Assessing Developments Using AIMSUN

Christine P. Haas*, MCE (Civil), Dipl.-Ing. (Bau), AITE

Computer simulation software packages have been gaining popularity in New Zealand over the past years. AIMSUN is one of the packages that is increasingly being used by local authorities and consultants. Traffic Design Group has built an AIMSUN model for the Taharoto Road area within the North Shore City. This paper summarises the work undertaken for the assessment of developments using AIMSUN. These developments include various land use activities and the implementation of a proposed Bus Rapid Transit project, including changes to bus routes. The paper focuses on the tools available in AIMSUN, including graphical animation to analyse the effects of developments and their access options.

This paper outlines the various steps required to build an AIMSUN model for the existing and future conditions, and subsequent analysis of various options. A demonstration of the Taharoto Road model is included in the presentation of the paper.

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** Since 2000 C. Haas has been working as a transportation engineer for Traffic Design Group in Auckland, New Zealand. ch@ak.tdg.co.nz*

Introduction

Micro-simulation models have gained popularity as practical analysis tools over the past decade. A number of computer simulation packages are available today such as CORSIM (USA), PARAMICS (UK), AIMSUN (Spain) and VISSIM (Germany). Using these simulation models proposed roading options can be tested and evaluated under existing and future traffic flow conditions before implementation. Detailed performance measures, such as delay and queue length, can be quantified to aid the decision-making process to implement a certain roading design.

This paper presents an overview of the model building process of an AIMSUN model for an urban area. This is done using the specific example of the Taharoto Road area, located in Takapuna, North Shore City. The data requirements are discussed as well as some of the difficulties encountered associated with the model calibration. This paper is intended as an introduction to the use of AIMSUN in development related projects.

Study Area and Project Scope

The study area is located to the north of Takapuna and shown in Figure 1. The area includes four signalised intersections and the Northern Motorway interchange with Northcote Road.

Figure 1: Aerial Photograph of the Taharoto Road Study Area

Taharoto Road functions as a major arterial and carries high traffic volumes to and from the motorway during morning and afternoon peaks. This area contains large developments, such as the North Shore Hospital and the Smales Farm development, as well as four schools. The Westlake Station associated with the Bus Rapid Transit (BRT) system is proposed to be located to the west of the Taharoto Road / Shakespeare Road intersection. This station will be serviced by a new road. Once the BRT system is operational a significant increase in bus traffic in the area is expected.

The main objective of building the Taharoto Road model is to investigate the operation of different roading and public transport options under existing and future traffic flow conditions. This must be done with special consideration given to the amount of additional traffic that will be generated by the surrounding developments as well as the access locations related to these developments. The model allows investigation of the effect of different levels of development on the surrounding road network. It will also be used to assess the effects of the proposed BRT system and associated bus lanes in the Taharoto Road area.

Methodology

The first step was selection of the portion of the road network to be included in the model. Based on the data requirements for the AIMSUN model, relevant field data, e.g. traffic flow data and lane configurations, was then collected. These first two steps of the model building process define the level of detail of the model in terms of network geometry and travel demand variation.

One-hour AIMSUN models for the existing morning and afternoon peak periods were built. Calibration of the models with available field data was carried out.

Trip distributions for the proposed developments in the area, such as the North Shore Hospital, the Smales Farm development and the various schools in the area were obtained from previous studies and documented. The Auckland Regional Council supplied estimated bus movements for the proposed Westlake Station of the BRT system.

The future background traffic in the area was developed for the medium term and long term scenarios. For the year 2005, growth predictions based on the existing traffic volumes were used. For the year 2011, traffic flows were based on a SATURN model of the area, excluding the traffic generated by the developments.

The future models for morning and afternoon peak periods were built. These models include different 'layers' such as the background traffic, the traffic generated by each proposed development in the area and anticipated bus traffic due to the BRT system. Visual calibration of the model was performed, and signal timings were adjusted accordingly.

