HIGHWAYS AGENCY

# Validation of Micro-simulation **Models Software Review**

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An Executive Agency of the Department for Transport

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# 1 Introduction

# Introduction

## 1.1 Introduction

The highways Agency commissioned Faber Maunsell to undertake a study to provide advice on the design and validation of micro-simulation models appropriate to the Highways Agency's motorway network. The study has four main aims:

- To provide a brief review of available micro-simulation software that is pertinent to the micro-simulation traffic modelling of schemes on the Highways Agency's motorway network;
- To review the existing parameters in the main micro-simulation modelling software that are currently being used for assessing Highways Agency schemes, and to establish the default values and the effect of varying these defaults;
- To identify available data sources that can be used to provide information on the most important and influential parameters for the Highways Agency motorway network; and
- To draft guidance on the use of micro-simulation for HA scheme development.

This report presents the findings of the brief review of the available micro-simulation software in terms of the current capabilities of the main packages used in the UK. The objective of this review report is to provide a database of information for use in the detailed technical analysis of the importance of individual parameters, within each software package and their influence on the results obtained.

The report identifies the main parameters available for the modelling of traffic behaviour, with an emphasis on motorway related modelling but also covering junction and urban area modelling. The sensitivity of the model outputs to changes in the parameters is to be tested using a series of models developed in each main software package. This bench testing of the packages will provide clear insights into the way in which the different software packages perform as parameters are changed and hence enable the HA to better understand how to assess models developed for HA applications.

The HA has previously undertaken reviews of available micro-simulation software in the late 1990's and more recently in 2003/04. These reviews identified that a wide range of micro-simulation packages existed in the UK and abroad but recognised there were a limited number of packages in active use in the UK.

Consequently, at the outset it was agreed that the detailed technical review and testing would focus on the packages that were already in use, and will continue to be used in the near future, to assess Highways Agency schemes. Subsequently, following discussions with the HA, the detailed technical review and parameter testing will concentrate on the following traffic micro simulation packages:

- AIMSUM;
- Paramics;
- SISTM; and
- VISSIM.

During the course of the previous reviews, which reported in October 2000 and April 2004 respectively, the following additional packages were identified as being relevant for motorway modelling:

| Software | 2000 Review | 2004 Review |
|---|---|---|
| HUTSIM | * | |
| DRACULA | * | * |
| FLOWSIM | * | |
| MITSIM | * | * |
| CORSIM | * | |

Whilst not wishing to discount these packages completely, an Internet review has revealed that there has not been as much development of these as there has with those above. In addition, some, such as CORSIM and MITSIM, have more of a presence in the United States with little or no application in the UK to date.

During the initial review it become apparent that a number of the above products are currently undergoing further development and may become more readily available in the UK while others could become more commonplace. The marketing agreement between SIAS and Quadstone in relation to their respective versions of Paramics has now ended and Quadstone are free to sell their version of Paramics in the UK. Consequently, the first stage of the review process included:

- DynaSIM Citilabs
- DRACULA WS Atkins
- FLOWSIM Univ of Southampton
- Paramics Quadstone version

The above software packages are not however to be subjected to detailed testing.

### 1.2 Layout of Report

The report has several chapters with chapter two providing a quick summary of the findings of the previous software reviews that provides a background to the update, and describes the approach to collating the required information for the study. This is followed by a series of chapters covering key aspects of micro-simulation software and how each software package handles them and the parameters that are used and the schemes to which the software has been recently been applied. Finally chapter four summarises the key findings of the review and provides a statement of the status of each piece of software with an emphasis on their application to the HA motorway network.

# 2 Previous Software Reviews /Guidance

# Previous Software Reviews / Guidance

## 2.1 Software Review 2000 and 2004

The review of Micro-simulation software reported on in October 2000 provided an overview of the packages available at the time. A concern relating to this report was that, with regard to the functionality of the software, it was already out of date by the time of publication. This was a result of the rapid development of micro-simulation software as applications became more widespread. User needs and competition between the developers for market share led to a sustained period of extensive development. Consequently, a number of the software developers were of the view that the review gave a false impression about the capabilities of each one.

