

Executive Summary

Most transportation agencies are not receiving the full benefits of integrating travel models and geographic information systems (GIS). While the commercial trend seems to be toward integration, many agencies continue to use stand-alone modeling packages or both GIS and modeling packages independently. Chief reasons are cost and prior investment in training and technology. The goal of this project was to develop user-friendly windows programs capable of integrating urban planning travel models and desktop GIS packages.

To demonstrate the GIS modeling environment, Tranplan (Urban Analysis Group) was integrated with several desktop GIS platforms: ArcView (ERSI), AtlasGIS (ERSI), MapInfo (MapInfo Corp.), and Maptitude (Caliper Corp.). This project consisted of two tasks: field testing of the Tranplan MapInfo environment and development and testing of the remaining interfaces.

The beta test sites concluded that the combined environments serve a useful function. The windows programs and documentation are currently available from the World Wide Web site at:

<http://www.ctre.iastate.edu/fhwa/>

Agencies without internet access can receive the programs and documentation by contacting the Center for Transportation Research and Education.

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**FHWA Priority Technology Program
Final Report**

Transportation Planning GIS

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Introduction

Urban planning models have long been available to assist planners in recommending decisions regarding transportation investment. Today, many planning agencies also use geographic information systems (GIS) for inventory and data presentation. Many studies have suggested the utility of GIS in the context of transportation forecasting and scenario analysis. Unfortunately, most of these agencies are not receiving the full benefits of integrating these two commonly used computer packages.

Some commercially available transportation modeling programs developed incorporate both modeling and GIS capabilities. For example, TransCAD (Caliper Corporation) and UFOSNET (RST International Inc.) are GIS systems that contain transportation forecasting procedures. In addition, the developers of Tranplan and QRSII, are currently either beta testing or releasing GIS capable interfaces. However, while the commercial trend seems to be toward integration, many agencies continue to use stand-alone modeling packages or both GIS and modeling packages independently. Chief reasons are cost and prior investment in training and technology.

The goal of this project was to develop user-friendly windows programs capable of combining urban planning models and desktop GIS packages. Previous efforts in this area, sponsored by the Iowa DOT, examined integrating a popular travel demand forecasting software with one GIS package. This work, sponsored by the FHWA, looks to extend that work to include additional GIS packages and incorporate user testing of the system developed. Focusing on a low-cost and learning curve, smaller urban areas represent the primary audience. However, the tools are also applicable to larger urban areas. To demonstrate the GIS modeling environment and to assist the largest number of users in the short run, Tranplan (Urban Analysis Group) was

integrated with several desktop GIS platforms. The GIS packages selected for the study were: ArcView (ERSI), AtlasGIS (ERSI), MapInfo (MapInfo Corp.), and Maptitude (Caliper Corp.). Tranplan was chosen, as it is used by five of the eight Iowa MPOs, and the four GISs represent desktop packages in wide use. Many, if not all, of the products developed and tested as part of this project could be extended to other modeling packages and GISs as well. In addition, the sponsors of this project do not wish to endorse any of the forementioned, commercially-available software packages used in this work. This project consisted of two tasks: field testing of the Tranplan MapInfo environment and development and testing of the remaining interfaces.

This report continues with a comparative analysis of the four integrated environments including: a brief summary of development, evaluations of the GIS packages, evaluations of the systems, and conclusions based on utility of each environment as interpreted by the developers. Evaluation of the four environments is followed by the evaluation from the four beta test areas. The report concludes with suggestions for future tool development and actions that would improve decision making through GIS integration with transportation models. In addition to this report, a project web site has been developed:

<http://www.ctre.iastate.edu/fhwa/>

The web site contains the project workplan, summaries of correspondence with the beta test sites, and documentation for operating each of the four modeling environments. The required programs and a sample network for Ames, Iowa, are provided to evaluate the environment.

Four Modeling Environments Developed and Tested

Task one involved development and comparison of the four integrated modeling environments. This section includes system-development issues, evaluates the GIS and the environments, and draws conclusions from the evaluation.

The four systems developed in this study were all designed to make optimal use of the capabilities of the modeling and GIS software. The modeling software determines forecasts of future traffic volumes for network elements, while the GIS stores, manipulates, and displays the spatial data from the model. Fortran programs were written to format travel model network data into appropriate structures for each GIS. Programs and procedures incorporate the network into the GIS for display and modification, revert the network format to an appropriate travel model structure, and return network output to the GIS environment for visualization and analysis of the results. To assist in the analysis, a limited number of decision support tools, including turning movement diagrams and visualization plots, were developed.

The four most widely used GIS packages were selected for this project (according to the 1995 GIS SourceBook and the 1997 GeoDirectory of Products and Services). All of these GIS packages operate on desktop personal computers (minimum 486 - 66 MegaHertz and 8 Megabytes of RAM). Familiarity with the GIS package of choice is assumed on the part of the user.

