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## Development of Activity Based Model: Draft Document

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## **I. INTRODUCTION**

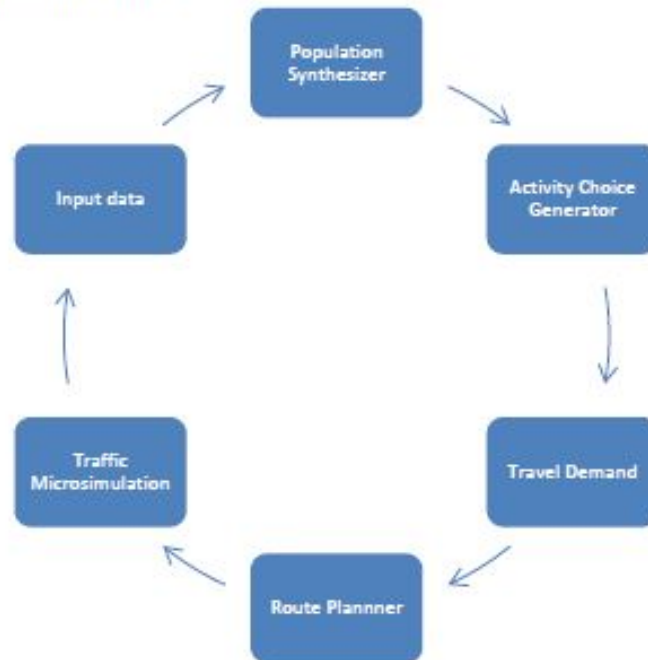
This document is intended to summarize the methodology applied thus far for the Fargo-Moorhead metropolitan area's activity based model (ABM). ABMs have been quite popular over the years, especially in larger metropolitan organizations such as the Atlanta Regional Council [4], San Francisco County Transportation Authority [5], and Virginia DOT [11]. Historically, the FM metropolitan utilized the traditional four-step travel demand model (TDM) approach. Before continuing with this document, it is the readers' responsibility to research into the general aspect of ABM, i.e. which MPO has already implemented this type of TDM, what is a tour, what is a chain, types of activities, etc. For further basic descriptions, please consult the ABM Meeting Memo [1] documentation from the following directory:

X:\Projects\Planning\Activity\_Based\_Model\_Research

The document is titled: "01\_23\_2014 FMCOG ABM Meeting Memo.pdf." The Advanced Traffic Analysis Center (ATAC) is tasked with researching into the creation of a proposed ABM. The research center explored various software which specialized in travel demand model: Caliper's TransCAD, Inro's Emme, PTV's VISUM, and Citilab's Cube Voyager. It was decided Cube Voyager was the best candidate for the following reasons below.

The following figure describes the cycle of ABM. They are as follow: (1) population synthesizer, (2) activity choice generator, (3) travel demand, (4) route planner, (5) traffic microsimulation, and (6) input data. Currently, progress so far has stalled at step (2). Progress is summarized in the next section.

Figure 1: Conceptual Framework



## II. PROGRESS

### a. ABM First Trial

It is important to note the default ABM module provided by Cube Voyager is inadequate as it vastly underestimates the total count of persons residing in the metropolitan. This was a result of inaccurate data, script format, and allowable user flexibility pertaining to the module. Hence, further research was conducted into finding a proper population synthesizer candidate. Potential programs which were considered: (1) CEMDAP, (2) TRANSIMS, and (3) PopSynWin.

### b. Population Synthesizer Assessment

It was decided CEMDAP was not a suitable candidate from the three. The program was a legacy software which was outdated. TRANSIMS lacked user-friendliness for those who did not possess computer programming background. The final candidate, PopSynWin, flawed for the following reasons: (1) no tolerance on sensitivity ranges and (2) one patch created for the software which left little room for troubleshooting and updating bugs and errors.

**c. ABM Second Trial**

It was decided ATAC would utilize Nashville's **experimental** ABM model (the experimental model is not an official but prototype; per request of the creator of the Nashville model, it shall not be quoted and for the present time, shall not be referenced unless required to in the future). Great success resulted from this prototype as a suitable population synthesizer was created. Furthermore, a working ABM has been recently completed. However, of important note is the fact that is **working NOT refined**. The model still must be tuned to the conditions of the Fargo-Moorhead metropolitan area and not the Nashville region (\*\*KEEP THIS FACT IN MIND\*\*).

**III. DATA ACQUISITION**

ABM is more complicated than the traditional four-step model. Therefore, it is understandable one must ascertain more data for such an endeavor. Providing a synthetic population requires data from: (1) 5-percent public use microdata sample (PUMS) for both North Dakota and Minnesota attain from the U.S. Census Bureau [9, 10], (2) TAZ socioeconomic data provided by ATAC [3], (3) initial FM road network also from ATAC [2], and (4) block group (BG) data for both North Dakota and Minnesota from the U.S. Census Bureau [7, 8]. Collection of numbers (1) and (4) were made possible by the U.S. Census Bureau. The PUMS data should be a .dat (a form of text file) format. Make sure once downloaded, open it in Notepad and save the files as a .txt file. The latter three should be in shapefile (.shp) or geodatabase (.gdb) formats.