In view of the perceived limitations of the 2000 review, and particularly in respect of the range of examples of micro-simulation applications an updated review took place in 2004. The 2004 review provided detail on the applications to which each package had been put and the latest position in terms of software features and capabilities.

It is the intention that the current review will reflect the most up to date status of each package and provide a broad indication of where development is heading.

The following tables (Table 2.1 and 2.2), represent the position at the time of the last review in 2004.

The previous reviews have concentrated on a statement of the various features available in the respective micro-simulation packages and their application. There has not been any significant attempt to understand better, how the packages work in respect of the modelling of motorway and urban conditions, or to establish what the key parameters are in the packages.

## 2.2 Advice and Guidance Notes

***Interim Advice Note 36/01 (IAN 36/01) : The Use and Application of Micro-Simulation Traffic Models, July 2001***

The 2000 micro-simulation software review undertaken by the Highways Agency resulted in the release of Interim Advice Note 36/01 (IAN 36/01) : The Use and Application of Micro-Simulation Traffic Models in June 2001.

The advice note covered a number of areas with respect to micro-simulation covering:

- When to use to micro-simulation approaches as opposed to conventional macro models;
- The micro-simulation packages available and their features; and
- Model development covering data requirements, model specification, calibration/validation, and reporting requirements.

Of particular relevance to the current study is the section on calibration and validation. The note provides a general discussion on calibration that highlights the fact that the parameters available for model calibration within a micro-simulation model are generally more detailed than those in a conventional model are. In particular, it notes that modifications are possible to network, vehicle and driver characteristics. The advice note also raises the importance of the randomisation process that is central to all micro-simulation packages and the degree of variation that this can produce in the model outputs.

With regard to calibrating a micro-simulation model, the note highlights the following:

- That the calibration should concentrate on those issues that affect the models objectives and that these will vary depending on the application to which the software is being put;

- That the model should initially be set up using the default parameters and the results reported;
- That analyses should be undertaken to assess modelled variation in relation to the desired accuracy of results; and
- That assessment of the impact of different random seeds is essential.

A particularly relevant issue raised in the advice note is that of undertaking sensitivity tests around the default values to establish whether this has a significant effect on the model outcomes. To undertake this in a meaningful manner, however, requires an understanding of what the most important parameters are for different types of scheme assessment. Aside from the highly important factors relating to the travel demand inputs and profiling the note identified, but without quantification of reasonable values, the following parameters as being of most importance in calibration.

| Highway Feature | Important Input Parameters |
|---|---|
| ***Roundabouts*** | Entry speed<br>Circulating speed<br>Gap acceptance |
| ***Signal Junctions*** | Signal timings<br>Geometric speed restrictions<br>Gradients<br>Vehicle acceleration profiles |
| ***Priority Junctions*** | Gap Acceptance |
| ***Links*** | Vehicle speed distribution<br>Arrival profile<br>Routing decision points<br>Lane usage and selection |

Many of the above are relatively obvious as they are important inputs, or intrinsically included, in the empirical formulae of more conventional models. The advice note only provides very broad pointers to the areas where calibration issues and parameter selection are likely to be critical. While some of the important input parameters are noted, there is no discussion on their relative importance or the range of acceptable values.

The current study has to focus therefore on taking the outline provided by the interim advice note and providing detail on the requirements for validation and calibration.

### *Micro-Simulation Modelling Guidance Note for TfL, July 2003*

Transport for London began making extensive use of micro-simulation techniques in 2002. In order to provide a framework for micro-simulation work carried out for TfL a review took place in 2002, which resulted in the release of Micro-Simulation Modelling Guidance Note for TfL, in July 2003.

The guidance note is a reference document for TfL staff as a basis for developing project specifications and evaluating micro-simulation models developed by others on behalf of TfL. There are several elements of the note that are of particular interest in the context of the current study as it covers key modelling issues to be considered, the data requirements for micro-simulation models, key parameters and their expected ranges, and a list of factors that need to be checked when assessing such models.