The last step is the testing of different roading and public transport options and the evaluation of the effects on the road network. At the time of writing this paper, the testing of different options was still in progress.

AIMSUN Computer Model

The model described in this paper was produced using Version 4.03 of the GETRAM software, which was developed by Transportation Simulation Systems Ltd. (TSS) of Barcelona, Spain. This software contains two main parts. One is the graphical network editor, TEDI. The other is the actual simulation software, AIMSUN (Advanced Interactive Microscopic Simulator for Urban and Non-Urban Networks)[1]. The software also includes an animated simulation display showing vehicles driving around on the road network.

AIMSUN simulates the behaviour of each vehicle on the network according to several vehicle behaviour models, such as car following and lane changing models, and the user-defined traffic controls. The position of all vehicles is updated for every simulation step, and the graphical output is refreshed. The user can define the length of a simulation step. The model described in this paper has been run with the default simulation step value of 0.75 seconds.

The data inputs required by the simulation model are discussed in the following sections. Microscopic simulation models are data-hungry by nature. The amount of detail in data input versus the desired detail in the output data must be considered when building a simulation model.

4.1 Network geometry

TEDI provides the graphical interface for entering the network geometry. Most of the network detail of the Taharoto Road model was derived from aerial photography and CAD drawings. These were imported into TEDI as map background. The road network was drawn on top of the map background using the drawing tools. The network is defined by sections (roads) and by nodes (intersections). Figure 2 shows the existing intersection layout for the Taharoto Road / Shakespeare Road intersection. Proposed roading layouts can be easily edited using TEDI. A possible future layout of the same intersection including bus lanes is shown in Figure 3.

4.2 Traffic demand

AIMSUN allows two methods of traffic demand data input. Firstly, the traffic demand can be entered by traffic flows on each entry link and subsequent turning percentages at each intersection in the TEDI interface. The drawback of this approach is that a vehicle does not know its final destination upon entering the network. Consequently, turning movements are carried out probabilistically and weaving patterns may be unrealistic. A more realistic lane changing behaviour for vehicles can be achieved using origin-destination matrices for traffic demand data input. AIMSUN has an interface with EMME/2, which is available in addition to the main programme. This interface enables the import and export of EMME/2 origin-destination matrices.

Since origin-destination data was not available, the Taharoto Road model is based on extensive intersection movement traffic counts.