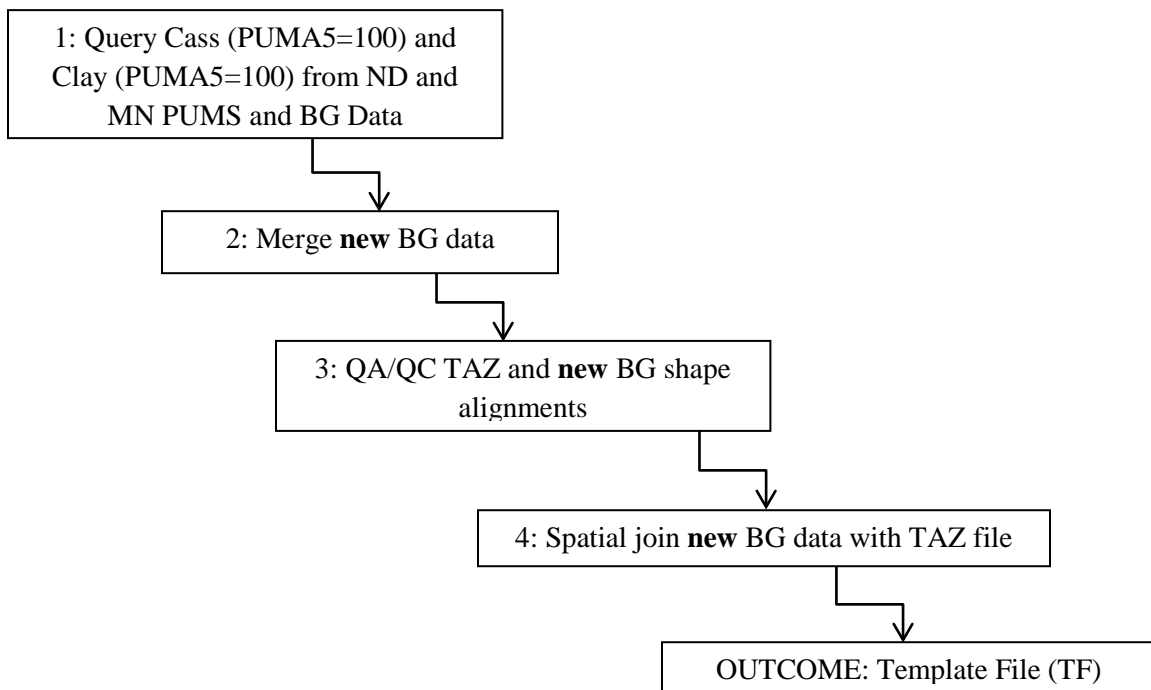
**IV. ANALYSIS PROGRAMS**

Geographical information system (GIS) editing was conducted using Esri's ArcMap. As stated earlier, functions related to travel demand modeling necessitated the use of Citilab's Cube Voyager as the most suitable candidate as Nashville's experimental ABM already utilized the said program.

## V. METHODOLOGY

### a. Data Manipulation and Aggregation using GIS

First and foremost, considerations were only given for the Cass (PUMA5 ID = 500) and Clay county (PUMA5 ID = 100) regions. PUMA5 attribute will be further discussed in sub-section C. Therefore, queries were used to extract public use microdata sample areas (PUMAs) and BG data for the said two regions. Secondly, merge the queried Cass and Clay county BG data. Thirdly, quality control and assurance was implemented for the TAZ and queried BG data. It was found that only one TAZ did not align with the BG; a simple fix which was alleviated in the editing mode of ArcMap. Fourth, spatial join the new BG data with the TAZ socioeconomic file. If done correctly, there should be no discrepancies in the newly created file. We will call this the **Template File (TF)**. To recount steps one to four so far:



Fifth, aggregate the necessary BG attributes from the **TF**. For example, individuals whose age is less than 18 are considered children, therefore create a new attribute field in the **TF** called “CHILD”, and sum up all fields related to age less than 18 (this would consider both males and females). The reader should also consult the following web link for metadata description [6]: <https://www.census.gov/geo/maps-data/data/docs/tiger/prejoined/ACSMetadata2011.txt>

\*\*\*\*\*EXPLANATION OF DATA AGGREGATION WITH ACS BG DATA\*\*\*\*\*

NOTE: The user should be performing Field Calculations in ArcMap using the **TF** (format can be either shapefile or geodatabase file) for this procedure.

Suppose we need the total number of individuals who are considered *male senior citizens*.

Typically, this group would consist of those whose ages are 65 and greater AND whose sex is male. Therefore, using the description provided in the first web link above and the BG data's attributes from the **TF** table in GIS, we need to sum up the following columns in a new field (the user may name the field whatever they wish, but for the sake of convenience, let's call it "ML\_SENRS"):

- B01001e20 – Total population of males whose ages are 65 and 66 years (Estimate);
- B01001e21 – Total population of males whose ages are 67 to 69 years (Estimate);
- B01001e22 – Total population of males whose ages are 70 to 74 years (Estimate);
- B01001e23 – Total population of males whose ages are 75 to 79 years (Estimate);
- B01001e24 – Total population of males whose ages are 80 to 84 years (Estimate);
- B01001e25 – Total population of males whose ages are 85 and up (Estimate).

We only need to **consider the estimated number**, not the margin of error (MOE) value as ABM reflects activities based on population counts replicating the actual population. This process can be repeated and manipulated based on the requirement of the study, i.e. females, children, income lower than \$15,000, income between \$30,000 and \$50,000, etc.

\*\*\*\*\*

At this point, it is assumed the reader(s) has a measurable knowledge on how to perform data manipulation and aggregation. Therefore, the sixth step was conducted in order to replicate the population synthesizer module from the Nashville ABM prototype. For this next procedure, the user, utilizing GIS must create fields to reflect the following:

- Income  $x < \$15,000$  ( $x_1$ );
- Income  $\$15,000 \leq x < \$30,000$  ( $x_2$ );
- Income  $\$30,000 \leq x < \$50,000$  ( $x_3$ );
- Income  $\$50,000 \leq x < \$75,000$  ( $x_4$ );



## FM Activity Based Model

- Income  $x > \$75,000$  ( $x_5$ );
- Total income count (TIC);
- Ratio of  $x_1$  to TIC;
- Ratio of  $x_2$  to TIC;
- Ratio of  $x_3$  to TIC;
- Ratio of  $x_4$  to TIC;
- Ratio of  $x_5$  to TIC.

Once this step is completed, the user has a finished **TF** ready to use in Cube Voyager. This file is the TAZ socioeconomic file to be used in ABM analysis; along with the PUMAs files for Cass and Clay counties, and the FM road network file.

### **b. Setting up the ABM in Cube Voyager**

NOTE: The reader(s) should have some proficiency and knowledge in using Cube Voyager before proceeding to the next step. The current FM ABM was created by the previous analyst, Vu Dang.

First and foremost, create a copy of the original road network of the FM area (this should be a .net file). Second, there should be **two** PUMAs files in text format already; one for Cass County and one for Clay County (.txt files). Third, make sure to create **keys** for: (1) the two PUMAs files, and (2) the FM road network.

