Safe roads, Reliable journeys, Informed travellers

HIGHWAYS AGENCY

Software Review

An Executive Agency of the Department for Transport

Table 3.1 Software Status

	SIAS Ltd	PTV	TSS	Univ of Southampton	CITILABS	TRL / HA	ATKINS / ITS Leeds	QUADSTONE
1. Software								
Current Release	**S-Paramics 2005 Release 1**	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
Release Dare	July 2005	March 2005	June 2005	Expected to be released in 2006	September 2005	September 2005	October 2000	June 2005
Recent improvements in features for modelling of motorway applications	• ITS motorway control • ALINEA and other algorithms for ramp metering • True dynamic route advice, • VMS signing on m/ways dynamically modify speed limits and lane closures, notifies incidents and congestion detected within the model etc. • Waypoint routeing - improves control of route choice in large networks • Congestion delay perception adjusted by aggression and awareness of driver • HGV speed and acceleration on inclines improved with SETRA data	• COM-Interface: makes VISSIM programmable e.g. with Visual Basic; network elements and vehicles accessible; driver behaviour can be changed from outside during simulation. • Interface between VISUM and VISSIM (VISUM is our transport planning software): generation of VISSIM networks including routing from macroscopic assignments • Dynamic Assignment improved: stochastic path search delivers more routes; MSA as an option included to improve convergence	AIMSUN NG is a new software tool, not an improved version of GETRAM v4.2. AIMSUN NG: • Integrates the previous TEDI, AIMSUN and 3D • Enhanced GIS interface for Data Integration • AIMSUN NG Server: Multi-thread simulation / Multiple networks submitted to server • Universal tool: keeps and improves the interfaces to EMME/2, Transyt, Scats, Utopia, VS-Plus, and GIS and adds interfaces to Saturn, Contram and Cube (and a beta version to Paramics).		- All replications are now managed inside the software. Results from multiple runs are automatically compiled and statistical comparisons are generated. Reports and graphs may be generated instantly. - Dynasim has been integrated into Citilabs' Cube software suite. It is now possible to seamlessly move and share data between our Macroscopic models (Voyager, Trips, TP+, TranPlan) and Cube Dynasim. This includes Traffic Flows, Routes, Networks, Junction data, PT Routes and Timetables, background maps, etc.	• Improved signalling and ramp metering capabilities • Longer simulation times and more vehicles can be modelled • Simulation output can be plotted using the Motorway Traffic Viewer (MTV) software • Improved lane changing algorithm		
What developments are to be incorporated in the next release and when is it to be released?	Some ITS updates Due early 2006	Release 4.2 will come ca. February 2006 - parallel computing: a VISSIM simulation can be distributed among several computers; results are recombined as if computed by one machine. - social-force-model for pedestrians included as an option. (this is a first step, pedestrian development will continue) - enhanced 3D graphic possibilities: state dependent signal heads, raod surface textures	Core Model review, Curve turnings, Logistics Mesoscopic simulator. To be released next Summer	Fuel consumption and emission pollution	A progressive lane change logic has been developed which is providing even better representation of flows in congested conditions and in complex geometries. The vehicles are also given more awareness as they look forward considering multiple network objects in their route to their destination.	Car following algorithm will be modified so that shockwaves are produced - early 2006	New and improved driver behaviour modelling including: a new roundabout model, improved lane-choice and lane-changing model. These are to be included in the release in Nov 2005. Key features which will be included in the next release in autumn 2006 include: public transport reliability modelling incorporating explicit modelling of passenger demand, route choice and simulation; motorway merge models.	
What developments may be expected in the longer term and are there any development priorities? If so, what are they? When are they likely to be implemented?	Major updates to achieve the goal of an integrated multi capability software suite to realise the goal of supporting holistic- design teams in a multi paradigm environment. Due out in 2006.	Integrated project workflow for VISUM and VISSIM, i.e. you can not only generate a VISSIM network from VISUM but you can go back and forth between the micro- and macro-model. - pedestrian model improvement: ped routing on tactical and strategic levels - export to 3D rendering software to produce highest quality animations	AIMSUN NG is becoming a multi-use integrated environment, and future developments will: - Improve the present capabilities, like adding user equilibrium based route choice - add new transport applications that allow new projects, like adding new macro/micro dimensions from Land -use to specific Pedestrian modelling	Interface with GIS to generate layouts and to input	Our primary priority is developing a simulation that is the most 'usable' working for the users and making their job easier. We are also committed to improving and expanding the integration with the Cube suite of software and working more closely with traffic control vendors.	Extension of modelling area to include the all purpose road junction feeding into/out of slip roads	Driver day-to-day learning models with traffic control; second-by-second noise and pollutant emissions modelling; development of (intersection) safety models; Incident generation and management; development of separate driver and vehicle models. Some of these are on-going research activities; the results of which will be implemented to DRACULA in 2-3 years time.	

Table 3.2 HA Network Modelling

2. HA Network Modelling	In terms of projects specifically related to the Highways Agency, please describe what motorway modelling has been undertaken with your software?
S-Paramics 2005 Release 1	• M11 Stansted • M6 Junction 1 • M42 between Junctions 5 and 6 • M42 ATM • M4 Bus Lane E of Heathrow • M18 between Junctions 2 and 4 • Whole of A1 past Newcastle/Gateshead • M6 Junction 40 • A14 Cambridge To Huntingdon • A27 Worthing to Lancing • M6 J3 Coventry • M5 Naish Hill • M5 Junction, Weston-super-Mare • M4 / A419 Commonhead Roundabout, Swindon • A17 Trunk Road at Wisbech • M74 Completion Scheme • M8 Baillieston to Newhouse • M8 Harthill Climbing Lane testing • M8 J13 to J29 road works modelling • M8 White Cart Road works modelling • M9 Glenbervie slips • Fife and West Lothian Regional Models also include large chunks of motorway (M8, M9, M90) • M8 Ramp Metering with ALINEA • M8 J2 Claylands & Newbridge model(s) • A720 Edinburgh City Bypass • A9 Perth Western Bypass • A90 between Perth and Dundee • A90 Dundee Kingsway • A92 Preston to Balfarg Corridor study • M8/M9 Newbridge Interchange • M8/M9 Newbridge Interchange • M8 Terminal Junction at Hermiston Gait • A720 Sherifhall Roundabout • A28 between Armagh and Newry, Edenaveys and Tullyhappy. • A7 between Crossgar and Carryduff • A3 between Armagh and Portadown • A13/M25 Lakeside Widening • M62 Junction 6 Improvements. • M4 Making better Use Study for the Welsh Assembly Government. • Study of the M25 involves the development of traffic models at three levels of detail - strategic, local and operational. • Working on a Paramics model for the M25 between Junction 27 and 31. • Working the M25 Golden triangle and simulating ATMS operations on the M42 • Work on the M25 for an inquiry into the location of potential MSAs down on the south west quarter • Work on A8000 near Edinburgh • M4/M5 Bristol Motorways • M5 J16/17 • M1 J13 • M25 J6 and J26 • M4 J11 • M4 J4 Hanley Cross • A2 in Kent • Access to the A2 from Easton Quarry
Vissim 4.10	M1 Junctions 31 to 42 M18 Junctions 1 to 3 M60 Junctions 6 to 18 M60 Junction 24 M62 Junctions 23 to 37 A1(T) Gateshead By-Pass
Aimsun NG 5.0	M1 Junction 19 Road Based Study M25/A2 Area A429 DBFO A470 Making Best Use Study
Flowsim 2.0	Ramp metering/merging, Lane loss, Diverge, VSL, Convoy, ACC
Cube Dynasim V.1.4.15	None in UK to date
SISTM	(1) M25 J10-16 (both carriageways) for Controlled Motorways (2) M42 J3A-J7A (both carriageways) for the development of NASS (3) M6 J20 northbound for ramp metering (4) M27 J10 & J11 eastbound for ramp metering (5) M8 Kingston Bridge - different lane configurations for roadworks (6) M2 (NI) - ramp metering
DRACULA	BB - Motorway Speed Control - M25 (Ronghui - ITS), Calibration of New Car Following Models - M25 (Ronghui Liu - ITS), M27 amd M8 - Development and Calibration of A Motorway Merge Model (Ronghui Liu - ITS), M5 J22 -J20 Contra Flow Testing (Atkins - B Betts/R Hale)
PARAMICS V5.1	None
Has your software been used for Motorway/Expressway modelling in countries outwith the UK?	
S-Paramics 2005 Release 1	• SH20 Mahunga Drive / Rimu Road Ramp Metering Opus was involved in the development and inception of an 'easy merge' ramp signal (ramp metering), in conjunction with the client, Transit NZ, in an effort to create a suitable system to control the rate and volume of traffic entering the motorway. Special features of the project included: the introduction of the ramp metering SCATS algorithm, but with some modifications suggested to the RTA to adapt the algorithm to be suitable for Auckland traffic conditions. • **A.T.M.S** – Auckland Harbour Bridge, New Zealand • SKM has constructed a Paramics model for the peak periods (AM 6:00am to 10:00am and PM 4:00pm to 7:00pm) of the Northern Motorway in Auckland, New Zealand. • Alkmaar ring road Simulation of the dynamic adjustment of the green wave on the Alkmaar Ring • Antwerp: • M50 Upgrade (for various appellants to the scheme), • Global Health private Health Care Facility (Private client), • M50 Toll plaza upgrade, second crossing (National Toll Roads), • Nuova Fiera Milano Systematica Spa has been charged to develop many S-PARAMICS traffic model of the new "Fiera Milano" accessibility road layout.
Vissim 4.10	In Germany: many applications, e.g. at the ABDS = Autobahndirektion Südbayern = South Bavarian Highway Agency In USA: many applications at Caltrans (= department of transport in California), etc. VISSIM has many hundred users all over the world. There are lots of freeway applications. Please understand that we as a vendor can not track all applications of the product. To get an impression, just scan the last Preprint-CD-Rom of the TRB annual meeting for the keyword "VISSIM". Some examples: "A Micro-simulation Model of a Congested Freeway using VISSIM." by Gabriel Gomes, Adolf May, Roberto Horowitz, U.C. Berkeley, TRB 2004 "I-85 Traffic Study: A State-of-the-Practice Modelling of Freeway Traffic Operation" by D. Ni, K. Strickland and C. Feng, presented at the Summer Simulation Multi-Conference. "Traffic Flow on Freeway Upgrades" by Werner Brilon and Andrea Bressler, TRB 04 - 2953 Many papers are available for download at: http://www.ptvamerica.com/library.html
Aimsun NG 5.0	Frankfurt, Germany, Barcelona, Spain, Bolonia-Fireze Motorway, Italy, - Auckland, New Zealand, Toowoomba bypass, Australia, Santiago de Chile, Chile, Stockholm, Sweden – Hangzhou, China – Helsinki, Finland – Alpine Tunnel, Switzerland – Pretoria, South Africa - Prague, Txequia, Rotterham, Holland, Minnesota, USA. All these just as an example to illustrate its extended use all over the world
Flowsim 2.0	U.K. and EC Projects (e.g. DIATS, TACO, AVERT, RTA, RHYTHM, etc.) Beijing Urban Expressway (Ring road intersection Traffic control)
Cube Dynasim V.1.4.15	Around the world, Dynasim has been used extensively for modelling motorways including: Construction staging, HOV and HOT lanes, Toll Facilities, Exclusive Truck Facilities, ITS Projects, Ramp Metering Strategies, Additional Lanes and New Geometric Configurations, Narrow Lanes, Shared Lanes and Exclusive Lanes.
SISTM	None
DRACULA	DRACULA has been used in Brisbane and Perth, Australia and New Zealand to model motorway and urban interchanges and motorway merges. The model has been used in South Africa to model an inter-urban expressway.
PARAMICS V5.1	Yes - widely used on motorways/freeways in over 40 countries Applications are too numerous to mention, however examples include California I680, I80, SAC50, Florida I5, Wisconsin FSOA, Indiana, In Europe: Gothenburg Helsinki Stockholm Germany, France, Italy, Netherlands, Belgium. Australia; Sydney, NSW, Brisbane, Queensland, Adelaide, South Australia, Melbourne, Victoria, Western Australia, Perth, Hobart Tasmania,