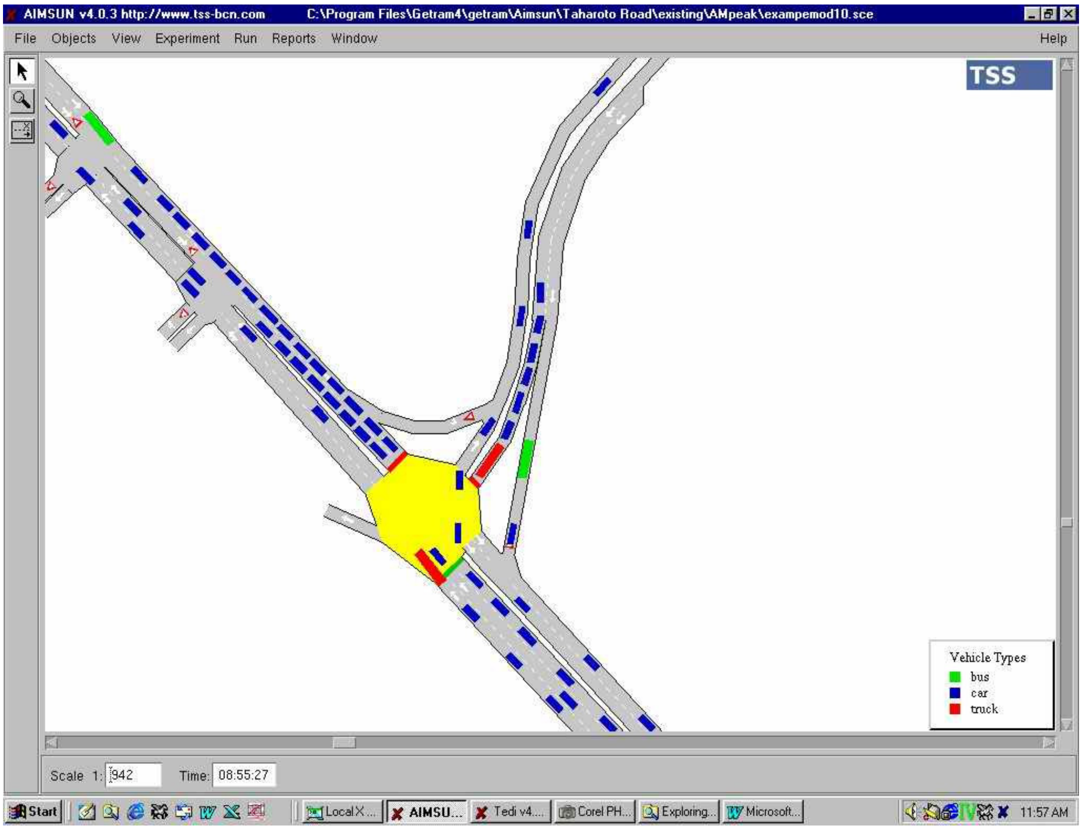


Figure 2: Shakespeare Road / Taharoto Road Intersection Existing Lane Configurations

