Comparison of Alternative Traffic Control Strategies at a T-Intersection

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Among the various parameters that may be evaluated for each roadway by NETSIM are average vehicle occupancy of roadway segment, stops per vehicle, average operating speed, and delay time per vehicle. The major features of the NETSIM model are listed below.

1. Microscopic, stochastic simulation of individual vehicle movements;
2. Simulation of full range of control features, including "Stop and "Yield" signs, turn controls, parking controls, fixed-time signals, vehicle-actuated signals, and real-time traffic control and surveillance systems;
3. Modular structure incorporating detailed treatment of car-following behavior, network geometry, grades, bus traffic, queue formation, intersection discharge, intralink friction and midblock blockages, and pedestrian-vehicular conflicts; and
4. Provision for flexible mix of standard output measures.

Other parameters that may be evaluated are bus system operational analysis, fuel consumption, and vehicle emissions for each individual vehicle grouping by type, automobile, truck, and bus. Major user options for the model include the following:

1. Simulation of traffic-actuated signal control;
2. Simulation of a surveillance system comprising various types of detectors;
3. Simulation of bus traffic;
4. Simulation of transient blockages within the traffic stream, such as parking violators, construction activity, and "incidents" such as stalled cars and accidents;
5. A variety of standard output options, including tabulation of origin-destination volumes; and
6. Statistical analysis of model outputs.

NETSIM MODEL USE

The NETSIM model is user-oriented. Noted here are model inputs and summary of input conditions, respectively. The inputs are readily available to the traffic engineer from office files or may be obtained from field data. The location-specific inputs are intralink target speeds, intersection discharge rates, input flow rates, frequency of rare events, intersection turning movements, bus system data, traffic composition, pedestrian flows and delays, amber phase behavior, network geometry and special channelization, signal timing, and detector location and type. The networkwide inputs include vehicle-generating distributions, gap acceptance distributions, parameters in car-following routines, parameters in lane-switching routine, and parameters in intersection movement routines.

INPUT CONDITIONS

The basis of all input data into the model for simulation is the link-node diagram. The link-node diagram converts the road system into a computer format for data translation. It is imperative that the link-node diagram for the system accurately represent that roadway, central business district, or intersection being modeled.

On completion of an accurate link-node diagram, the input data are then coded on preprint, 80-column, data-coding forms. On completion of computer simulation runs to debug data errors, the actual simulations are made, with changes in various control strategies, geometrics, etc., made for each run. Following completion of various simulations, comparison is then made of change effects on the system operation being modeled.

The model has been used for evaluation of various control strategies on arterial roadways and individual intersections. As with any form of analytical tool, the model has its limitations. In particular, its effective use is totally dependent on the quality of data inputs.

This is particularly true in the case of network coding and the treatment of unusual or non-standard traffic conditions. Considerable reliance must be placed in this case on the ingenuity of the analyst to abstract the essential operating characteristics of the network that he or she wishes to simulate and to transform these into an appropriate set of quantified, coded inputs.

The model includes a large number of discrete input parameters describing various aspects of traffic performance. These may be estimated either as a set of standard "default" values embedded in the program or as input to a given model run. The capacity to override the standard set of default parameters provides the user with an important degree of flexibility, particularly with respect to the treatment of non-standard geometry or operating characteristics that are unique to that area. It also imposes an additional requirement on the analyst, however, to evaluate very carefully those input characteristics whose accurate estimation appears critical to the particular study or intended analysis.

A wide range of potential user options and output formats is provided. Again, this is done deliberately to provide the maximum possible degree of analytical flexibility. However, this still imposes a requirement on the analyst to carefully structure the problem at the outset and identify clearly the options to be invoked and outputs to be generated before making a simulation run. It is particularly important in this context that a carefully structured program be developed for the analysis and evaluation of model outputs.

INTERSECTION STUDIED FOR SIMULATION

Figure 1 illustrates the intersection on East Travis Boulevard and Dover Avenue in Fairfield, California, as it appeared in 1977. The intersection had experienced a rear-end accident problem from vehicles waiting to turn north on to Dover from eastbound East Travis due to the lack of a left-turn pocket. The intersection met volume warrants from signalization, but funding was limited.