Table 3.3 Network Inputs

3. Network Inputs	A number of network modelling inputs that are important for motorway modelling are identified below. Please indicate if these are elements which are included in your software and whether or not they can be easily modified by the user.						
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM**	**DRACULA**	**PARAMICS V5.1**
Traffic Composition	*Default* YES *User Definable* YES Up to 32 different vehicle classes. Each class may be allocated to a vehicle type group and the proportion of that class in the group defined. Each group will then have an OD trip matrix assigned to it with time based.	*Default* YES *User Definable* YES For each traffic input or OD-matrix, a traffic composition can be defined as percentages of user defined vehicle types.	*Default* YES *User Definable* YES Different vehicle types, each one with its own time-sliced matrix; plus time tables for Public Transport (Buses, LRT…). This data can be imported from other applications.	*Default* YES *User Definable* YES Traffic is classified into 5 categories: Car, Van, Bus, Lorry and bicycle. There is a default setting D153 composition rate. Users can define composition by a dialogue interface.	*Default* YES *User Definable* YES Through vehicle definition screens within the software	*Default* NO *User Definable* YES 5-minute O/D matrix for each vehicle class	*Default* YES *User Definable* YES Proportions can be specified for buses, taxis, HGVs and LGVs. The default traffic composition is 100% car	*Default* YES *User Definable* YES Vehicles classes represent a proportion of each OD matrix with multi-level OD matrices available. A single vehicle class can represent 0.01-100% of an OD matrix. Vehicles classes can be OD based or fixed route.
Vehicle Types/Classes	*Default* YES *User Definable* YES The default vehicle types may be adjusted and each vehicle type has individually configurable physical, behavioural, dynamic and visual properties.	*Default* YES *User Definable* YES The user can define an arbitrary number of vehicle types. A vehicle type comprises a large set of characteristics of vehicle and driver.	*Default* YES *User Definable* YES The possibility of defining as many vehicle types as required, plus a library of default vehicle types, each one characterized by a list of parameters and the value for each parameter is generated at the same time as the vehicle, sampling from a truncated normal distribution.	*Default* YES *User Definable* YES Traffic is classified into 5 categories: Car, Van, Bus, Lorry and Bicycle	*Default* YES *User Definable* YES Through vehicle definition screens within the software	*Default* YES *User Definable* YES Data on vehicle performance, i.e. acceleration and braking rates, reaction to gradients. Up to 8 vehicle classes can be defined.	*Default* YES *User Definable* YES There are currently seven types of vehicle defined in DRACULA. These are dummy vehicle, small passenger cars, bus type 1, bus type 2 (e.g. guided bus), taxi, light goods vehicles & heavy goods vehicles.	*Default* YES *User Definable* YES Limitless vehicles classes with default and user defined characteristics available, both physical and behavioural.
Vehicle Length	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES
Speed Distributions	*Default* YES *User Definable* YES Every vehicle has a "target" speed determined by the geometry and assigned values of the link, the physical capabilities of the vehicle and the values of Aggression and Awareness – which are randomly assigned from a configurable distribution. Therefore speed distribution is not input as such but is derived from physical and psychological conditions.	*Default* YES *User Definable* YES Desired speed distributions can be defined as empirical distributions.	*Default* YES *User Definable* YES There is a parameter called 'desired speed' which determines the speed at which the driver would like to drive. The de-facto speed is conditioned by elements like surrounding traffic conditions, top legal speed or the 'speed acceptance' parameter.	*Default* YES *User Definable* YES Desired speeds are normally distributed according to the speed limit of a road link. Users can modify the distribution by input	*Default* YES *User Definable* YES Through vehicle definition screens within the software	*Default* YES *User Definable* YES User can supply a distribution for each vehicle class; normal, uniform, Poisson or a user-defined distribution can be input	*Default* *User Definable* Speed distributions are implicitly specified in DRACULA through the modelling of individual drivers' desired speed factor. All vehicles have a desired speed factor which controls how fast the vehicle wants to travel relative to the average link speed. Minimum and maximum values for the desired speed factor can also be specified, meaning that there is a range over which the desired speed factors may be selected. In the micro-simulation, each vehicle has its own desired speed factor which is randomly selected from a normal distribution	*Default* NO *User Definable* NO Vehicle Speed is an output Cannot be selected as an input parameter. Parameters are available to limit and control the desired speed of vehicles. Desired to target speeds will vary depending on individual vehicles characteristics such as Aggression and Awareness.
Vehicle Acceleration / Deceleration	*Default* YES *User Definable* YES OGV acceleration and deceleration is adjusted according to incline and the implied deceleration to a gradient dependent maximum speed.	*Default* YES *User Definable* YES User defined speed-acceleration-functions are assigned to the vehicle for maximum technical acceleration and deceleration, and for the acceleration and decelerations applied by the driver if no special situations take place.	*Default* YES *User Definable* YES Three main parameters for its control: maximum acceleration, maximum deceleration and normal deceleration. The value of acceleration/decceleration is calculated by functions also using factors like reaction time, distance to desired speed or distance to vehicle in front.	*Default* YES *User Definable* YES Acceleration/deceleration rates are calculated by a Fuzzy Logic based Car Following model based on car following conditions and individual driver behaviour.	*Default* YES *User Definable* YES Through vehicle definition screens within the software	*Default* YES *User Definable* YES User can supply a distribution for each vehicle class; normal, uniform, Poisson or a user-defined distribution can be input	*Default* YES *User Definable* YES Vehicle acceleration and deceleration values are entered for normal acceleration rate, maximum acceleration rate, normal deceleration rate and maximum deceleration rate. For each characteristic four pieces of information can be specified: the mean value, the coefficient of variation, the maximum value and minimum value.	*Default* YES *User Definable* YES Acceleration profiles by vehicles type can be input by text file input. Both a default and the TWOPAS gradient model are available
Gradients	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES
Speed Reduction for Horizontal Geometry	*Default* YES *User Definable* YES Maximum speeds are inferred from the curvature of the link to keep the horizontal acceleration due to curvature to 0.3g. Similarly at junctions the position and angle of the locus points infers a maximum speed.	*Default* YES *User Definable* YES Stretches of the road can be defined as reduced speed areas. If a driver approaches a reduced speed area, his desired speed is set according to the desired speed distribution defined for that reduced speed area. When leaving the area, the original desired speed is restored.	*Default* YES *User Definable* YES Speed is calculated according to the radius of the curve, but that speed is an explicit parameter that the user can edit for calibration. For instance, the user can detect a too long queue and realise that it is so because of a too low turning speed in a nearby intersection.	*Default* NO *User Definable* NO	*Default* YES *User Definable* YES Parameter on the trajectory	*Default* NO *User Definable* NO SISTM does not model curvature	*Default* NO *User Definable* YES As with gradients, the bendiness of a link is taken account of when determining the free flow speed of a link.	*Default* YES *User Definable* YES Automatically calculated from curve radius and super elevation factor. Can be overridden by user by adjusting Curve Speed Factor and link speed if observed speeds differ from default safe link speed.
Vehicle spacing at standstill?	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES

Driver Behaviour What parameters are available to vary car following behaviour and can they be modified by the user? Please list these in order of priority (i.e. most effective first and describe how they are used)	*Default* YES *User Definable* YES ***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.	*Default* YES *User Definable* YES ***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. ***There are many more parameters to influence driver behaviour.***	*Default* YES *User Definable* YES ***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. Some more for overtaking or in case of local circumstances	*Default* YES *User Definable* YES Relative speed to leading vehicle Driver preferred following distance (time headway) Separation (time headway) Vehicle type	*Default* YES *User Definable* YES ***Headways*** A primary input to the car following logic. This parameter is critical in determining the stability and capacity of the flow. ***Standstill Distance*** As flow breaks down in congested conditions, this parameter becomes. ***Look Ahead Distance and Reaction Times*** These parameters are critical to defining the stability of flow and the speed and length of shockwaves in the system ***Lead/Lag Gap Acceptance for Lane Changing*** These parameters are critical for defining the aggressivity of lane changing and are of course a function of the vehicles speed	*Default* YES *User Definable* YES ***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	*Default* *User Definable* DRACULA contains a car-following model which calculates a vehicle's acceleration in response to its desired speed and the relative speed and distance of the preceding vehicle. Depending on the magnitude of the relative distance, a vehicle is classified into one of three regimes: free-moving, following or close-following. The parameters required to determine the progress of vehicles are: the ***desired speed*** (relative to the mean speed on any individual link), the ***desired minimum headway***, the ***reaction time***, the ***rate of acceleration*** and the ***rate of deceleration***.	*Default* YES *User Definable* YES ***Mean Target Headway*** - the target time (headway) between a vehicle and the preceding vehicle ***Mean Driver Reaction Time*** - The time lag between a the change in speed of a vehicle and the reaction to that speed change by the following vehicle ***Aggression*** - The individual aggression parameter of a vehicle will determine and influence (mainly) the speed of free flowing vehicles, lane choice, target headway and overtaking stimuli. ***Awareness*** - parameter determines if a vehicle follows vehicle in front or a vehicle further in front
Can driver awareness (of other vehicles) be influenced?	YES The gap acceptance factors - how far to look and what gap to accept are adjustable. At junctions the "visibility" measure controls when vehicles begin to make gap acceptance decisions as they approach a junction.	YES - the user can choose, how many vehicles ahead can be seen by the driver - if specified, the vehicles on the neighbouring lanes can affect the driver by their lateral position.	YES Two main models: visibility distance (local parameter) and two-lane model (in order to evaluate conditions in neighbouring lanes when driving and also feel 'friction').	YES The average speed of vehicles 50m ahead.	YES This is considered in their 'look ahead' distances. Also certain link types can be made aware of conflicting vehicles approaching to merge.	YES The car following model uses the perceived braking rate of the vehicle in front. This can be specified as a distribution that is correlated with driver awareness (and is also vehicle class dependent)	YES The new motorway merge model, currently in test version, explicitly models the influence of the ramp traffic on motorway traffic and vice versa.	YES Aggression and Awareness can be modified via GUI and text file Gap acceptance can be adjusted to suit individual locations and vehicles classes. Visibility can used to influence gap acceptance at intersections/junctions.
Merge/Diverge Areas How does your software deal with the modelling of them in congested and un-congested conditions? How are vehicles informed of the need for a lane change? How does main line traffic behave with regard to merging slip road traffic in un-congested conditions? How does the model deal with slip road merges in congested conditions (e.g. merge in turn?)?	Vehicles proceed in normal conditions with a range of acceptable lanes. They will select a lane from this range with more aggressive or faster drivers tending to the right. If congestion in one lane means another is more attractive, they will change lane. At the hazard warning distance from a merge, diverge, lane gain or drop, or junction they will re-assess their lane range based on the manoeuvre they are about to make. This distance is varied by aggression and awareness. If a vehicle is blocked from making this lane change by traffic then it will probably receive a "courtesy slow" from another vehicle which will allow it to make the lane change. Note that these vehicles must be moving to be able to slow to create the gap. At ramps the merging vehicle will adjust speed to match a gap and vehicles on the main carriageway will make "courtesy slow" speed adjustments and "courtesy lane change" manoeuvres to allow mergers to enter the main carriageway. At pinch pointsseveral merge arrangements can be represented, such as merge in turn and lane changing in advance of road works. These responses can be controlled via fixed hazard signposting and VMS gantries within the model, and the distance of the required manoeuvres from the hazard defined.	VISSIM implements a cooperative merging model. Vehicles know their routes and thus know, where they have to change lane at the latest. The merging vehicle adapts his speed to the speed level of the main stream and is able to anticipate arriving gaps. The gap acceptance model allows smaller gaps if the lane end is approached. The vehicles in the main line cooperate, i.e. they decelerate in order to widen a gap and let the merging vehicle in. In congested merging conditions, a set of special behaviour rules are implemented, e.g. relaxing space gap conditions to avoid deadlock situations if two vehicles want to swap lanes.	Vehicles are informed of the need for a lane change through two parameters: zone 1 and zone 2, which are time distances to the critical point (depend on driver and vehicle type). The first time distance represents the first information, but the lane-change initiative may come to be cancelled due to other factors like traffic conditions. The second time distance is the one during which changing lanes becomes the first priority and the driver must change lanes. As traffic conditions worsen, the drivers run less risks and change lane sooner. As for acceleration lanes, there are two available models, one in which drivers begin to look for a gap as soon as they enter the acceleration lane, and a second one in which drivers first use the lane to accelerate and once they are reaching the end of the lane, they try to change lane. In fluid conditions drivers in the main lanes will try to move out of the first lane to generate space for the in-coming ones. As traffic becomes congested, their 'friendliness' will decrease.	Traffic on motorway carriageway will show different speed and headway distributions in congested and un-congested conditions. In FLOWSIM, the fuzzy logic based car-following and lane change behavioural models can recognize these differences automatically, and will show different car-following and lane change behaviour. If taking merging from a slip road as a type of lane change, then there are three different types of lane changes in FLOWSIM model. These are: (1) merge from slip road, (2) forced lane change, and (3) optional lane change. Merge: vehicles get the information of the need for a merge from road link attributes, and then follow the fuzzy logic based motorway merge behavioural model for a merge performance. Forced lane change: vehicles get the information of the need for a forced lane change by comparing their journey route and the road link attributes, and then follow the fuzzy logic based motorway forced lane change behavioural model for a forced lane change performance.	Vehicles are set with a look ahead distance or awareness. They are aware of a need to exit and are aware of how far they are from the exit and how many lane changes must be made to exit. The vehicles then go through three stages. In the first, they are initially informed of their need to exit and are more reluctant to change lanes in the opposite direction of their exit to improve their condition. In the second stage, they begin attempting to change lanes to their exit. The closer they get the more aggressive they become. Finally, the last stage is a defined 'emergency stop' location at which point they will force a lane change regardless of the availability of a gap. In congested conditions when the traffic has completely broken down and there is queuing on multiple legs, the vehicles will take turns and each vehicle on the mainline will allow a vehicle on the ramp to enter... This is somewhat controlled through the vehicle aggressivity though. Sometimes you see a couple from the ramp slip in and other times you see vehicles on the mainline which did not give a courtesy merge.	No difference in modelling in congested or uncongested conditions. In merge areas, drivers on the entry slip road are given a lane changing score which reflects their desire to move right into other slip road lanes and onto the main carriageway. Main carriageway drivers upstream of a merge area are given a lane changing desire to move from lane 1 to lane 2 to create gaps for merging vehicles. In diverge areas, drivers are given a lane changing score which reflects their increasing desire to move into lane 1 (or a lane that continues into the exit slip road) upstream of the diverge. In all cases users can give their own values for the lane changing desires and the locations where these become active. Each merge or diverge can be configured differently. Default values can also be used.	A new motorway model is being developed for DRACULA and is expected to be released in 2006. The new model explicitly models the acceleration lane and the interactive behaviour and influence between the merging and the motorway traffic. In the current DRACULA model, merges are modelled as priority junctions with a turn priority marker M coded in the network data file to tell the software that the junction is a merge. The merging traffic at the junction gives way to one stream (one lane) of traffic from the right. The decision to merge is controlled by the gap-acceptance model within DRACULA. This represents the critical gap (seconds) in the opposing stream of traffic that the driver feels safe to accept: if the gap is greater or equal to the critical gap, then the driver merges, other wise he slows and waits until a suitable gap is available. The key parameter for gap-acceptance is the normal acceptable gap (in secs) for the manoeuvre being contemplated. DRACULA allows the minimum gap to be reduced if the traffic is very heavy and moves slowly-a representation of frustation on the part of the waiting traffic.	Merging vehicles attempt to merge onto highway using user defined parameters unique to ramp/merging traffic. Vehicles on mainline are aware of the vehicles attempting to merge and may perform a lane change to create a gap for merging vehicles if there is an available gap in the lane to their right. Diverging is controlled by link-based signposting. Vehicles are aware of their route, however the lane choice for each path is derived to each vehicle based on a signpost distance (from the diverge) and graduated by the vehicle's awareness and the signpost range parameter. Vehicles can see beyond the next downstream diverge by using a Lanechoices feature which is a path based signposting rule and allows vehicles to arrange themselves by lane based on their routing path