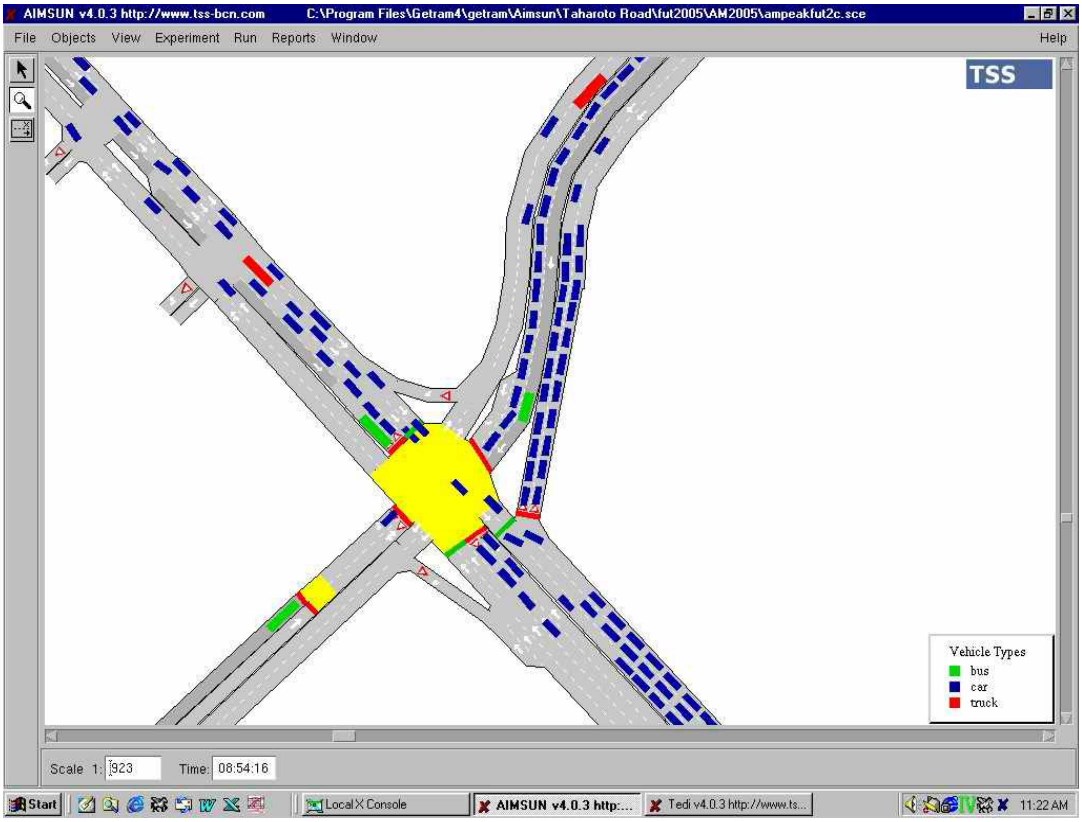


Figure 3: Shakespeare Road / Taharoto Road Intersection Future Lane Configurations

4.3 Traffic control

AIMSUN is not able to simulate adaptive traffic control with the standard software offered. A fixed time signal control must therefore be assumed, although coordination between signals can be defined. For the Taharoto Road model SCATS data for the peak periods was obtained from the North Shore City Council and averaged over the peak times.

A separate interface is available for AIMSUN, which is capable of linking AIMSUN to any adaptive signal control system's software, e.g. SCATS. The externally calculated adapted signal timings can then be imported for the simulation in AIMSUN.

4.4 Vehicle characteristics

For each vehicle type the traffic flows must be entered separately rather than as a percentage of the total flow. The amount of data to be entered therefore increases with the number of vehicle types defined. The number of vehicle types in the Taharoto Road model has been limited to three: cars, heavy vehicles and buses.

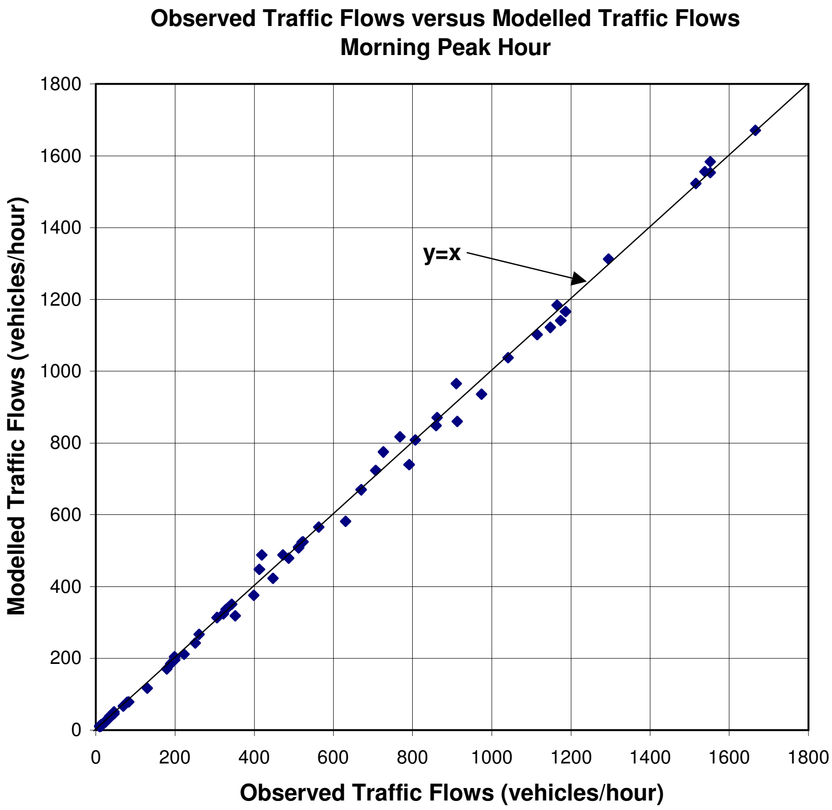
Different vehicle types and their characteristics can be entered into the model through TEDI. A number of vehicle characteristics for New Zealand traffic conditions have been investigated by Hughes [2]. The Taharoto Road model uses the main vehicle characteristics for New Zealand cars as outlined in his thesis. For heavy vehicles and buses, no accurate field data exists, so default values were used. The significance of local data for vehicle characteristics is illustrated by the simulation of queue length. The New Zealand value for minimum distance between cars, a main factor in simulating the queue length, varies significantly from the default value contained in AIMSUN. Using the default values for vehicle characteristics will therefore result in an underestimation of queue length.

