.49	10.80	0.66	11.87
L(c)	-163.25		-159.05		-159.12		-161.53	
L(β)	-154.09		-148.05		-148.11		-138.37	
L(β)-L(c)	9.16		11.00		11.01		23.16	

Table 6.12 Split Population Survival Model (Out-of-Home Non-Fixed Social-Recreational Activity; N=106)

Variable	Exponential Distribution		Normal Distribution		Logistic Distribution		Weibull Distribution	
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
<i>Split Population Choice Model of Continuation/Termination of Out-of-Home Non-Fixed Social-Recreational Activity</i>								
Constant	-7.55	0.00	-7.53	0.00	-7.55	0.00	-7.50	0.00
<i>Hazard-Based Activity Duration Model</i>								
Constant	-2.20	-3.36	-4.02	-14.51	-3.24	-8.72	-2.69	-7.05
Mode of travel from the previous location is SOV			1.94	8.89	1.74	7.90	1.21	5.87
Mode of travel from the previous location is multi-passenger auto driver			1.78	6.11	1.57	6.05	1.04	4.23
Mode of travel from the previous location is multi-passenger auto passenger			2.01	3.72	1.73	4.78	1.14	3.55
Current time is between 3:00 AM and 12 noon	2.83	3.63	2.46	8.48	1.95	5.40	2.11	5.91
Current time is between 12 noon and 7:00 PM	2.11	2.85	1.62	6.19	1.21	3.49	1.38	4.00
Current time is between 7:00 and 10:00 PM	1.89	2.59	1.47	5.12	1.00	2.86	1.16	3.39
Current time is before first outside fixed activity	0.18	1.81	0.31	5.56	0.30	6.27	0.29	6.31
Current time is after last outside fixed activity			-0.40	-1.92	-0.39	-2.85	-0.40	-3.78
Shape Parameter	1.00	1E+10	0.77	15.14	0.38	12.96	0.46	13.30
L(c)	-139.05		-155.68		-144.60		-131.60	
L(β)	-128.41		-115.61		-107.53		-91.69	
L(β)-L(c)	10.64		40.07		37.07		39.91	

Table 6.13 Split Population Survival Model (Out-of-Home Non-Fixed Other Activity; N=1545)

Variable	Exponential Distribution		Normal Distribution		Logistic Distribution		Weibull Distribution	
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
<i>Split Population Choice Model of Continuation/Termination of Out-of-Home Non-Fixed Other Activity</i>								
Future-time outside fixed activity (hours)	0.29	4.31	0.28	4.81	0.27	4.80	0.29	4.38
Time until the next fixed activity start time (hours)	-3.94	-3.48	-3.45	-3.86	-3.33	-3.88	-3.90	-3.51
Constant	0.38	2.46					0.60	3.72
Number of persons in the household			-0.07	-2.08	-0.07	-2.06		
Number of vehicles available in the household			0.18	3.48	0.24	5.06	0.13	2.86
Mode of travel from the previous location is SOV	0.18	2.41	0.30	3.52				
Mode of travel from the previous location is multi-passenger auto passenger	0.26	1.75	0.41	2.36				
Mode of travel from the previous location is public transit	0.12	3.16	1.38	1.87	1.07	1.76		
Time traveled from the previous location (hours)	0.36	5.40	0.28	4.34	0.33	4.69	0.37	5.05
Current time is between 5:00 and 7:00 PM	0.17	1.95	0.23	1.81	0.30	2.62	0.17	1.73
Current time is between 7:00 and 9:00 PM	0.52	4.18	0.62	3.94	0.75	4.97	0.50	3.45
Current time is before first outside fixed activity	-1.83	-13.65	-1.93	-14.76	-1.95	-14.98	-1.94	-12.61
Current time is after last outside fixed activity	-2.12	-16.52	-2.13	-17.21	-2.13	-17.39	-2.23	-14.70
Shape Parameter	1.00	1E+10	1.35	38.17	0.78	31.54	1.07	31.57
L(c)	-2218.27		-2127.3		-2142.63		-2158.62	
L(β)	-1871.65		-1896.78		-1913.62		-1871.14	
L(β)-L(c)	346.62		230.52		229.01		287.48	

6.1.4 Work and School Location Choice Model

FAMOS is not a full-fledged land use or urban simulation model that includes residential location choice and work location choice models. However, residential location choice and work/school location choice are important processes that affect activity-travel patterns of individuals. Therefore, FAMOS incorporates residential location and work/school location determination in the population synthesis procedure (HAGS). A simple multinomial logit model is used to determine the zone of the work/school location for each individual that is working and/or going to school. Table 6.14 presents the work/school location choice model that is currently in FAMOS. It can be used to determine the probability that an individual will work or go to school in a certain zone.