Table 3.4 Matrices and Assignment

4. Matrices and Assignment								
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
Traffic Input (Matrices/Turning Proportions/Both)	BOTH Traffic input may be by matrix or by a fixed route. S-Paramics also has a matrix estimation module which is used to refine an OD matrix if link and turn counts are available	BOTH	BOTH	MATRICES	MATRICES	MATRICES	MATRICES	BOTH
Can matrices be profiled over the model time period?	YES Separate demand matrices may be used for different time periods. More detailed trip departure profiles (5 minute intervals) may be used and assigned individually to a trip, set of trips or to an origin zone	YES Matrices have a time interval for which they are valid. Several matrices may overlap in time.	YES Separate matrices. Those matrices can be imported from other applications (Excel, Emme/2, Saturn…)	YES Separate Matrices	YES Individual matrices are developed for each time slice	YES An O/D matrix is required for each 5-minute period and for each vehicle class	YES Demand levels can be profiled over the model time period within DRACULA.	YES Demand can be periodic, containing OD specific profiles, split by user class, journey purpose, vehicle type etc., intervals of 5 minutes can be profiled
Routing Control (Fixed Routes / Dynamic Assignment)	BOTH	BOTH	BOTH	BOTH	BOTH	FIXED	FIXED	BOTH
Generalised Cost Options (Time / Distance / Surcharge (Tolls) / All)	ALL	ALL	ALL	TIME	DISTANCE, TOLLS 'TRIGGERS'	NONE	NONE	ALL
Please describe the assignment methodology which should be adopted for your software	First a hierarchy of major and minor routes which are perceived differently by familiar and unfamiliar drivers is required. The coefficients of the generalised cost equation are then set for the model although these may also be set individually for each vehicle type. • Route cost perturbation will then ensure that multiple routes are chosen. • Route congestion feedback to the familiar drivers will adjust the cost for a trip • Variance in cost	Dynamic assignment by iterated simulations to reach a stochastic user equilibrium. -Route choice function of type Kirchhoff (equivalent to a Logit function with logarithmis costs) -general cost function (travel time, distance, toll, other cost) user definable for driver classes -MSA or exponential smoothing of travel times from one iteration to the next. -special treatment of congested links	For a Highway model with no route choice variation during the simulation period, Fixed Routes. For a mixed model with dynamic route choice according to traffic conditions along the day, then 1. Evaluate the mean time between origin and a destination. 2. According to that distance choose a value for the 'shape factor' parameter of the logit function. 3. According to the attractiveness that high capacity enjoys over low capacity, choose a value for the 'Capacity penalization' parameter.	Traffic is assigned to the 'shortest route' with flow applied to the network in 8 iterations with consideration of the varied journey times after each assignment	Users may limit routes as they wish. Routes may be limited until only one is available if they wish to define the routes explicitly. The simulated vehicles are trying to reach their destination and are trying to improve their condition locally as well as for the trip overall. 'Triggers' may also be defined where the traffic can be routed locally based on some perceived congestion or queuing on the upstream portions of the network or based on information given to the vehicle via some other outside influence (ITS Technologies).	No assignment	DRACULA models usually take their network structure, demand and routing patterns from a SATURN model, so the assignment methodology should be considered at this stage of the modelling process.	Vehicle's routing is calculated 'on the fly' from routing tables that take into consideration vehicle position, destination zone, familiarity, link restrictions at the basic level. Stochastic assignment includes variation in perceived cost and Dynamic Assignment adds congested costs to familiar drivers for route selection. All vehicles store their path based on the next two downstream intersections only, as this allows routing to change dynamically with the simulation time.
Does this allow a converged assignment to be achieved in all conditions?	No	No. (MSA will provide a converged solution in nearly all cases of practical relevance)	Yes.	Yes	Depending on the simulation. If there are extreme events being simulated (Random Incidents or Lane Closures) convergence may not be achieved.		A converged assignment should have been achieved during the SATURN stage of the modelling.	As a dynamic model Quadstone Paramics does not run iterative loops. Every vehicle determines routing as they pass through an intersection that offers a route choice.
Can vehicle paths be influenced by Route Guidance / Familiarity?	YES An ITS sign which is either a roadside Variable Message Sign or a network wide broadcast unit may be used to inform vehicles of delays at route choice waypoints or of amended speeds on road sections.	YES Familiarity: the network available to a vehicle class can be restricted in order to model incomplete knowledge of the road network. Route Guidance - Variable message signs can be modelled by so called partial route decisions, i.e. a network element that overrides a part of the route of vehicle	YES A wide range of global/local Route Guidance/Familiarity phenomena can be achieved in all vehicles or just a subgroup through the use of guided vehicles, ITS elements like VMS and parameters like compliance percentage. Familiarity can be directly modelled with the use of detectors' data and/or statistics from previous simulations(driver's memory).	YES Route guidance is considered by vehicle route re-assignment/change. All drivers are assumed to have the same familiarity of the road network	YES Triggers may be set simulating route guidance technologies. Available routes may be limited simulating user familiarity of different user classes.	PARTLY Routeing is fixed, but user can influence the lanes that drivers use	NO	YES Routing can be modified/influenced by: Major/Minor link hierarchy, Routing category/hierarchy, Link cost factors, Familiarity/unfamiliarity, VMS/route guidance/ITS etc using API (Programming) tool
How does this model deal with 'abnormal blockages'?	A vehicle attempting to change will proceed at reduced speed in the wrong lane. It may be offered a gap to move into by another vehicle but if no courtesy lane change opportunity is available it will eventually get to the point where it has to make the turn and will do so from the wrong lane. A vehicle that finds its path across a queued stream of traffic is blocked will eventually force its way across.	There is a possibility in VISSIM to define a maximum waiting time for a vehicle in a lane changing process, and after that time the vehicle is removed from the simulation.	In case of congestion the vehicle has to wait. In case of acceleration lane, give-way or stop the vehicle becomes increasingly aggressive. In case of an intersection, the user has the option of activating a feature that will remove such an obstructing vehicle.	In motorway merge, when approaching the end of a slip road, a merging driver will take smaller gaps. In very congested condition, drivers may have to stop at the end of slip road to wait for a suitable gap.	Vehicles are always able to change lanes. If a vehicle reaches it's defined emergency stop location and couldn't work out the lane change, it will force a merge into the traffic.	In such a situation the vehicle will just sit there until a gap arises	In DRACULA, the abnormal blockage is minimised by two explicit behavioural models of drivers' lane-changing. Firstly, DRACULA models the cooperation behaviour of drivers in the major flow or the target lane who provide courtesy yielding to create gaps for the lane-changing vehicle. Secondly, the variable gap-acceptance model in DRACULA represents the in driver behaviour in that the accepted gap values decrease as a function of wait-time.	User controlled option to reroute exists - vehicles in the wrong lane for a turn have the option to take another exit and detour to reach destination Critical lane changing exists for vehicles which are outside their correct lane
Can vehicles overtake others on the same lane? eg car passing motorcycle	NO	YES	NO	NO	YES	NO	NO	NO