The note identified a number of limitations that existed in the available packages, at the time of the preparation of the note, and particularly in relation to applications in urban areas. These included:

- Limited pedestrian modelling capability, with the exception of VISSIM;
- Overtaking on single carriageways;
- Inability to optimise signal timings and offsets; and
- Small changes in arrival times of vehicles at congested junctions can have significant impacts due to limited control on specifying entry profiles.

Developments over the past three years have led to the main micro-simulation packages in use in urban areas improving their capabilities in each of the above areas.

The note also provided some guidance on the acceptable values of key parameters, in the modelling of urban traffic conditions, as shown in Table 2.3.

**Table 2.3 Parameter Recommendations : TfL Guidance Note**

| Parameter | Recommendation |
|---|---|
| Gap acceptance | Mean of 2.5 sec and standard deviation of 1.5 sec |
| Minimum headway for lane changing | 5.0m |
| Acceleration (m/s2) | >2.5 |
| Standstill distance (front to rear) (metres) | 1.0 |
| Driver lane selection | Should be set to enable high rate of lane changing |
| Reaction time (e.g. at signals) | Set to minimum allowable |

Furthermore, the note provided guidance on how well validated a model should be in terms of stop line throughput by vehicle type, saturation flow per lane, capacity per junction arm, maximum queue, and average delay.

In terms of assessing models provided to TfL the review identified several issues that the project engineers should examine in order to satisfy themselves that the models were robust. These included:

- Visual checking of the simulation to ensure that excessive lane swapping does not occur, unreasonable lane usage, inappropriate vehicle behaviour in relation to overtaking stationary vehicles or passing cyclists, unrealistic manoeuvres, inappropriate vehicle stops, and vehicles in the wrong lane;
- Have stop line and link flow surveys been done and are the implied saturation flows consistent;
- How have traffic signals been optimised;
- Has a suitable warm-up period been adopted, usually expect at least 15 minutes;
- Has a suitable run-off period been used, at least 30 minutes;

- How have pedestrian arrival rates been modelled where pedestrian flows exceed 400 people per hour;
- Have sensitivity tests been carried out on key parameters; and
- Ensure that a minimum of three random seeds have been used;

Whilst the above naturally focus on urban related factors they are pertinent to this study in relation to how motorway junctions are modelled within micro-simulation models submitted to the HA.

**Table 2.1 2004 Software Review**

| | AIMSUN2 | PARAMICS (SIAS) | SISTM | VISSIM | DRACULA | FLOWSIM | MITSIMLab | Quadstone Paramics |
|---|---|---|---|---|---|---|---|---|
| Country of development | Spain | UK | UK | Germany | UK | UK | USA | UK |
| Developer | TSS | SIAS/ Quadstone | TRL | PTV | University of Leeds | University of Southampton | MIT (USA) | Quadstone |
| UK Agent | None | SIAS/ Quadstone | TRL | PTV Newcastle FaberMaunsell | WS Atkins | None | None | Quadstone |
| Urban | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| Motorway | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Vehicle types – | As many as desired | As many as desired | 8 | As many as desired | 6 | 4 | 15 | As many as desired |
| Max Network size | No limit | No limit | 99 Km | No limit | No limit | I section | No limit | No limit |
| | | | | | | | | |
| O/D matrix | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Turning proportions at junctions | ✓ | ✓ | | ✓ | | | ✓ | |
| Alternative Route Proportions | ✓ | | | ✓ | | | ✓ | ✓ |
| Incremental time step | 0.5 – 1.0 second | 0.5 second | 5/8ths second | 0 – 1.0 seconds | 1 second | User set- no limits | 0.1-0.5 second | 0.5 – 0.1 second |
| Graphical network builder | ✓ | ✓ | | ✓ | | | ✓ | ✓ |
| Graphics 2-dimensional presentation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3- dimensional presentation | ✓ | ✓ | ✓ | ✓ | | | | ✓ |
| Runs on PC | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | | | | | | | |
| Car following | Gipps | Internal | Gipps | Weidemann | Modified Gipps | | Wicks | Modified Gipps |
| Lane Changing | Modified Gipps | Internal | Modified Gipps | Weidermann | Internal | | Internal | Modified Gipps |
| Gap Acceptance | Distribution of parameters | Internal | | User specified but has defaults | Internal | | Internal | Internal |
| Driver Awareness / Aggressiveness | Combination of speed acceptance, gap waiting time, and acceleration rate distributions | | 8 awareness and 8 aggressiveness values. Derived from 1990's research | Achieved by varying parameters such as safe braking distance, headway, and speed distributions | Combination of desired speed, gap acceptance and headways | | 12 parameters | 8 awareness and 8 aggressiveness values. Derived from 1990's research |
| Assignment | Dynamic route choice. Can be based on generalised cost. User can specify own algorithms. | Route choice allowed based on standard route and perceived costs. | None | Dynamic route choice. Uses generalised costs and Kirchoff's law for distribution across routes | Pre determined fixed routes. Can use SATURN assignment routes | | Pre-determined paths | Dynamic route choice. Based on generalised costs and perceived costs. |