Four Modeling Environments Compared

This section provides a comparison of the operational characteristics from each of the four environments. The network utilized in the assessment represents a small urban area with a population of 50,000. The network has 79 traffic analysis zones, 369 nodes, and 541 links. The

computer used to perform the analysis was a Pentium Pro operating at 150 MegaHertz with 16 Megabytes of RAM running Windows 95. The versions of the software used in the test included Tranplan Version 8.0 for Windows, ArcView Version 2.1a, AtlasGIS Version 3.03, MapInfo Professional Version 4.1, and Maptitude Version 3.0c.

The first test determined the time required to import the test network into each GIS. A view of the test network within one GIS packages is shown:



Time required to complete this step follows:

<u>Package</u>	<u>Time</u> ¹
Tranplan-ArcView	7-12 minutes
Tranplan-AtlasGIS	6-12 minutes
Tranplan-MapInfo	3-8 minutes
Tranplan-Maptitude	4-10 minutes

¹ Time varies with experience.

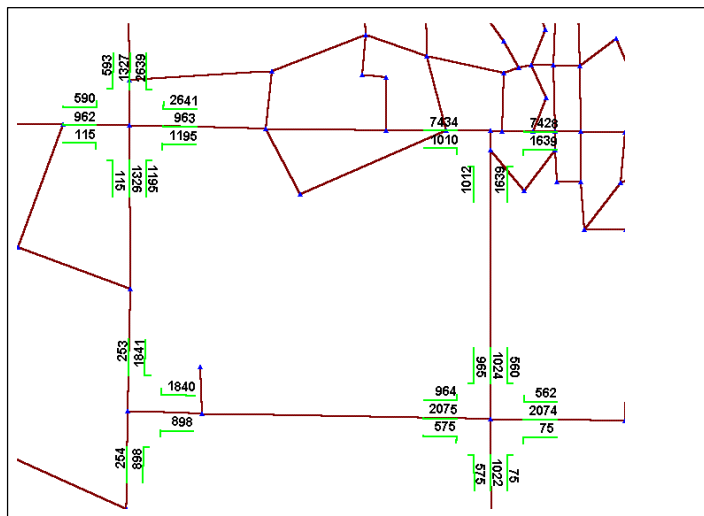
Once in the GIS, the next test examined the time required to run Tranplan and incorporate the new link volumes as link attributes. The time required to run Tranplan alone is two minutes.

Time required to run Tranplan from each GIS environment follows:

<u>Package</u>	<u>Time</u> ¹
Tranplan-ArcView	7-15 minutes
Tranplan-AtlasGIS	10-20 minutes
Tranplan-MapInfo	4-12 minutes
Tranplan-Maptitude	6-15 minutes
¹ Time varies with experience.	

The next tests analyze the time required to develop turning movement diagrams, visualization plots, network comparisons, and to modify network infrastructure characteristics.

The turning movement diagrams for each GIS package contain directional turning arrows for all traffic movements. An example of the turning movement display follows:

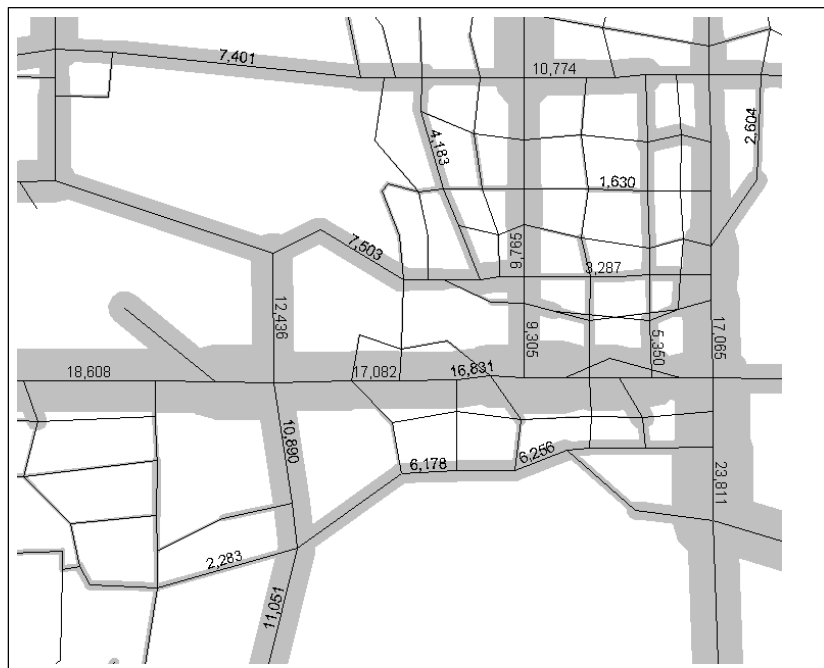


The time required to develop turning movement diagrams follows:

