GIS Based Model Interfacing: Incorporating Existing Software and New Techniques into a Streamlined Interface Package

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The ability to visualize data has grown immensely as the speed and functionality of Geographic Information Systems (GIS) have increased. Now, with modeling software and GIS, planners are able to view a prediction of the future traffic demands in their jurisdiction. With the creation of a streamlined interfacing program that seamlessly connects the modeling software and the GIS package, planners can spend less time computing and more time assessing needs. The interface also provides analytical tools to assist the user in validation and assessment of the traffic model, all of which are executed in a GIS environment. Tools such as the shortest path through the network, time radius from a zone or node, traffic origins and destinations from a select link, and screenline validation have all been completely automated. Through the use of pull-down menus and mouse clicks, activities that were previously time consuming events have become streamlined computer tasks, taking only a fraction of the original time. Key words: Geographic Information System, transportation modeling, analysis tools.

INTRODUCTION AND OVERVIEW

The ability to visualize data has grown immensely as both computing speed and Geographic Information Systems (GIS) functionality have increased. Now, with traditional modeling software and GIS, planners are able to visualize future traffic trends in their jurisdiction. With the creation of a streamlined interfacing program that seamlessly connects the modeling software and the GIS package, planners can spend less time computing and more time assessing needs.

The four-step transportation modeling process that exists today—trip generation, trip distribution, mode split, and traffic assignment—originated in the 1950s and has remained relatively unchanged since. During the 1960s and 1970s, main frame computers were utilized with programs such as UTPS and PlanPack to reduce the amount of hand calculations required to complete a model run. These innovations allowed the larger agencies responsible for transportation modeling to computerize the four-step modeling process. However, the cost to own and operate a main frame computer was often too high to allow smaller planning agencies to use these methods.

By the 1980s, personal computers had become both faster and cheaper than many main frame computers. Through the use of a transportation modeling package known as TranPlan, many smaller planning agencies were utilizing personal computers to run the four-step modeling process. Although TranPlan could quickly give output, this output was only in text format that required analyzing pages of printed material. Despite the effort required to analyze a network after it had been modeled, the benefit of having the modeling process automated was still enormous.

During the 1990s, visualization of data became much more prevalent. Through the use of spatially-oriented GIS packages, network data could be displayed visually. This new tool offered users the ability to analyze their modeled network data in a spatial or geographically correct format. The ability to look at data associated with a particular attribute could now be done through visual analysis rather than through the use of the printed text files. Although the GIS tool provided many new benefits, transferring data from TranPlan to the GIS was still a cumbersome process.

Although software packages that incorporated both GIS functionality and transportation modeling techniques have been created (TransCAD), many modelers have remained TranPlan users. Due to state-wide licensing agreements, TranPlan is available free of charge from some state Department of Transportation offices. The acquisition of the ArcView GIS package by modelers has been required due to a federal program known as Taz-up. With these two software packages available, an interface could be implemented to allow users to automate the data transferal process.

The first interfaces were DOS programs written in FORTRAN. These interfaces automated many of the data transfer processes, however, the robustness of these data transfer programs was often very minimal at best. The required inputs to the programs were very strictly formatted and often confusing. Input errors by the user would cause the interface to crash, forcing the process to be reexecuted.

Through the incorporation of Visual Basic and Avenue scripting, the GIS interface assists the transfer of data between TranPlan and ArcView. By using pull-down menus and mouse clicks, additional time savings have been accomplished by eliminating manually time consuming activities with streamlined computer tasks. Context sensitive help screens explain what input is required, while format-verifying functions notify the user where errors are occurring. The interface also provides analytical tools to assist the user in validation and assessment of the traffic model, all of which are displayed in a GIS environment. Tools such as the shortest path through the network, time radius from a zone or node, traffic origins and destinations from a select link, and screenline validation have all been completely automated.

This paper serves a three-fold purpose. The first section provides a sample of the GIS-based interface environment. Section two includes a list of calibration techniques and analysis tools, which have been implemented in the interface programming. These prescribed

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techniques should be quite useful, regardless of the GIS environment in which they are preformed. Finally, section three provides a discussion on the advantages and disadvantages of the interface versus conventional modeling practices.

