

# LATEST TRENDS IN MICRO SIMULATION: AN APPLICATION OF THE PARAMICS MODEL

CHRISTOFF KROGSCHEEPERS and KENT KACIR\*

BKS (Pty) Ltd, 222 Durban Road, Bellville, RSA

\* Siemens Energy & Automation, Inc., Gardner Transportation Systems, Portland, Oregon, USA

## ABSTRACT

Transportation systems have become more complex and frequently congested. As a result, microscopic simulation has gained recognition as an effective way for quantifying traffic operations. Microscopic simulation models can address various types of network issues, and in more recent developments they also provide a tool for evaluating Advanced Traffic Management Systems (ATMS), Travel Demand Management (TDM), Intelligent Transportation Systems (ITS) and Advanced Traveler Information Systems (ATIS). With the constant increase in desktop computing power, the use of microscopic simulation models to model real applications are becoming more widespread. A variety of microscopic simulation models are currently available from academic and commercial sources, and new models are continually being developed. This paper presents a brief overview of available microscopic simulation models, a description of different simulation techniques and modelling approaches with examples and specific references to the PARAMICS model. The authors of this paper have recent detailed experience in working with the PARAMICS model and see the need to expose the traffic engineering community within South Africa to what is sometimes called the “new generation” of simulation models. The PARAMICS model is a suite of software tools for microscopic simulation that includes time-step traffic simulation of freeway, surface street and dense network operations. This paper presents several real-world examples of the application of PARAMICS to illustrate the advantages and disadvantages of micro-simulation.

## 1. INTRODUCTION

Just as complex as the world we live in, is the theory of traffic flow and understanding of driver behaviour. However complex, the advance in computing power has made possible the high-level detail found in the newer generation of microscopic simulation that incorporates much of the traffic flow theory. The demand for traffic model simulation as an analysis tool has increased with the increasing complexity traffic networks and desire for a comprehensive evaluation of the network or sub-network (including all related entities). In addition, public society is taking a more active role in the decision making process, which drives the need for understandable output such as high-definition graphics. Computer simulation and the associated graphic animation provide an ideal tool for public participation. Lastly, simulation is being applied to traffic networks to evaluate system wide effects resulting from the implementation of ATMS, TDM, ITS and ATIS concepts.

Traffic simulation has been the topic of many publicized papers and textbooks and hence will not be repeated in this paper. Instead, this paper will only provide an overview of simulation with a summary of current available simulation models, highlighting the more prevalent features and international use of these models. The paper will conclude with a specific discussion on the features of the PARAMICS model with reference to recent real world applications. This paper makes no attempt to identify which traffic simulation model is the best to use. The answer to that question resides with the individual users and their specific needs. It is an objective of this paper to provide information to potential users of simulation models about the latest trends in traffic model simulation to enable a more informed decision on which model to use.

## 2. THE SIMULATION PLAYING FIELD

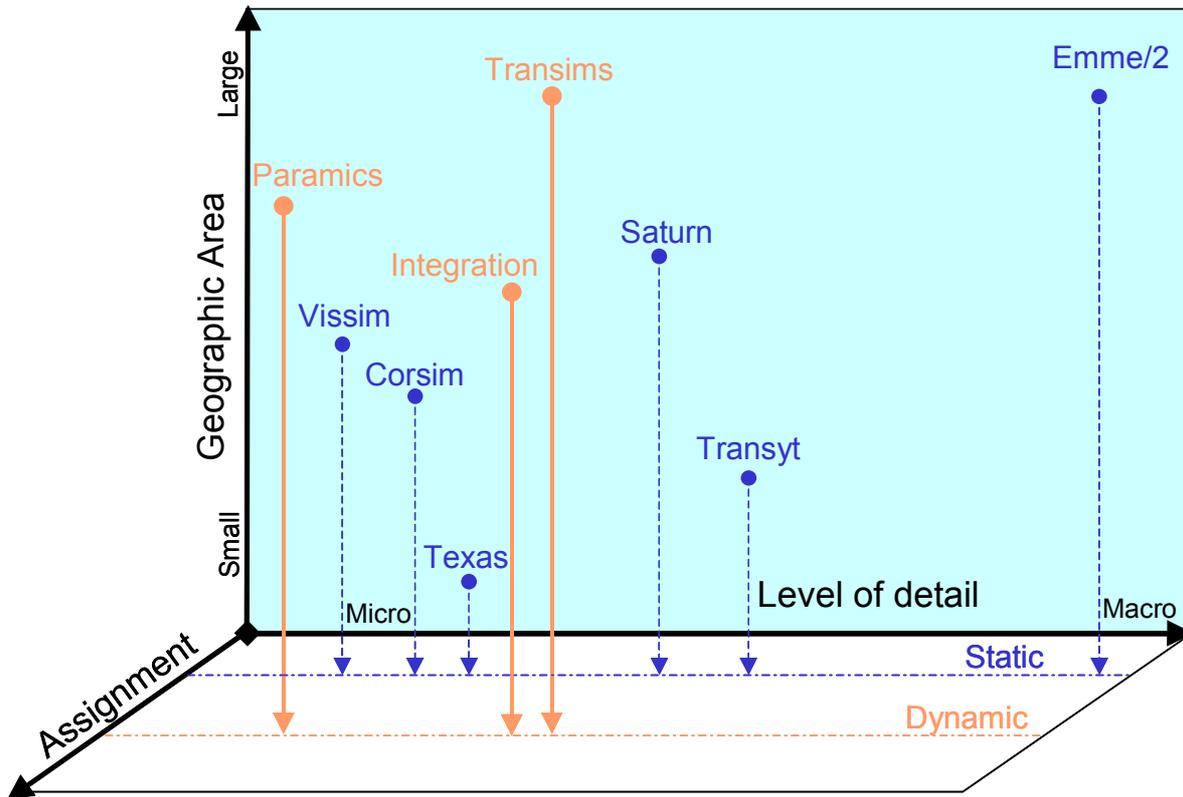
Simulation can be defined as a representation of all or part of the real world through the use of a computer model and updating the computer model by moving it through time at either equal time steps or depending on the next event in the system (Drew 1968). In the final research report of the SMARTTEST (Simulation Modelling Applied to Road Transport European Scheme Test) project (1999), 57 simulation models were identified. Nearly all these models used a time update approach. Only three of the models used an event update approach. Traffic simulation models can be classified in various different ways and the remainder of this section will concentrate on the more common ways of classifying simulation models.