Table 3.5 Junction Control

5. Junction Control								
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
What parameters/options are available for priority junction / roundabout control?	Turn priority. Lane choice Stop lines where a vehicle waits for a gap in traffic Kerb points for road geometry Visibility to describe where vehicles are able to see oncoming traffic and hence can react to it Gap acceptance modifiers for junction specific conditions Link end stop times Link end speeds to prescribe turn speed or to simulate traffic calming measures. Signpost distance to inform vehicles to consider moving to the correct lane.	For each conflict point, gap acceptance can be defined. It can be differentiated between stop signs and yield signs. Gap acceptance can consider time gaps and spatial gaps.	There are several options. The simplest one is just priority signs; it is even possible to define a matrix of priorities for complex intersections.	Gap size (time), vehicle types, etc. For example, a Bus or HGV will need a larger gap than a car.	Any type of junction may be modelled. Priority of vehicles is established through the use of different priority objects placed in the simulation.	SISTM cannot model all purpose road junctions	For roundabouts, parameters are available to define circulating speed, the acceptable gap (sec) used upon entering the roundabout and the distance on a roundabout which the entry traffic would look back for potential conflicts. For priority junctions, several parameters are available including: acceptable gap (secs), miniumum acceptable gap (secs), waiting time before reducing acceptable gap (secs), waiting time (secs) before taking on the minimum acceptable gap, and a courtesy	Turn priority to establish priority hierarchy. Visibility is used to determine how far from the stopline/give way a vehicle can see conflicting vehicles in order to identify an acceptable gap. Patience, an internal parameter to replicate a driver's willingness to take a smaller gap if there is no acceptable gap in a designated time frame. Stopline location and gap acceptance criteria to adjust the positions of the give way locations and the acceptable gaps criteria. Roundabout behaviour to replicate more realistic gap acceptance/merging at roundabouts. Entry/exit lane specification to replicate the designated lanes, circulating and entry, for the desired exits. Link stop time to replicate any position where vehicles stop completely before considering a gap. Link end speeds to represent points where vehicles slow down before considering a gap. Signposting distance to replicate the distance drivers become aware of which lane to choose for their desired exit and signposting range to show variance in the signposting parameter. Nextlanes to replicate the preferred downstream lane.
Are the values associated with these parameters variable (e.g. by vehicle type)?	YES	?	YES	YES	YES		? Some of these parameters can be defined for specific junctions and links, eg the gap acceptance parameters can be defined for individual junctions. They can not be defined by vehicle type, as they are applied to all vehicles.	SOME
Are there any standard parameter sets available which would produce results comparable with empirical programs such as ARCADY / PICADY?	NO	NO	YES/NO Believes it is possible, but is checking.	YES Yes. For example, a Bus or HGV will need a larger gap than a car. Yes. For, example: delay, queue length, journey time, etc.	NO However users have created their own in other areas. This is just a reflection of the software being new to the UK and parameter set not having been published yet.		NO	YES Documents available that provide comparison results between ARCADY, PICADY, TRANSYT and Quadstone Paramics
Can lane specific parameters be defined?	YES	YES	YES	YES	YES		NO	YES
Can 'Yellow Boxes' be included (at least the behaviour can be modelled)?	YES	YES	YES	NO	YES		YES	YES
Can network elements be linked to specific vehicle types?	YES	YES	YES	YES	YES		YES	YES
Can variable cycle times be modelled?	YES	YES	YES	YES	YES		NO	YES
Can selective vehicle detection be modelled? (e.g. bus priority schemes)	YES	YES	YES	YES	YES		YES	YES
Can different signals plans be called during model periods?	YES	YES	YES	YES	YES		YES Different signal plans can be called if modelling schemes such as bus priority.	YES
How are saturation flows treated in the software? Are they an input parameter? Does lane width / gradient / geometry etc. influence saturation flow?	Saturation flow is used in S-Paramics only during the "Equisat" signal time optimisation process where it may be calculated from the geometry of the junction and the opposing turn counts Saturation flow is not used as an input parameter. Saturation flows may be measured for junctions by observing the headways of vehicles as they cross a signal stop	Saturation flows are an outcome of the settings of the driving behaviour parameters. In the manual, parameter settings are given to achieve certain saturation flow values.	Saturation flows are a result, but Level of Service (Standard) can be visualized and statistical results can be compared to Capacity (input parameter). Characteristics like continuous lines or reserved lanes and parameters like gradient or zones of the section will affect saturation flow. Part of the geometry affects.	1.) No special treatment required for saturation flows in FLOWSIM. 2.) Influence of lane width may be considered by defining different speed limits of link/lane attributes. 3.) Influences of Gradient/geometry etc. on saturation flow are not considered.	The achieved saturation flows are a result of the vehicle definition, mix, network geometry, and control. Certainly this is a primary calibration parameter that should be checked and verified.		Saturation flows are not input into DRACULA. Instead, junction or turn saturation flows are determined by the car-following rules used by the car-following model. The rate of flow of vehicles through a junction therefore depends on the speed and position of the preceding vehicle.	Saturation flow is not an input. Saturation flow or throughput is an output that is based on the car-following algorithms and simulation engines Comparative calculations are available for signalised intersections
Can different junctions/nodes be controlled by a single controller?	YES	YES	YES	NO	YES		YES	YES

Table 3.6 Network Strategies

6. Network Strategies	Can the following strategies / operations be modelled?							
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
Road works	YES This depends on the nature of the work. Options include: 1) A simple road closure 2) Lane closure with speed and perceived link cost changes 3) Closure with delay warning via an ITS system Note that route choice and modification of choice will be automatic through the route assignment module.	YES If lanes are closed, this can be modelled directly. Different driving behaviour in roadwork areas can be modelled by assigning modified behaviour parameter sets to the road works link types. (e.g. larger car following headways) Dynamic assignment will react on capacities changes by road works.	YES Incidents. 'Incidents' is a feature used to model road works and accidents. The spot for the incident is set with the mouse and a dialog window gives access to edit several other parameters, like the area affected by the incident.	YES Treated as lane(s) drop	YES New network scenarios can be added modifying the 'existing' condition and comparisons can be made. Modifications for construction generally deal with altering speeds, number of lanes, lane widths, available turning movements, etc.	YES Lane closures, obstructions	YES DRACULA can model planned road works and other regular incidents (eg illegally parked vehicles), where location and duration can be specified. Such incidents are modelled as lane closures for the specified period and locations of the lane involved. To model a lane closure or blockage, the lane should be specified as a reserve lane and then reserved for the DUMMY vehicle class.	YES Lane closures can be modelled, contra flow lanes can also be modelled Link speed should be manually adjusted for behaviour effect of road works/narrow lanes Options exist to prevent lane changing and restriction of wide vehicles from narrow lanes. Congestion created by road work may avoided by familiar drivers using dynamic routing algorithms.
Accidents	YES Paramics measures the effect of user input "accidents" in the form of "incidents", and can also determine the propensity to accidents at points of potential conflict (e.g. weaving sections). Incidents are modelled by specifying a rate at which they happen (one vehicle in N) or specific times at which they occur and a location, type of incident and duration. A vehicle will stop at the specified time and place and subsequently vehicles will slow to pass if possible or will adjust their routes. ITS information may be applied if required.	YES Same method as with road works	YES Accidents are modelled with the 'incidents' feature, as mentioned in the previous (Road works) item.	YES It is treated as lane(s) drop, but has a pre settled start time and time period of road blocking	YES Accident vehicles are generally modeled as an additional type. These may be scheduled at a certain time/location or the time/location may be allowed randomly within a certain area.	YES Obstructions which block one or more lanes for a specified time period and (if brought to drivers' attention using VMS) encouraging drivers out of the affected lane(s)	NO DRACULA does not model irregular incidents, such as accidents, whose location, duration and frequency of occurrence can not be pre-defined.	YES Incidents can be simulated and defined by the user API can be used to simulate rerouting or route guidance changes 'rubbernecking' option available with other incident specific parameters
Ramp Metering	YES S-Paramics was used in Glasgow on a project funded by the Scottish Executive to calibrate it using an existing Ramp metered junction. An ACI based ramp metering controller was built to implement ALINEA based ramp metering. This was then further tested on the A720 Edinburgh bypass simulation model.	YES Ramp metering can be modelled with the functionality provided for vehicle actuated signal control. E.g. the Alinea-Algorithm is implemented in VISSIM's programming language VAP.	YES There's a 'Ramp Metering' icon that, when activated, allows to set the control point with the mouse. A dialog window from the control plan gives access to other complementary parameters like the type of control or the time-of-the-day / set-of-conditions that will activate the metering.	YES Different ramp metering algorithms, e.g. ALINEA, may be simulated on motorway, expressway intersections. Ender users may decide which metering algorithm to use.	YES This is no problem using the default tools provided in the signal control module. Detectors may be placed on the mainline altering the timing of the ramp meters.	YES (1) Parameters for the algorithm (e.g. ALINEA, fixed) that determine the metering rate (2) A queue override mechanism (3) A co-ordination mechanism if the metering rate is to depend on other sites (4) A driver reaction time to the signal settings	NO	YES Either using fixed time traffic signals or vehicle actuated ramp metering APIs have been used to implement existing algorithms and real time ramp metering projects
Variable Speed Limits	YES Variable speed limits may be imposed in two ways depending on how they are deemed to vary. If the restriction is by time of day then use time periods and adjust the limit in the link description. If the restriction is due to incident detection (i.e. MIDAS) or to congestion then an ITS controller may be produced to implement the restrictions	YES Desired speed decisions can be controlled externally by Vissim's programming language VAP, so the control logic can be modelled there.	YES There is a feature called 'Action' that allows to model initiatives for dynamic traffic management, like variable speed limits or vehicle re-routing. Variable speed limits are implemented in a similar way as metering: a point in which to take place, a time-of-the-day / set-of-conditions to become active and, if necessary, the type of vehicles/drivers which is going to affect.	YES Varied speed limit on different motorway sections.	YES Vehicle's desired speeds may be altered based on detector inputs.	YES Can be implemented as either: (a) a stand-alone system where flow, speed or occupancy levels govern the speed limit (b) a Controlled Motorways system with the same parameters as the real M25 system		YES Speed controls can limit maximum speed on link API can be used to link this to external control or data (pollution or congestion for example). Link speeds can be controlled during a simulation by periodic file changes.
Narrow Lanes	YES Speed modifications or changes to perceived costs can be entered separately by the user, but since we have little research data available, no automatic adjustment of these factors is applied.	YES The simplest way is to define modified driver behaviour parameter to the narrow lane links. But it is a swell possible to choose a simulation mode where lane width and vehicle with are explicitly considered in the driving model.	YES A narrow lane model is not explicitly included, but the same effect can be easily achieved changing the values of a few local parameters	YES By different speed distributions	YES Lane width is set as a parameter of the roadway trajectory. Vehicles automatically adapt to the given width and react appropriately.	NO	NO Not explicitly, but only through the effect of narrow lanes on free-flow speeds.	YES Quadstone Paramics is lane based and takes little direct account of vehicle or lane width. Effect can be simulated visually and by reducing speed on link via link speed, speed controls or API

