A GIS Application: Integrating Traffic Count Data with an EMME/2 Travel Model Network

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Abstract

Accurate traffic counts are vital for the development and application of well-calibrated travel demand models. These traffic counts need to be matched to a model's directional links and nodes on the EMME/2 travel model network, but creating this linkage is often very labor-intensive and time consuming. To improve the efficiency of the traffic count coding process, King County has developed a method to relate traffic counts stored in a GIS database with specific links in an EMME/2 network.

This method applies GIS to identified count station tags on the EMME/2 network, then uses network node coordinates to determine the location and orientation of individual network links. After the count station is linked to the model network, traffic counts can be batched into an EMME/2 network for model validation. This can save significant processing time, and also makes it possible to develop a regional travel model / traffic count database. The resulting system can then be easily updated, as new traffic counts become available.

The first section of this paper will introduce the common methods of traffic count collection and application. The general coding process to link these counts with the travel model is described in the second section. The methodology for GIS integration of traffic counts with an EMME/2 network is described in detail in the third section. Finally, conclusions and recommendations on the methodology are presented in the final section.

Traffic Count Database Management and Application

Accurate traffic counts are vital for the development and application of well-calibrated travel demand models. Counts are typically collected periodically by area jurisdictions, and saved in a variety of formats.

- ***Traffic Count Collection and Storage***

The most frequently used equipment for collecting through traffic counts on local streets and arterials are tube counters; loop-detectors are usually used for freeways. Manual counts are mainly utilized to derive detailed turning movements at intersections. Video cameras are also sometimes used to record both through and turning movement counts. Counts are usually taken on weekdays – ideally collected over at least three consecutive days to obtain the most representative counts. Days that might render an abnormal count because of seasonal, construction, or traffic incident variables are generally avoided. Count results are normally totaled for 15-minute or one-hour intervals. To get the most consistent results, it is preferable to collect counts at different sites using the same time frame, agency, and collection method.

Traffic counts are typically stored as hard copy, in electronic format in a spreadsheet or database, or as GIS coverage. King County publishes an annual report "Historical Traffic

Counts," which is available in all three formats. This report contains average weekday daily directional traffic counts for the previous 10 years at about 360 count stations located within unincorporated King County. The data is organized in tabular format. This study will use this King County database for demonstration of the GIS integration process.

- ***Traffic Counts Used for Travel Demand Model***

The following are typical uses for traffic counts in travel demand modeling:

<u>Screenline Analysis</u>
Screenline analysis is one of the most important tools used for the validation of travel models. Screenlines that monitor travel patterns in the study area are identified, and the forecast traffic volumes are compared with observed traffic counts where network links cross each screenline.

<u>Statistical Analysis</u>:
The R-square, t-test, and root-mean-square are typical statistical analysis tools used in the reasonableness check of a travel model. The observed traffic counts are compared with the assigned traffic volumes from the model. This comparison can show how close the model comes to replicating existing traffic conditions. Outstanding issues can be identified from this analysis for correction or for further detailed analysis

<u>Demand Adjustment</u>
In the travel model calibration process, traffic counts can also been used to adjust the trips assigned to the network. The more area traffic counts data, the better the results of this adjustment.

<u>Origin-Destination Calculation</u>
Developing an Origin-Destination (O-D) survey is a very time-consuming and expensive process; therefore, the amount of data available for this analysis is very limited. Traffic counts can be used to adjust the O-D calculations to extend the value of the survey results.

<u>Other Applications</u>
Traffic counts are also used to calculate volume/capacity (V/C) ratios, and volume-delay function calculation.

<u>Traditional Processes to Link Traffic Counts with Travel Demand Model</u>

To take advantage of the EMME/2 software matrix and regression modules, traffic counts are usually input into the EMME/2 databank for model validation and statistical analysis. Screenline analysis for the validation of model can be operated within or outside EMME/2. These processes are described as below.