**Table 2.2 Potential Motorway Features 2004 Review**

| | AIMSUN2 | PARAMICS (SIAS) | SISTM | VISSIM | DRACULA | MITSIM | QUADSTONE PARAMICS |
|---|---|---|---|---|---|---|---|
| Motorway weaving | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Motorway merges / diverges | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Ramp metering | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Motorway at-grade intersections | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Motorway grade-separated intersections | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Unsignalised roundabouts / gyratories | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Motorway shock waves | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Signalised roundabouts / gyratories | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| 4 lane motorway | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5 lane motorway | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Dynamic speed controls | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Automatic cruise control | ✓ | | ✓ | ✓ | | | |
| Variable speed limits | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Incident detection system | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Incidents | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Variable message signs | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Static route guidance | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Dynamic route guidance | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Toll Plazas | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Vehicle detectors | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Priority Lanes- HOV | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Crawler lanes | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Road charging | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| Congestion charging | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| Roadworks | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

# 3 Current Review

# Current Review

## 3.1 Proposed Study Approach

The aim of the current study is to extend the review of micro-simulation software to identify key parameters and their influence on model outputs. The emphasis in the study is on motorway applications and the eventual provision of guidance on the use of micro-simulation and the outputs that will be required in order to enable HA to make informed decisions on the veracity of the modelling processes.

In order to achieve this a more technically orientated approach is required where quite detailed information on how each software package handles key motorway features is required in the software review stage, and where bench testing of the effect of changing key parameters in each package is a critical aspect for developing a better understanding.

The first stage in the study is the undertaking of a review of the status of the respective software packages and the eliciting of the views of the developers on how their software product handles different aspects of the modelling of motorway behaviour, and the type of recent applications that the packages have been applied to. A questionnaire was designed and distributed to each of the software developers and contained sections covering:

- Software status;
- HA network related applications;
- General motorway / expressway applications;
- Network and Driver Behaviour parameters and inputs;
- Matrices and assignment capabilities;
- Junction control;
- HA motorway strategy modelling;
- Model outputs;
- Random Seed recommendations.

The remainder of this chapter presents a brief summary of the responses received from the developers in the form of summary tables for each aspect outlined above with a short section of accompanying discussion.

The aim of this review is not to repeat everything that was included in earlier reviews but to focus on new developments and on the mechanisms available within each software package for the modelling of motorways and their connections to the remainder of the highway network. The report is effectively an extension to the 2004 review and the final reports from this study could well incorporate the two review reports together.

## 3.2 Software status

Table 3.1 summarises the key responses received from the developers of each of the eight simulation packages that were included in the main review. With the exception of DRACULA each of the packages has a latest release version that was issued in 2005 and it is clear that each piece of software has undergone extensive development over the past few years and that this process shows little sign of easing up.

The rapid increase in the popularity of micro-simulation as a decision support tool for the assessment of the effect of changes to the road system and a mechanism for visualising the traffic situation and aiding in the design of, and consultation on, integrated traffic management or motorway control measures has created an environment where users have driven development by requests for new features.