A SAMPLE OF THE GIS BASED INTERFACE ENVIRONMENT

As with traditional modeling processes, there is a large amount of data that needs to be accumulated before the traffic modeling process can begin. In this regard, the GIS-based interface is no different. To begin with, a representation of the city needs to be created. This includes acquiring information on Traffic Analysis Zones (TAZs) and major streets in the network, along with frictional and external data for the network. The formatting of the raw data for input into the modeling software can then either be done by the GIS or externally through an assortment of means. By choosing to format the data in the interface, the entire network can be transformed into a digital network by simply drawing the streets to be modeled. Once the links and nodes data files have been created, the formatting of the production/attraction file(s) and the external station data files should also be completed. Below is a list of all required data files for successful use of the GIS interface. The formatting should be consistent with the requirements of the traffic modeling software as discussed in the software user manual.

- Node data file
- Link data file
- Production/Attraction data file (may be stored in separate files)
- External Stations data file
- Friction file
- Turn Penalty/Prohibitor file (optional)

To begin the modeling process through the GIS interface, the modeled network must be created. By using the interface to format the street data, this process has already been completed. If the interface was not used to format the data, then the link and node data must be input into the interface. Other information about the network—such as the number of TAZs and coordinate information— are also prompted at this point. Successfully running this portion of the interface will result in the creation of a GIS database that contains attributes of the links and nodes making up the network along with a visual plot of the network. Figure 1 shows the nodes and links files in GIS.

The second step in the GIS modeling interface is to “load” traffic onto the newly created network through the use of traffic modeling software. The interface creates the required control files to operate the modeling software, then remotely runs the modeling program. However, the option to use preexisting control files is also given, allowing the user to customize the modeling process. Once the traffic modeling process is completed, which indicates the four-step modeling process is complete, then the interface creates a new GIS database containing the “loaded” network attributes, and a new visual plot of the network is overlaid upon the original network. Figure 2 shows the loaded links and the TAZ centroids, along with the original nodes and links files. Note that not all of the original links are contained in the loaded links. Centroid connectors are not included as part of the loaded links file.