- ***Calculation within EMME/2 (e.g., Regression Analysis, Screenline Analysis)***

    - Define screenlines on the model network
    - Identify links cut by the screenlines
    - Input observed traffic counts one by one for each link into the travel model as link attributes
    - Run model for project alternatives
    - Calculate the ratio of observed traffic counts and model forecast traffic volumes for each individual link, or for an array of links along a screenlines
    - Use module to plot the regression analysis results

- ***Calculation outside EMME/2 (e.g., Screenline Analysis)***

    - Define screenlines from model network plots, and identify those links that are cut by these screenlines
    - Manually input observed traffic counts one by one for each link into the spreadsheet or database
    - Run model for project alternatives
    - Manually input the model's traffic count forecasts for each link to the spreadsheet or database
    - Calculate the ratio of observed counts to model output for each individual link, or for an array of links along a screenlines

GIS Tool to Link Traffic Counts with EMME/2 Network

The process of manually inputting traffic counts into either a spreadsheet or an EMME/2 network is tedious and time-consuming. It is much more efficient to automatically link traffic counts directly with the model. Below is King County's method for linking its GIS traffic databases with the EMME/2 network.

- ***GIS based travel demand model***

GIS can be a very useful tool for travel demand model development and applications. With GIS, traffic analysis zones (TAZ) can be created with more accurate boundaries, which meet with the creation criteria. The land use information can be validated more efficiently. With GIS streets coverage overlapped with EMME/2 network, travel model network development becomes more easy and accurate. It improves the validation of land use data and the accuracy of travel model network coding significantly. The land use data are tied to the travel model and can be used as the spatial analysis and provide useful information for transportation planning. The GIS-based travel model network can provide the consistency for the region.

- ***Identify and tag network count stations***

The first step is to identify the intersections in the model network (nodes) which correspond to intersections with traffic counts (count stations). If GIS coverage of count stations is available from the jurisdiction's traffic engineering section, this coverage can be overlaid on theEMME/2 network in order to tag the appropriate nodes. King County count stations are shown in Figure 1.

