Proceedings of the 1991 Winter Simulation Conference
Barry L. Nelson, W. David Kelton, Gordon M. Clark (eds.)

INTEGRATING GIS, SIMULATION AND ANIMATION

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ABSTRACT

This paper describes techniques for combining the strengths of geographical information systems (GIS), microscoipic simulation and computer animation. We describe a simulation system integrated with an existing GIS to provide the user with the capability of accessing and managing the information transfer between the GIS and the simulation models. This integrated system need not be limited to simulation alone; other calculations which are essential for the traffic engineer can be integrated as well. For example, the calculation of highway capacity is a basic need of all traffic engineers. The software to perform these calculations can, itself, be integrated with both the GIS system, traffic simulation and animation. Such a system offers the engineer a capability that goes beyond analysis: the engineer can now perform designs of his system exploring alternative treatments to identify the most effective technique for improving traffic operations.

1 INTRODUCTION

This paper describes techniques for combining the strengths of geographical information systems (GIS), microscopic simulation and computer animation. Specifically, we will discuss how a traffic simulation model with graphics animation capability can be integrated with a GIS system and thereby provide enhanced computing capability together with multimedia presentation.

The integration of a microscopic traffic simulation model with interactive computer graphics has already been discussed in Lieberman and Andrews (1990). Here, we describe how we have integrated a simulation system with an existing GIS. This integration provides the user with the capability of accessing and managing the information transfer between the GIS and the simulation models.

With this system, an engineer can bring up a display of his roadway system, then provide an animated display of traffic movements over the roadway system that has just been simulated. Alternatively, the engineer can access the GIS display, select a roadway segment, then request that the animation developed during a prior simulation analysis be shown immediately, thereby bypassing the simulation process.

The user can apply this system to browse along his roadway network selecting elements within that network for the purpose of identifying the performance attributes under stated conditions. Essentially, this system provides an inventory of traffic operations everywhere within his system.

As indicated earlier, the information generated by the traffic simulation model can be exported to the GIS database. Likewise, data contained within the GIS can be transferred to the simulation model. The GIS has the capability of interrogating this database in ways that are most meaningful to the engineer. For example, the engineer can ask the system to identify all links (sections of roadway) on the map display that exhibit a delay per vehicle in excess of X seconds. These and other questions can be used to identify the operational characteristics of the roadway system under study in a matter of a few minutes using the data generated by the simulation model and the data management capabilities of the GIS.

This integration of these separate disciplines represents an important step forward to providing a complete information system to the traffic engineering profession. This paper will discuss some of the features of this system and demonstrate how it can be used productively.

2 OVERVIEW OF PROCESS

We have developed software procedures that allow us to interface custom application software with an existing package named TransCAD. TransCAD is a proprietary product of the Caliper Corporation that integrates a GIS system with a wide variety of transportation planning tools.

We have extended this capability by adding traffic simulation models to the existing set of tools.

Specifically, we have created a package named HCM/Cinema that:

- Provides an interactive Graphics User Interface (GUI) for entering data
- Computes intersection capacity
- Performs a simulation of traffic operations
- Presents an animation of traffic flow.

HCM/Cinema is interfaced with TransCAD to form a powerful tool that combines several requirements of traffic engineers. Figure 1 presents a display provided by TransCAD. The user may "Pick" any intersection for analysis with HCM/Cinema. The data associated with that intersection, that is stored within TransCAD, is then transferred to the HCM/Cinema data base.

3 WORKS WITH READILY AVAILABLE MAP FILES

With TransCAD you can build your base map out of readily available and inexpensive map files such as TIGER from the Bureau of the census and Digital Line Graphs (DLGs) from the U.S. Geological Survey. TransCAD translates TIGER and DLGs into topologically complete GIS data bases. It takes only moments to set up your PC to convert the files. With TIGER you can build a complete highway network and add spatial reality to existing networks. TIGER contains information that lets you create an indexed street file that can be used for geocoding and address matching.

4 HCM/CINEMA DISPLAYS

Figure 2 depicts a typical display of this tool. The data shown can either be imported from TransCAD or entered via the keyboard in response to "prompts" presented at the bottom of the screen. This display presents the data in both tabular and geographical format; any data entry or modification is displayed immediately in graphical format as well as tabular.

Figure 3 is a display of the summary results of a capacity analysis. Any display may be printed by depressing a Function key. All these data can be transferred to the TransCAD data base, permitting the user to directly access these results without reentering HCM/Cinema.