Table 3.7 Model Outputs

7. Model Outputs	In terms of the direct output from the model, what can be produced? The list below provides some basic examples of output. Indicate if any outputs require additional modules over and above are provided with the basic software package						
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
Classified link flows	YES	YES	YES	YES	YES		YES	YES
…by lane	YES	YES	YES	YES	YES		YES	YES
Flows by specified time periods	YES	YES	YES	YES	YES		YES	YES
Classified turning flows	YES	YES	YES	YES	N/A		YES	YES
Queue length measurements	YES	YES	YES	YES	YES		YES	YES
…by vehicle numbers	YES	YES	YES	YES	YES		YES	YES
…by queue length	YES	YES	YES	YES	NO		YES	YES
…by lane	YES	YES	YES	YES	YES		YES	YES
Vehicle Speed measurements	YES	YES	YES	YES	YES		YES	YES
…by vehicle type/class	YES	YES	YES	YES	NO		YES	YES
…by lane	YES	YES	YES	YES	YES		YES	YES
Travel time measurements	YES	YES	YES	YES	YES		YES	YES
…by vehicle type/class	YES	YES	YES	YES	YES		YES	YES
…by time period	YES	YES	YES	YES	YES		YES	YES
…by specific route	YES	YES	YES	YES	YES		YES	YES
Vehicle Emissions	YES	YES	YES	YES	NO		YES	YES
	Carbon Monoxide / Carbon Dioxide / Total hydrocarbons / Oxides of Nitrogen Fuel consumption / Particulates Each vehicle type is linked through its engine class to a pollution database which was derived from a study on the M25 in 1997. Emissions are output by location based on link and may also be graphically displayed as a 3D surface to help identify hotspots	There are two emission models: - a detailed model based on engine maps for CO, CO2, HC, NOx - a simpler aggregated emission model EnvPro that implements the models resulting from the EU research projects QUARTETT and MODEM. EnvPro was developed at the TORG in Newcastle.	CO2, NOX, HC (un-burnt hydrocarbons) + User defined	The total amount of emission by type of major pollutants	CO2, CO, hydrocarbon, NOX and particulates		The programme outputs for each link and for the whole network time averages for the following pollutant emmissions: carbon, hydro-carbons and NOx	Any input by user - Monitor module allows user defined emission data standard are: CO, CO2, Total Hydrocarbons, NOXs, Particulates, Fuel consumption
Delay Measurements	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
Traffic signal timings	Basic Package	Basic Package	Additional	Basic Package	Basic Package			Basic Package
…saturation flows	Basic Package	Basic Package	Basic Package	(not required)	Basic Package			Basic Package
Individual vehicle records	Basic Package	Basic Package	Basic Package	Basic Package (by specification)	Basic Package	Basic Package	Basic Package	Basic Package
Overall network data	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
…by time period	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
…by vehicle type	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
…by travel time	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
…by distance	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
Zone to zone data	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
…by time period	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
…by vehicle type	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
…by travel time	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
…by distance	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package

Table 3.8 Random Seed Recommendations

8. Random Seed	S-Paramics 2005 Release 1	Vissim 4.10	Aimsun NG 5.0	Flowsim 2.0	Cube Dynasim V.1.4.15	SISTM v6.0.005	DRACULA	PARAMICS V5.1
Do you recommend the use of various seed values? **If so, how many?**	It depends on the model – you are trying to get a reasonable confidence interval around your results. You need more results in a congested model with traffic on the cusp of flow breakdown than you need on a model where everything is flowing freely. Same as in reality – A journey on an empty road has a predictable duration. A journey across a city in the peak hour hasn't. Having said that the good practice guide mentions 10 as a reasonable start point	Yes, for a reliable result multiple runs with different seed values are necessary. In general, more runs will be needed in highly saturated situations.	Yes, it is not a recommendation but a necessary condition to produce focused statistics The number of replications is a function of different factors like the size of the model or the traffic state, and the number of replications has to be increased until the desired standard variation of statistics has been reached The user manual includes a full explanation on these necessities and the associated evaluation process. Anyhow, experience indicates that an average of 10 replications produce significant results.	Yes. The FLOWSIM uses varied seed values, which are randomly selected by computer in a simulation.	Yes Tthe software is designed so the only way to get numerical data is if a user does at least three replications However many are needed to reach the desired statistical confidence level.	Yes, we usually combine the results from various seeds Traffic demand files in SISTM usually define flows for each O/D pair and each vehicle class with a temporal resolution of 5 minutes. When individual vehicles are generated at the upstream ends of the model, they are not spaced equally within this 5 minute slice, they are bunched more realistically. The algorithm that creates the bunching uses a pseudo random number generator function to create the realistic bunching pattern. 6 is common, but more may be used if the results vary greatly.	Yes. DRACULA is a stochastic simulation model; there are many random processes used/occurring during the simulation (e.g. vehicles' random parameters and drivers' random behaviour. To get some confidence in the simulation predictions, it is a good practice to run the simulation several times with different random seeds. The number of simulation runs depends on the level of variance introduced to the model when considering the level of accuracy required. In practice, ten simulation runs may be a practicable number but the user should ensure that the level of accuracy required has been achieved.	We usually recommend between 5 and 15 simulation runs during the final stages of the calibration to prove that the simulation and network are robust. From these tests it is acceptable to analyze and report on a seed value that provides a near median value for Vehicle Time/Distance traveled
If multiple seeds are used for the base model development should the same seeds be used for the design testing?	In general we do not recommend using the same seed for testing and there is no correlation between seed and network performance.	No. There is no theoretical reason for that. If the number of runs is determined correctly, any seed values can be used.	Yes, in order to eliminate an unnecessary variation at the time of data comparison..	No, not necessary. In each simulation run, seeds are randomly generated by the computer/simulation model, FLOWSIM.	We do not recommend this. A true 'statistical analysis' of both should be performed using randomly generated seed values	Yes, If there are large differences in the results between seeds, advisable to run the model with even more seeds, say 20 for example to obtain more confidence in the average values.	Yes, we recommend so.	In Quadstone Paramics is it possible to separate the seed streams, allowing the same profiles of generated vehicles to be released onto he network if no zoning or OD parameters are changed. Therefore it may be appropriate to use the same seed values if the demand and release profiles are not to change. If this is not the case then there will be no significant difference between using the same seed values or a new series of seed values.
Should a single seed value from the base assessment be used for the design option testing?	No Not unless you are constrained to the same releases. You should be using multiple runs and any seeds	No For design testing, several seed values must be used as well.	No A single seed will produce equivalent results to those that could be gathered during a randomly selected single day. Such low reliability makes necessary to run several replications.	No No. Seeds for any distributions in FLOWSIM simulation are randomly generated by the computer/simulation model	No No. A statistical analysis should be performed on the options as well.	No No, usually the same set of seeds should be used, and the results averaged in the same way	No No, we recommend use of multiple runs for all scenarios and evaluate the scenarios from the means and variances of the runs.	This option is left to the user, although there is no reason not to do this providing the network is robust and has undergone sensitivity testing with multiple seeds.
Do these only affect the traffic input or do they also impact on the speed distributions, acceleration rates etc assigned to vehicles?	Both	In Vissim, the seed value affects all of the mentioned values and many more.	All those magnitudes (vehicles' parameters, decisions, demand generation, ...) are produced with the random seed, so different random seeds have a direct impact in the parameters and an indirect one in the statistics	As long as a simulation period is adequately long (e.g. > 60 minutes), different seeds shouldn't cause statistically significant difference on simulation results	The seeds do not change the distributions. They only are changing how individual vehicles parameters are drawn from a defined distribution	The overall speed and acceleration distributions of the vehicles generated will be the same, but individual vehicles will be different	In DRACULA, the random processes apply both to the input (for example in representing day-to-day demand variability, distributions of vehicle characteristics such as acceleration and desired speed) and during the simulation (for example, a random decision as to whether to proceed or stop when the amber light is on).	Using the Separate Seeds option the release profiles will maintain a single seed stream and will therefore not be influenced by network operation. With a single seed simulation traffic behaviour can affect release proportions.
What variation would you expect in: **traffic flows?** **queue lengths?** **vehicle speeds?** **journey times?** **If there is significant variation in the results, how can these be used for economic assessment when small performance improvements can lead to significant economic benefits?**	It all depends on the network. On an uncongested network I expect low variation. On a near capacity network, a larger variation. You have to do the statistics and use the confidence intervals. If you are basing your economic assessment on small variations in a single run of a simulation then you are at risk of making errors when you factor them up.	See the explanation above. This is a stochastic experiment. There are sound mathematical methods to separate random variations from systematic variations (at least with a user defined confidence level).	Quality of results will depend on data quality, and the desired minimum standard deviation of results will determine the necessary number of replications	There shouldn't be statistically significant differences on the above outputs when different seeds used in FLOWSIM. FLOWSIM is a stable simulation model. Many applications have shown that, for the same input data, outputs will not be significantly different.	+/- 4% Queue, Speeds, and Travel Times are a result of the simulation and depend heavily on the level of congestion and the parameters defined within the model. It is critical that a statistical analysis be performed and the confidence level of the results be taken into account.	This will depend on how close the flows are to the capacity of the motorway. By taking the average of many seeds and quoting the mean values with standard deviations, you can have more confidence in the values obtained.	We recommend the use of the null hypothesis test to demonstrate that the estimated economic benefits are statistically significant compared to the variation found within the simulation.	Variance will depend on the individual network however tests on networks delivered the following variations: traffic flows + or - 4% queue lengths + or - 5 % Vehicle speed + or - 5 % journey times + or - 5 %
Given the potential concerns re-economic assessments, would you consider it appropriate to use 1 seed value to develop a calibrated/validated?	No – use several	No. It is _never_ appropriate to use only 1 seed value	It is like evaluating a network's behaviour based on a single day phenomena. That single day may have been an exceptional one. Averages should be generated.	For a stable simulation model, simulation results should not be sensitive to seed variations and random selection is a much more robust approach.	No. Never	No, the same approach should be used for calibration and validatio. Start with 6 seeds, and if there is a large variation between them consider using more.	No.	It is acceptable to use 1 seed value for basing economic assessment upon, provided that sensitivity testing has shown the seed value run to be robust and a run close to the median of a series of seed runs. It is equally acceptable to base the economic assessment on an average of several runs, although this will not provide an individual simulation run that can be analyzed separately.

APPENDIX B : Full Developer Questionnaire Responses

	SIAS Ltd	PTV	TSS	Univ of Southampton	CITILABS	TRL / HA	ATKINS / ITS Leeds	QUADSTONE
1. Software								
What is the name and version number of the current release?	**S-Paramics 2005 Release 1**	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
When was the software released?	July 2005	March 2005	June 2005	Expected to be released in 2006	September 2005	September 2005	October 2000	June 2005
How many formal updates are released each year?	1	1-2	1 (average)	N/A	2	3	2	3
Are intermediate releases issued between formal updates? If 'Yes', how many and how are they issued?	YES If required, an interim release is made available on the S-Paramics support site and users notified. This happened once last year in addition to the two scheduled major releases, and addressed specific issues, not new functionality.	YES We release ca. 10 "service-packs" per year. They contain bug fixes and minor enhancements.	YES An average of 6 intermediate releases. Our users are informed through the users' forum and a link is provided to download an installation program for the update.	N/A	YES A rolling 'beta' incorporating bug fixes and user enhancements destined for the next formal release is constantly being updated and is available for users if they wish to use it	YES Issued within TRL only, as required	YES The intermediate releases are made on demand and are generally in response to user-identified bugs. The number of intermediate releases vary.	YES approx 1-3 file download from web site
What are the key changes/improvements since the last traffic micro-simulation review (2000)?	There have been many updates The most prominent are: ACI – Advanced Control Interface for signals and ITS control. This gives us: • Links to UTC controllers : SCOOT SCATS CCOL Spot/Utopia • ITS motorway control • ALINEA and other algorithms for ramp metering • True dynamic route advice, see next • VMS signing on m/ways dynamically modify speed limits and lane closures, notifies incidents and congestion detected within the model etc. Car Park VMS advises drivers on available capacity and Paramics re-routes to those with available capacity. Routeing – improved route control for large and small area models • Waypoint routeing - improves control of route choice in large networks • Congestion delay perception adjusted by aggression and awareness of driver • And for small models – path based routeing as an alternative to zones and OD matrices DAT – Data Analysis Tool A purpose built tool for : • Aggregating the stats from several runs of a model •Comparing these aggregations with base and design models •Evaluation of the differences in performance between base and design models • Screen-lines and cordons quick to input and use as data filters for these comparisons • Overlay of events on the road scheme • Comparison of journey times across runs and models • Select link analysis • Queuing analysis • Comparison of the model with survey data • Cut and paste of results into	• COM-Interface: makes VISSIM programmable e.g. with Visual Basic • Interface between VISUM and VISSIM (VISUM is our transport planning software) • Dynamic Assignment much improved • Model for roadside parking • Complete redesign of the user interface using Microsoft Forms	AIMSUN NG is a new software tool, not an improved version of GETRAM v4.2. AIMSUN NG: • Integrates the previous TEDI, AIMSUN and 3D • The AIMSUN NG environment offers the same functions and possibilities as previous GETRAM v4.2 and many more • Integrates Plug-in tools (extensions to the core application) like a transportation planning tool (AIMSUN Planner): Automatic Traversal OD Matrix estimation / Macro-micro modelling capability: Simulate only a sub-network of a given network / OD Matrix operations – Assignment, Adjustment, Traversal etc. and many more… • The process of integration has been used to add several more improvements • Enhanced GIS interface for Data Integration • Enhanced User friendly GUI: Editing features – unlimited number of cut, paste, copy etc of all network elements / Multiple views of the network concurrently in both 2D and 3D / Customizable alternate drawing layouts of network state and vehicles (Thematic representation) • AIMSUN NG Server: Multi-thread simulation / Multiple networks submitted to server • AIMSUN NG SDK: Next generation API / API functionality not restricted to the model but also the User Interface / User can customize the GUI – add menus, windows etc. / User can define Plug-ins – additional modules to extend the environment or support the model • Universal tool: keeps and improves the interfaces to EMME/2, Transyt, Scats,	Did not participate in the last traffic micro-simulation review in 2000	1 - The philosophy of building and maintaining simulations have changed. The simulation is considered in four pieces; Networks, Traffic Flows, Signal Plans, and PT Routes/Time Tables. In a single file users may develop all the network scenarios and create scenarios of all the flow sets that will be analysed. These individual components then can be mixed and matched to create unique simulations. Redundancy is eliminated and consistency guaranteed through a project. 2 - All replications are now managed inside the software. Results from multiple runs are automatically compiled and statistical comparisons are generated. Reports and graphs may be generated instantly. 3 - All animations are now fully interactive. 3DS maps can be added and are used in the same way as DXF or image backgrounds. Any animation may be exported to a DynaViews file. This is a compiled 'exe' file that users may freely distribute to share their simulation results. For individuals DynaViews, there is nothing to install but they still have all the capabilities to zoom and browse around the animation as users with full versions of Dynasim. 4 - Dynasim has been integrated into Citilabs' Cube software suite. It is now possible to seamlessly move and share data between our Macroscopic models (Voyager, Trips, TP+, TranPlan) and Cube Dynasim. This includes Traffic Flows, Routes, Networks, Junction data, PT Routes and Timetables, background maps, etc. Users can quickly visualize the flows predicted by the macroscopic models as well	(1) New software for creating a network from scratch (2) A 3-dimensional view of the motorway being modelled (3) Improved signalling and ramp metering capabilities (4) Longer simulation times and more vehicles can be modelled (5) Simulation output can be plotted using the Motorway Traffic Viewer (MTV) software (6) Improved lane changing algorithm		Not Included in 2000 review