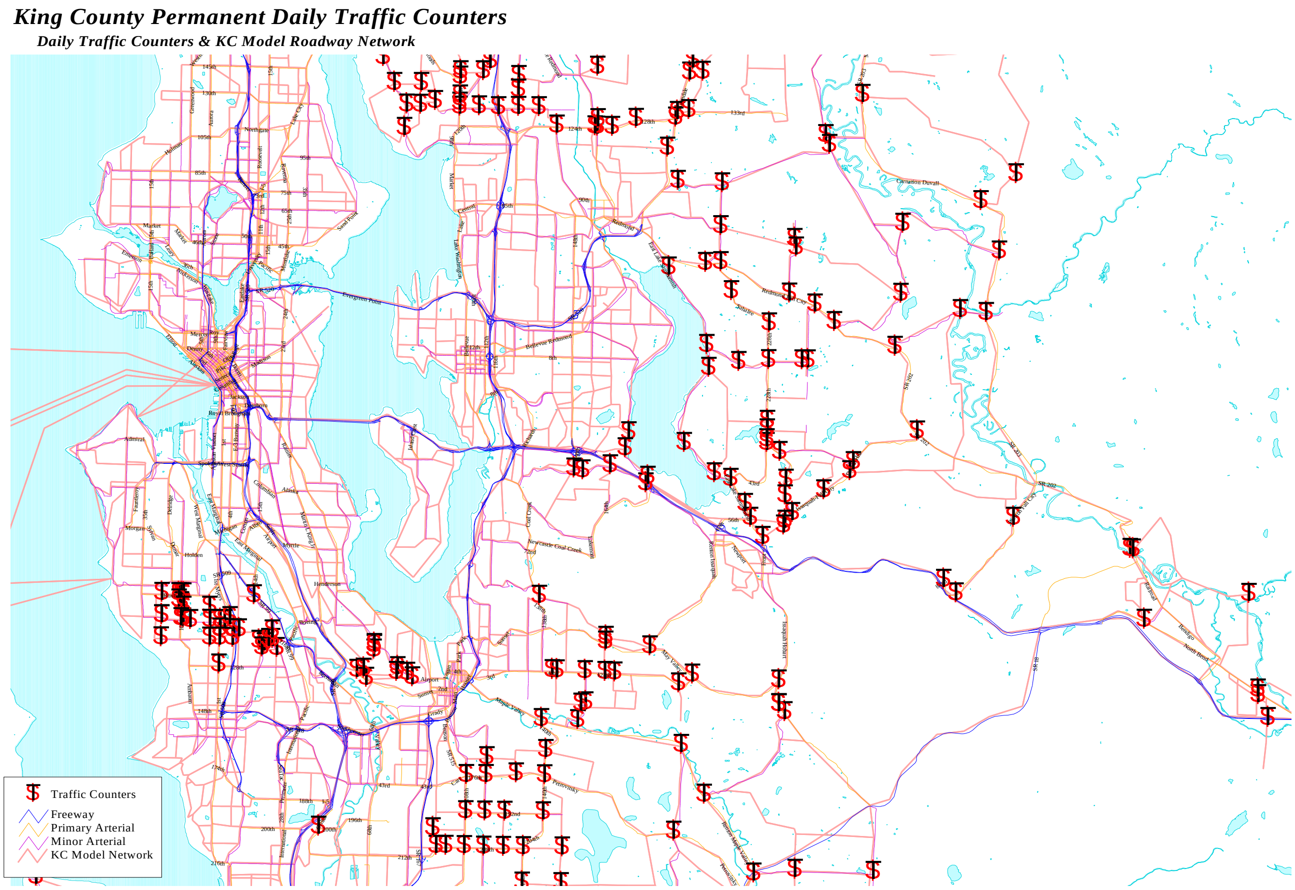

Figure 1. King County Count Stations with EMME/2 Network

- ***Modify network for links with dual count (double-tagged) stations***

Sometimes, there will be more than one count station along a given EMME/2 network link. To avoid double-tagging such links, they are split so that each network link is associated with only one count. Below is the process to split these links.

  - Punch xy coordinates of nodes with count station tags
  - Punch links with 1 or 2 nodes with nonzero count station tag
  - Identify links with both nodes having count station tags

- ° Split links with two nodes with count station tags
- ° Calculate midpoint of links with 2 count station tags ((xi+xj)/2, (yi+yj)/2)
- ° Identify available node numbers
- ° Number link midpoints with available nodes
- ° Create batchin file, read into EMME2bank
- ° Manually split links with new nodes
- ° Delete split links

- ***Create link definition table and Identify link orientation***

Travel direction must be specified for each link. First, punch out link and node information from the EMME/2 model network and import this data into a spreadsheet. One difficulty is that intersections are not always perfectly aligned to north-south and east-west cardinal directions. To minimize the chance of mis-assigning the orientation of a link, those links not falling near to an obvious cardinal direction are excluded (Figure 2).

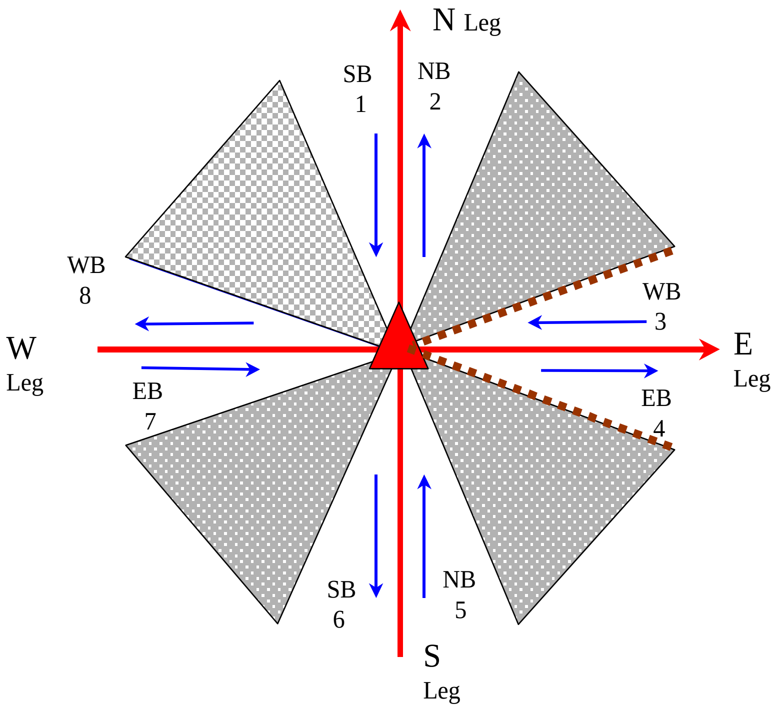

Figure 2. Cardinal Direction

To do this, calculate the change in coordinates between link *i* and *j* nodes. If the ratio of change is less than 2:1 than the link orientation is ambiguous, and the link is not tagged.