Calibration

Calibration of the model ensures that the model simulations realistically replicate the existing traffic conditions. No standardised procedures exist that define when a model can be assumed to be calibrated. A number of statistical procedures can be used to assess the model's performance but again no quantitative definition of calibration is available.

The amount of calibration required is largely defined by the intended applications of the final model. The degree of calibration is limited by the input data. In the case of the Taharoto Road model the travel demand data was entered in a single time slice of one hour. Consequently, the average traffic conditions over the peak hour are modelled. The Taharoto Road model was calibrated using the flow data on each section. Figure 4 shows a scatter plot of the observed traffic flow versus the modelled flow data at some 60 key locations for the morning and afternoon peak hours. The data approximately lies on the $y=x$ line, indicating that the model is able to reproduce the observed traffic flows accurately. A coefficient of determination (R^2) of 0.99 was reached for both peak hour models.

Other performance measures, such as travel time, travel speeds and queue length, can be used to calibrate the model. Ideally, a combination of performance measures should be used for the calibration of a model. Hughes presented weightings for the different performance



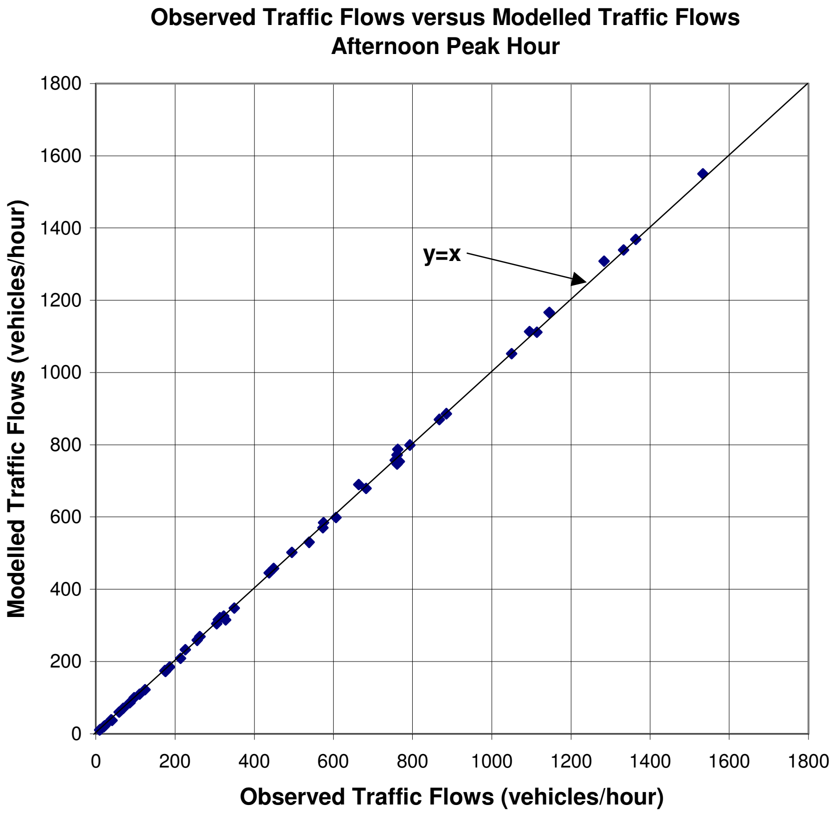


Figure 4: Morning and Afternoon Peak Hour Scatter Plots

measures used to calibrate an AIMSUN model with traffic flow having the most weight followed by travel time, speed and the location of traffic jams [2].