The user can then request the software to perform a simulation of traffic operations reflecting the design just established as part of the capacity analysis. This simulation model, named TRAF-NETSIM, developed for the Federal Highway Administration, is a microscopic stochastic model which replicates individual vehicle trajectories. Figure 4 shows some statistics generated by the simulation model.

5 ANIMATION DISPLAYS

The simulated vehicle trajectories can be displayed through animation. The animation provides the user with an overhead view of the traffic environment. Figure 5 is a single frame from the animation display.

It is not necessary for a user to access the animation display by performing a capacity analysis. If the necessary data has been input previously, the user may display the animation from a TransCAD screen by "Picking" a node (intersection), then show the animation almost immediately after selecting the case of interest.

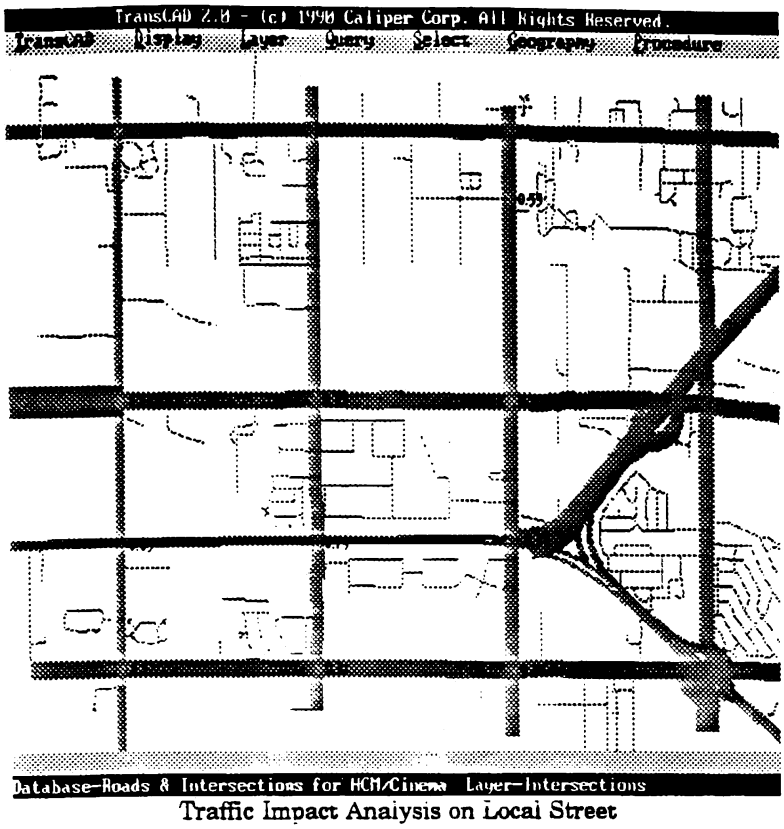
6 SUMMARY

The integration of GIS with simulation and animation offers the traffic engineer a capability not even imagined just a few years ago -- and all on a PC platform! This capability greatly enhances the engineer's productivity and the quality of his end-products. It also presents further opportunities to develop more powerful tools in the near future.

REFERENCES

Lieberman, E., Andrews, B. 1990. "The Role of Interactive Graphics When Applying Traffic Simulation Models", in 1990 Winter Simulation Conference Proceedings, ed. Balci, O., et al.

EDWARD LIEBERMAN, President of KLD Associates, Inc., has over 20 years' experience in designing, programming and applying simulation models.



Traffic Impact Analysis on Local Street
(Bandwidths denote traffic volume)