Next, create seven applications (.app) in the FM ABM catalog called: population synthesizer, initial skims, accessibility, activity travel simulator, travel aggregator, assignment, and GIS outputs. The apps should be in Cube Voyager not TP+. Then load these into the catalog screen itself by clicking “Insert” and then clicking “Application Group”; both of these can be found at the top-left portion of the screen. Find the directory where these applications were saved and upload them. We will begin with the first module: Population Synthesizer. *Figure 2* below summarizes what needs to be done before proceeding to sub-section C.

**Fargo-Moorhead Activity-Based Model**

Click Insert, and then click Application Group. Find application and upload.

Uploaded applications will show up here.

Create TF key

Create Cass and Clay County PUMAs keys

Create "CASSCLAY" (Seed Data) key

Create FM road network key

Key	Value
Scen. Name	Base
Internal TAZ	592
TAZ	TAZ_2010_BG_Clay_County_Coord.dbf
ND PUMS	X:\...\CensusData2000\pums5_38.txt
MN PUMS	X:\...\CensusData2000\pums5_27.txt
CASS AND CLA	X:\...\ABM\Output\CASSCLAY.DBF
Iterations	5
Year	2010
Network	X:\...\ABM\Input\DPNET00A.net
Total TAZ	624
HOV_Occ	1

Figure 2 (above): Main screen of the Fargo-Moorhead activity-based model. Progress so far includes: population synthesizer, initial skim, accessibility, and activity travel simulator.

### c. Population Synthesizer (Pop Syn)

In ABM, it is important to generate a synthetic population in order to reflect the actual population count of the study area. If the Fargo-Moorhead metro area has a total population of 215,000, then that is the goal that the analyst should aim for. On the following page, *Figure 3* is an overview of the Pop Syn module. There are 11 total steps with descriptions set above each of the step. It is the analyst's responsibility to understand the fundamentals of the script, i.e. the parameter variables such as "HHLDID" is for "Household ID", "HHSIZE" is for "Household Size", "INCOME", etc. Discrepancies should be investigated. For example, a result of 185,000 for a synthetic populace falls short of the 215,000 (rough estimate of the FM metro area), why is that? The reader should peruse into the existing data and compare:

- How many households (HH) category were there in the TAZ file?
- Does the **HH size category of the TAZ file** match with the **HH size category of the script for the Pop Syn**?
  - IF the script broke the category into: 1, 2, 3, ..., 7+ household sizes AND the TAZ file only had categories of: 1, 2, 3, and 4 HH size, THEN it is obvious discrepancies exist in the yielded Pop Syn (the yielded amount could be lower because HH size past "4" was not accounted for).

Because of the geographic location of the FM metropolitan area, it being on the border of two states, this complicates the merging of data in for Step 9 of the Pop Syn module (Nashville's model was convenient as the region falls within the state of Tennessee only). Merging was conducted first in Excel for the following files: (1) CassCtyRegion.dbf and (2) ClayCtyRegion.dbf. Because Excel 2010 do not allow saving documents as .dbf, the following steps were exercised:

1. The result was saves as an .xlsx file;
2. Quality control and assure no overlaps occur for the household ID;
3. Open the .xlsx as a table in Microsoft Access;
4. Export as a .dbf (it does not matter what type of .dbf, i.e. III, IV);
5. Save new .dbf (in this case, it was saved as "CASSCLAY.dbf");
6. Bind CASSCLAY.dbf (Seed Data) as input file for Step 9.

A key was then created in Cube Voyager for the "CASSCLAY.dbf" file (see *Figure 2* above).