The actual calibration of the model is carried out by changing the numerous parameters of the model, which influence the vehicle behaviour in three different ways. The global parameters such as reaction time, lane changing parameters and queue up and leaving speed influence the general behaviour of all vehicles regardless of type. The section parameters such as speed limit, turning speeds and visibility distance are defined for each section of the network and influence the behaviour of all vehicles on a given section. Vehicle parameters such as maximum desired speed, minimum distance between vehicles and give-way times influence a certain vehicle type throughout the network.

It is important to produce realistic traffic flow conditions at the border of the model. For example, ramp metering was used to replicate congested motorway conditions at the Northcote Road Interchange during morning peak times. Some of the lane usage behaviour proved to be difficult to reproduce. In order to realistically model the observed excessive queueing in one lane of a two lane road section it was necessary to define different road sections for each lane.

A good understanding of the operational characteristics of the modelled area is required in order to achieve an acceptable model calibration. Empirical knowledge of certain driver behaviours and traffic patterns is an important element in the calibration process. For example, in the Taharoto Road study area a significant number of drivers use the North Shore Hospital as a shortcut to avoid queues at the Taharoto Road / Northcote Road intersection. In the future, these manoeuvres will be prevented resulting in a redistribution of traffic flows on the network. The future models take this redistribution into account.

Model calibration is a lengthy process based on a trial and error approach. It is recommended to change one parameter at a time to be able to attribute a change in model behaviour to a particular parameter.

Analysis

AIMSUN provides the user with many tools to measure the operational performance of the modelled road network. The user can specify the statistical data that will be collected during a model run. Data can be gathered periodically in user-defined time intervals or over the entire simulation time period. Statistical data is available for the entire system and each road section of the model. Traffic streams can be defined and statistical data can be obtained for these traffic streams. Traffic detectors at which statistical data is gathered can also be defined.

A simulation emulates the behaviour of a complex system in which randomness is involved [3]. Each simulation run produces one possible behaviour of the system. Therefore, many model runs must be performed for each scenario. Twenty runs were carried out for each of the different scenarios of the Taharoto Road model. Figure 5 shows a screen shot during one simulation with an aerial photograph displayed in the background. Vehicles are queuing up on the southbound approach of the intersection during the morning peak period. The two right-hand lanes of this approach, which lead to the motorway, show longer queues than the