Table 6.14 Multinomial Logit Model of Work/School Location Choice

Variable	Coef	t-stat
Industrial employment by place of work (in 10,000)	0.236	2.594
Commercial employment by place of work (in 10,000)	5.211	2.016
Service employment by place of work (in 10,000)	6.590	4.640
School enrollment (in 10,000)	0.883	3.818
Sample size	2912	
L(c)	-4689.996	
L(β)	-2781.008	
L(β)-L(c)	1908.9877	
ρ^2	0.4049626	

With respect to establishing work and school schedules, a Monte Carlo simulation procedure is used to draw a work/school start time and a work/school end time for each individual who works and/or goes to school. These time points are drawn from the observed work/school start and end time distributions derived from the Southeast Florida Regional Household Travel Survey. No special predictive models are developed for work/school start and end times because these are generally dependent on institutional structures and constraints for which data is not typically available. Thus, the work/school times are preserved mostly from the observed data; however a small random number within +/-5 minutes is added to the draw to account for the fact that respondents typically round start and end times to the nearest 5th or 10th minute in a travel survey.

6.1.5 Mode Choice Models for Fixed Activities

This subsection presents estimation results for mode choice models for fixed activities. As mentioned earlier, fixed activities are those that tend to be relatively fixed in time and space and are mandatory in nature. In FAMOS, these are considered to be work, school, and return home activities. The tables in this subsection provide estimation results for mode choice models for fixed activities.

Table 6.15 Multinomial Logit Model of Worker's Mode Choice for Fixed Activity

Alternative	Variable	Coef	t-stat
SOV	Constant	1.875	11.137
	Distance (miles)	0.129	4.838
	Travel time (min)	0.016	2.016
	Travel Cost (\$)	-0.626	-3.668
	Number of vehicles \geq Number of licensed drivers in household	1.572	11.228
	Travel in peak period	0.425	3.779
	Previous mode is SOV and current location is Broward County	1.371	8.163
	Previous mode is SOV and current location is Miami-Dade County	1.292	7.695
	Previous mode is SOV and current location is Palm Beach County	0.873	5.845
HOV driver	Constant	0.886	4.515
	No children in household	-0.656	-6.494
	Distance (miles)	0.124	5.317
	Number of vehicles \geq Number of licensed drivers in household	1.204	6.923
	Current time is between 3:00 and 6:00 AM	-1.211	-2.796
	Current time is between 7:00 and 10:00 PM	0.546	3.433
	Previous mode is HOV driver and current location is Broward County	2.459	15.318
	Previous mode is HOV driver and current location is Miami-Dade County	2.106	13.493
	Previous mode is HOV driver and current location is Palm Beach County	2.008	12.552
HOV Passenger	Distance (miles)	0.121	5.294
	Peak period dummy	0.775	4.547
	Previous mode is HOV psgr and current location is Broward County	5.081	15.887
	Previous mode is HOV psgr and current location is Miami-Dade County	5.137	13.979
	Previous mode is HOV psgr and current location is Palm Beach County	5.174	14.047
Public Transit	No licensed drivers in household	4.096	7.867
	Residential location in Miami-Dade County	1.424	6.545
	Previous mode is transit and current location is Broward County	3.816	4.763
	Previous mode is transit and current location is Miami-Dade County	4.027	2.896
	Previous mode is transit and current location is Palm Beach County	3.448	5.277
Walk/Bike	No licensed drivers in household	1.347	4.194
	Trip origin and destination are in the same zone	1.150	2.598
	Age of individual \geq 65 yrs	4.649	9.065
	Previous mode is walk/bike and current location is Broward County	4.685	9.822
	Previous mode is walk/bike and current location is Dade County	4.118	7.975
	Previous mode is walk/bike and current location is Palm Beach County	4.118	7.967
N		5839	
L(c)		-9397.508	
L(β)		-2600.983	
L(β)-L(c)		6796.525	
ρ^2		0.72323	
ρ^2_{adj}		0.72275	