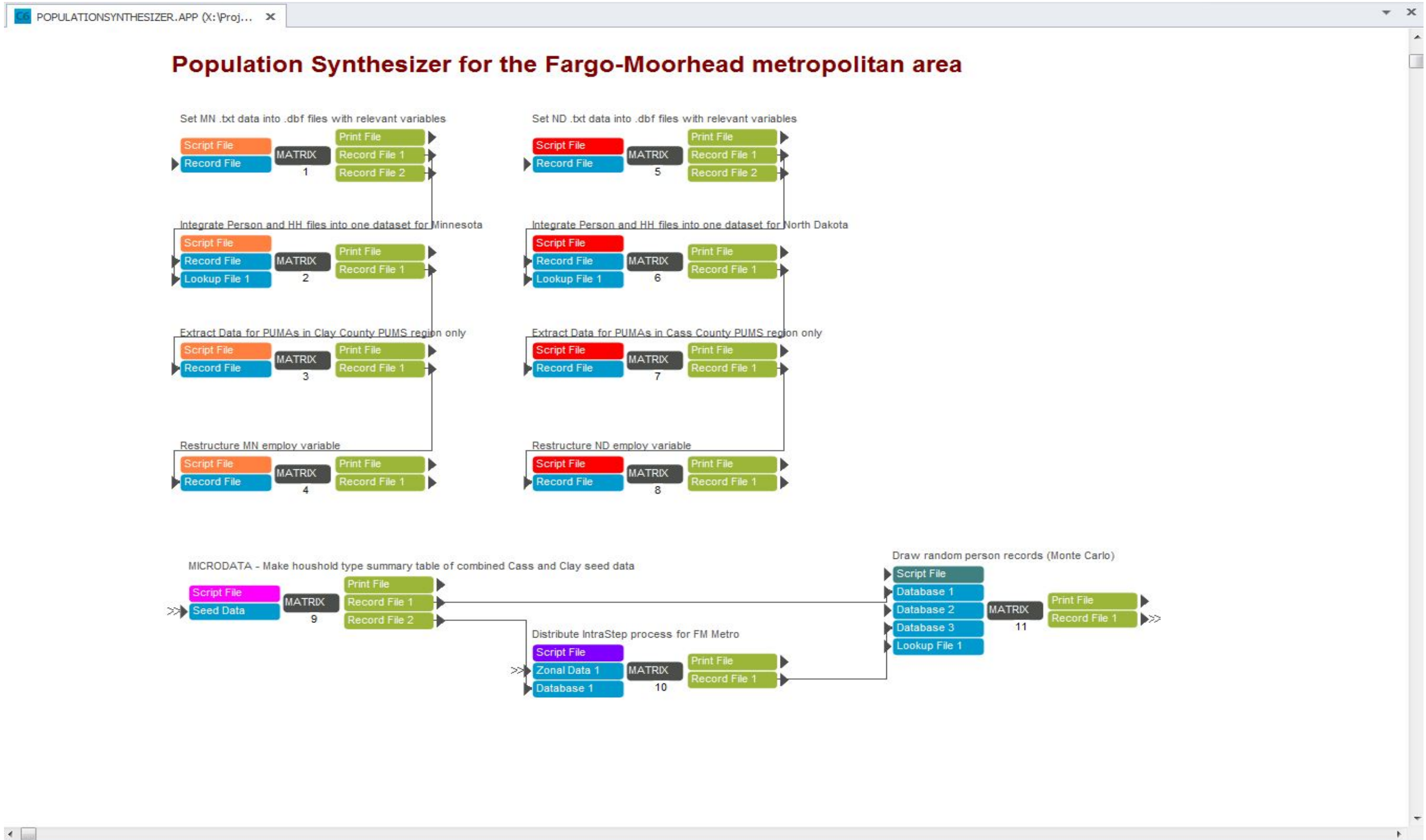


Figure 3 (above): Population synthesizer module developed for the Fargo-Moorhead metropolitan area using Cube Voyager 6.0. There are a total of 11 steps created for both Cass and Clay Counties.

To continue, begin with Step 1 of the Pop Syn module. Step 1 uses the PUMS data acquired from the U.S. Census Bureau for Minnesota (MN). This procedure generates **two** tables: (1) randomly generated households and (2) randomly generated persons in households. Step 2 integrates both the person and household files into one dataset for MN and is titled “MinnesotaPUMS.dbf.”

Think of it as a merge of two files and sorted by household ID and person ID. Step 3 extracts the data from the “MinnesotaPUMS.dbf” file for the PUMA region Clay County resides in (PUMA = 00100; or in this case selpuma5=100). The reader can find the attribute “selpuma5” in the script of Step 3, “02MAT00M.S.” Step 4 reconstructs the MN employ variable for Clay County. These are based on hours of work, school enrollment type, and income. To recount:

- STEP 1 – Set MN PUMS data to break into randomly generated households and persons.
- STEP 2 – Integrate both persons and households into one dataset for MN.
- STEP 3 – Extract PUMA region of Clay County from the MN randomized dataset.
- STEP 4 – Restructure the MN dataset for employment variable.

Steps 5 through 8 are similar as the first four steps except it pertains to ND data.

Step 9 utilizes the “CASSCLAY.dbf” file created at the end of sub-section C to make household type summary table by combining both Cass and Clay seed data. In this step, household incomes from the input database file are separated into different ranges for income category. The outcomes are two files: (1) a sample total and (2) each randomly generated household ID created in the previous procedures are matched up with an income category with respect to type and size category. The sample total creates 20 arbitrary types and each type is broken down into different combinations by size and income category. For example, see below:

- Type 1 relates to Size Category = Income Category = 1;
- Type 2 relates to Size Category = 1 & Income Category = 2;
- Type 3 relates to Size Category = 1 & Income Category = 3;
- ...;
- Type 20 relates to Size Category = 4 & Income Category = 5;

Step 10 distributes types from the sample total database file amongst the different traffic analysis zones (TAZ) from the socioeconomic data. This is known as a distributive intrastep process for the metropolitan area. The last procedure, Step 11, is to draw the random person records using Monte Carlo simulation. By using the randomly generated households output, Cass and Clay

County seed data, from Step 10, and the sample totals as a reference, the analyst is able to create a synthetic population of the Fargo-Moorhead metropolitan area (“SYNTHETIC.DBF” file).

**d. Initial Skims**

Generation of skims is essential in ABM for the process enables us to clean unnecessary attributes and keep what is needed. For this case, we keep the name of the link in the network along with the free-flow speed (FFS) and free-flow time (FFT); where FFT equals to  $T_0$ . The FM ABM utilizes the Nashville experimental ABM. Therefore, the following peak hours were considered: morning rush hour (AM), evening rush hour (PM), lunch or midday rush hour (MD), and off peak which are any hours not within the other three (OP). The figure summarizes the execution order of the module.

NOTE: Each metropolitan will most likely have different beginning and end times for rush hour. After the ABM has been completed, refining it is prudent. Consideration SHOULD go into these rush hours, i.e. applying a constant factor for each peak hour category.