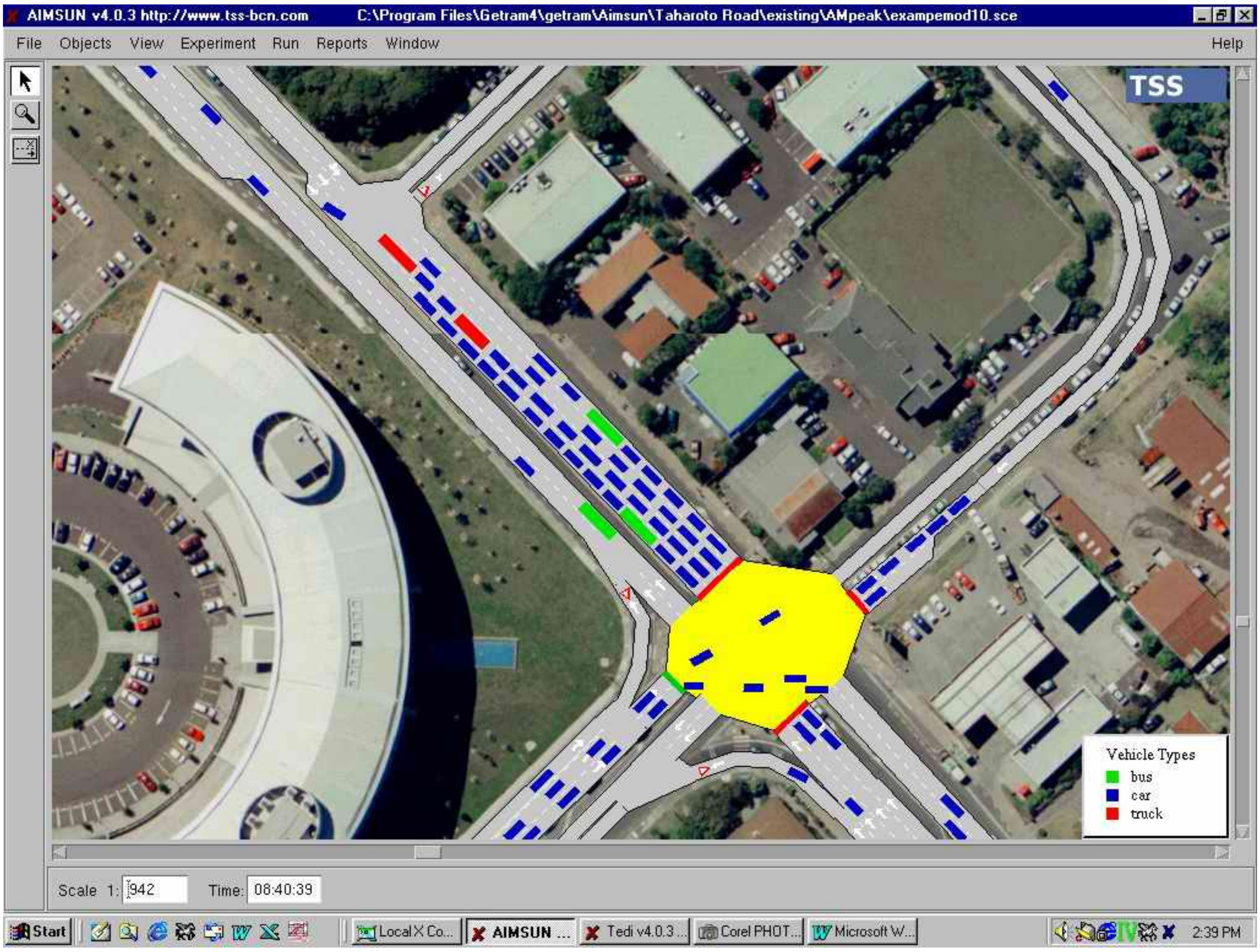


Figure 5: Screen Shot during a Simulation Run

File Report in 'C:\Program Files\Getram4\getram\Aimsun\Taharoto Road\existing\AMpeak\AIMSUN'