Table 6.16 Multinomial Logit Model of Student's Mode Choice for Fixed Activity

Alternative	Variable	Coef	t-stat
SOV	Constant	2.023	6.943
	Travel time (min)	0.079	4.901
	Age of individual is between 16 and 20 years	-1.508	-5.162
	Age of individual > 40 years	1.382	2.162
	Previous mode is SOV and current location is Broward County	1.756	3.469
	Previous mode is SOV and current location is Miami-Dade County	3.973	3.867
	Previous mode is SOV and current location is Palm Beach County	1.354	2.294
HOV Driver	No children in household	-1.445	-3.255
	Distance (miles)	-0.140	-2.809
	Travel time (min)	0.171	5.820
	Residential location is Palm Beach County	0.803	2.233
	Age of individual is between 16 and 20 years	-1.585	-4.410
	Age of individual >40 years	1.578	2.249
	Terminal prism vertex is between 4:00 and 8:00 PM	1.038	3.256
	Current time is between 7:00 and 10:00 PM	1.614	2.074
	Previous mode is HOV driver and current location is Broward County	2.736	3.076
Previous mode is HOV driver and current location is Miami-Dade County	2.832	4.309	
Previous mode is HOV driver and current location is Palm Beach County	1.935	2.918	
HOV Passenger	Travel time (min)	0.078	5.722
	Age of individual < 16 years	0.839	4.808
	Morning peak period dummy	0.859	4.719
	Evening peak period dummy	1.749	4.014
	Previous mode is HOV psgr and current location is Broward County	2.615	7.410
	Previous mode is HOV psgr and current location is Miami-Dade County	2.408	7.428
Previous mode is HOV psgr and current location is Palm Beach County	3.464	7.045	
Public Transit	Travel time (min)	0.024	4.856
	Evening peak period	-1.913	-2.246
	Terminal prism vertex is between 4:00 and 8:00 PM	0.770	4.674
	Previous mode is walk/bike and current location is Broward County	4.812	5.181
Previous mode is walk/bike and current location is Dade County)	2.936	5.637	
Walk/Bike	Trip origin and destination are in the same zone	1.280	5.018
	Previous mode is walk/bike and current location is Broward County	4.134	5.181
	Previous mode is walk/bike and current location is Dade County	3.815	5.604
	Previous mode is walk/bike and current location is Palm Beach County	3.731	5.821
N		1959	
L(c)		-3152.8889	
L(β)		-918.6762	
L(β)-L(c)		2234.2127	
ρ^2		0.70862	
ρ^2_{adj}		0.7062	

Table 6.17 Multinomial Logit Model of Other's Mode Choice for Fixed Activity

Alternative	Variable	Coef	t-stat
SOV	Constant	1.574	3.465
	Travel time (min)	0.036	2.308
	Number of vehicles \geq Number of licensed drivers in household	0.779	3.420
	Personal income is between \$30,000 and \$60,000 per year	0.682	2.508
	Personal income > \$60,000 per year	1.981	2.854
	Current time is between 9:00 PM and 12:00 midnight	1.129	2.853
	Previous mode is SOV and current location is Broward County	1.623	4.091
	Previous mode is SOV and current location is Miami-Dade County	1.524	3.815
	Previous mode is SOV and current location is Palm Beach County	1.925	4.778
HOV Driver	Constant	2.567	6.401
	No children in household	-1.157	-5.378
	Travel time (min)	0.036	2.189
	Personal income > \$60,000	1.710	2.354
	Current time is before 12:00 noon	-0.947	-3.458
	Previous mode is HOV driver and current location is Broward County	3.158	7.187
	Previous mode is HOV driver and current location is Miami-Dade County	2.739	6.071
	Previous mode is HOV driver and current location is Palm Beach County	2.770	7.111
HOV Passenger	Current time is before 12:00 noon	-1.142	-2.129
	Current time is between 9:00 PM and 12:00 midnight	2.457	3.594
	Previous mode is HOV psgr and current location is Broward County	6.342	10.843
	Previous mode is HOV psgr and current location is Miami-Dade County	5.855	9.591
	Previous mode is HOV psgr and current location is Palm Beach County	6.576	10.732
Public Transit	Travel time (min)	0.043	3.101
	Travel time for public transit - travel time for walk/bike (min)	-0.195	-2.692
	Age of individual \geq 65 years	2.821	3.041
	Previous mode is walk/bike and current location is Miami-Dade County	5.536	4.047
Walk/Bike	Age of individual \geq 65 years	-2.082	-2.523
	Previous mode is walk/bike and current location is Broward County	6.543	5.165
	Previous mode is walk/bike and current location is Miami-Dade County	5.080	6.377
	Previous mode is walk/bike and current location is Palm Beach County	5.379	6.022
N		1355	
L(c)		-2180.7884	
L(β)		-480.0557	
L(β)-L(c)		1700.7327	
R ²		0.77987	
R ² _{adj}		0.77815	