	other tools for report production • PEARS –Economic assessment to WebTAG unit 3.5.6 guidelines Batch Farm. A means of using a number of PCs to process simulation runs. Makes effective use of company computing power by automatically assigning tasks to PCs overnight or when their users are away. Graphics and GUI • Signals interface is similar to MCSE141 (Linsig users will find it very familiar) • Inclusion of 3ds models as vehicle shapes, overlays, annotation etc • Simultaneous multiple views of simulation model • Integrated demand matrix and profile editor Simulation • HGV speed and acceleration on inclines improved with SETRA data • Articulated vehicles rendered as such		Utopia, VS-Plus, and GIS and adds interfaces to Saturn, Contram and Cube (and a beta version to Paramics). The interface to Synchro is still in the process of translation from v4.2 to NG.		as exploit existing data sets, including network shape files, traffic control databases, traffic count databases to jump start the simulation process.			
What developments are to be incorporated in the next release and when is it to be released?	Some ITS updates A modernised GUI to improve usability of the software and reduce dependency on third party products which have proved problematical in the past. Updates to the links to UTC packages Due early 2006	Release 4.2 will come ca. February 2006 - parallel computing - social-force-model for pedestrians - enhanced 3D graphic possibilities	Parking facilities, Core Model review, Curve turnings Logistics Mesoscopic simulator. To be released next Summer	Fuel consumption and emission pollution	1. A progressive lane change logic has been developed which is providing even better representation of flows in congested conditions and in complex geometries. The simulated vehicles may cooperate more effectively and all the dimensions of the vehicles are now being modelled. The vehicles are also given more awareness as they look forward considering multiple network objects in their route to their destination. 2. There have been more refinements and optimizations to the animation facility. 3. All parameters defining vehicle behaviour is now accessed through the standard interface allowing easier calibration of the simulation and easier creation of new vehicle types. 4. More driver behaviour algorithms are being added and the users are being given the option to use whatever algorithm they feel is most appropriate.	(1) Car following algorithm will be modified so that shockwaves are produced - early 2006 (2) 3-dimensional viewing software to be upgraded for v6.0.005 compatibility - it is "frozen" at v6.0.000 due to the developers not supplying their source code or binaries. Discussions between HA and the contractor about the release of this code are on-going.	New and improved driver behaviour modelling including: a new roundabout model, improved lane-choice and lane-changing model. These are to be included in the release in Nov 2005. Key features which will be included in the next release in autumn 2006 include: public transport reliability modelling incorporating explicit modelling of passenger demand, route choice and simulation; motorway merge models.	Development plan not available for public release
What developments may be expected in the longer term and are there any development priorities? If so, what are they? When are they likely to be implemented?	Major updates to achieve the goal of an integrated multi capability software suite to realise the goal of supporting holistic- design teams in a multi paradigm environment. Due out in 2006. SIAS will of course be happy to discuss these goals with the HA to refine them to better meet the HA's needs		is reflected in the fifth question, AIMSUN NG is becoming a multi-use integrated environment, and future developments will: - Improve the present capabilities, like adding user equilibrium based route choice - add new transport applications that allow new projects, like adding new macro/micro dimensions from Land -use to specific Pedestrian modelling	Interface with GIS to generate layouts and to input	Our primary priority is developing a simulation that is the most 'usable' working for the users and making their job easier. We are also committed to improving and expanding the integration with the Cube suite of software and working more closely with traffic control vendors.	Extension of modelling area to include the all purpose road junction feeding into/out of slip roads	Driver day-to-day learning models with traffic control; second-by-second noise and pollutant emissions modelling; development of (intersection) safety models; Incident generation and management; development of separate driver and vehicle models. Some of these are on-going research activities; the results of which will be implemented to DRACULA in 2-3 years time.	Development plan not available for public release

2. HA Network Modelling	In terms of projects specifically related to the Highways Agency, please describe what motorway modelling has been undertaken with your software?
S-Paramics 2005 Release 1	**SIAS Ltd England.** • M11 Stansted • M6 Junction 1 • M42 between Junctions 5 and 6 • M42 ATM • M4 Bus Lane E of Heathrow • M18 between Junctions 2 and 4 • Whole of A1 past Newcastle/Gateshead • M6 Junction 40 • A14 Cambridge To Huntingdon • A27 Worthing to Lancing • M6 J3 Coventry • M5 Naish Hill • M5 Junction, Weston-super-Mare • M4 / A419 Commonhead Roundabout, Swindon • A17 Trunk Road at Wisbech **SIAS Ltd Scotland work for Scottish Executive** • M74 Completion Scheme • M8 Baillieston to Newhouse • M8 Harthill Climbing Lane testing • M8 J13 to J29 road works modelling • M8 White Cart Road works modelling • M9 Glenbervie slips • Fife and West Lothian Regional Models also include large chunks of motorway (M8, M9, M90) • M8 Ramp Metering with ALINEA • M8 J2 Claylands & Newbridge model(s) • A720 Edinburgh City Bypass • A9 Perth Western Bypass • A90 between Perth and Dundee • A90 Dundee Kingsway • A92 Preston to Balfarg Corridor study • M8/M9 Newbridge Interchange • M8/M9 Newbridge Interchange • M8 Terminal Junction at Hermiston Gait • A720 Sherifhall Roundabout **SIAS Ltd Scotland work for the Northern Ireland Roads Service** • A28 between Armagh and Newry, Edenaveys and Tullyhappy. • A7 between Crossgar and Carryduff • A3 between Armagh and Portadown **Boreham Consulting Engineers Ltd** (vladica.mitrovic@boreham.com) • A13/M25 Lakeside Widening • M62 Junction 6 Improvements. **Capita Symonds** (Paul.Turner@capita.co.uk) • M4 Making better Use Study for the Welsh Assembly Government. **Siemens Traffic Controls** (luke.normington@siemens.com) • Have done some modelling work which encompasses a motorway junction and the slip roads associated with this junction. We are happy for you to pass on our details to anyone who may be interested in this work. **Hyder Consulting Ltd** (Colin.Gale@hyderconsulting.com) • Study of the M25 involves the development of traffic models at three levels of detail - strategic, local and operational. **Parsons Brinckerhoff** (SandersC@pbworld.com) • Working on a Paramics model for the M25 between Junction 27 and 31. **Mouchel Parkman** (nabil.abou-rahme@mouchelparkman.com) • Working the M25 Golden triangle and simulating ATMS operations on the M42 **MVA** (dtindall@mva.co.uk) • Work on the M25 for an inquiry into the location of potential MSAs down on the south west quarter • Work on A8000 near Edinburgh **Others** • M4/M5 Bristol Motorways • M5 J16/17 • M1 J13 • M25 J6 and J26 • M4 J11 • M4 J4 Hanley Cross • A2 in Kent • Access to the A2 from Easton Quarry
Vissim 4.10	PTV has limited knowledge on how many Vissim U.K. motorway models exist, as various Consultants and Agencies have access to Vissim.
Aimsun NG 5.0	M1 Junction 19 Road Based Study M25/A2 Area A429 DBFO A470 Making Best Use Study
Flowsim 2.0	Ramp metering/merging, Lane loss, Diverge, VSL, Convoy, ACC
Cube Dynasim V.1.4.15	As Cube Dynasim has just recently been released in the U.K., not aware of any specific projects. The MVA Group in Edinburgh probably has the most experience with Dynasim in the U.K.
SISTM	(1) M25 J10-16 (both carriageways) for Controlled Motorways (2) M42 J3A-J7A (both carriageways) for the development of NASS (3) M6 J20 northbound for ramp metering (4) M27 J10 & J11 eastbound for ramp metering (5) M8 Kingston Bridge - different lane configurations for roadworks (6) M2 (NI) - ramp metering
DRACULA	BB - Motorway Speed Control - M25 (Ronghui - ITS), Calibration of New Car Following Models - M25 (Ronghui Liu - ITS), M27 amd M8 - Development and Calibration of A Motorway Merge Model (Ronghui Liu - ITS), M5 J22 -J20 Contra Flow Testing (Atkins - B Betts/R Hale)
PARAMICS V5.1	None
Has your software been used for Motorway/Expressway modelling in countries outwith the UK?	
S-Paramics 2005 Release 1	**Opus International** James.Morgan@opusinternational.co.uk • SH20 Mahunga Drive / Rimu Road Ramp Metering Opus was involved in the development and inception of an 'easy merge' ramp signal (ramp metering), in conjunction with the client, Transit NZ, in an effort to create a suitable system to control the rate and volume of traffic entering the motorway. Special features of the project included: the introduction of the ramp metering SCATS algorithm, but with some modifications suggested to the RTA to adapt the algorithm to be suitable for Auckland traffic conditions. • **A.T.M.S** – Auckland Harbour Bridge, New Zealand The project involved the Design and provision of the Advanced Traffic Management System (ATMS), including a comprehensive dynamic event management facility to assist in the management of traffic situations (incidents, road works, etc). This was provided as a software development to allow semi automatic or automatic responses to be created. Evaluation of the system was completed as a function of the analysis of the system rules and the response plans developed for specific incidents. A PARAMICS traffic model was developed of the entire area and provided outputs for the study that included the impact of the ATMS. Outputs included a calculation of the economic benefits of the scheme based upon the improved speed and journey time of vehicles during incident management, and also included an evaluation of the management of traffic speeds during peak hours. This system represents current "state of the art" implementation of ATMS within New Zealand. **SKM** (TInnes@skm.co.nz) • SKM has constructed a Paramics model for the peak periods (AM 6:00am to 10:00am and PM 4:00pm to 7:00pm) of the Northern Motorway in Auckland, New Zealand. The matrices totalled 100,000 vehicles and the models were built to test ramp metering options. This section of Auckland's motorway is very congested with 8km queues in the morning period. **Grontmij** (Nick Cohn@grontmij.nl) • Alkmaar ring road Simulation of the dynamic adjustment of the green wave on the Alkmaar Ring • Antwerp: 18 linked infrastructure projects including: Oosterweel tunnel and bridge, Redesigned Ring (R1), New and extended tramways, Redesigned urban boulevards • Helmund. Linking Paramics model to Spot Utopia Traffic control system • Limburg Province. Wide area network of entire province including motorway, rural and urban networks • Flevoland province Wide area network of entire province including motorway, rural and urban networks (Under construction) **SIAS Ireland** (graeme.inglis@sias.ie) The M50 Motorway creates a C around the city and carries an AADT of approx 90,000 in 2 lanes. At this stage SAIS Ireland have modelled most of the M50 for various projects including; • IKEA (Fingal CC), • M50 Upgrade (for various appellants to the scheme), • Global Health private Health Care Facility (Private client), • M50 Toll plaza upgrade, second crossing (National Toll Roads), • Stadium Ireland (Sport Campus Ireland ltd) • Lehaunstown Interchange Upgrade (Dun Laoghaire Rathdown County Council) We have also modelled a shorts section of the M1 motorway as part of the Dublin Port Tunnel study. (Dublin City Council) **Systematica** (Brignone@systematica.net) • Nuova Fiera Milano Systematica Spa has been charged to develop many S-PARAMICS traffic model of the new "Fiera Milano" accessibility road layout. The tested schemes included many different infrastructural alternatives (flyover, grade separated junctions, roundabouts) on an extremely important and congested area in the North West of Milan area. The new "Fiera Milano" is located close to some of the most important Italian motorways (A4 Torino-Venezia, A8 Milano-Como, Tangenziale Ovest Milano) plus some other important and heavily congested roads, such as "SS 33" "SS 233" and "SP 46". • "New Bergamo Sport Arena" Systematica Spa has been charged to develop a specific S-PARAMICS traffic for the evaluation of the planned "Nuovo stadio di Bergamo" accessibility road layout. The tested schemes included many different infrastructural alternatives (flyover, grade separated junctions, roundabouts) on an extremely important and congested area in Lombardy Area, close to A4 Bergamo toll plazas and Bergamo ring road. In both cases, S-PARAMICS demonstrated to be the proper tool to