File : GLOBAL.EST

Close

	FLOW Veh/h	DENSTY veh/Km	SPEED Km/h	H. SPEED Km/h	TRAVEL T. h:mm:ss	DELAY T. h:mm:ss	STOP T. h:mm:ss	STOPS #/Veh	QUEUE LENGHT Mean / Max	TRAVEL Km	FUEL litres
* Taharoto Rd S	1707	15.7	47.0	46.7	0:00:24	0:00:01	0:00:00	0.0	0.0 / 0.0	536.1	0.8
=bus	42	0.4	47.6	47.5	0:00:23	0:00:01	0:00:00	0.0	0.0 / 0.0	13.2	0.0
=car	1635	15.1	47.0	46.7	0:00:24	0:00:01	0:00:00	0.0	0.0 / 0.0	513.4	0.0
=truck	30	0.3	46.1	46.0	0:00:24	0:00:01	0:00:00	0.0	0.0 / 0.0	9.4	0.8
* Taharoto Rd N	1495	10.3	48.6	48.2	0:00:24	0:00:00	0:00:00	0.0	0.0 / 1.7	484.8	0.6
=bus	45	0.3	48.4	48.4	0:00:24	0:00:00	0:00:00	0.0	0.0 / 0.0	14.6	0.0
=car	1430	9.8	48.6	48.2	0:00:24	0:00:00	0:00:00	0.0	0.0 / 1.7	463.7	0.0
=truck	20	0.1	46.0	45.6	0:00:25	0:00:02	0:00:00	0.0	0.0 / 0.0	6.5	0.6
* Westlake Girl	54	2.0	15.5	8.6	0:00:07	0:00:05	0:00:05	0.5	0.1 / 2.0	0.9	0.0
=bus	0	0.0						0.0 /	0.0 0.0	0.0	
=car	53	2.0	15.4	8.5	0:00:07	0:00:05	0:00:05	0.5	0.1 / 2.0	0.9	0.0
=truck	1	0.0	19.9	19.9	0:00:03	0:00:00	0:00:00	0.0	0.0 / 0.0	0.0	0.0
* Takapuna Girl	54	1.0	48.0	47.4	0:00:01	0:00:00	0:00:00	0.0	0.0 / 0.0	0.7	0.0
=bus	0	0.0						0.0 /	0.0 0.0	0.0	
=car	54	1.0	48.0	47.4	0:00:01	0:00:00	0:00:00	0.0	0.0 / 0.0	0.7	0.0
=truck	0	0.0						0.0 /	0.0 0.0	0.0	

Figure 6: AIMSUN Output File

two left-hand lanes, which are destined for Takapuna. The model adequately replicates the existing conditions.

The results of a model run can be readily presented graphically on the network in form of colour coding. Alternatively, the user can define any performance measure for a specific section of the network, which then will be printed in diagrammatic form over the simulation time period. For a more detailed analysis the results can be stored in different file formats such as ASCII, ODBC format or directly to an existing database. Figure 6 shows an example of a result file in ASCII format. The various performance measures, such as flow, density and speed, are listed for each section of the model. All values are also broken up by vehicle type.

Discussion

Data for the model validation needs to be set aside. During the initial data collection phase, allowance for the collection of validation data should be made. To simplify the data input the Taharoto Road model was built by entering a single one-hour time slice, specifying the hourly traffic flow. With the use of smaller time slices, e.g. 15 minutes, for the traffic flow data the varying traffic demand over the peak hour can be expected to be reproduced more accurately. Consequently, performance measures such as queue length and travel time can be expected to correspond more closely to observed field data. The balance between the amount of work to build such a detailed model and the desired accuracy of the output has to be determined.

AIMSUN has a number of additional powerful tools that are not explained in detail in this paper. This includes the simulation of vehicles guided by variable message signs (VMS). AIMSUN is also capable of incident simulation. A useful tool for the evaluation of public transport services is the ability to input bus routes, which can be defined in detail with bus stops, time tables and dwelling times at each stop. All performance measures can be obtained separately for each of the defined public transport routes.

The non-adaptive signal control as contained in AIMSUN's standard module limits the degree of realism to which a network operating under an adaptive signal system can be replicated.

Summary and Conclusion

The AIMSUN modelling undertaken for the Taharoto Road study area has shown that the existing traffic flow conditions in a congested urban area can be reproduced in simulations with a good degree of accuracy. However, the calibration of the model is time consuming.

The model can be used to test and evaluate different roading and public transport options, which can be easily defined within the graphic editor TEDI. The graphical animation part of the simulation model has proven to be a very useful tool for presentations to the public.

It is hoped that by outlining the basic methodology of the model building process this paper will encourage the use of AIMSUN in New Zealand, and its application to find viable solutions for future roading systems.

It is recommended that further research be carried out to improve simulations. In particular in the field of calibration of AIMSUN and for the definition of appropriate vehicle parameters for New Zealand more research is needed.

Acknowledgements

The BRT team of the North Shore City Council commissioned Traffic Design Group to develop the Taharoto Road model described in this paper. The views expressed in the paper are those of the author and do not necessarily reflect the views of Traffic Design Group.

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