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***THE REMAINDER OF THIS PAGE WAS INTENTIONALLY LEFT BLANK.***

## GENERATE SKIMS

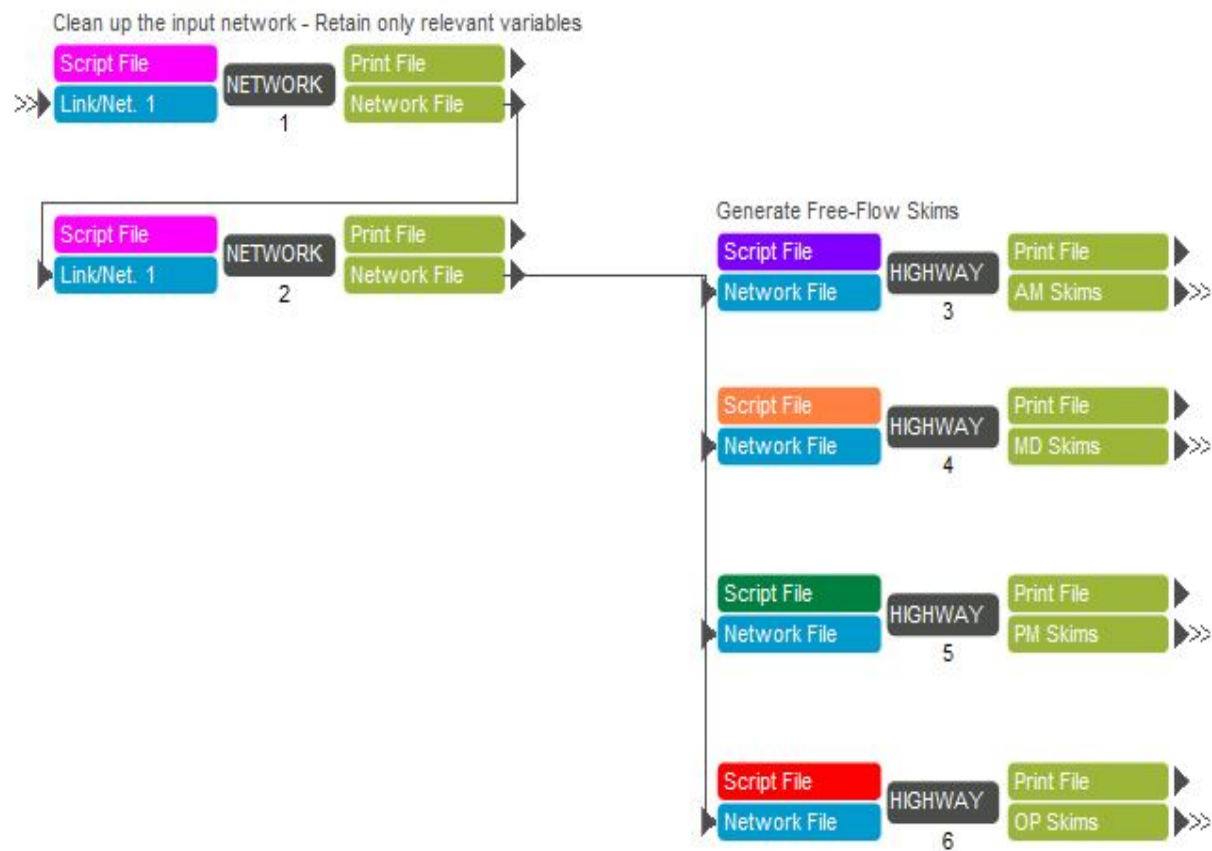


Figure 4 (above): Initial skims module developed for the FM activity-based model. There are six total processes.

Steps 1 cleans up the existing input file and retaining attributes that are essential for this module. Step 2 renames these attributes to something more similar to that of the Nashville model. Steps 3 through 6 generate the free-flow skims for the four peak periods: AM, PM, MD, and OP.

**e. Accessibility**

Accessibility module, itself, is an extensive procedure. This process utilizes the four output files from the Initial Skims module and the TAZ socioeconomic data. The purpose of this step is to generate accessibility values for BOTH **outgoing** and **returning** trips for **single occupant vehicles** (SOV) for the **four peak hours**. The categorization is listed below:

ACCESSIBILITY TYPE	VEHICLE TYPE	PEAK HOUR	PURPOSE
AMWACC1	SOV	AM	WORK
AMWACC2	SOV	AM	WORK
PMWACC1	SOV	PM	WORK
PMWACC2	SOV	PM	WORK
MDWACC1	SOV	MD	WORK
MDWACC2	SOV	MD	WORK
OPWACC1	SOV	OP	WORK
OPWACC2	SOV	OP	WORK
AMSACC1	SOV	AM	SCHOOL
AMSACC2	SOV	AM	SCHOOL
PMSACC1	SOV	PM	SCHOOL
PMSACC2	SOV	PM	SCHOOL
MDSACC1	SOV	MD	SCHOOL
MDSACC2	SOV	MD	SCHOOL
OPSACC1	SOV	OP	SCHOOL
OPSACC2	SOV	OP	SCHOOL
AMOACC1	SOV	AM	OTHER
AMOACC2	SOV	AM	OTHER
PMOACC1	SOV	PM	OTHER
PMOACC2	SOV	PM	OTHER
MDOACC1	SOV	MD	OTHER
MDOACC2	SOV	MD	OTHER
OPOACC1	SOV	OP	OTHER
OPOACC2	SOV	OP	OTHER

*Figure 5 (above): For simplicity and organization purposes, the accessibility type has been sorted by purpose of work, school, and other.*

The Fargo-Moorhead metropolitan area, currently, has no heavy occupancy vehicle (HOV) lanes. Therefore any consideration pertaining to HOV in the Cube script has been “commented out” (temporarily disregarded). The figure below is an overview of how the Accessibility module should be set up.



## Generate Accessibility Measures

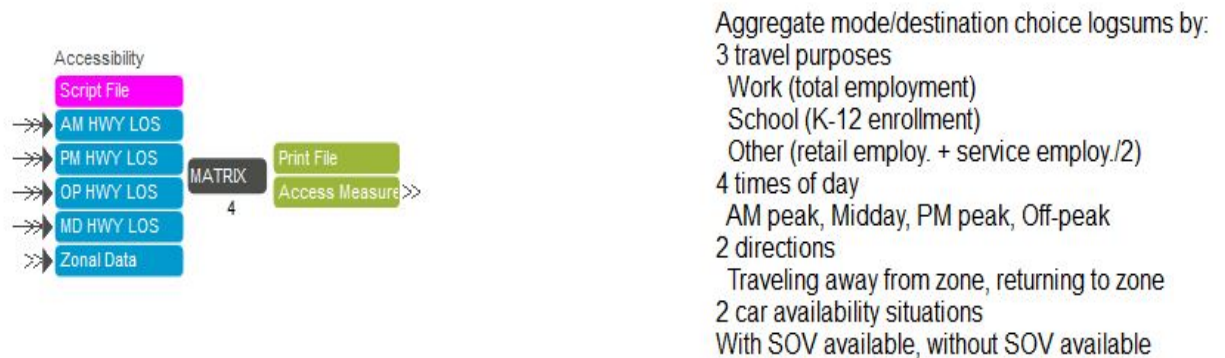


Figure 6 (above): Accessibility module created for FM ABM. Utilizing the four peak period skim files and the socioeconomic data, accessibility measures were created for those periods with respect to SOV, return and going trips, and by three types of purposes.