Table 3.1 only relates to the improvements made in the software capabilities in the field of motorway modelling, which is the key objective of this study. Many more improvements have taken place in the areas of:

- Data input with more windows based junction editors;
- Alignment of software with current UK microprocessor traffic signal control phase based approaches;
- Extraction and presentation of data from the models to support wider traffic, economic and environmental analyses;
- Integration of packages with SCOOT, or the incorporation of signal control command languages that enable replication of integrated traffic signal control;
- Improved flexibility in how individual vehicles and links in the network can be specified so that specific types of driver behaviour can be represented in a wide range of different geometric situations; and
- Extensive improvements in the visual capabilities of the software packages with 3D simulation now almost standard.

With respect to motorway modelling almost all packages have seen improvements in how merge/diverge can be modelled and how motorway management techniques such as ramp metering can be modelled.

The micro-simulation software packages are still in an intensive development period and each developer, certainly for the main packages used in the UK (Paramics, Vissim, and Aimsun), are providing new releases on a regular basis. The competition to establish market share has driven development to meet user's needs and each package is now extending the capabilities it contains to cover a wider area of application.

Earlier versions of the individual packages showed weaknesses in certain areas. For example, Paramics was initially designed with large network applications in mind but reservations were expressed by some users as to the more generic approach to the detailed behaviour at junctions that existed and the lack of flexibility in parameter definition. In the case of Vissim, the degree of detail and flexibility of parameter definition at a junction level was considered by many to be a strength of the software but that this imposed a burden in developing large networks, as so many parameters needed defining. Each package has now moved some way to eradicating these issues as Paramics has extended the set of parameters that can be specified to control headway and gap acceptance at different junction types, and Vissim now enables larger networks to be more readily coded as it enables generic junctions to be defined which can then be enhanced by the user.

The above are typical of the nature of changes taking place in the software market and many of the differences that existed between packages in the earlier days no longer exist and each package, with the exception of SISTM, applies to motorway and urban areas and can model the integration between the two. Consequently, the pace of software development is such that any statement on the software status requires constant upgrade to ensure that it is up to date.

### 3.3 HA network related applications

Table 3.2 summarises the current known applications of each of the packages on studies on the UK motorway network. The developer's responses were supplemented by our knowledge of other motorway applications undertaken by consultants and for which the developer had no direct knowledge.

Paramics, Vissim and SISTM have all seen extended application on the HA motorway network.

### 3.4 General motorway / expressway applications

Table 3.2 summarises the current known applications of each of the packages on motorway applications outside of the UK. With the exception of SISTM and FLOWSIM the packages have seen extensive application for motorway / expressway modelling throughout the world.

### 3.5 Network and Driver Behaviour parameters and inputs

Table 3.3 provides a summary of the parameters specified in relation to the physical and driver behaviour elements input to micro-simulation models. The table reveals that there is considerable variation in the manner, and the extent to which, the user can specify factors.

In terms of vehicle types and vehicle specifications, each package enables a number of vehicle types to be determined with the minimum of vehicle types being five and the maximumas many as desired. All packages include default values for vehicle compositions, types and physical characteristics such as vehicle length and power relationships. In this respect, therefore there is little difference between the packages.

Speed distribution is a critical factor that influences motorway operations and plays a key role in success of variable speed limits in moderating and stabilising flows. All the software packages have one thing in common and that is that each vehicle that enters the network is assigned a target/desired speed that they will attempt to drive at subject to interaction with other vehicles and the network characteristics. However, there are fundamental differences in how the user can control the distribution of desired speeds from which the software will randomly select each vehicles desired speed.

In VISSIM, FLOWSIM, DYNASIM and SISTM the user is able to select the type of distribution used in allocating desired speeds and is able to enter in user specified speed distributions that equate to observed data. This provides the required flexibility in the system to model a key feature in the performance of motorways and to calibrate the models to known speed distributions.

PARAMICS, AIMSUN and DRACULA do not allow the user to specify a distribution, and desired speeds are drawn from a normal distribution with some capability to apply cut-offs for minimum and maximum speeds.