One of the most basic classifications of simulation models is the detail in which the system is being modeled. To this extent, simulation models can be classified as microscopic, mesoscopic or macroscopic. At the *macroscopic* level, the network and the associated traffic are modeled similar to pipe flow models, where the relationships between the parts of the system are based on analytical models. In its most *microscopic* form, a simulation model would endeavour to replicate the behaviour of a driver, the characteristics of the vehicle being driven and their interaction with the road environment and other vehicles on the road. The interaction between vehicles is based on vehicle following, gap acceptance models and vehicle kinematics. Combinations of microscopic and macroscopic models are often classified as *mesoscopic*. The British TRANSYT program (Byrne et al. 1982) is an example of macroscopic simulation of urban arterial signal control coordination and the American FREQ- and FREFLO-programs (Byrne et al. 1982) are related to freeway analysis. A mesoscopic approach with groups of vehicles is used in CONTRAM (Leonard et al. 1978), a tool for analysis of street networks with signalized and non-signalized intersections. With the increasing computing power of the desktop PC, the latest trend in traffic model simulation is microscopic, such as the VISSIM (Fellendorf and Vortisch, 2000) and PARAMICS (Quadstone, 1999) models.

Simulation models are generally classified based on the type and size of the network. At the most simplest level is the simulation of isolated intersections; a step up would be the simulation of corridors, and at the highest level is the simulation of networks. Historically, the smaller the network, the higher the level of detail in either traffic replication or graphical output, but this is changing with the power of the desktop PC.

The simulation of networks invariably involves the simulation of urban networks, which include a variety of intersection types varying from unsignalized to signalized, freeway ramps and even roundabouts. The combination of all these types of control and the driver behaviour at each are indeed a daunting task. This makes the simulation task complex and the number of existing simulation tools for network analysis is relatively small in comparison with the number of programs for isolated intersections and road sections. A widely known model of networks is probably the American NETSIM (Byrne et al. 1982). One of the well-known large-area simulation programs is EMME/2, with SIMTRA and TEXAS Model as examples of isolated intersection simulation on the other end of the scale. Some simulation models such as FRESIM (FHWA) and SISTM (TRRL) have been developed specifically to simulate freeway operations. Figure 1 is a graphic representation of the simulation landscape in terms of the level of detail and the size of the network as well as the type of assignment (static or dynamic). Figure 1 is not a comprehensive picture that includes all the available simulation models, but does illustrate some of the available models and how they relate in terms of detail provided and size of modeled area.

Simulation models can also be classified in terms of how the traffic demand is applied to the network. Traffic demand can be applied at individual intersections by the use of turning movements (input by user) or with the use of an origin-destination (O-D) matrix. The model relying on an O-D matrix for the input of traffic demand requires a route assignment model to assign trips to the network between origins and destinations. This assignment method can be static or dynamic. In dynamic assignment models, route selection by individual vehicles change continually depending on the state of the system as the network is entered. In static assignments the route selection between origins and destinations remains constant throughout the simulation regardless of the state of the system. Traditional planning model assignments are based on static assignment where the route selection is obtained through a search of a state of equilibrium on all the links in the network in terms of some measure of effectiveness such as travel time or a measure of trip cost. Some of the latest simulation models, such as TRANSIMS and PARAMICS, endeavour to dynamically select the optimum route between an origin and a destination.



**Figure 1: Conceptual Simulation Playfield (partial list of models)**

The simulation of demand is another new area of simulation where it has gone from aggregate gravity modelling to individual based disaggregate choice models. To simulate demand, the challenge is to reproduce the trip pattern (number, time of day, purpose, origin-destination pattern, modal split and use of routes) of the population within an area by combining the individual behaviour. The American TRANSIMS model is one of the most advanced modelling approaches and combines demand modelling and traffic flow behaviour in an effort to describe the system behaviour in one simulation environment (Smith et al. 1995).

Issues regarding traffic safety have been a difficult simulation problem. Simulation programs are programmed to avoid collisions, although most of the latest models allow for incidents to occur on the network. However, the modeler predetermines such incidents. There are trails for the use of simulation to model safety (Sayed, 1997), but a general approach to the problem and widely used safety simulation tools are still missing (Pursula, 1999). The simulation of crashes is related to human centered simulation where the central issue is the perception-reaction of drivers. This is sometimes called *nanosimulation* to separate it from traditional microscopic simulation.