### f. Activity Travel Simulator (ATS)

ATS is exactly what it is titled. The procedure simulates unified records of the travel activities of a study area. These activities are broken down into: (1) patterns, (2) tours, and (3) trips. The ATS first generates random numbers (RN) using the known number of both internal and external TAZs. For the FM metropolitan, the total is 624. The second procedure of the module is what was stated in the second and third sentence of this paragraph. It combines the four peak period skim files, socioeconomic data, accessibility measures, the output from the RN generation previously stated, and the synthetic population (POP SYN). To recount what is needed:

- FOUR peak period SKIMS file;
- TAZ socioeconomic data file;
- ACCESSIBILITY MEASURES file;
- RN seed file;
- POP SYN file.

The analyst WILL most likely run into the most errors so far on Step 2 of the ATS module. A series of debugging and troubleshooting the script to have the module run for the FM scenario would be needed. Below is an overview of the ATS in Cube:

## Activity Travel Simulator

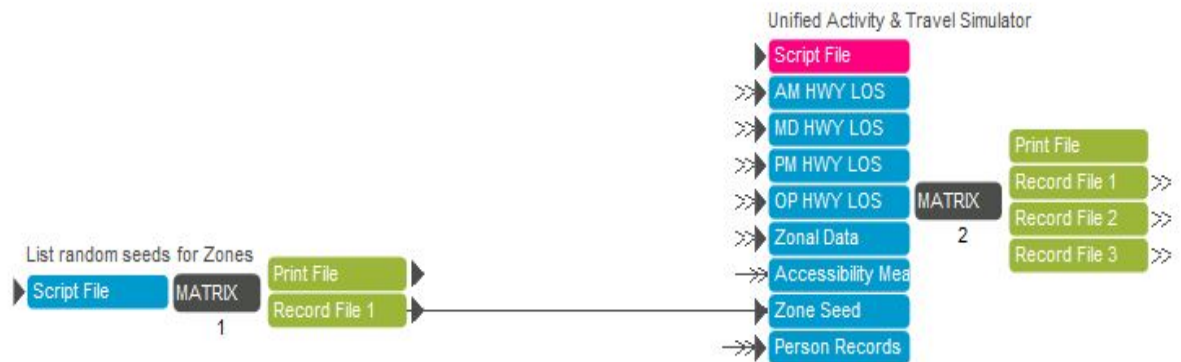


Figure 7 (above): Activity travel simulator module developed for the FM ABM. Although containing only two execution orders, the second will be, by far, the most difficult to debug.

In past runs, errors have commonly occurred between script lines 927 and 993. The anomaly can be explained by the fact that the FM metropolitan area lacks high occupancy vehicle (HOV) lanes whereas the Nashville network contains such facilities. For the time being, the HOVUTIL[dst] parameters have been left in place in order to facilitate a successful run. However, this should be changed and manipulated for the FM metropolitan area.

The analyst should take care when conducting such procedures as HOVUTIL[dst] affects other “xxxUTIL[dst]” factors. For example, in line 957 of step “2” titled “Unified Activity & Travel Simulator”, the equation for MSUMUTIL[dst] is as follow:

$$msumutil[dst] = sovutil[dst] + \mathbf{hovutil[dst]} + trnutil[dst] + walkutil[dst]$$

The script had to be changed for the FM metro from lines 958 to 964. With respect to MSUMUTIL[dst], further constraints had to be implemented to calculate the ZONEUTIL[dst].

Figure 8 below is a snippet of the sectional script. In summary, ZONEUTIL[dst] is given a

## FM Activity Based Model

nonzero value if and only if MSUMUTIL[dst] is greater than 0. Otherwise, the ZONEUTIL[dst] is equal to zero. It should be noted the TPURP[TOUR] =  $x$  was originally part of the Nashville model and has remain unchanged so far. This part may have to change for the FM model.

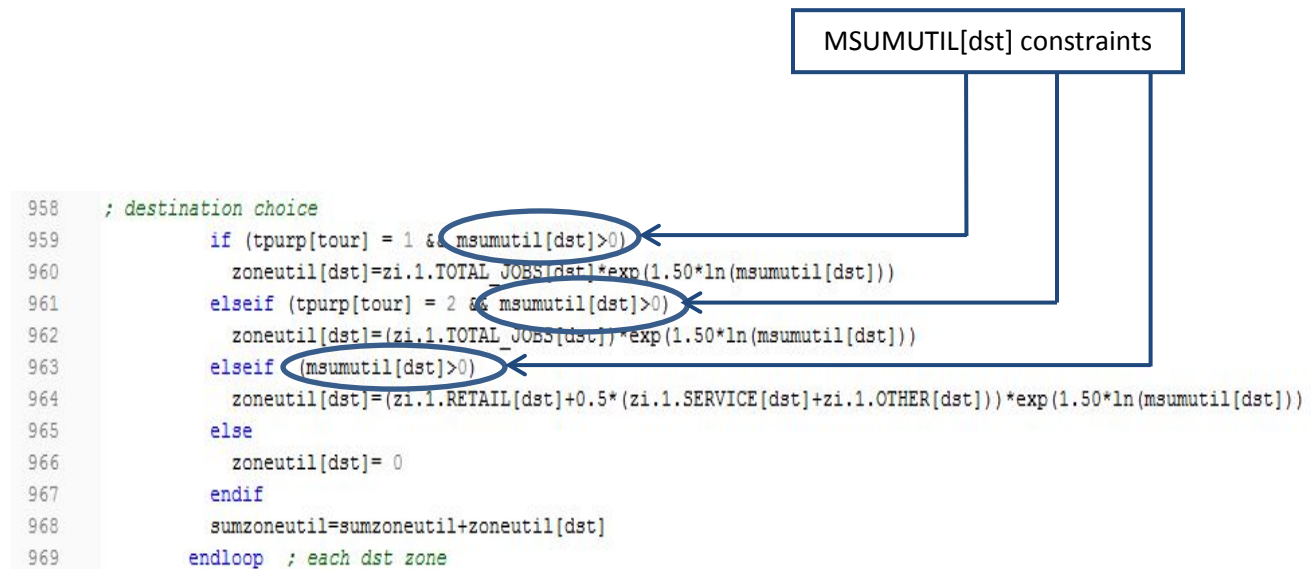


Figure 8 (above): ZONEUTIL[dst] calculation based on new MSUMUTIL[dst] constraints for the FM metro area.