Each package has default values for vehicle acceleration /deceleration profiles and the impacts of gradients on these, although in some cases the defaults are meaningless in the context of motorway behaviour and are not applicable. Each package does however enable the user to specify acceleration values and profiles that enables the model calibration to different circumstances.

With the exception of SISTM all packages allow the modelling of horizontal curvature effects. In the case of Paramics, Aimsun, Dynasim and Dracula the packages automatically adjust speeds to allow for curvature effects. Vissim provides a facility for the user to apply speed reduction areas that are user specified to match the expected speeds in each situation. It is also noted that in the case of S-Paramics and Paramics Quadstone that the speed values determined from the geometry can be over-ridden by user specified values if required.

When asked which parameters were available for varying car following behaviour and their relative importance the answers were generally very consistent across all packages, albeit with different naming conventions. In order the key parameters were:

- Headway;
- Acceleration/ deceleration;
- Desired speeds;
- Gap acceptance for lane change;
- Driver reaction time; and
- Awareness of vehicles and obstacles in front

The user is able to modify each of these in one form or another thereby providing the ability to calibrate the model to local conditions.

### 3.6 Matrices and assignment capabilities

All the reviewed packages can accept vehicle matrices with a profile over time. In the case of Paramics, Vissim and Aimsun vehicle demands can be input as entry flows and turning proportions at each node entered. With the exception of SISTM and Dracula the packages now have dynamic routing control as well as the standard fixed control. There is an increasing availability of dynamic assignment techniques in micro-simulation models, and this is generally in response to increase in the spatial size of modelled areas. Paramics, Vissim and Aimsun have made significant changes to their dynamic assignment options in recent years and as such, the capabilities are significantly improved. This improvement in route choice is important in the context of motorway modelling; as there are distinct route choices made by drivers at merge and diverge as to which lane to select where double entry slips exist. Incorrect entry lane proportions can have a significant impact on model performance and hence ability to replicate this is highly important.

With the advent of Intelligent Transport Systems (ITS) and its application to the motorway and trunk road network, many of the packages have improved the representation of the influence of route guidance or advisory signage on routing and driver behaviour. The only packages that do not have this full capability are SISTM and Dracula as neither has dynamic routing.

### 3.7 Junction control

Table 3.5 provides a summary of the software capabilities with respect to junction control. With the exception of SISTM, which does not model junctions at all, the other packages are capable of handling all standard junction types and in recent times have improved their capability to undertake sophisticated traffic control.

### 3.8 HA motorway strategy modelling

Table 3.6 shows that almost all of the developers claim that their packages can model road works, accidents, ramp metering, variable speed limits, and narrow lanes. The brief descriptions provided indicate that in the majority of cases the modelling of these factors makes use of the tools available in the package and not by in built functions, although there are some exceptions to this. Consequently, there would appear to be considerable flexibility that would enable calibration to local circumstances and to incorporate new research as it becomes available, such as for narrow lane running effects.

A number of recent improvements made to the tools enable the detailed definition of motorway strategies and the modelling of their effects. However, in most cases the facilities available are only as good as the data that is available on the responses that drivers make when confronted with different interventions. It can be summarised that the packages now have many of the tools but there are still data deficiencies and driver responses for which there is limited availability of hard evidence.

It will be important in the study to identify the main areas of data and knowledge deficiency and suggest appropriate data collection and research programmes that would eventually lead to more informed specifications of certain response mechanisms.

### 3.9 Model outputs

Table 3.7 summarises the outputs that are directly available from each package. The range of outputs readily provided by the packages is rapidly increasing and more importantly, the user interfaces for extracting and analysing the extensive data have undergone considerable improvement in some packages, such as Paramics and Aimsun, and others are following this lead.

The volume of data available from a typical micro-simulation run is vast and covers a wide variety of data that can be post processed to provide detailed traffic and environmental related measures.

### 3.10 Random Seed recommendations

Finally, Table 3.8 presents the developers responses on the issue of random seeds and their impacts on model outputs. This is an important area for consideration in the study as it has implications for peoples perceptions of the outputs from micro-simulation models, their application in the provision of data to support economic assessments, and their implication for model turn round times when large scale motorway applications are under consideration.