6.1.6 Mode Choice Models for In-Home Discretionary Activities

In addition to return home trips that may be mandatory and temporally fixed, there may be other intermediate return-home trips that are not mandatory. Thus, a distinction is made in FAMOS between mandatory return home trips that constitute fixed activities and discretionary return

home trips that do not constitute fixed activities. Mode choice models for these activities are presented in this section.

Table 6.18 Multinomial Logit Model of Worker's Mode Choice for In-Home Discretionary Activity

Alternative	Variable	Coef	t-stat
SOV	Travel time (min)	0.470	3.312
	Number of vehicles \geq number of licensed drivers	2.134	4.130
	Previous mode is SOV and current location is Broward County	2.131	5.274
	Previous mode is SOV and current location is Miami-Dade County	2.038	4.688
	Previous mode is SOV and current location is Palm Beach County	2.026	4.998
	Age of individual is between 16 and 20 years	-2.250	-2.646
	Morning peak period	3.729	6.363
	Evening peak period	1.405	2.095
HOV Driver	No children in household	-1.378	-4.468
	Cost (\$)	0.383	2.690
	Number of vehicles \geq number of licensed drivers	2.245	4.207
	Previous mode is HOV driver and current location is Broward County	1.475	3.477
	Previous mode is HOV driver and current location is Miami-Dade County	1.072	2.190
	Previous mode is HOV driver and current location is Palm Beach County	1.979	4.447
	Age of individual is between 16 and 20 years	-3.600	-3.452
	Age of individual is between 31 and 40 years	0.595	2.003
HOV Passenger	Evening peak period dummy	1.891	2.728
	Cost (\$)	0.374	2.576
	Previous mode is HOV psgr and current location is Broward County	4.565	3.834
	Previous mode is HOV psgr and current location is Miami-Dade County	5.728	5.862
	Previous mode is HOV psgr and current location is Palm Beach County	5.243	4.628
	Age is between 16 and 20 years	-4.445	-3.305
Public Transit	Terminal prism vertex is between 4:00 and 8:00 PM	-2.583	-2.632
	Travel time (min.)	14.394	3.109
Walk/Bike	Previous mode is public transit and current location is Broward County	4.238	2.769
	Previous mode is walk/bike and current location is Broward County	4.890	2.991
	Previous mode is walk/bike and current location is Miami-Dade County	6.895	5.134
	Terminal prism vertex is between 8:00 PM and 12:00 midnight	-3.098	-2.043
N		760	
L(c)		-1223.1728	
L(β)		-246.3594	
L(β)-L(c)		976.8134	
ρ^2		0.79859	
ρ^2_{adj}		0.79624	

Table 6.19 Multinomial Logit Model of Student's Mode Choice for In-Home Discretionary Activity

Alternative	Variable	Coef	t-stat
SOV	Constant	2.083	6.850
HOV Driver	Previous mode is HOV driver and current location is Miami-Dade County	3.341	3.837
	Previous mode is HOV driver and current location is Palm Beach County	2.076	2.907
HOV Passenger	Previous mode is HOV psgr and current location is Miami-Dade County	4.060	4.818
	Current time is between 12:00 noon and 3:00 PM	-1.145	-2.488
Public Transit	Constant	-3.637	-5.408
	Residential location is Miami-Dade County	4.226	4.443
Walk/bike	Trip origin and destination are in the same zone	2.980	5.983
	Age of individual < 16 years	-3.292	-7.262
N		250	
L(c)		-402.3595	
L(β)		-120.7908	
L(β)-L(c)		281.5687	
ρ^2		0.69979	
ρ^2_{adj}		0.69436	

Table 6.20 Multinomial Logit Model of Other's Mode Choice for In-Home Discretionary Activity