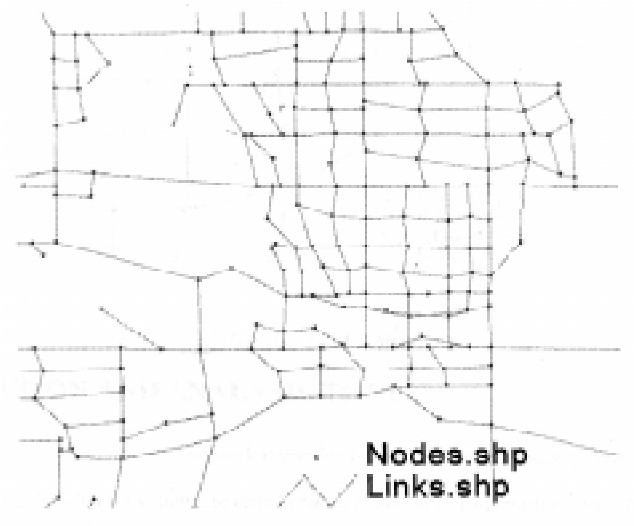


FIGURE 1 Original network

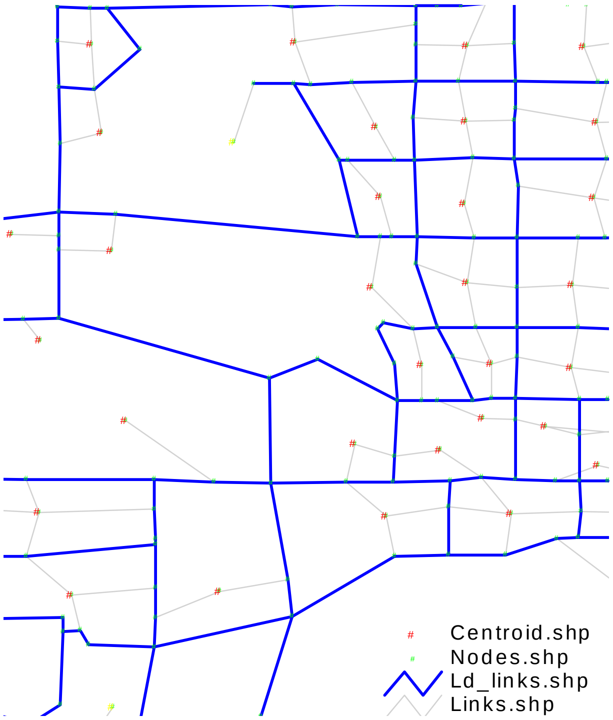


FIGURE 2 Loaded network

CALIBRATION AND ANALYSIS TOOLS

A set of tools to visualize the loaded network is provided to help calibrate the newly created model. By comparing the model’s loaded volumes to actual ground counts in a visual manner through the use of GIS, the user is able to distinguish loaded links that are inconsistent with their respective counted volumes. The first tool for visualizing and calibrating is the validation plot. This tool, which follows guidelines set forth in a recent report describing new calibration techniques, calculates the ratio between the loaded volume and the counted volume, then displays the link according to this ratio. The displayed link will appear blue for a low loaded to counted ratio or red for a high ratio. The link is also buffered according to the total loaded volume as shown in Figure 3. A similar display option is the calibration plot, which displays the total loaded volume on each link as one of five colors. Figure 4 shows an example of the calibration plot.

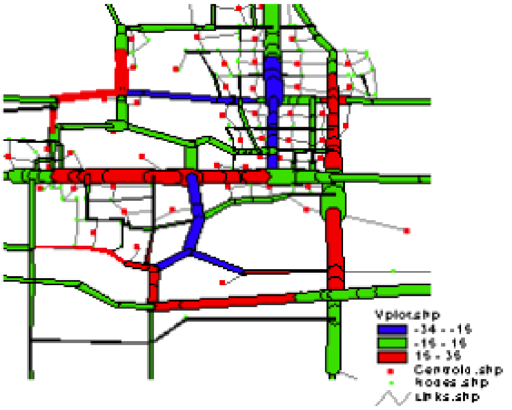


FIGURE 3 Validation plot

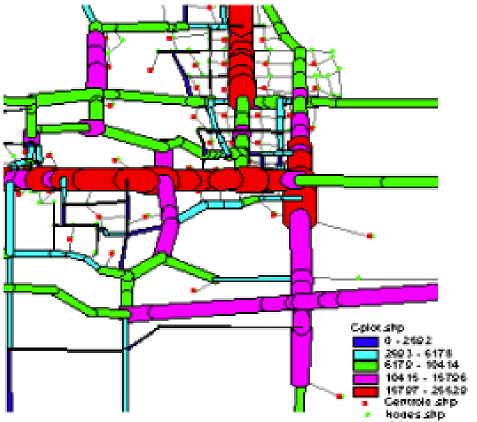


FIGURE 4 Calibration plot

The second tool implemented by the GIS interface is a screen/cut/cordon line display. The user can create up to ten screen lines at one time in the GIS environment. Screen lines are useful in identifying coding errors that appear as drastic differences in loaded volume between parallel and similar roadways. Each newly created screen line will produce a new visual GIS plot and database of all links in the network that the screen line intersects (see Figure 5).

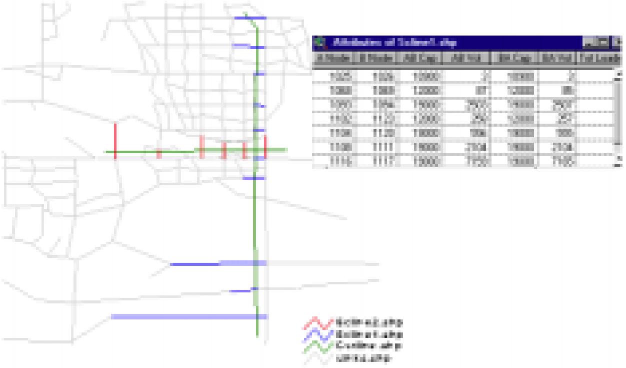


FIGURE 5 Screen lines

Finally, a select link analysis tool allows the user to specify a particular link and then quickly identify the origins and destinations of all trips using the selected link. A visual plot of the number of trips either originating or terminating at all TAZs in the network is produced. Figure 6 shows a plot of the percent of trips from each TAZ that are origins or destinations.