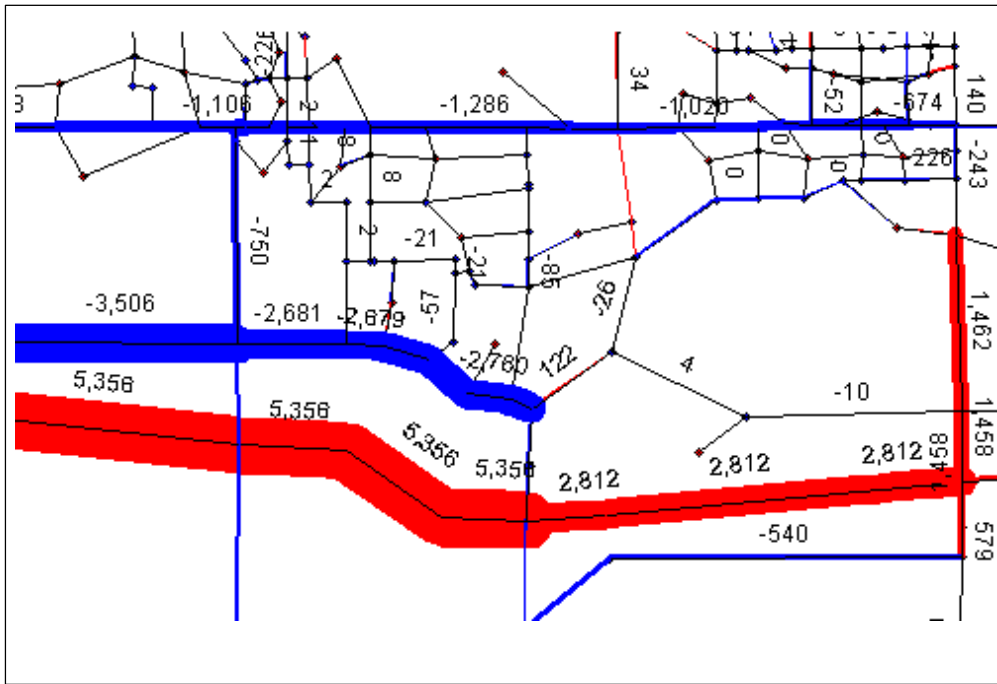
<u>Package</u>	<u>Time</u> ¹
Tranplan-ArcView	6-12 minutes
Tranplan-AtlasGIS	7-14 minutes
Tranplan-MapInfo	2-7 minutes
Tranplan-Maptitude	4-10 minutes

¹ Time varies with experience.

The visualization plots consist of buffered and labeled links. AtlasGIS allows link buffering through themes. MapInfo and Maptitude both use dialog boxes to develop buffers. ArcView can't buffer elements, however, numerous line styles and widths can be used to develop effective plots. All the packages have convenient labeling capabilities. An example visualization plot with links buffered proportionally to Tranplan loaded volume and selected links labeled with Tranplan loaded volume follows:



Analyzing different network alternatives within the GIS packages identifies changes in loaded volume. An example scenario analysis plot is shown. In the figure, an infrastructure modification scenario was developed. Links were buffered to represent increases or decreases in traffic and labeled with the respective change in traffic volume.



The final ability examined was scenario development. Tranplan's HNIS module graphical scenario development tools were imitated in each GIS environment. The GIS environments require more data than HNIS. However, the GIS environments can incorporate additional data sets when developing scenarios. For example, CAD files, aerial photographs, and TIGER linework can be shown as background information.

The modeling environment's time discrepancies were not entirely related to the GIS package. Some differences resulted from the level of development for each environment. Additional programs and automation are available in some environments, where others require

manual manipulation. A goal of future work is to improve all the environments, automating where possible.

User Testing and Feedback

Task two was a six-month beta test of one modeling environment (Tranplan MapInfo). The test sites were located in three Iowa MPOs (Des Moines, Waterloo, and the Quad Cities) and one city traffic engineering department (Ames). These metropolitan areas range in population from 50,000 to 400,000. Each office was using Tranplan and MapInfo independently prior to the test.

The overall response to the integrated environment was favorable. The test-site staff indicated that the programs serve a valuable function, especially with respect to graphical presentation and display. One site commented the ability to develop "sharp, easy to read presentation quality maps that not only grab the attention of policy makers and the public, but also illustrate useful traffic information and future transportation needs, was a top priority." Another comment indicated that the environment provided more flexible plotting features than operating Tranplan alone. The environment allowed additional options regarding line widths, lettering fonts, colors, and general layout capabilities.