Alternative	Variable	Coef	t-stat
SOV	Constant	2.502	7.080
	Distance (miles)	0.289	2.647
	Previous mode is SOV and current location is Broward County	1.768	3.755
	Previous mode is SOV and current location is Dade County	1.442	2.963
	Previous mode is SOV and current location is Palm Beach County	1.701	3.819
	Current time is between 12:00 noon and 7:00 PM	-1.371	-5.279
HOV Driver	Distance (miles)	0.286	2.616
	Previous mode is HOV driver and current location is Broward County	1.918	4.096
	Previous mode is HOV driver and current location is Miami-Dade County	1.906	3.952
	Previous mode is HOV driver and current location is Palm Beach County	2.190	4.820
	Current time is between 3:00 and 9:00 AM	-2.112	-5.734
	Terminal prism vertex is between 4:00 and 8:00 PM	1.127	2.829
	Terminal prism vertex is between 8:00 PM and 12:00 midnight	1.426	3.551
HOV Passenger	Distance (miles)	0.326	3.013
	Previous mode is HOV psgr and current location is Broward County	5.486	7.037
	Previous mode is HOV psgr and current location is Miami-Dade County	5.786	4.894
	Previous mode is HOV psgr and current location is Palm Beach County	6.582	7.409
	Current time is between 3:00 and 9:00 AM	-2.504	-2.637
	Current time is between 12:00 noon and 7:00 PM	-2.163	-3.410
Walk/Bike	Previous mode is walk/bike and current location is Broward County	3.672	4.198
	Previous mode is walk/bike and current location is Palm Beach County	4.301	5.176
	Previous activity is social-recreational	1.744	2.369
N		792	
L(c)		-1274.6748	
L(β)		-370.4045	
L(β)-L(c)		904.2703	
ρ^2		0.70941	
ρ^2_{adj}		0.70643	

6.1.7 Joint Destination-Mode Choice Models for Out-of-Home Discretionary Activities

FAMOS includes a set of joint destination-mode choice models for out-of-home discretionary activities. Joint destination-mode choice models offer a powerful framework for determining the destination zone for an out-of-home activity based on the mode choices available to the traveler, modal constraints, and level of service of alternative modes. This subsection provides model specifications and estimation results for the joint destination-mode choice models currently incorporated into FAMOS.

Table 6.21 Multinomial Logit Model of Worker's Destination and Mode Joint Choice for Out-of-Home Discretionary Activity

Alternative	Variable	Coef	t-stat
SOV	Constant	4.341	18.505
	Previous mode is SOV and current location is Broward County	1.566	9.956
	Previous mode is SOV and current location is Miami-Dade County	1.368	8.147
	Previous mode is SOV and current location is Palm Beach County	1.776	10.639
	Household size = 2	0.698	3.538
	No children in household	-0.483	-2.637
	Distance (miles)	-0.131	-11.341
	Travel time (min)	-0.033	-4.318
	Auto travel cost (\$)	1.133	6.352
	Previous activity is out-of-home fixed activity	0.840	7.120
	Next activity is shopping	0.803	3.979
	Next activity is social-recreational	-1.098	-3.463
	Terminal prism vertex is between 9:00 and 11:00 PM	0.912	3.227
	Current time is between 12:00 noon and 3:00 PM	-1.070	-5.014
Current time is between 6:00 and 9:00 PM	-0.963	-6.159	
HOV driver	Constant	4.986	21.453
	Previous mode is HOV driver and current location is Broward County	0.724	3.254
	Previous mode is HOV driver and current location is Miami-Dade County	0.708	2.960
	Previous mode is HOV driver and current location is Palm Beach County	1.259	5.088
	No children in household	-1.439	-7.609
	Distance (miles)	-0.227	-24.018
	Travel cost (\$)	1.361	4.336
	Next activity is social-recreational	-1.438	-4.181
	Terminal prism vertex is between 9:00 and 11:00 PM	0.828	2.870
	Current time is between 3:00 and 6:00 PM	0.496	3.477
Current time is between 12:00 noon and 3:00 PM	-0.557	-2.469	
HOV Passenger	Previous mode is HOV psgr and current location is Broward County	4.483	10.086
	Previous mode is HOV psgr and current location is Miami-Dade County	4.679	10.885
	Previous mode is transit and current location is Miami-Dade County	4.354	11.035
	Previous activity is in-home discretionary activity	1.177	4.530
	Next activity is social-recreational	-2.047	-3.666
	Distance (miles)	-0.171	-11.854
	Age of individual is between 18 and 40 years	1.076	4.004
	Age of individual is between 41 to 65 years	1.416	5.579
Public Transit	Terminal prism vertex is between 7:00 and 9:00 PM	0.697	2.651
	Terminal prism vertex is between 9:00 and 11:00 PM	0.943	2.480
	Constant	2.731	4.047
Walk/Bike	Number of transfers	-1.975	-3.257
	(Travel time for public transit) - (travel time for walk/bike) (min)	-0.166	-2.987
	Previous mode is walk/bike and current location is Broward County	2.853	3.667
	Previous mode is walk/bike and current location is Miami-Dade County	3.228	6.353
	Previous mode is walk/bike and current location is Palm Beach County	3.266	2.103
Destination	No licensed driver in household	3.589	3.870
	Age of individual is between 18 and 40 years	-0.678	-2.475
	Number of single family dwelling units (in 10000)	2.297	10.120
	Number of multi-family dwelling units (in 10000)	1.387	8.302
	Industrial employment by place of work (in 10000)	-1.739	-2.175
	Commercial employment by place of work (in 10000)	6.403	11.702
Service employment by place of work (in 10000)	1.850	8.940	
School enrollment (in 10000)	0.790	4.121	