A new application area in simulation is the use and effects of telematic services in traffic. The advent of the Advanced Transport Telematic Applications made possible by combining the developments in informatics and telecommunications applied to transportation problems, has created new objectives and requirements for micro-simulation models (SMARTTEST, 2000). "The objective of micro-simulation models is essentially, from the model designers point of view, to quantify the benefits of Intelligent Transportation Systems (ITS), primarily Advanced Traveller Information Systems (ATIS) and Advanced Traffic Management Systems (ATMS). Micro-simulation is used for evaluation prior to or in parallel with on-street operation. This covers many objectives such as the study of dynamic traffic control, incident management schemes, real-time route guidance strategies, adaptive intersection signal controls, ramp and mainline metering, etc." (SMARTTEST, 2000).

### **3. THE PLAYERS ON THE FIELD**

Since the landscape is expansive and with at least 57 simulation models (SMARTTEST, 2000) available to traffic engineers, the decision making process to invest in one of these models or to apply a model to a specific problem is indeed daunting. Moreover, many models have been developed and calibrated for local conditions which make them very country or region specific. Apart from driver behaviour and vehicle kinematics some models are also very network specific and have been developed to allow for driving on one side of the road only and are not easily applied in countries that use the other side of the road. Applying a model that can only simulate traffic on the right hand side of the road in a left hand drive environment becomes very complex, specifically in a network environment.

In Table 1 is listed 33 available simulation models and these are summarized in terms of country of origin and the company or institution involved in the development. In Table 1 is also summarized the Telematic features that can be found in these models, which is only a partial list of available features in most models. This table has been adapted and expanded from the information published in the SMARTTEST project (1999).

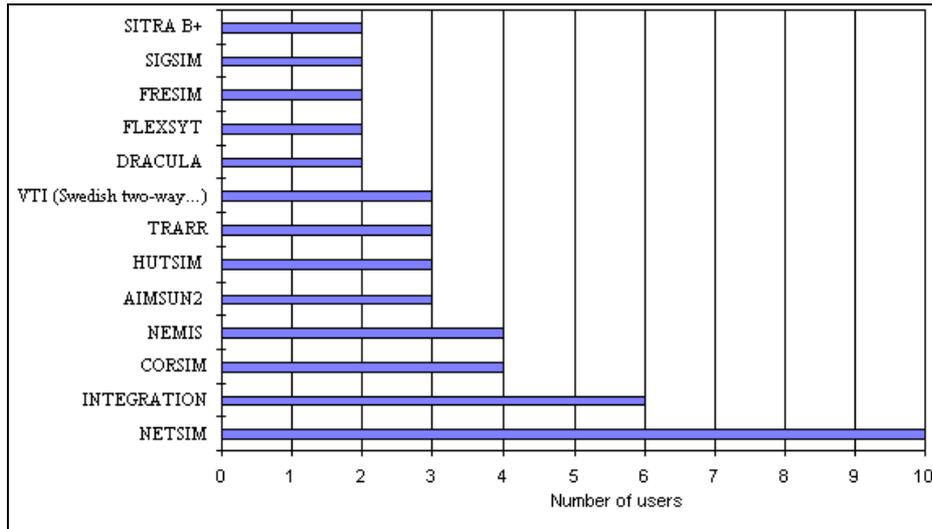
From a survey of 51 users as identified in the SMARTTEST project (1999), the most widely applied model is NETSIM, which is the arterial/freeway model contained in CORSIM. A summary of the responses is illustrated in Figure 2. Figure 2 shows the NETSIM model applied nearly twice as much as any other model. Table 1 also identifies the top three simulation models as NETSIM, INTEGRATION, and CORSIM, all from North American origin. The United States Federal Highway Administration supports two of these models, while INTEGRATION was developed at Queen's University in Canada. The predominance of North American-origin models could be attributed to the financial support of these simulation models as well as the wide application of the models in the consulting and engineering environment.