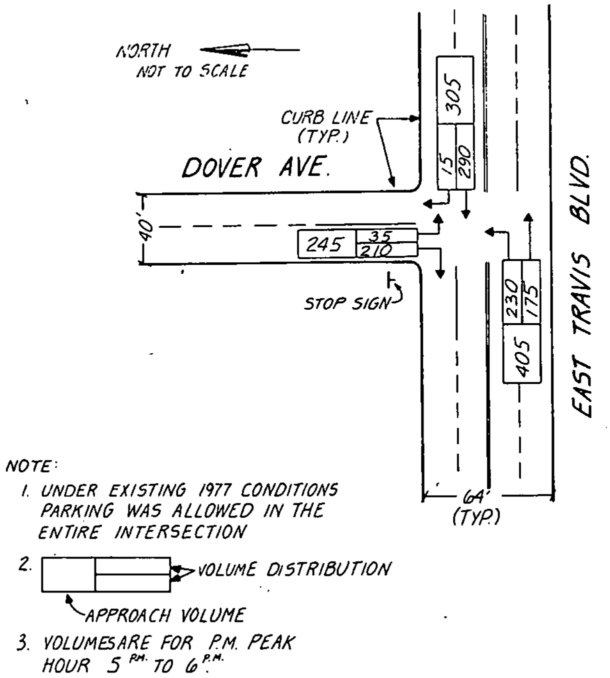
A number of alternatives with various laning and traffic signal control strategies were evaluated in order to maximize benefit for dollars invested.

ALTERNATIVE INTERSECTION CONFIGURATIONS ANALYZED

The various alternatives analyzed are listed below:

Alternative	Alternative Description
Existing	Existing stop sign traffic control and laning (Figure 1)

Figure 1. East Travis Boulevard and Dover Avenue: existing condition, 1977.



Alternative	Alternative Description
1	Existing stop sign traffic control, left turn lane for west approach of East Travis with no parking on East Travis, left and right turn lanes on Dover, with no parking on Dover
2	Two-phase traffic signal (Figure 2) for traffic control with existing travel lanes
3	Two-phase traffic signal (Figure 2) for traffic control, with traffic lane configuration of alternative 1
4	Three-phase traffic signal (Figure 2) for traffic control with traffic lane configuration of alternative 1

All alternatives were compared with the existing intersection operation.

The link-node diagram for the intersection is shown in Figure 3. The model runs were made on the California Department of Transportation headquarters computer facilities.

COMPARISON OF SIMULATION RESULTS

Table 1 lists certain specific results for each of the alternatives modeled. By inspection, the existing traffic control without turn pockets appears to operate most efficiently. However, a very minor decrease in overall efficiency would occur with the installation of turn lanes on Dover and East Travis. Through elimination of on-street parking it would be possible to install the turn lanes, thereby creating a refuge for turning vehicles. This would end vehicles turning from the through lane on East Travis and keep right-turning vehicles on Dover from being held up by the low volume of vehicles turning left from Dover.

Figure 2. Two-phase and three-phase proposed traffic signalization.

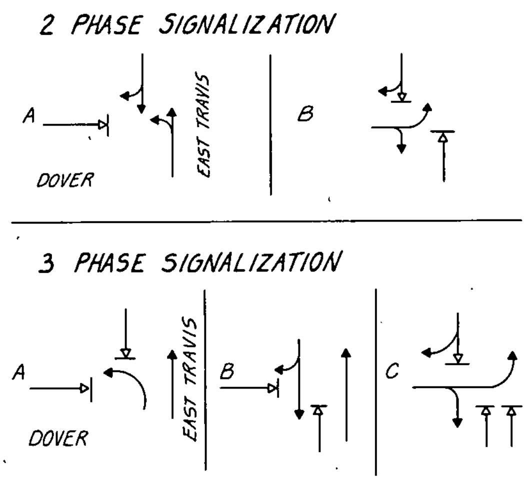


Figure 3. Link-node diagram: East Travis Boulevard and Dover Avenue.

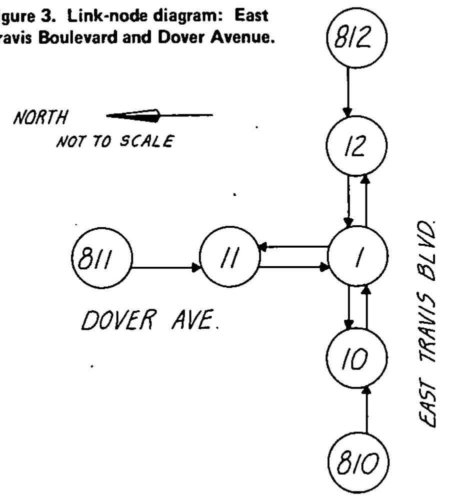


Table 1. System values for alternatives studied.