N	2645
L(c)	-10347.3008
L(β)	-4941.731
L(β)-L(c)	5405.5698
ρ^2	0.52241
ρ^2_{adj}	0.52217

Table 6.22 Multinomial Logit Model of Student's Destination and Mode Joint Choice for Out-of-Home Discretionary Activity

Alternative	Variable	Coef	t-stat
SOV	Constant	4.144	6.622
	Distance (miles)	-0.139	-6.438
	Age of individual is between 18 and 40 years	1.843	3.328
	Age of individual is greater than 40 years	2.628	3.643
	Previous mode is SOV and current location is Broward County	2.561	2.319
	Previous mode is SOV and current location is Palm Beach County	1.707	2.996
HOV Driver	Constant	3.856	5.664
	Travel time (min)	-0.108	-5.699
	Residential location is Palm Beach County	1.565	3.104
	Age of individual is between 18 and 40 years	1.619	2.903
	Previous mode is HOV driver and current location is Miami-Dade County	2.064	3.203
HOV Passenger	Trip is made during peak period	1.008	2.152
	Constant	4.264	7.300
	Distance (miles)	-0.077	-3.408
	Travel time (min)	-0.105	-6.607
	Number of vehicles in household \geq Number of licensed drivers	0.912	3.023
	Previous mode is HOV psgr and current location is Miami-Dade County	1.837	4.261
	Age of individual is less than 16 years	2.008	4.356
	Trip is made during peak period	0.682	2.335
Current time is between 9:00 AM and 12:00 noon	1.165	2.982	
Public Transit	Residential location is Miami-Dade County	1.523	3.081
	Residential location is Palm Beach County	1.350	2.425
	Previous mode is transit and current location is Broward County	4.249	4.479
	Previous mode is transit and current location is Miami-Dade County	2.013	2.427
	Previous mode is transit and current location is Palm Beach County	3.096	2.917
	Current time is between 12:00 noon and 3:00 PM	1.103	2.478
	Terminal prism vertex is between 4:00 and 8:00 PM	0.926	2.201
Walk/Bike	Residential location is Miami-Dade County	1.134	3.076
	No licensed drivers in household	5.988	4.814
	Trip origin and destination are in the same zone	6.401	20.201
	Previous mode is walk/bike and current location is Broward County	1.948	2.804
	Previous mode is walk/bike and current location is Miami-Dade County	1.950	2.501
	Previous mode is walk/bike and current location is Palm Beach County	3.968	4.493
Destination	Number of single family dwelling unit (in 10000)	2.861	3.072
	Commercial employment by place of work (in 10000)	9.332	4.362
	Service employment by place of work (in 10000)	1.928	2.812
	Destination is in the same county of the next fixed activity)	2.161	3.791
N		1086	
L(c)		-4248.457	
L(β)		-1324.783	
L(β)-L(c)		2923.674	
ρ^2		0.68817	
ρ^2_{adj}		0.68774	

Table 6.23 Multinomial Logit Model of Other's Destination and Mode Joint Choice for Out-of-Home Discretionary Activity