**Table 1: List of Available Simulation Models**

Model	Intitution/Company	Country	Features/Function of Simulation Model (Transportation Telematics)																				
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
AIMSUN2	Universitat Politècnica de Catalunya, Barcelona	Spain	X	X	-	X	-	X	X	X	-	X	X	-	-	X	-	-	-	-	-	-	X
ANATOLL	ISIS and Centre d'Etudes Techniques de l'Equipement	France	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
AUTOBAHN	Benz Consult - GmbH	Germany	X	X	-	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	-	X	X
CASIMIR	Institut National de Recherche sur les Transports et la Sécurité	France	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
CORSIM	Federal Highway Administration	USA	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DRACULA	Institute for Transport Studies, University of Leeds	UK	X	X	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X
FLEXSYT II	Ministry of Transport	Netherlands	X	X	X	X	X	X	X	-	-	-	-	-	-	X	-	-	-	-	X	-	X
FREEVU	University of Waterloo, Department of Civil Engineering	Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X
FRESIM	Federal Highway Administration	USA	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
HUTSIM	Helsinki University of Technology	Finland	X	X	X	X	-	-	-	X	-	X	-	-	-	X	-	X	-	X	X	X	X
INTEGRATION	Queen's University, Transportation Research Group	Canada	X	X	X	X	X	X	-	X	-	X	X	-	X	X	X	-	-	-	-	X	X
MELROSE	Mitsubishi Electric Corporation	Japan	X	X	-	X	X	-	X	-	-	X	X	-	-	X	X	X	X	X	-	X	X
MICROSIM	Centre of parallel computing (ZPR), University Cologne	Germany	-	X	-	X	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-
MICSTRAN	National Research Institute of Police Science	Japan	X	X	X	X	-	-	X	-	-	X	X	X	-	-	X	-	-	-	-	-	X
MITSIM	Massachusetts Institute of Technology	USA	X	X	-	X	X	X	-	X	-	X	X	-	-	X	-	-	-	-	-	X	X
MIXIC	Netherlands Organisation for Applied Scientific Research - TNO	Netherlands	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-
NEMIS	Mizar Automazione, Turin	Italy	X	X	X	-	-	X	X	X	-	X	X	-	-	-	-	X	-	-	-	X	X
NETSIM	Federal Highway Administration	USA	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
PADSIM	Nottingham Trent University - NTU	UK	X	X	-	-	-	-	X	-	-	-	X	-	-	-	X	-	-	-	-	-	X
PARAMICS	The Edinburgh Parallel Computing Centre and SIAS Ltd	UK	X	X	-	X	X	X	X	X	X	X	X	-	-	X	X	-	X	-	-	X	X
PHAROS	Institute for simulation and training	USA	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLANSIM-T	Centre of parallel computing (ZPR), University of Cologne	Germany	X	X	X	X	-	-	X	X	X	X	X	X	-	-	X	-	X	-	-	X	-
SHIVA	Robotics Institute - CMU	USA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	X
SIGSIM	University of Newcastle	UK	X	X	X	X	X	X	-	-	-	-	-	-	X	-	-	X	-	X	-	X	X
SIMDAC	ONERA - Centre d'Etudes et de Recherche de Toulouse	France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
SIMNET	Technical University Berlin	Germany	X	X	X	X	-	X	-	X	-	X	X	X	-	-	-	X	-	-	-	-	X
SISTM	Transport Research Laboratory, Crowthorne	UK	-	-	-	X	X	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	X
SITRA-B+	ONERA - Centre d'Etudes et de Recherche de Toulouse	France	X	X	X	-	-	X	-	-	-	X	X	X	-	-	-	-	-	-	-	-	X
SITRAS	University of New South Wales, School of Civil Engineering	Australia	X	X	-	-	-	X	-	-	-	X	X	-	-	-	-	-	-	-	-	-	X
SIMTRAFFIC	David Hush and Associates, Inc.	USA	Not evaluated																				
TRANSIMS	Los Alamos National Laboratory	USA	Not evaluated																				
THOREAU	The MITRE Corporation	USA	X	X	-	X	-	-	-	X	-	X	X	-	-	-	-	-	-	-	-	-	X
VISSIM	PTV System Software and Consulting GMBH	Germany	X	X	X	X	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	X

- |   |                                       |    |                                    |    |                                     |
|---|---------------------------------------|----|------------------------------------|----|-------------------------------------|
| 1 | Co-ordinated traffic signals          | 8  | Variable message signs             | 15 | Congestion pricing                  |
| 2 | Adaptive traffic signals              | 9  | Regional traffic information       | 16 | Adaptive cruise control             |
| 3 | Priority to public transport vehicles | 10 | Static route guidance              | 17 | Automated highway system            |
| 4 | Ramp metering                         | 11 | Dynamic route guidance             | 18 | Autonomous vehicles                 |
| 5 | Motorway flow control                 | 12 | Parking guidance                   | 19 | Support for pedestrians and cyclist |
| 6 | Incident management                   | 13 | Public transport information       | 20 | Probe vehicles                      |
| 7 | Zone access control                   | 14 | Automatic debiting and toll plazas | 21 | Vehicle detectors                   |

Source: Adapted from SMARTEST Project (July 1999)



**Figure 2: Application of Simulation Models (51 respondents - SMARTEST, 2000)**

#### 4. PARAMICS

PARAMICS is a microscopic traffic simulator developed by SIAS Ltd and Quadstone Ltd of Scotland. This model is a microscopic simulation tool designed for a wide range of applications where traffic congestion is a predominant feature. It has extensive visual capabilities, and relatively high performance in terms of the speed of simulation. The scalability of PARAMICS allows its application across a whole spectrum of network sizes, from single intersections up to national networks, with the only constraint being that of the hardware on which the model is run. PARAMICS can run on Windows or Unix based operating systems.

##### 4.1 Features of the model

At the microscopic level, driver and vehicle interactions are simulated based on individual driver behaviour and vehicle kinematics. Vehicle-to-vehicle interactions are based on vehicle following, gap acceptance and vehicle kinematics. The car following model in PARAMICS is based on a psycho-physical model, instead of a deterministic model. The driver behaviour is based on research conducted at the Transport Research Laboratory where it was concluded that driver aggressiveness and awareness are sufficient to describe the behaviour of most drivers (Quadstone, 1996). At least 16 different vehicle types can be modeled of which some can be used to denote purpose rather than vehicle characteristics. Any number of demand matrices can be specified and each can be associated with different time periods.

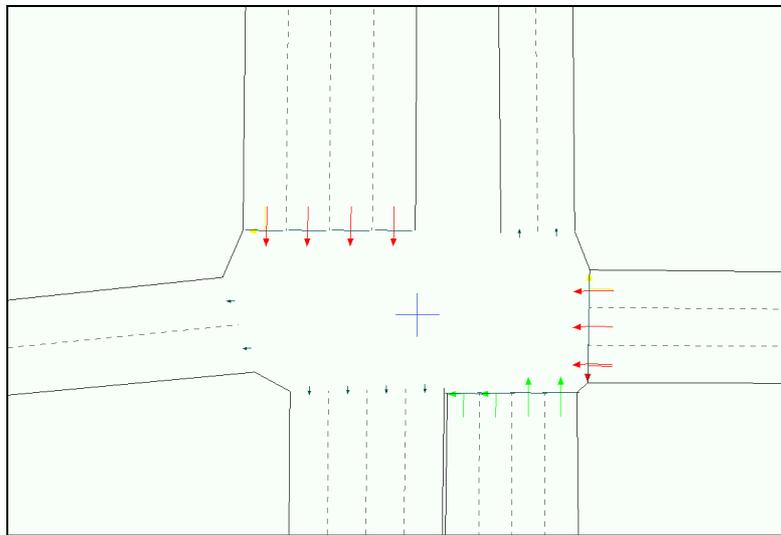
The PARAMICS model generates traffic demand from an origin-destination matrix. The demand between zones can be identified for different times of the day and with different profiles within specific time periods. Different zone pairs can thus have different demand tables with distinctly different demand patterns. For each vehicle trip, a unique vehicle is created which carries a conceptual driver and passenger. The vehicle carries a set of parameters that define the physical and behavior characteristics of that driver-vehicle unit. The PARAMICS model is capable of modeling many aspects of the transportation network including (Paramics, 1999):