Without question, each developer recommends the use of a range of random seeds, five through to fifteen appears to be common, and that this should be applied in calibration and testing of schemes. The random seed affects both the exact release of vehicles into the model and then how a vehicle acquires its characteristics from the various distributions. It is clear therefore that each run will produce different answers when different random seeds are produced, the critical factor to ascertain is how different will they be and how to ensure that statistically robust answers are obtained.

It is interesting to note that the software developers did not expect the outputs from different seeds to result in changes in flows, queues, and journey times of more than 5%.

# 4 Summary

# Summary

## 4.1 Summary

The software review carried out in the study has concentrated on gathering together detailed information from the developers of the main software platforms of potential interest to the Highways Agency. It was not intended that this review pass critical comment on the responses received from the developers or to make comparative judgements between the software platforms. The objectives of the review was simply to produce a statement of the current position of each software platform, and to ascertain which parameters the developers considered were most critical in modelling of motorway applications.

It was also important to understand which parameters in the software contained calibrated default values which should not be amended without good grounds and an evidence base to do so, and those that could be acceptably adjusted by the user to reflect the particular scenarios they are faced with.

It is evident that there is significant development taking place in each of the micro-simulation software packages as the range of applications to which they are being applied is extended. Consequently, in order for this review to continue to be a useful document it should be updated on a reasonably frequent basis.

It should be noted that the information provided in this review is therefore a statement of the developers views as to the features and capabilities of the respective packages. Any technical commentary on the actual outturn capabilities of the individual packages that are being subject to detailed testing, Paramics, VISSIM, AIMSUM and SISTM, will be separately reported.

## 4.2 Primary Parameters for Detailed Technical Assessment

The software review informs the more detailed technical work in that it identifies the main parameters that the individual developers believe have the greatest influence on how their software operates, particularly in respect of motorway and trunk roads in the UK. The parameters identified are summarised below and will comprise the starting point for the detailed technical testing in phase two of the study.

***PARAMICS***

***Headway -*** The mean headway between vehicles

***Gap -*** The minimum gap between vehicles

***Awareness and Aggression -*** Each driver has awareness and aggression values with the default settings using a normal distribution.

***Overtaking -*** The tendency to overtake on dual carriageway and on single carriageway roads is adjustable through the vehicle behaviour editor.

***Vehicle dynamics -*** Speed and acceleration are normally constrained when in following mode but the HGV incline constraints will have an effect on car following both by the vehicle itself and those behind it.

To the above list we have also added random seed, gradients, and HGV length.

***VISSIM***

***Minimum desired headway***
Strong influence on capacity.

***Temporary lack of attention***
This is a parameter that describes the possibility per second that a driver does not react for a definable time period (typically a few seconds) to their surroundings. This parameter allows to model breakdown in freeway flow.

To the above list we have also added number of observed vehicles ahead, following variation distance, random seed, and gradients.

***SISTM***

***Simulation time increment*** in sixteenths of a second (also known as the "epoch") - user can use values of 8, 10, 12 or 16; 10 is the calibrated value. This value is also used in car following and lane changing calculations as the reduced reaction time when a forced lane change is being made.

***Braking rate*** adopted if vehicle ahead's brake lights are seen - single parameter (known as P5) which the user can modifiy

***Driver's perceivable acceleration*** - single parameter (known as P8) which the user can modifiy

To the above list we have also added random seed, gradients, and distance to diverge signposts

***AIMSUM***

***Reaction Time***
It is critical factor for global results on traffic flows and queues.

***Max. Acc. / Normal Decel.***

***Desired Speed / Max Decel.***
Maximum deceleration allows higher risk levels, and desired speed.

***Speed Acceptance***
Determines whether the driver will adhere to speed limits

***Min Distance between Vehicles***
This parameter will slightly affect capacity but will be important for queue lengths.

To the above list we have also added random seed, gradients, and number of observed vehicles.

# APPENDIX A

Micro-simulation Questionnaire

# APPENDIX B

Micro-simulation Questionnaire: Detailed Developer Responses

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