Another danger to be aware of is script section containing lines 981 to 993. Initial attempts to remove the HOVUTIL[dst] parameters failed. Nonzero constraints applied similarly to Figure 8 failed for MSUMUTIL[dst] failed as well. The original script is shown in Figure 9. The removal of the HOVUTIL[dst] is shown in Figure 10. The MSUMUTIL[dst] nonzero constraints are shown in Figure 11. It was therefore decided to keep the HOVUTIL[dst] in place for the time being as this method was the only one allowing successful runs.

```
981 ; determine mode
982   target=rand()*msumutil[dst]
983   sumzoneutil=0
984   if (target < sovutil[dst])
985     mode=1
986   elseif (target < (sovutil[dst]+hovutil[dst]))
987     mode=2
988   elseif (target < (sovutil[dst]+hovutil[dst]+trnutil[dst]))
989     mode=3
990   else
991     mode=4
992   endif
993   tmode[tour]=mode
```

Figure 9 (above): Original script from the Nashville experimental ABM model.

## FM Activity Based Model

```
981 ; determine mode
982     target=rand()*msumutil[dst]
983     sumzoneutil=0
984     if (target < sovutil[dst])
985         mode=1
986     elseif (target < (sovutil[dst]+trnutil[dst]))
987         mode=2
988     else
989         mode=3
990     endif
991     tmode[tour]=mode
```

Figure 10 (above): First attempt was to remove the HOVUTIL[dst] parameter entirely.

```
981 ; determine mode
982     target=rand()*msumutil[dst]
983     sumzoneutil=0
984     if ((target < sovutil[dst]) && msumutil[dst]>0)
985         mode=1
986     elseif ((target < (sovutil[dst]+trnutil[dst])) && msumutil[dst]>0)
987         mode=2
988     else
989         mode=3
990     endif
991     tmode[tour]=mode
```

Figure 11 (above): Second attempt was to remove the HOVUTIL and apply nonzero constraints to MSUMUTIL.

### g. Travel Aggregator

The fifth module of the FM ABM is the travel aggregator (TG). The TG, based on *Figure 12*, has four procedures which : (1) splits trips by the time of day, (2) includes a conversion process where the output of these trip files from step “1” are converted into matrix files, (3) an analysis was conducted for traveler income, and (4) an accumulation of the income table from step “3.” Not to be confused with the Accessibility module, the TG was able to remove results related to HOVs. The reader can find such parameters to be commented out in the script files for steps “2” and “4.” Conversion of these trip tables were for the four respective time of day (TOD): AM, MD, PM, and OP. The same is applicable to the traveler income.

## Travel Aggregator

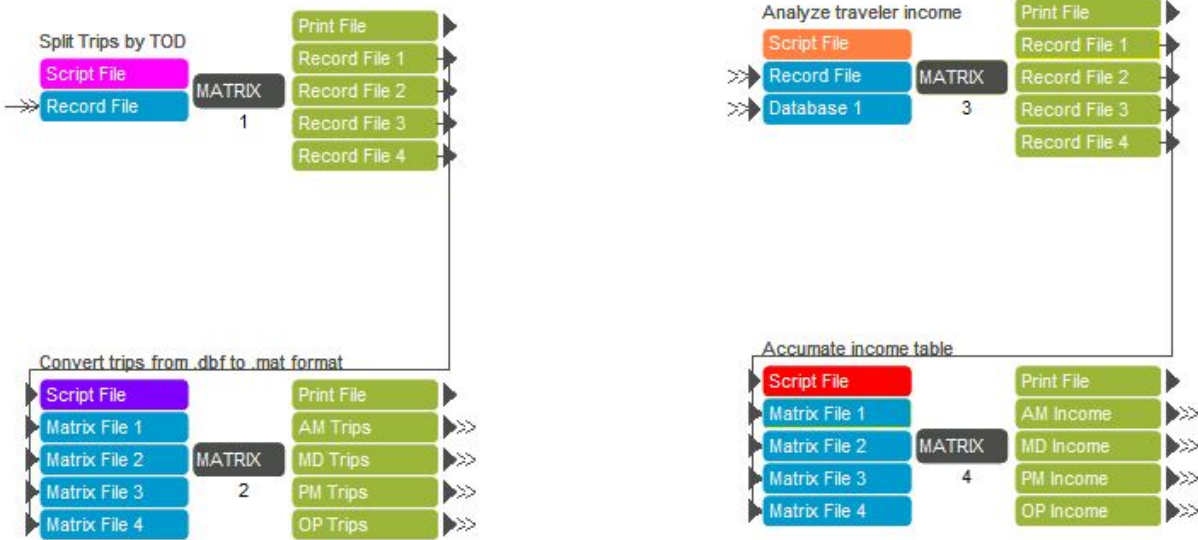


Figure 12 (above): The travel aggregator includes for steps. It is primarily use for data conversion and trip income.

### h. Assignment

Similar to the traditional four-step travel demand model (TDM), the ABM includes an assignment stage. Trips and traveler income are inputted for each TOD, see *Figure 13*, where the results would yield a cost matrix and road network for the respective time of day. This module should be changed in the future as it considers HOV. The factor was kept in place for reasons similar to the ATS module, i.e. script is dependent on measures set based on data where changing a line in the script to meet FM needs may result in null values or errors.

When changing the four scripts to meet the Fargo-Moorhead case, the reader should look particularly at script lines 41, 44, 50, 52 – 55 and 57 – 62 as these pertain to time, tolls, and distance related to HOV. The matter is shown in *Figure 14*. It would be best to perform further investigation into these scripts.