- Mixed urban and freeway networks
- Right-hand and left-hand drive capabilities
- Advanced signal control
- Roundabouts
- Public transportation
- Car Parking
- Incidents
- Truck-lanes, high occupancy vehicle lanes

Accurate coding of the network features is essential to the accuracy of the PARAMICS model, since these geometric features affect traffic behaviour. Examples of features that are taken into account in the PARAMICS model are:

- Positions of stop and curb lines
- Junction signal timings
- The location of bus stops
- Location of pedestrian crossings
- Lane arrangements including permitted turns
- Access restrictions
- Areas where on-street parking affect the performance of vehicles

In Figure 3, a typical PARAMICS intersection layout is shown, where the user has full control of the lane widths, position of curbs, position of stop lines, and direction of stop lines. Saturation flow through an intersection is not provided as an input to the model, but is derived by the model based on the geometric layout and the vehicle characteristics.



**Figure 3: Typical Intersection Layout in PARAMICS**

The real-time and 3D graphics features of the PARAMICS model are very useful for coding, debugging and presentation to clients and the public. The PARAMICS model allows real time tracing of individual vehicles through the network also from a driver's perspective, including a dashboard view on which all the information that the driver/vehicle is carrying with it such as amongst others origin, destination, patience, awareness and aggression. Also displayed are the speed of the vehicle and all acceleration and deceleration. More of the graphic output properties of the PARAMICS model are shown in the figures in Section 4.2.

Like most other simulation programs, the PARAMICS model output statistics are summarized in ASCII files. Available post processing software allows the user to obtain graphic summaries of the data. However, the output results still need to be further post-processed and summarized.

## **4.2 Application of PARAMICS**

The PARAMICS model has been successfully applied by the authors to analyze various types of roadway networks and network alternatives. The remainder of this paper will list and discuss some of the recent projects with a discussion on the challenges and the lessons learned while applying the model.

#### 4.2.1 Closely Spaced Intersections/Interchange Design

The PARAMICS model has been successfully applied to evaluate a number of interchange design options. PARAMICS is one of a few simulation programs that specifically model roundabouts, and was used to evaluate the operation of roundabouts at the terminal intersections of two interchanges. The simulation was done, firstly to analyze the effect of possible queue spillbacks but also to prepare presentation material for use in public presentations. Roundabouts are still very new in many areas in the United States and the public is very skeptical when these devices are proposed. The interchange with the roundabout terminals is shown in Figure 4

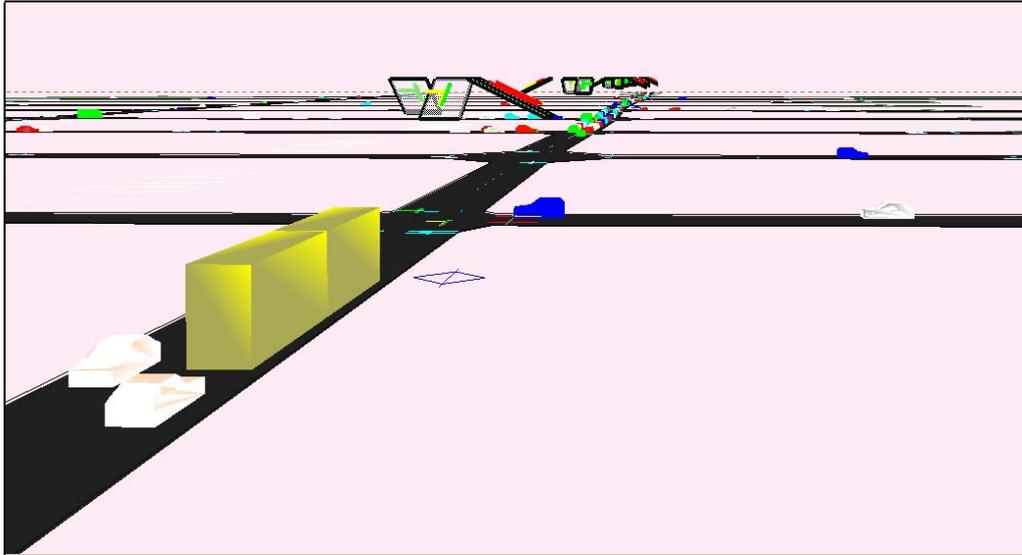


**Figure 4: Interchange Simulation**

Simultaneous simulation during a public presentation of the existing layout and two future options was successfully used to convey the different scenarios to the public. In addition the client used video files of the simulation both on tape and on a project web site to further inform the public and educate them on the different options.

#### 4.2.2 Streetcar/Light Rail

Portland is in the process of constructing a new streetcar program that will operate within the central business district. The streetcar will be run at-grade and share the street with traffic. The streets along which it will be running are basically two-lane, two-way streets with on-street parking. The simulation model was employed to help answer the question of how much the streetcar will be delayed by general traffic as well as parking maneuvers. Figure 5 illustrates the streetcar and the grid network. Also shown in Figure 5 are the overhead signal displays.