	simulate motorways typical elements, such as on and off ramps, overtaking, lane use for different vehicle types, different paying systems at toll plazas (automatic, cash, cards…)
Vissim 4.10	In Germany: many applications, e.g. at the ABDS = Autobahndirektion Südbayern = South Bavarian Highway Agency In USA: many applications at Caltrans (= department of transport in California), etc. VISSIM has many hundred users all over the world. There are lots of freeway applications. Please understand that we as a vendor can not track all applications of the product. To get an impression, just scan the last Preprint-CD-Rom of the TRB annual meeting for the keyword "VISSIM". Some examples: "A Micro-simulation Model of a Congested Freeway using VISSIM." by Gabriel Gomes, Adolf May, Roberto Horowitz, U.C. Berkeley, TRB 2004 "I-85 Traffic Study: A State-of-the-Practice Modelling of Freeway Traffic Operation" by D. Ni, K. Strickland and C. Feng, presented at the Summer Simulation Multi-Conference. "Traffic Flow on Freeway Upgrades" by Werner Brilon and Andrea Bressler, TRB 04 - 2953 Many papers are available for download at: http://www.ptvamerica.com/library.html
Aimsun NG 5.0	Example: Frankfurt, Germany - Barcelona, Spain - Bolonia-Fireze Motorway, Italy - Auckland, New Zealand - Toowoomba bypass , Australia- Santiago de Chile, Chile – Stockholm, Sweden – Hangzhou, China – Helsinki, Finland – Laussane, Switzerland – Pretoria, South Africa - Prague, Txequia - Rotterham, Holland - Minnesota, USA - ... all these just as an example to illustrate its extended use all over the world.
Flowsim 2.0	U.K. and EC Projects (e.g. DIATS, TACO, AVERT, RTA, RHYTHM, etc.) Beijing Urban Expressway (Ring road intersection Traffic control)
Cube Dynasim V.1.4.15	Around the world, Dynasim has been used extensively for modelling motorways including: Construction staging, HOV and HOT lanes, Toll Facilities, Exclusive Truck Facilities, ITS Projects, Ramp Metering Strategies, Additional Lanes and New Geometric Configurations, Narrow Lanes, Shared Lanes and Exclusive Lanes.
SISTM	
DRACULA	DRACULA has been used in Brisbane and Perth, Australia (John Carlisle Consulting) and New Zealand (Montgomery Watson) to model motorway and urban interchanges and motorway merges. The model has been used in South Africa (Arcus Gibb Ltd) to model an inter-urban expressway.
PARAMICS V5.1	Yes - widely used on motorways/freeways in over 40 countries Application are too numerous to mention, however examples include California I680, I80, SAC50, Florida I5, Wisconsin FSOA, Indiana, In Europe: Gothenburg Helsinki Stockholm Germany, France, Italy, Netherlands, Belgium. Australia; Sydney, NSW, Brisbane, Queensland, Adelaide, South Australia, Melbourne, Victoria, Western Australia, Perth, Hobart Tasmania,

3. Network Inputs	A number of network modelling inputs that are considered to be key to successful motorway modelling are identified below. Please indicate if these are elements which are included in your software and whether or not they can be easily modified by the user.							
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM**	**DRACULA**	**PARAMICS V5.1**
Traffic Composition	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* *YES* *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* NO *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES
	Up to 32 different vehicle classes may be defined and different physical, dynamic and appearance characteristics assigned to them. Each class may be allocated to a vehicle type group and the proportion of that class in the group defined – this may vary over time. Each group will then have an OD trip matrix assigned to it with time based profiles applied to an individual trip, a set of trips or the whole group. This is all managed either graphically with manipulability graphs, in tables in a GUI or may be edited independently and entered through ASCII files.	For each traffic input or OD-matrix, a traffic composition can be defined as percentages of user defined vehicle types.	Different vehicle types, each one with its own time-sliced matrix; plus time tables for Public Transport (Buses, LRT…). This data can be imported from other applications.	Traffic is classified into 5 categories: Car, Van, Bus, Lorry and bicycle. There is a default setting D153 composition rate. Users can define composition by a dialogue interface.	Through vehicle definition screens within the software	5-minute O/D matrix for each vehicle class	The proportions of each type of vehicle within the overall demand can be specified in a parameter file. Proportions can be specified for buses, taxis, HGVs and LGVs. The default traffic composition is 100% car. In addition, traffic composition can be loaded in as part of multple-user-class assignment results directly from SATURN.	Vehicles classes represent a proportion of each OD matrix with multi-level OD matrices available. A single vehicle class can represent 0.01-100% of an OD matrix. Vehicles classes can be OD based or fixed route
Vehicle Types/Classes	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES
	The default vehicle types and the proportions of these types are based on the NESA/COBA classifications. These may be adjusted as required through the Paramics GUI. Each vehicle type has individually configurable physical, behavioural, dynamic and visual properties. Multi part vehicles (i.e. OGV, Tram, car and caravan or bendi-bus) are managed and will bend as they negotiate curves.	The user can define an arbitrary number of vehicle types. A vehicle type comprises a large set of characteristics of vehicle and driver. Vehicle types can be grouped in vehicle classes for use in filters, evaluation etc.	A library of vehicle types is provided. Each vehicle type is characterized by a list of parameters and the value for each parameter is generated at the same time as the vehicle, sampling from a truncated normal distribution. The normal distributions for each vehicle type are differentiated by different average values and standard deviations.	Traffic is classified into 5 categories: Car, Van, Bus, Lorry and Bicycle	Through vehicle definition screens within the software	Data on vehicle performance, i.e. acceleration and braking rates, reaction to gradients. Up to 8 vehicle classes can be defined.	There are currently seven types of vehicle defined in DRACULA. These are dummy vehicle, small passenger cars, bus type 1, bus type 2 (e.g. guided bus), taxi, light goods vehicles & heavy goods vehicles. Each type of vehicle is represented by a name and a unique number. It should be noted, however, any of these seven types of vehicles can be re-defined by the user to a type of their choice as long as the users can provide vehicle characteristics for the new type.	Limitless vehicles classes with default and user defined characteristics available, both physical and behavioural
Vehicle Length	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES
Speed Distributions	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* *User Definable*	*Default* NO *User Definable* NO
	Every vehicle has a "target" speed for the link it is travelling on determined by the geometry and assigned values of the link, the physical capabilities of the vehicle and the values of Aggression and Awareness – which are randomly assigned from a configurable distribution. Therefore speed distribution is not input as such but is derived from physical and psychological conditions.	Desired speed distributions can be defined as empirical distributions.	There is a parameter called 'desired speed' which determines the speed at which the driver would like to drive. The de-facto speed is conditioned by elements like surrounding traffic conditions, top legal speed or the 'speed acceptance' parameter.	Desired speeds are normally distributed according to the speed limit of a road link. Users can modify the distribution by input	Through vehicle definition screens within the software	User can supply a distribution for each vehicle class; normal, uniform, Poisson or a user-defined distribution can be input	Speed distributions are implicitly specified in DRACULA through the modelling of individual drivers' desired speed factor. The average link speeds as defined in the network data file. In addition, all vehicles have a desired speed factor which controls how fast the vehicle wants to travel relative to the average link speed. Minimum and maximum values for the desired speed factor can also be specified, meaning that there is a range over which the desired speed factors may be selected. All of these values are specified in the vehicle characteristic/parameter text file. In the micro-simulation, each vehicle has its own desired speed factor which, like all other vehicle characteristics in DRACULA, is randomly selected	Vehicle Speed is an output Cannot be selected as an input parameter. Parameters are available to limit and control the desired speed of vehicles. Desired to target speeds will vary depending on individual vehicles characteristics such as Aggression and Awareness.