Figure 1: Sample TransCAD Screen

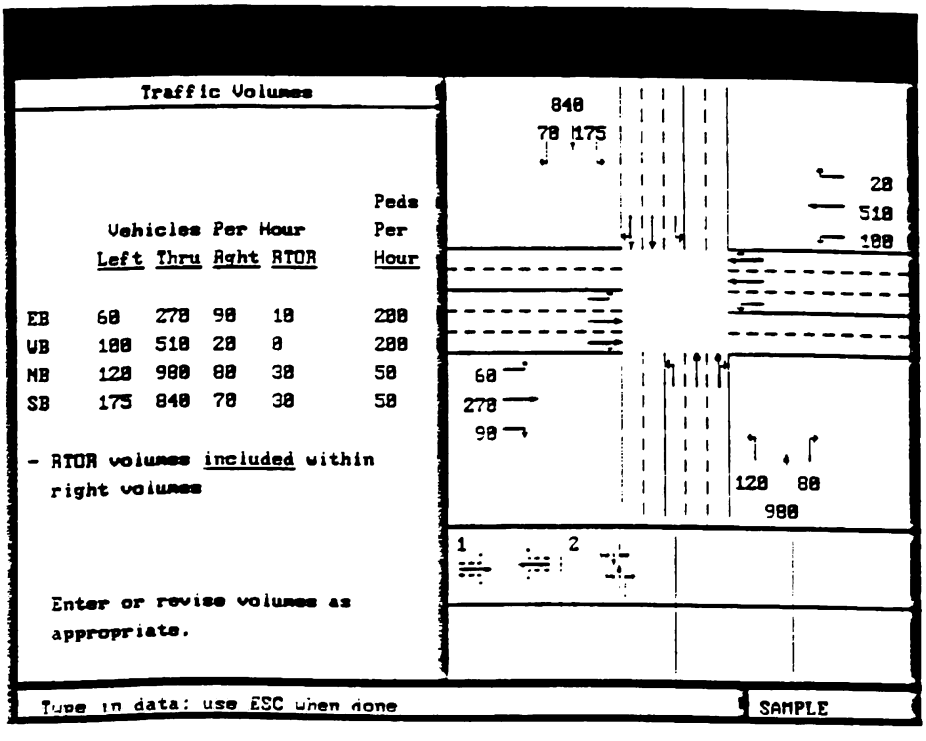


Figure 2: HCM/Cinema Input Screen

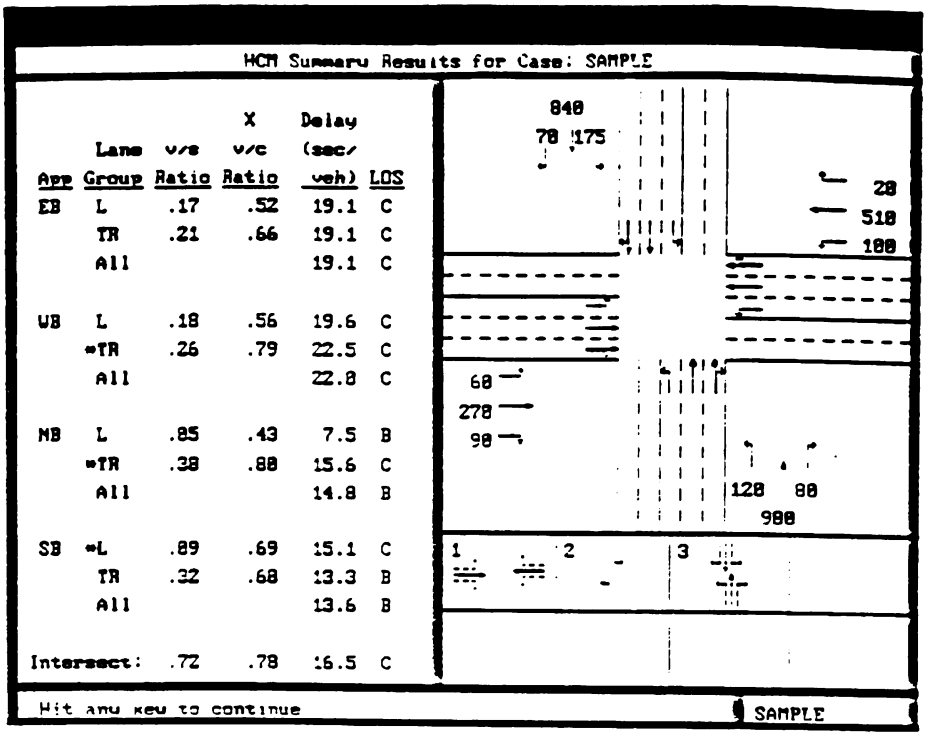