Alternative	Variable	Coef	t-stat
SOV	Constant	4.010	13.903
	Distance (miles)	-0.073	-5.614
	Travel time (min)	-0.091	-9.605
	Auto travel cost (\$)	1.319	5.345
	Single person household	0.799	6.710
	Number of vehicles in household \geq number of licensed drivers	0.810	6.968
	Previous mode is SOV and current location is Broward County	1.700	12.199
	Previous mode is SOV and current location is Miami-Dade County	2.052	12.175
	Previous mode is SOV and current location is Palm Beach County	1.540	12.840
	Age of individual is between 21 to 30 years	0.818	2.874
	Age of individual is between 31 to 40 years	1.274	4.848
	Age of individual is between 41 to 50 years	1.362	5.249
	Age of individual is between 51 to 60 years	1.255	4.899
	Age of individual is greater than 60 years	0.748	3.289
	Personal annual income is between \$30,000 and \$60,000	0.217	2.157
	Personal annual income is greater than \$60,000	0.774	3.352
Current time is between 7:00 and 9:00 PM	-1.124	-3.667	
HOV Driver	Constant	3.709	11.907
	Distance (miles)	-0.056	-4.141
	Travel time (min)	-0.091	-9.333
	Travel cost (\$)	1.155	4.587
	No children in household	-0.671	-6.476
	Number of vehicles in household \geq number of licensed drivers	0.331	2.852
	Previous mode is HOV driver and current location is Broward County	1.790	11.576
	Previous mode is HOV driver and current location is Miami-Dade County	1.313	7.615
	Previous mode is HOV driver and current location is Palm Beach County	2.066	14.050
	Next activity is 'other'	0.521	5.726
	Age of individual is between 21 and 30 years	1.553	5.179
	Age of individual is between 31 and 40 years	2.186	7.878
	Age of individual is between 41 and 50 years	1.689	6.029
	Age of individual is between 51 and 60 years	1.510	5.231
	Age of individual is greater than 60 years	1.323	5.038
	Personal annual income is greater than \$60,000	0.681	2.850
Trip is made in evening peak period	0.407	2.505	
Current time is between 9:00 AM and 12:00 noon	-0.239	-2.775	
Current time is between 7:00 and 9:00 PM	-0.821	-2.697	
HOV Passenger	Constant	4.378	22.325
	Travel time (min)	-0.130	-23.183
	Travel cost (\$)	1.492	3.921
	Previous mode is HOV psgr and current location is Broward County	3.914	11.390
	Previous mode is HOV psgr and current location is Miami-Dade County	3.734	10.553
	Previous mode is transit and current location is Miami-Dade County	4.017	14.058
Trip is made in evening peak period	1.163	5.894	
Public Transit	Constant	3.788	8.745
	Travel time (min)	-0.024	-3.969
	(Travel time for public transit) - (travel time for walk/bike) (min)	-0.129	-5.053
	Previous mode is transit and current location is Broward County	3.779	2.657
	Previous mode is transit and current location is Palm Beach County	5.036	4.120

	Trip origin and destination are in the same zone	5.526	27.346
	No licensed drivers in household	3.517	9.907
Walk/Bike	Previous mode is walk/bike and current location is Broward County	2.900	5.464
	Previous mode is walk/bike and current location is Miami-Dade County	3.645	7.117
	Previous mode is walk/bike and current location is Palm Beach County	2.298	4.331
	Residential location is Palm Beach County	-0.482	-2.336
	Age of individual is between 41 and 50 years	0.696	2.567
	Trip is made in evening peak period	0.735	2.083
Destination	Number of single family dwelling unit (in 10000)	1.556	7.453
	Number of multi-family dwelling unit (in 10000)	1.540	10.291
	Commercial employment by place of work (in 10000)	7.179	15.093
	Service employment by place of work (in 10000)	1.410	8.457
	School enrollment (in 10000)	0.616	3.209
	Destination is in the same county of the next fixed activity)	1.365	15.252
N		4582	
L(c)		-17924.889	
L(β)		-7600.09	
L(β)-L(c)		10324.799	
ρ^2		0.576	
ρ^2_{adj}		0.57585	

The above models have been estimated using advanced statistical and econometric procedures. Estimation of these models for a particular area requires large sample activity and travel diary survey data for the specific area. Econometric model estimation software packages such as LIMDEP or GAUSS would have to be used to try a large number of alternative model specifications (thousands of alternative specifications are possible for the fully family of models) and identify the most appropriate model specification for implementation in the area. Thus, the re-creation of the family of models for a specific area is a monumental effort that requires substantial time and budget. Therefore, it is recommended that users first try and apply the default models available within FAMOS to see if the default models can offer plausible results. Small adjustments to these models can be made within FAMOS to facilitate model calibration to an area. If all such attempts fail to yield plausible results, then consideration should be given to investing resources in the development of area-specific activity-based travel demand models that would work within the FAMOS framework.