Comparing the environment to Tranplan alone generated mixed responses. One agency found Tranplan's HNIS module superior when labeling node and link features through a provision ensuring that labels do not overlap. This was not included in the Tranplan-MapInfo environment. Another found MapInfo's ability to zoom, add text, and custom titles or labels a definite advantage.

Regarding model runs, the reactions were mixed. One agency stated the environment did not assist operators who had experience running Tranplan alone. Another agency identified the Tranplan-MapInfo scenario development as cumbersome. The agency encountered difficulty working with decimal numbers in both systems. However, both agencies stated they would probably use the GIS-based editing features with more experience. Another agency, where the users had received limited Tranplan training, the network editing capabilities were judged superior to HNIS. To summarize, it is likely that operators proficient in operating Tranplan alone will continue, and operators with more GIS experience will probably prefer the Tranplan-MapInfo environment.

The validation and visualization plotting capabilities elicited positive response. Validation in Tranplan involved link by link "checking" to determine accuracy. The automatic color coding and labeling of percent traffic differences was found to be more efficient. This method possesses the potential to save several hours during validation of a new or updated model.

Regarding the ability to develop and display turning diagrams, two agencies identified the ability as useful. One agency indicated numerous turning movement requests from developers and city planners. Although the agency found the turning movement diagrams drawn to an inappropriate size and manual effort to re-size arrows was required, they used and will continue to use the feature. The other agency indicated the ability to display, plot, and review the turning movements volumes was an improvement over Tranplan alone, which lacks a mechanism for effectively plotting turning movements.

The final capability evaluated was the comparison of different networks. One agency identified that traffic differences displayed graphically is useful. They were pleased with the ability to develop graphics supporting potential infrastructure modifications.

The following table summarizes the comments (including a measure of user knowledge of Tranplan modeling and MapInfo) from the most knowledgeable (1) to the least knowledgeable (4).

	<u>Experience Level</u>			
Tranplan knowledge	1	2	3	4
MapInfo knowledge	1	4	2	3
<u>Items Identified</u>	<u>Agency Responses</u>			
Graphic presentation	Favorable	Favorable	Favorable	Favorable
Labeling features	Favorable	Prefer Tranplan Alone	Favorable	
Layout properties		Favorable	Favorable	
Develop alternative networks	Favorable	Prefer Tranplan Alone	Prefer Tranplan Alone	Favorable
Performing model runs			Prefer Tranplan Alone	Favorable
Visualization plots			Favorable	
Turning movement diagrams		Favorable	Favorable	
Alternative analysis	Favorable	Favorable	Favorable	

Future Improvements Suggested

Improvements to the Tranplan-MapInfo environment may be identified. One reviewer suggested refining programs to eliminate errors requiring the restarting of operations. The reviewer stated the ability to correct problems and continue from the current point, without repeating steps, would improve operation. This suggestion has been partially addressed through

the modification of selected programs removing common file management errors. However, additional modifications are planned.

Automating selected analytical calculations was suggested to improve operation. The agency's ASCII Tranplan network files were formatted differently than the Tranplan-MapInfo environment required. Manual effort was required to update existing network files. To address this problem, formatting programs will be modified, allowing differences in network structure to be handled absent of manual user effort.

Increasing the ability to customize the visualization plots and turning movement diagrams was another suggestion. Network differences and varieties of desired output for visualization plots, allowing users to control the information used and appearance of the network, would be helpful. To address this suggestion, possible modifications to the programs, including dialog boxes displaying customizing options, are being considered for the visualization plots and turning movement diagrams.

Regarding the operational environment, one agency identified that a system written entirely in windows programming, verses using a DOS shell for the Fortran programs, would improve operation. This would allow the environment to operate more efficiently when using the Windows 95 and Windows NT operating systems. Another suggestion was for the environment to run required Fortran programs and Tranplan control files without opening separate windows. Having operational switches to control Tranplan functions would be helpful. Although helpful, these improvements are beyond the scope of the current project, and software vendors are addressing these issues.

Conclusion

The beta test sites concluded that the combined Tranplan-GIS environments serve a useful function. As mentioned, the environments are not problem free. The existing problems, however, will be addressed; and all the environments will be modified to respond to the beta test suggestions mentioned previously. The programs and documentation are currently available from the World Wide Web site at:

<http://www.ctre.iastate.edu/fhwa/>

Environment improvements will be forthcoming and can be obtained from the web site, with completed versions of all programs available at the end of March 1997. However, agencies interested in testing the programs as-is may download the appropriate files from the project web site. Agencies without internet access can receive the programs and documentation by contacting the Center for Transportation Research and Education (515) 294-8103. The test network provided with the programs allows users to familiarize themselves with the programs, and the documentation is intended to substitute formal training.

The environments developed in this project represent one step toward improving transportation planning. The ability to visualize networks and identify differences between travel modeling scenarios provides planners the ability to make better, more informed decisions, thus improving the overall quality of the transportation system.