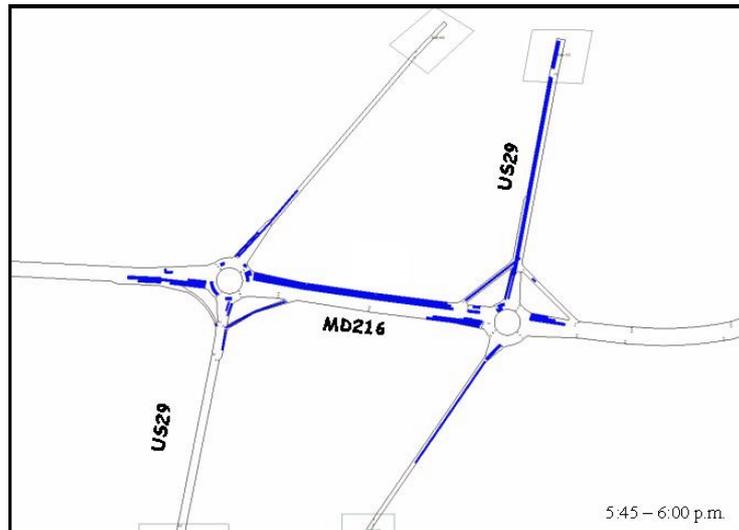
**Figure 5: Streetcar Simulation in Portland**

The simulation showed that the streetcar would create sufficient gaps in front of the car and that the streetcar would generally cause more delay to the street traffic than what the street traffic would cause delay to the street car. Therefore it was decided to continue with two-lane, two-way operation rather than converting the streets to one-way couplets.

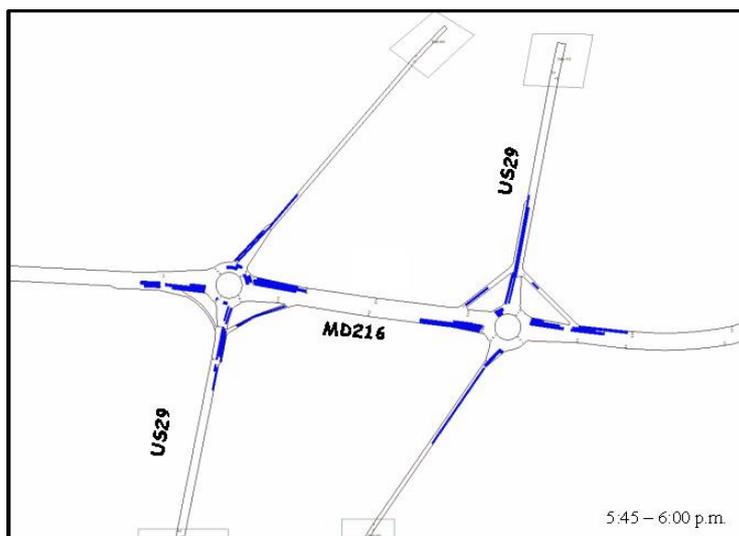
The ability of the PARAMICS model to simulate transit vehicles and to provide priority to buses and streetcars was clearly illustrated in this study. The PARAMICS model permits the definition of fixed bus routes and the association of bus stops with certain routes. The dwell times at bus stops are defined by the arrival rate of riders at the stops and also by the percentage of riders alighting from the vehicles at the bus stops. In addition, the effect of on-street parking on vehicle delay as well as the effect of pedestrians on intersection capacity could be illustrated and taken into account.

#### **4.2.3 Roundabout Simulation**

The PARAMICS model can directly simulate a modern roundabout. A number of roundabouts have been coded and analyzed by the authors using the PARAMICS model. These simulations were conducted whenever specific site related issues were identified such as nearby signalized intersections, highly unbalanced flows, or to evaluate the effect of approach meters on the performance of the roundabout. Roundabouts are known for not operating very well under unbalanced flows. Approach metering of roundabouts could assist to balance the queues and delay on the different approaches. Figures 6 and 7 show the maximum queue lengths at two closely spaced roundabouts with and without approach metering. The screen captures of Figures 6 and 7 are from the Analyzer program, which is the post-processing tool provided with the PARAMICS model.