## Perform Highway Assignment for 4 time-periods using Distributed Processing

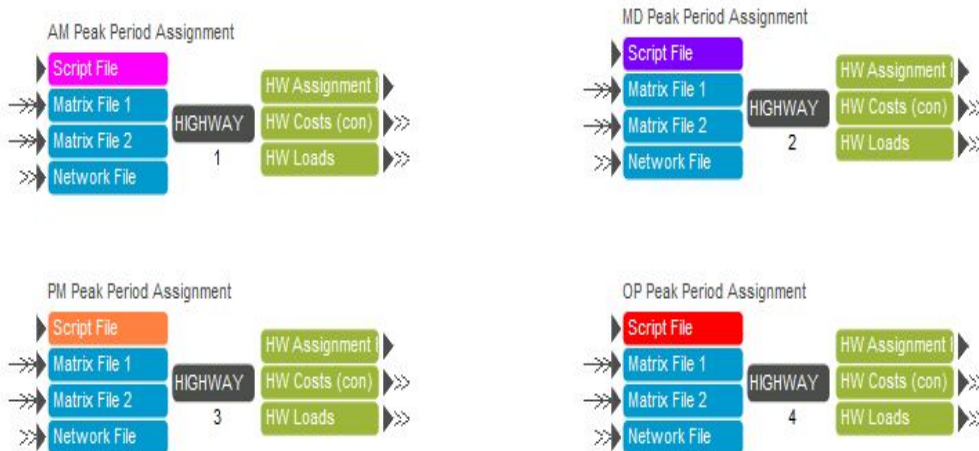


Figure 13 (above): Trip assignment module for the four TOD peak periods. Outputs were cost matrices and road networks.

For the FM metropolitan area, we are not concerned with HOV. As shown in *Figure 14*, MW[11] deals with HOV trips, MW[21] deals with HOV trip income, MW[33] pertains to SOV tolls, MW[34] is HOV time, MW[35] is HOV distance, and MW[36] is for HOV tolls. Initial attempts conducted similarly in the ATS module, as stated earlier, ended in failure. Errors include computational errors or index not found. As with the computational errors, these resulted from the division of zero-value denominators for each entry (one cannot expect to divide a numerator by zero to get a value since it is termed as infinity).

---

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```

38  PROCESS PHASE=ILOOP
39
40  mw[10]=(mi.1.1) ; All Trips = sov
41  mw[11]=(mi.1.2) ; All Trips = hov
42
43  mw[20]=(mi.2.1) ; SZ Trips = sov
44  mw[21]=(mi.2.2) ; SZ Trips = hov
45
46
47  PATHLOAD PATH = COST, VOL[1]=mw[10], VOL[3]=mw[20] EXCLUDEGRP=1,
48  mw[31]=PathTrace(cost),
49  mw[32]=PathTrace(li.Distance),
50  mw[33]=PathTrace(lw.toll)
51
52  PATHLOAD PATH = COST, VOL[2]=mw[11], VOL[4]=mw[21],
53  mw[34]=PathTrace(cost),
54  mw[35]=PathTrace(li.Distance),
55  mw[36]=PathTrace(lw.toll)
56
57  MW[31][I] = rowmin(1) * 0.5
58  MW[32][I] = rowmin(2) * 0.5
59  MW[33][I] = rowmin(3) * 0.5
60  MW[34][I] = rowmin(4) * 0.5
61  MW[35][I] = rowmin(5) * 0.5
62  MW[36][I] = rowmin(6) * 0.5
63
64  ENDPROCESS
65

```

Figure 14 (above): The original script from the Nashville experimental ABM where HOV parameters were left in place for reasons similar to the ATS module.

**i. GIS Outputs**

As with any TDM product, it is best to share results visually on a road network. The seventh and last procedure shown in Figure 15, GIS outputs, performs the conversion task of providing a finalized .net file based on the highway (HW) loads from the Assignment stage. These files then could be converted to shapefile (.shp) format when the output network files are open.

## GIS Outputs - Save to GDB



Figure 15 (above): Finalization of network files for the four TOD peak periods within the FM ABM.

## VI. CONCLUSION

The methodology of the ABM may be overwhelming at first. However, through timely practice and familiarization, the reader should be able to refine the initial ABM for the Fargo-Moorhead metropolitan area to the region’s specific needs. Refinements are possible as flaws and errors were pointed out in various parts within this report, i.e. the ATS and Assignment modules to name a few.

The resulting synthetic population is an underestimation of the actual total population. The reason can be the fact that the TAZ file only has attributes for household sizes “1” to “4+”. However, the script categorizes households past “4+” as “4”, “5”, “6”, and “7+” with respect to the random generation process. Obviously, such nonconformity would yield discrepancies in results. It has been stated ATAC may reach out to FM Metro COG about further acquisition of TAZ-related socioeconomic data.

Additional small changes are required for the Accessibility and Initial Skims modules. For example, currently the FM metro area does not have any actual data for the midday (MD) peak period. The MD may have to be omitted. However, the reader probably knows any changes made may also result in erroneous results. Therefore great care should be exercised.

Stating from earlier beginning from the ATS module, readers should be wary about the utilization of the HOVUTIL[dst] as it affects both directly and indirectly other parameters within various modules. Zero and nonzero constraints applied to certain script lines in order to force the script to run successfully is an acceptable practice but discretion should be practiced when conducting



## FM Activity Based Model

such steps, i.e. if this value/line was changed, what would it affect? The analyst should also take steps to conduct quality control and assurance of the results.

An effective method would be to compare the results of one particular module with that of the same module in the Nashville experimental ABM. No doubt there will be differences in values. However, there should be subtle similarities. For example, Nashville is a much larger metropolitan than the FM area. Therefore, their resulting AM, MD, PM, and OP trips will probably much higher. However, if let's say the AM total trips was "0" for FM metro, this is obviously not possible because it is saying no one lives in the metro or travels anywhere. Or the case if the AM trips of the FM area are larger than Nashville, this is also not possible as the randomly generated household and person counts for the former is drastically smaller than Nashville.

The sixth application, the Assignment module, would also require changes. Due to the influence of the HOV-related parameters, refinement was hindered thus far. However, the reader(s), after reading this report, would have a better understanding on how to manipulate the current scripts to run the FM ABM without the reliance of the HOV-related variables. The final application, GIS outputs, requires no change as of the moment.

Although the Fargo-Moorhead metropolitan area is considered a medium metropolitan because the population is between 200,000 and 1,000,000, it is growing at a fast rate. Hence, the facilitation of a refined and working activity-based model is necessary. Shortcomings such as utilizing the Census 2000 PUMS data can be eventually alleviated when acquisition of Census 2010 PUMS is possible as the Nashville experimental model also used the 2000 data.

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