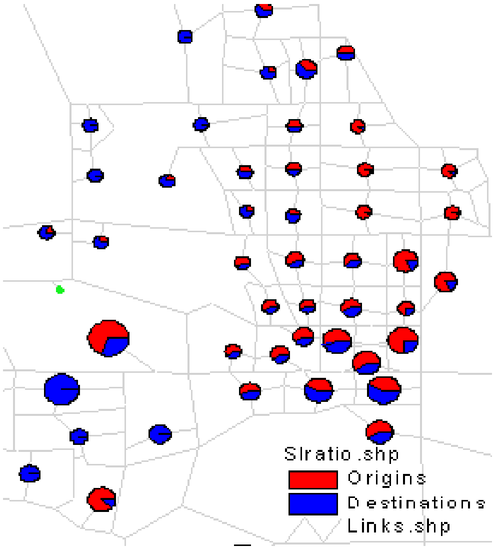
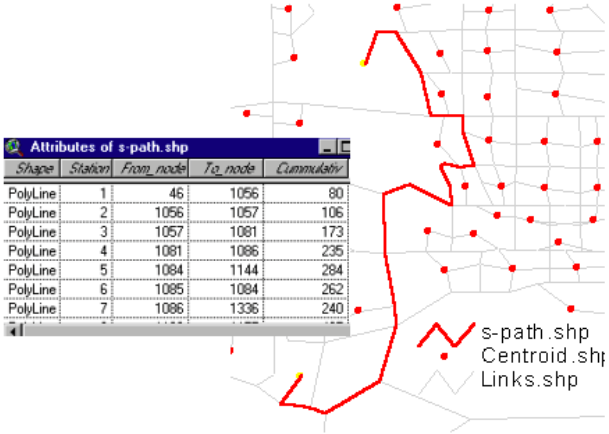


FIGURE 6 Select link ration

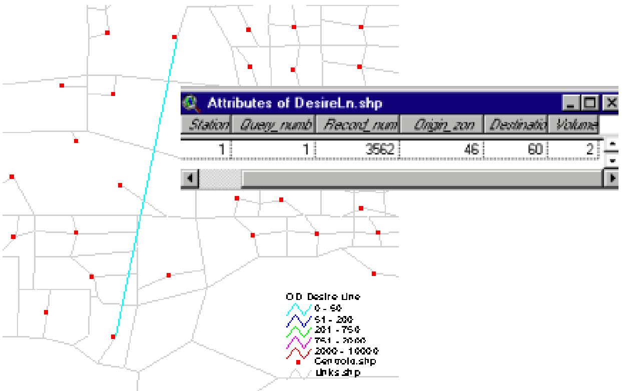
The GIS interface also includes several other analysis tools. The shortest path finder prompts the user to select an origin and destination TAZ. A control file for the modeling software is created which will identify the optimal path according to distance through the network. The modeling software is executed, and the results are displayed visually on top of the existing GIS network. A database table showing all links that make up the shortest path is also displayed. Figure 7 shows the shortest path file along with the attributes table.


Attributes of s-path.shp

Shape	Station	From_node	To_node	Cummulativ
PolyLine	1	46	1056	80
PolyLine	2	1056	1057	106
PolyLine	3	1057	1081	173
PolyLine	4	1081	1086	235
PolyLine	5	1084	1144	284
PolyLine	6	1085	1084	262
PolyLine	7	1086	1336	240

FIGURE 7 Shortest path

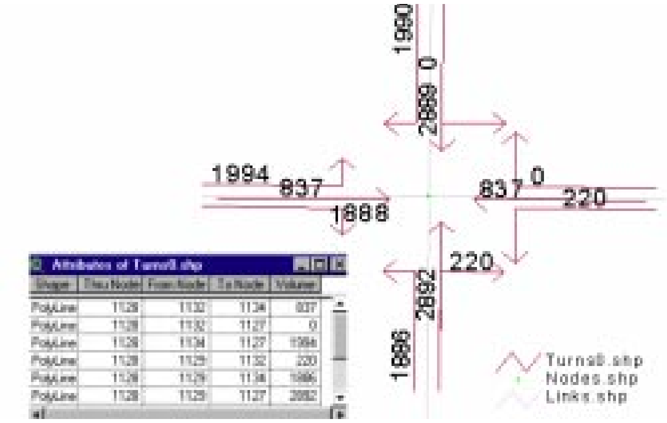
The origin/destination desire line tool allows the user to identify the loaded volumes that are traveling between two TAZs. This line is visually displayed and then colored according to the loaded traffic volume between the two points. Through a desire line, any cell in a origin/destination matrix can be displayed as part of the visual network (see Figure 8).