**Figure 6: Maximum queue lengths on approaches - no approach meters (Paramics Screen Capture)**



**Figure 7: Maximum queue lengths on approaches - With approach meters (Paramics Screen Capture)**

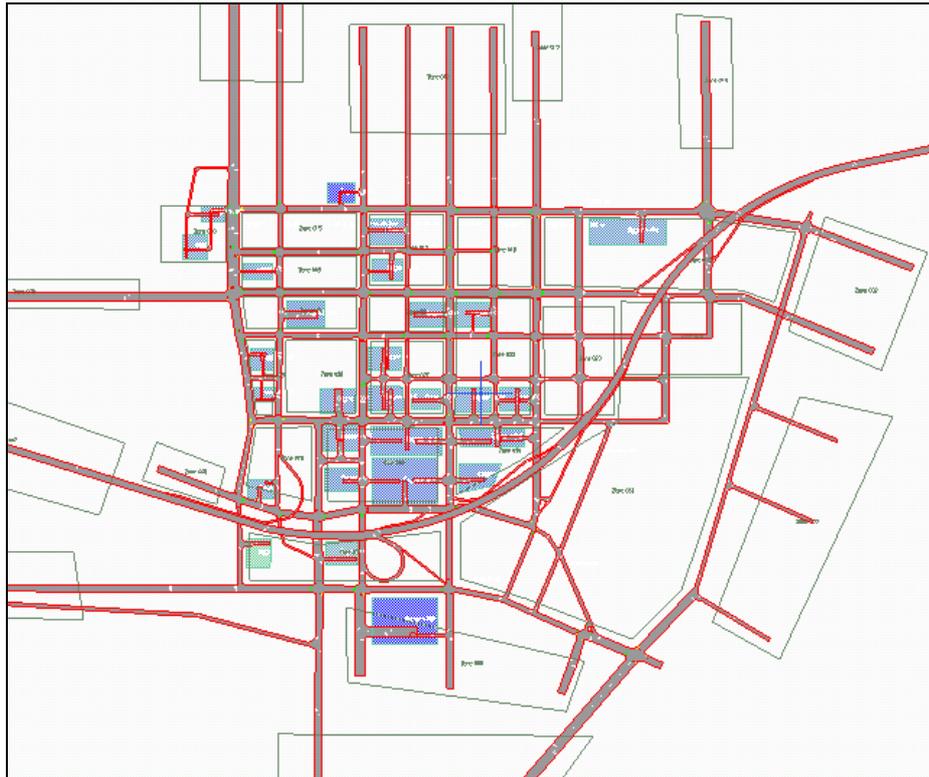
Experience in simulating roundabouts has shown that the PARAMICS model has the capability to simulate roundabouts and the effect of approach metering to mitigate an imbalance in approach volumes. This is something few simulation models can do accurately. Paramics has been validated mostly against British analytical methods with very little validation research outside of the United Kingdom.

#### **4.2.4 Central Business District Simulation (Tampa)**

One of the most extensive applications of the PARAMICS model by the authors was the simulation of downtown Tampa, Florida (USA). This street network covered almost 100 intersections in the downtown area and included a section of the Crosstown Expressway. The first part of the project evaluated a proposed reversible lane system from the freeway into and out of the downtown area. The second part of the project evaluated changes to some of the downtown streets, including lane and total street closures. The most challenging part of the study was the validation of the model when comparing modeled volumes against the

actual counted volumes. Modeling such an extensive network with multiple route options was a true test for the dynamic routing options in the PARAMICS model.

One of the features of the PARAMICS model is the simulation of parking garages. Rather than loading and unloading the network with zone connectors, traffic originates from car parks and enters car parks as a final destination. This fosters a very detailed simulation of downtown intersections and entrances/exits to parking garages. Parking garages can be associated with any zone, and trips from/to a zone need not end in the zone or originate from a zone, but could come from or go to an associated parking garage in another zone. The PARAMICS model keeps track of the occupancy of each parking garage and reports when the garage is full. A typical screen capture of the downtown area of Tampa is shown in Figure 8.



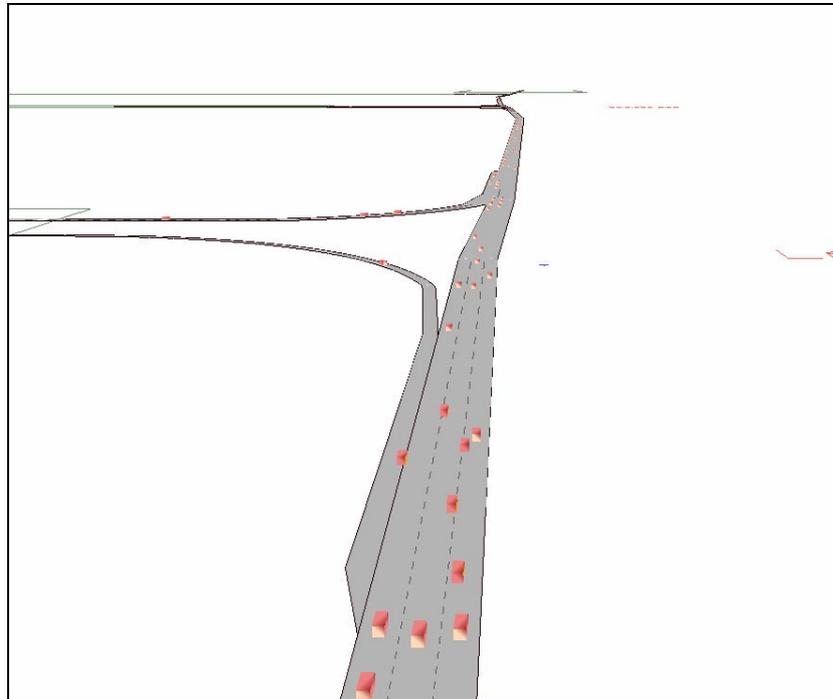
**Figure 8: PARAMICS Screen Capture of Downtown Tampa Model**

Traffic assignment in PARAMICS can be based on three different methods of assignment, the first being a least cost route between two zones, which obviously results in a single route between the origin and the destination. The second method is based on a stochastic variation of route cost, which effectively increases the number of alternative routes between a specific origin and destination. The third method provides feedback about the delay along the route to drivers, which allows them to update their route selection based on the state of the system. The successful validation of a model such as this one is not only a function of the route assignment methodology, but also of the accuracy of the origin-destination matrix. The PARAMICS model is also very sensitive to network geometry and link speeds. Once validated, the simulation model provided a unique tool to evaluate different alterations to the network and their effect on the system.