Figure 3: Summary Screen

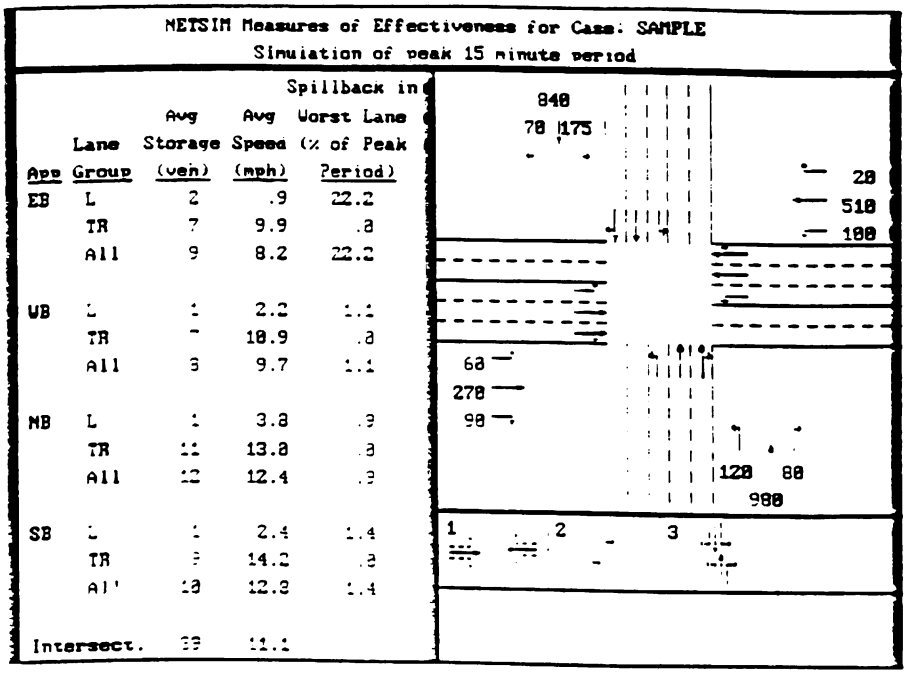


Figure 4: Results from Simulation Model

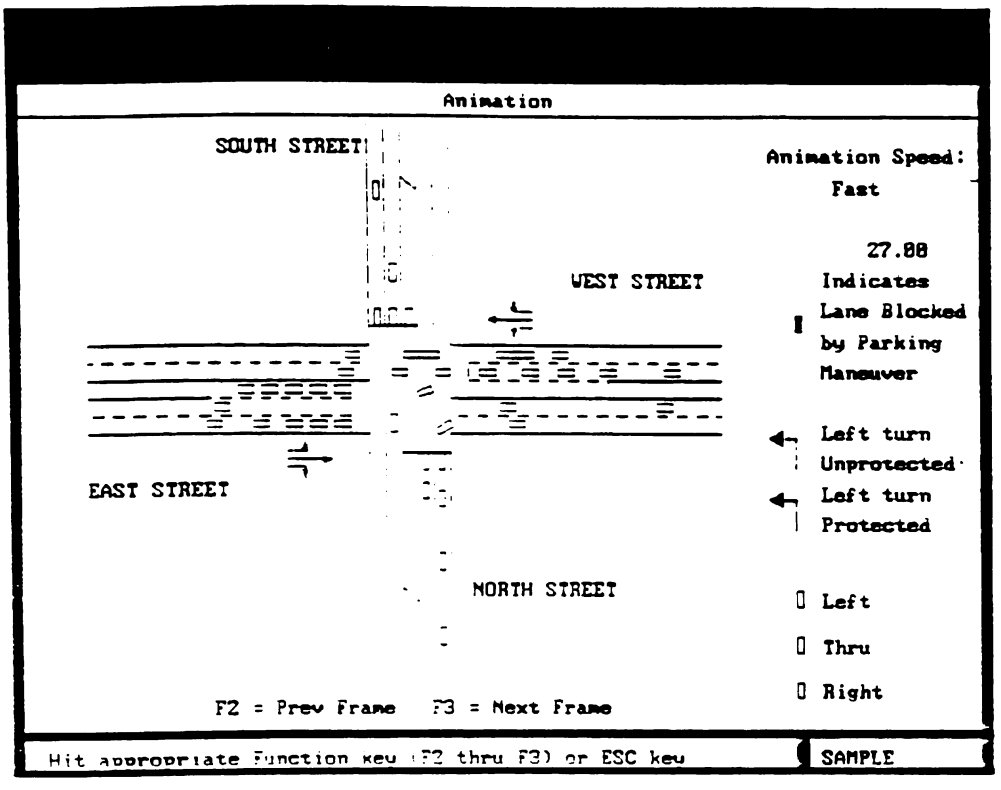


Figure 5: Animation Display