- ° Punch xy coordinates of nodes with count station tags (Table 1)

Table 1. Node Tagged with Count Station

NODE	X-COORD	Y-COORD	STATION
2010	1317835	262151	0
2011	1268632	244898	0
2012	1267666	245187	0
2013	1293650	298611	0
2235	1315276	262218	2082
2236	1320759	262047	2074

- Punch links having nodes with nonzero count station tag
- Calculate abs(dx/dy) (Table 2)

Table 2. Calculation of abs(dx/dy)

		I-NODE			J-NODE			DOUBLE			
I-NODE	J-NODE	I-STATION	I-XCOORD	I-YCOORD	J-STATION	J-XCOORD	J-YCOORI	STATIONS?	DELTA-X	DELTA-Y	abs(dx/dy)
2010	2235	0	1317835	262151	2082	1315276	262218	1	-2559	67	38.19
2010	8218	0	1317835	262151	2080	1320393	262083	1	2558	-68	37.62
2122	4279	0	1292061	279904	2016	1293528	279537	1	1467	-367	4.00
2122	9040	0	1292061	279904	2006	1292015	280185	1	-46	281	0.16
2122	9042	0	1292061	279904	2007	1292015	279438	1	-46	-466	0.10

- If abs(dx/dy) is between 0.5 and 2 then exclude, not a cardinal direction
- If abs(dx/dy) > abs(dy/dx) tag EW else tag NS
- If count station inode not = 0 then tag outbound
- If count station jnode not = 0 then tag inbound
- Tag direction:
  East/West Links:
  - If dx<0 then link is WESTBOUND
  - If dx>0 then link is EASTBOUND

  North/South Links:
  - If dy<0 then link is SOUTHBOUND
  - If dy>0 then link is NORTHBOUND
- Tag approach:
  - If outbound and WESTBOUND then W leg
  - If outbound and EASTBOUND then E leg
  - If inbound and WESTBOUND then E leg
  - If inbound and EASTBOUND then W leg
  - If outbound and NORTHBOUND then N leg
  - If outbound and SOUTHBOUND then S leg
  - If inbound and NORTHBOUND then S leg
  - If inbound and SOUTHBOUND then N leg

Figure 3 shows an example steps to identify link orientation.

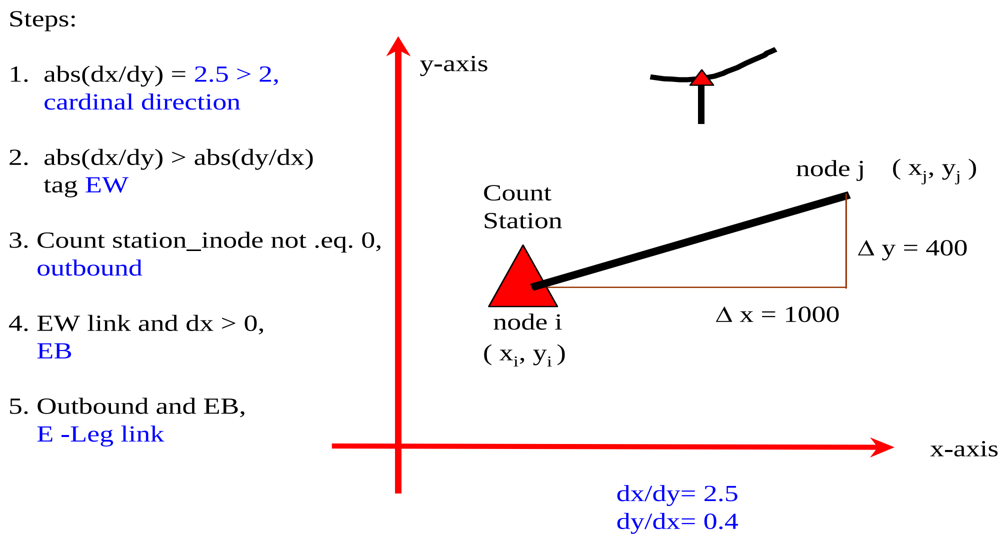

Figure 3. E-Leg Link of a Count Station

- Next, tag each link with the final count tag information:

Leg	**Direction**	**Tag**
N	SB	1
N	NB	2
E	WB	3
E	EB	4
S	NB	5
S	SB	6
W	EB	7
W	WB	8

- Finally, combine the count station tag from the node with the count tag divided by 10:

- **Example:** The westbound approach on the east leg at count station 2082 would be tagged 2082.3 (Table 3)

Table 3. Create Link Tag Table

I-NODE	J-NODE	I-NODE I-STATION	J-NODE J-STATION	abs(dx/dy)	EW or NS	IB or OB	LEG	DIR	CODE	STATION CODE
2010	2235	0	2082	38.19	EW	IB	E	WB	3	2082.3
2010	8218	0	2080	37.62	EW	IB	W	EB	7	2080.7
2122	4279	0	2016	4.00	EW	IB	W	EB	7	2016.7
2122	9040	0	2006	0.16	NS	IB	S	NB	5	2006.5
2122	9042	0	2007	0.10	NS	IB	N	SB	1	2007.1

- The spreadsheet file with the count information is also set up with the same tag scheme. The counts are then read into a spreadsheet by linking them to the count tag. The output can then be batched out to an EMME/2 compatible input file. (Tables 4 and 5)

Table 4. Count Data with the Same Tag Scheme

station	LEG		LOOKUP	CODE	Y89	Y90	Y91	Y92	Y93	Y94	Y95	Y96	Y97	Y98	Y99
2082	N-SB		1	2082.1	1297	2112	2407	2520	2572	2623	2680*	2730*	2780*	3799	4464
2082	N-NB		2	2082.2	1883	2169	3021	3203	3479	3549	3620*	3690*	3750*	4433	3691
2082	E-WB		3	2082.3	7969	8319	8513	8403	8482	8652	8830*	7427	7863	8581	6163
2082	E-EB		4	2082.4	8491	7952	9426	9505	8863	9040	9230*	9170	8849	9656	7342
2082	S-NB		5	2082.5	7700	6929	8170	8466	8549	8720	8900*	9060*	9210*	9592	8801
2082	S-SB		6	2082.6	7724	8454	8320	8570	8413	8581	8760*	8920*	9070*	9014	8240
2082	W-EB		7	2082.7	11107	12107	12040	10634	12056	12297	12560*	12790*	13010*	11937	11547
2082	W-WB		8	2082.8	11059	11175	10829	11064	10992	11212	11450*	11660*	11860*	11095	11203

Table 5. emme/2 Linkage with Count Data

inode	Jnode	code	97vol	98vol	99vol
2010	2235	2082.3	7863	8581	6163
2235	2010	2082.4	8849	9656	7342
8216	2235	2082.5	9210	9592	8801
2235	8216	2082.6	9070	9014	8240
2907	2235	2082.7	13010	11937	11547
2235	2907	2082.8	11860	11095	11203

- Read in and review counts
  The counts are read into the EMME/2 databank. They are then plotted and checked against the count book.

- ***Results***

When this technique was tested using King County traffic data, the original GIS table contained 2072 individual directional daily counts. Of these, 1252, or about 60% were successfully linked and input to the EMME/2 model network. Links not identified on a cardinal direction (i.e. northwest as opposed to north) were not automatically linked and need to be related by hand. A common problem occurs when a roadway makes a 'jog' just before the intersection that is not reflected on the model network. As a result, the link direction is sometimes misassigned. These problems can be helped by close consultation with a jurisdiction's traffic engineering section to improve coordination in the data coding process. An example may be to use Section I, II, III, VI instead of NW, EW.

Conclusions and Recommendations

The above method to use GIS to link counts with the EMME/2 model can simplify and speed up the process for inputting traffic data. A regional traffic count database, incorporating data from many jurisdictions in a consistent format, will greatly improve the efficiency and accuracy of this process.

Data transfer between GIS and EMME/2 is not limited to traffic count data. After the initial link is established between the EMME/2 model and count station location and orientation, any data in a consistent format can be linked to EMME/2. This may include accident data, roadway and intersection configurations, or other information. The transfer of data can also operate in the other direction; model output can easily be linked to the GIS database to assist with intersection analysis or operational models.

Acknowledgment

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