#### **4.2.5 Freeway Simulation (Orlando)**

The Florida Department of Transportation has considered the construction of a high occupancy (HOV-lane) lane on a section of Interstate 4 through downtown Orlando, Florida. The impact of the HOV-lane was studied with a number of other simulation packages, but the department also requested an analysis with the PARAMICS model to evaluate its performance and accuracy. The freeway currently accommodates more than 6,000 vehicles per hour along three lanes in the peak direction. It was possible to validate the model of the 9-mile section of freeway based on existing counts and speeds at strategic locations. The existing conditions network was then extended to include the freeway and the future estimated demand. The

PARAMICS model clearly showed the advantages of the HOV-lane, but also that there would be significant disturbance at the entrances and exits to the HOV lanes. These disruptions at the entry and exit points could offset the benefits in terms of travel time which could be realized on the mainline due to the lower volume of traffic. Figure 9 shows a section of the eastbound roadway at the Lee Street Interchange.



**Figure 9: Interstate 4 - Orlando**

The PARAMICS model permits restriction on specific lanes to allow only certain vehicle types on such links. Therefore, the model identifies all high occupancy vehicles and would only allow these vehicles in the HOV-lane and can do the assignment based on the best route selection. The default values of 1 second for the average headway and reaction time had to be reduced to 0.8 seconds to obtain reasonable validation. In a recent study by Der-Horng, Xu and Chandrasekar (2000) on the calibration of PARAMICS based on a section of Interstate 5, they found that the best results were obtained with an average headway of 0.615 seconds and average reaction time of 0.415 seconds.

## **5. SUMMARY**

This paper provides an overview of the current simulation environment with a summary of current available simulation models. The paper concludes with a specific discussion on the features of the PARAMICS model with reference to recent real world applications.

The purpose of this paper is not to recommend a specific simulation model, since there is no simple answer to which is the best model. However, the reader is provided with insight into the current “new generation” of simulation capabilities. There are many traffic simulation models available to the transportation professional and none do everything (and the list of simulation models would probably continue to grow!). The traffic engineer is always faced with the challenge of choosing the model most suited for the specific application. The PARAMICS simulation model is used as an example of how the latest simulation models can be applied in real world situations. Although the PARAMICS model is a very versatile simulation tool, the authors would not want to advocate its use for every simulation need and any for any traffic network.

## 6. REFERENCES

- Byrne, A., de Laski, A., Courage, K., and Wallace, C. (1982) *Handbook of computer models for traffic operations analysis*, Technology Sharing Report FHWA-TS-82-213. Washington, D.C.
- Der-Horng, L., & Xu, Y., (2000) Parameter Calibration for PARAMICS using Genetic Algorithm, *Annual Meeting of the Transportation Research Board*, Washington D.C.
- Drew, D.R. (1968) *Traffic flow theory and control*, New York: McGraw-Hill.
- Fellendorf, M., and Vortisch, P. (2000) Validation of the Microscopic Traffic Flow Model VISSUM in Different Real-World Situations, *Annual Meeting of the Transportation Research Board*, Washington D.C.
- Leonard, D., Tough, J., and Baguley, P. (1978) *CONTRAM: a traffic assignment model for predicting flows and queues during peak periods*, Transport and Road Research Laboratory, TRRL Laboratory Report 841
- PARAMICS User Guides - Version 3.0*, (1999) Quadstone Ltd, Edinburgh, UK.
- Pursula, M., (1999) Simulation of Traffic Systems - An Overview, *Journal of Geographic Information and Decision Analysis*, vol.3, no.1, pp. 1-8.
- Sayed, D., (1997) Estimating the safety of unsignalized intersections using traffic conflicts, *Proceedings of the third international conference on intersections without traffic signals*, Kyte, M., ed., pp. 230-235, Portland, Oregon.
- SMARTTEST Project Final Report*, (1999), European Commission, 4th Framework Programme, Transport RTD Programme, Contract N°: RO-97-SC.1059.
- Smith, L., Beckman, R., Anson, D., Nagel, K., and Williams, M. (1995) TRANSIMS: Transportation analysis and simulation system. *Proceedings of the 5th National Conference on Transportation Planning Methods Applications*, Seattle.
- Quadstone Ltd, (1996) Wide Area Microscopic Traffic Simulation – UK Motorway Validation Report, Edinburgh.

# **LATEST TRENDS IN MICRO SIMULATION: AN APPLICATION OF THE PARAMICS MODEL**

**CHRISTOFF KROGSCHEEPERS and KENT KACIR\***

BKS (Pty) Ltd, 222 Durban Road, Bellville, RSA

\* Siemens Energy & Automation, Inc., Gardner Transportation Systems, Portland, Oregon, USA

## **J CHRISTOFF KROGSCHEEPERS**

Christoff Krogscheepers provides 13 years of experience in the areas of transportation engineering and planning. He has been involved in transportation impact studies, area-wide transportation planning efforts, environmental impact studies, corridor studies, traffic signal system studies, transit planning, airport master planning and project planning of civil engineering projects both in South Africa and in the United States. He obtained a Bachelor of Engineering degree from the University of Stellenbosch (South Africa) a Masters degree in transportation engineering from the University of Pretoria (South Africa) and a Doctor of Philosophy from the University of Natal (South Africa) for his study of simulating human behavior at roundabouts. As a senior lecturer at the University of Natal, he has been involved in teaching courses in transportation engineering and planning at both the undergraduate and graduate level. He has been involved in research projects in South Africa at both the local and national level and has served on the national advisory committee on "Traffic calming guidelines" for South Africa. He has played an active part in the planning and implementation of a Master Plan (landside and airside) for Cape Town International Airport, which included a sub-area transportation model of the road network surrounding the airport. For the past two years he worked for a leading consulting firm in the United States.