Although the models include numerous explanatory variables, it should be noted that the user does not necessarily need these variables to begin using FAMOS. Many of these variables are generated and simulated internally during the model run. Thus, the user needs to have only those databases that are described and specified in Chapter 2.

6.2 Validation Results

This section presents selected summary validation results to illustrate the ability of FAMOS to replicate observed travel behavior data. It should be noted that these validation results were obtained with absolutely no adjustments, special calibration procedures, or adjustment factors. These validation results were obtained from a raw complete run of FAMOS from beginning to end. Given that absolutely no special calibration procedures were employed to “fit” FAMOS output to observed travel survey data, the validation results show that comprehensive activity-based models such as FAMOS are able to replicate observed travel behavior. It is to be noted that this user manual only provides some summary validation results at the overall aggregate population level. Additional validation studies within specific market segments, modes, and geographical areas are not included in this user manual for the sake of brevity. It has been found that FAMOS is able to replicate observed behavior within smaller subgroups of the population or geographical subareas quite well.

Table 6.24 compares average daily trip rates while Table 6.25 compares average number of daily fixed and flexible activities. It is found that FAMOS replicates the overall observed averages quite closely.

Table 6.24 Comparison of Observed and Predicted Average Daily Trip Rates

Group	Observed	FAMOS
Worker	3.9	4.3
Student	3.0	3.3
Other	4.2	3.8

Table 6.25 Comparison of Observed and Predicted Average Daily Fixed and Flexible Activities

Group	Fixed Activities		Flexible Activities	
	Observed	FAMOS	Observed	FAMOS
Worker	1.2	1.2	2.4	2.2
Student	1.0	1.0	2.0	1.8
Other	0.0	0.0	2.7	2.2

Table 6.26 provides a comparison of observed and predicted first departure time and final arrival time (at home). This comparison shows that FAMOS is able to capture the temporal aspects of travel behavior quite well, while recognizing the spatio-temporal constraints governing these aspects of behavior. In this table, time is represented in continuous clock

minutes with 12:00 midnight being zero and 12:00 midnight at the end of the day being 1440 minutes. Thus, 6:00 AM would be 360, 6:00 PM would be 1080, and so on.

Table 6.26 Comparison of Observed and Predicted First Home Departure Time and Final Home Arrival Time

Group	First Home Departure Time		Final Home Arrival Time	
	Observed	FAMOS	Observed	FAMOS
Worker	470	440	1075	1192
Student	472	496	986	1055
Other	627	498	962	967

Finally, Table 6.27 provides validation results for modal split. The modal split validation is given for each market segment considered in FAMOS. The model system is found to provide reasonable mode split validation results.

Table 6.27 Mode Split Validation Results by Market Segment

Mode	To Fixed Activities		To Flexible Activities	
	Observed	FAMOS	Observed	FAMOS
Workers				
SOV	79.3%	66.9%	63.1%	69.1%
HOV Driver	12.0%	24.0%	26.6%	19.9%
HOV Passenger	5.4%	6.5%	7.2%	7.1%
Transit	1.4%	1.1%	0.7%	1.1%
Other	1.9%	1.5%	2.4%	2.9%
Students				
SOV	13.6%	17.2%	18.2%	18.4%
HOV Driver	6.4%	10.0%	14.1%	11.0%
HOV Passenger	54.6%	47.0%	60.5%	57.1%
Transit	17.6%	13.7%	1.3%	8.3%
Other	7.9%	12.2%	5.9%	5.2%
Others				
SOV	39.1%	50.0%	42.2%	42.0%
HOV Driver	26.1%	25.3%	28.9%	31.8%
HOV Passenger	28.0%	21.1%	23.4%	16.7%
Transit	1.7%	2.6%	1.4%	1.1%
Other	5.1%	1.1%	4.1%	8.4%

7. ADDITIONAL READING

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