Station	Query_numb	Record_num	Origin_zon	Destinatio	Volume
1	1	3562	46	60	2

FIGURE 8 Desire line

Another analysis tool contained by the GIS interface is the turning movement display. Using this tool requires that during the four-step modeling process, the turning movements were saved to a file. To display the turning movements, the user simply selects the node in the GIS network. A visual plot of all turning movements going through the selected node will then be displayed, along with a database containing the volumes from the modeling process. An example of a turning movement display is found in Figure 9.



Shape	Thru Node	From Node	To Node	Volume
PolyLine	1128	1132	1134	837
PolyLine	1128	1132	1127	0
PolyLine	1128	1134	1127	1994
PolyLine	1128	1129	1132	220
PolyLine	1128	1129	1134	1886
PolyLine	1128	1129	1127	2892

FIGURE 9 Turning movement display

The last analysis tool is the time radius display. By selecting a node in the GIS network and then specifying a time, the interface will create a visual plot of all links that could be reached from the selected node within the specified time. Figure 10 shows an example of a time radius display.

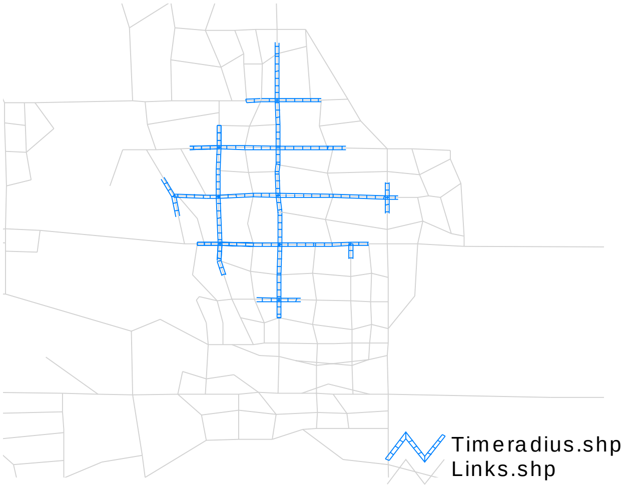


FIGURE 10 Time radius

ADVANTAGES/DISADVANTAGES OF THE GIS INTERFACE

As computation time becomes shorter and the demands on professional time become greater, the need for an innovative way to use computers to automate time-consuming processes becomes more apparent. Through the use of a GIS interface such as the proposed package above, such automation can be achieved. Even more valuable is the ability to visually identify the network with very little effort. A GIS can quickly and efficiently display large amounts of data in a form that allows for easy debugging by the user. Another advantage of the GIS interface is that modeling can be done without an in-depth knowledge of the modeling software. Since, data formatting and naming conventions are automated by the interface, many computational errors are eliminated.

Through the use of the analysis tools, more advantages from the interface can be obtained. The user can quickly locate useful information about the network without running a new model process or searching through previous model reports. By repeatedly running analysis tools, an in-depth picture of the underlying data can be found and errors identified. Due to the nature of a GIS, all the information about the network can be stored inside of the GIS project. This is a huge benefit when errors in the input data are identified. Corrections on the data can be done in GIS, and the modeling process can quickly be repeated. The result is a very short turn-around time in creating a more accurate model.

Similar to any new product, there are some disadvantages to the GIS interface. To users who are not familiar with GIS, there is a disadvantage to learning a new software program. Although most GIS packages are relatively user-friendly, there is still a noticeable learning curve when beginning a new GIS package. Another disadvantage is that familiarity with the data is no longer needed. Conventional modeling required much more preparation of the data before inputting it into the modeling process. With automated processes, the user has less of an idea where to begin looking for errors.

The greatest disadvantage to creating an automating interface such as the proposed package above is that many users will treat it as a "black box." Rather than carefully analyzing the progress of the modeling process, a user can point and click their way to unreliable information. Since computers cannot produce good information from bad data, it is still the user's ultimate responsibility to verify results. Although the interface provides tools to do such verification, the user must still be aware of the what, why, and how of the modeling process.

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