Alternative[a]	Avg Speed (mph)	Stops per Vehicle	Total Delay (min)	Fuel Consumption (miles/gal)	Vehicle Emissions (g/mile): Hydrocarbons	Carbon Monoxide	Nitric Oxide
Existing	20.34	0.30	31.2	9.69	3.67	59.58	7.84
1	20.25	0.31	31.5	9.67	3.68	59.98	7.84
2	18.03	0.51	44.5	8.77	4.31	70.91	8.84
3	19.78	0.37	33.4	9.50	3.80	61.98	8.00
4	19.24	0.40	36.1	9.36	3.93	63.90	8.18

Note: System values are model outputs for each of the alternatives for the entire system shown in Figure 3 during the peak hour from 5:00 to 6:00 p.m.
[a]Traffic input volumes and turning movements were the same for all alternatives.

The fuel use and air quality consequences of each alternative are also listed in Table 1. Increased emphasis on air quality impact of transportation alternatives can be evaluated via an optional subprogram resident in the NETSIM model.

RECOMMENDED PROJECT

Based on analysis of parking use, traffic engineering analysis of field data, NETSIM simulation data analysis, and professional judgment, it was recommended that the turn pockets on Dover Avenue and turn pocket on East Travis Boulevard eastbound movement with stop sign control on Dover Avenue be implemented.

CONCLUSION

In my opinion, the NETSIM computer simulation model further expands the traffic engineer's ability to analyze and evaluate alternatives in a cost-effective manner.

Typical Application of the TEXAS Model

Glenn E. Grayson

This paper describes a simple application of the TEXAS computer model by a traffic engineer in a small city. (TEXAS is a microscopic model for simulation of traffic at a single intersection. It is currently available from the Texas State Department of Highways and Public Transportation.) TEXAS allows traffic engineers to evaluate changes in intersection parameters (traffic flow, intersection geometry, and intersection control) and to see what effect those changes have on the vehicles' and intersection's performance. TEXAS is comprised of three separate computer programs: GEOPRO, DVPRO, and SIMPRO (see Figure 1).

GEOPRO takes geometric information about the intersection system (approach lengths, number of lanes per approach, lane geometry and type, and location of any sight distance restrictions) in a cartesian coordinate manner; it produces a list of possible paths down which vehicles will travel. This path information is used as input to SIMPRO. DVPRO also produces input for SIMPRO. This driver-vehicle processor takes volume and headway distribution information and creates a time-ordered list of vehicles. Three types of drivers and 16 classes of vehicles are used. SIMPRO takes these two inputs and a third, which contains the description of intersection control (from unsigned to signed to signalized) and the duration of simulation. Vehicles are "stepped through" the system, and speed and delay statistics are gathered for each time increment for each vehicle.

At the end of the simulation run, the statistics are summarized for the total intersection, for each approach, and for each turn movement in each approach. During a typical time increment, each car examines the vehicle in front, the adjacent lane(s), and the traffic control at the intersection. Then it makes a deterministic decision whether to speed up, slow down, start, stop, or change lanes. Because of the deterministic nature of the model, the traffic engineer is able to ascertain the effects of a change in one of the three parameters (traffic flow, intersection geometry, and intersection control) with only two runs: "before" and "after". The following is a description of how I used the model in just this way and was able to make comparisons between two runs.

Richardson is a Dallas suburb with a population of 80 000. Its 53 traffic signals are located at arterial intersections on a suburban grid and are, for the most part, noninterconnected and fully actuated. When these signals were installed, multiphase, fully actuated operation was the state of the practice. At many of the locations left-turn phasing was provided, even though during the peak period only three to five vehicles made the left turns each cycle. It had been observed that those three left-turning vehicles were causing unnecessary delays to the opposing through movement. With the increased emphasis today on reducing overall delay and fuel consumption, about 10 locations were targeted for protected left-turn removal in one or both directions. On January 10, 1981, left-turn green arrows

Figure 1. TEXAS model: flow process.