							from a normal distribution. The results are distributions of desired speeds for each link. This allow modelling of different road types and associated different speed distributions, for example a network with motorway links with average speed of 70mph and urban roads with speed of 30mph.	
Vehicle Acceleration / Deceleration	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES
	OGV acceleration and deceleration is further adjusted according to incline and the implied deceleration to a gradient dependent maximum speed is calculated to match data from SETRA in France. Note the Level of Service studies in Dublin Port Tunnel were dependent on these features.	In the vehicle type definition, user defined speed-acceleration-functions are assigned to the vehicle for maximum technical acceleration and deceleration, and for the acceleration and decelerations applied by the driver if no special situations take place.	Three main parameters for its control: maximum acceleration, maximum deceleration and normal deceleration. The value of acceleration/decceleration is calculated by functions also using factors like reaction time, distance to desired speed or distance to vehicle in front.	In FLOWSIM, acceleration/deceleration rates are calculated by a Fuzzy Logic based Car Following model based on car following conditions and individual driver behaviour. However, the distribution of the behavioural parameter may be modelled to reflect significant car following behavioural differences in different areas or countries	Through vehicle definition screens within the software	User can supply a distribution for each vehicle class; normal, uniform, Poisson or a user-defined distribution can be input	Vehicle acceleration/deceleration values are entered via a vehicle characteristics/parameters test file. Values are entered for normal acceleration rate, maximum acceleration rate, normal deceleration rate and maximum deceleration rate. For each characteristic four pieces of information can be specified: the mean value, the coefficient of variation, the maximum value and minimum value.	Acceleration profiles by vehicles type can be input by text file input. Both a default and the TWOPAS gradient model are available
Gradients	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* NO *User Definable* NO	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* NO *User Definable* NO	*Default* YES *User Definable* YES
							These can not be modelled explicitly, but can be represented via the link speed coded in the network data file.	
Peed Reduction for Horizontal Geometry	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* NO *User Definable* NO	*Default* YES *User Definable* YES	*Default* NO *User Definable* NO	*Default* NO *User Definable* YES	*Default* YES *User Definable* YES
	Maximum speeds are inferred from the curvature of the link to keep the horizontal acceleration due to curvature to 0.3g. Similarly at junctions the position and angle of the locus points infers a maximum speed. This may be adjusted to achieve a preferred speed but usually it is the observed vehicle trajectory that sets the speed rather than setting a speed independently of geometry.	Stretches of the road can be defined as reduced speed areas. If a driver approaches a reduced speed area, his desired speed is set according to the desired speed distribution defined for that reduced speed area. When leaving the area, the original desired speed is restored.	The speed is calculated according to the radius of the curve, but that speed is an explicit parameter that the user can edit. For instance, the user can detect a too long queue and realise that it is so because of a too low turning speed in a nearby intersection. The automatic solution is to edit the turning movement and raise the value of that turning speed.		Parameter on the trajectory	SISTM does not model curvature	As with gradients, the bendiness of a link is taken account of when determining the free flow speed of a link.	Automatically calculated from curve radius and super elevation factor. Can be overridden by user by adjusting Curve Speed Factor and link speed if observed speeds differ from default safe link speed.
Vehicle spacing at standstill?	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES
<u>Driver Behaviour</u> What parameters are available to vary car following behaviour and can they be modified by the user? Please list these in order of priority (i.e. most effective first and describe how they are used)	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* YES *User Definable* YES	*Default* *User Definable*	*Default* YES *User Definable* YES
	<u>Headway</u> The mean headway between vehicles can be adjusted and then further adjusted on each link. There are further headway modifiers for HGVs and temporarily reduced headways in merge situations. <u>Gap</u> The minimum gap between vehicles – used in slow speed situations may be adjusted. A separate setting may be used for highway links. <u>Awareness and Aggression</u> Each driver has awareness and	<u>Minimum desired headway</u> Strong influence on capacity. <u>Temporary lack of attention</u> 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. There are many more parameters to influence driver behaviour. Please refer to the VISSIM manual.	<u>Reaction Time</u> It is the main factor to set the agility of the vehicles and the drivers' capacity to react. It is critical factor for global results on traffic flows and queues. <u>Max. Acc. / Normal Decel.</u> These two parameters complement the one on Reaction time. If the driver reacts quickly but then has no mechanical performance features to transmit his/her intentions to the vehicle, then the 'Reaction Time' agility results diminished.	Relative speed to leading vehicle Driver preferred following distance (time headway) Separation (time headway) Vehicle type	<u>Headways</u> A primary input to the car following logic. This parameter describes how closely one vehicle is comfortable following another as a function of speed. This parameter is critical in determining the stability and capacity of the flow. <u>Standstill Distance</u> As flow breaks down in congested conditions, this parameter becomes important in being able to calibrate the flow and throughput at low speeds in congested	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. Normal reaction time expressed as number of epochs - single parameter (known as P11) which the user can modify Braking rate adopted if vehicle ahead's brake lights are seen -	DRACULA contains a car-following model which calculates a vehicle's acceleration in response to its desired speed and the relative speed and distance of the preceding vehicle. Depending on the magnitude of the relative distance, a vehicle is classified into one of three regimes: free-moving, following or close-following. The parameters required to determine the progress of vehicles are: the desired speed (relative to the mean speed on any individual link), the desired minimum headway, the reaction time, the	***Mean Target Headway*** - the target time (headway) between a vehicle and the preceding vehicle ***Mean Driver Reaction Time*** - The time lag between a change in speed of a vehicle and the reaction to that speed change by the following vehicle ***Aggression*** - The individual aggression parameter of a vehicle will determine and influence (mainly) the speed of free flowing vehicles, lane choice, target headway and

	aggression values. The more aggressive will tend to higher speeds and smaller gaps. The distribution of these factors is set by the modeller through the GUI. The default settings use a normal distribution. <u>Overtaking</u> The tendency to overtake on dual carriageway and on single carriageway roads is adjustable through the vehicle behaviour editor. On single carriageway roads three abreast overtaking is allowed and its probability is controlled for each link. Further options are available in the dual carriageway mode to set the headway at which a lane change to overtake will be considered. The parameters have been extensively tested for economic assessment of single carriageway roads in Scotland and Northern Ireland. <u>Vehicle dynamics</u> 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.		<u>Desired Speed / Max Decel.</u> Maximum deceleration allows higher risk levels, and desired speed higher acceleration or higher stable speeds. <u>Speed Acceptance</u> This is the final parameter affecting speed, this one determines whether the driver will result too prudent or on the contrary will break the law. <u>Min Distance between Vehicles</u> This parameter will slightly affect capacity but will be important for queue lengths, and critical in those cases in which queues can come to become a problem in a nearby intersection. Some other complementary parameters for other behaviours like overtaking, merging or anticipating.		conditions. <u>Look Ahead Distance and Reaction Times</u> These parameters are critical to defining the stability of flow and the speed and length of shockwaves in the system <u>Lead/Lag Gap Acceptance for Lane Changing</u> These parameters are critical for defining the aggressivity of lane changing and are of course a function of the vehicles speed	single parameter (known as P5) which the user can modifiy Driver's perceivable acceleration - single parameter (known as P8) which the user can modifiy	rate of acceleration and the rate of deceleration. All of these values can be modified by the user via the vehicle characteristic text file. The effectiveness of these parameters essentially depends on the situation being modelled. When trying to calibrate a model dealing with a congested situation, experience has shown that minimum headway distance and reaction time are quite effective in helping to get more traffic on a link if, for example, you are not modelling enough traffic on a particular link.	overtaking stimuli. ***Awareness*** - parameter determines if a vehicle follows vehicle in front or a vehicle further in front
	YES	YES/NO	YES/NO	YES	YES	NO	YES	YES
Are there any papers to support the use of specific parameters?	Paramics licence holders have access to a range of technical papers relating to various aspects of the software. In addition, more widely distributed documents provide such information. Most recently, the Micro-simulation Consultancy Good Practice Guide held by all licence holders and distributed to other bodies including HA.		Papers or articles illustrate the Software's functionalities and real life situations for which it has meant a solution. It is not a claim but those cases are supported by calibrated models (simulated data = real network's data). The use of specific parameters is described in the Users Manuals and supported by examples. The training course includes documentation, theory and exercises on calibration.	1.) Wu, J, Brackstone, M, and McDonald, M (2000) Fuzzy Sets and Systems for a Motorway Microscopic Simulation Model. International Journal of "Fuzzy Sets and Systems", Vol. 116, No. 1, 2000, pp. 65-76. 2.) Wu, J, McDonald, M, and Brackstone, M (2003) The Calibration and Validation of a Fuzzy Logic Based Microscopic Car Following Model. Transportation Research part C. 2003, pp. 463-479.	Technical documentation is provided when the software is installed. A calibration document is part of the users manual.	No pubished papers, only internal HA documents	An analysis of the choice of some of the parameter values is presented in Bonsall, P., Liu, R. and Young, W. (2005), Modelling safety-related driving behaviour – impact of parameter values. Transportation Research, 39A, 425-444.	various including I680 report from PATH for Headway and Reaction Time
	YES	YES	YES	YES	YES	YES	YES	YES
Can driver awareness (of other vehicles) be influenced?	The gap acceptance factors - how far to look and what gap to accept are adjustable. At junctions the "visibility" measure controls when vehicles begin to make gap acceptance decisions as they approach a junction.	- the user can choose, how many vehicles ahead can be seen by the driver - if specified, the vehicles on the neighbour lanes can affect the driver by their lateral position.	Two main models: visibility distance (local parameter) and two-lane model (in order to evaluate conditions in neighbouring lanes when driving and also feel 'friction').	The average speed of vehicles 50m ahead.	This is considered in their 'look ahead' distances. Also certain link types can be made aware of conflicting vehicles approaching to merge.	The car following model uses the perceived braking rate of the vehicle in front. This can be specified as a distribution that is correlated with driver awareness (and is also vehicle class dependent)	The new motorway merge model, currently in test version, explicitly models the influence of the ramp traffic on motorway traffic and vice versa.	Awareness can be modified from GUI and text file. Other parameters are covered in the Junction Control section and are modified by graphical interface or text file.
What documentation is available on the calibration of the car following models?	See answer above relating to papers in support of specific parameters.	Similar answer as to the question about freeway applications. There are many papers describing applications that include calibration and validation.	Absolutely all of it: from the mathematical algorithms to examples on their practical use.	The following paper may be used as a reference for model calibration and validation. 1.) Wu, J, McDonald, M, and Brackstone, M (2003) The Calibration and Validation of a Fuzzy Logic Based Microscopic Car Following Model. Transportation Research part C. 2003, pp. 463-479.	A technical document is provided as part of the software installation.	Internal HA documents	Calibration of the model entails adjusting parameters incrementally until the flow on a given link correlates well with either an observed count or the flow on the link when modelled in SATURN. A new methodoloy for calibrating car-following models based on the loop detector data is presented in "A general framework for the calibration and validation of car-following models along an uninterruped open highway" by Ronghui Liu and Jiao Wang at the 4th IMA International Conference on MAthematics in Transport, 7-9 Sept 2005, London	Publically available Quadstone Paramics reports
<u>**Merge/Diverge Areas**</u> How does your software deal with the modelling of them in congested and un-congested	Vehicles proceed in normal conditions with a range of acceptable lanes. They will select a lane from this range with more aggressive or faster drivers	VISSIM implements a cooperative merging model. Vehicles know their routes and thus know, where they have to change lane at the latest. The merging vehicle adapts	Vehicles are informed of the need for a lane change through two parameters: zone 1 and zone 2, which are time distances to the critical	Traffic on motorway carriageway will show different speed and headway distributions in congested and un-congested conditions. In FLOWSIM, the	Vehicles are set with a look ahead distance or awareness. They are aware of a need to exit and are aware of how far they are	No difference in modelling in congested or uncongested conditions. In merge areas, drivers on the entry slip road are given a lane	A new motorway model is being developed for DRACULA and is the testing mode and expected to be release in 2006. The new model explicitly models the	Merging vehicles attempt to merge onto highway using user defined parameters unique to ramp/merging traffic.

conditions? How are vehicles informed of the need for a lane change? How does main line traffic behave with regard to merging slip road traffic in un-congested conditions? How does the model deal with slip road merges in congested conditions (e.g. merge in turn?)?	tending to the right. If congestion in one lane means another is more attractive, they will change lane. At the hazard warning distance from a merge, diverge, lane gain or drop, or junction they will re-assess their lane range based on the manoeuvre they are about to make. This distance is varied by aggression and awareness. If a vehicle is blocked from making this lane change by traffic then it will probably receive a “courtesy slow” from another vehicle which will allow it to make the lane change. Note that these vehicles must be moving to be able to slow to create the gap. At ramps the merging vehicle will adjust speed to match a gap and vehicles on the main carriageway will make “courtesy slow” speed adjustments and “courtesy lane change” manoeuvres to allow mergers to enter the main carriageway. At pinch points (e.g. motorway road works) several merge arrangements can be represented, such as merge in turn and lane changing in advance of road works. These responses can be controlled via fixed hazard signposting and VMS gantries within the model, and the distance of the required manoeuvres from the hazard defined.	his speed to the speed level of the main stream and is able to anticipate arriving gaps. The gap acceptance model allows smaller gaps if the lane end is approached. The vehicles in the main line cooperate, i.e. they decelerate in order to widen a gap and let the merging vehicle in. In congested merging conditions, a set of special behaviour rules are implemented, e.g. relaxing space gap conditions to avoid deadlock situations if two vehicles want to swap lanes.	point (depend on driver and vehicle type). The first time distance represents the first information, but the lane-change initiative may come to be cancelled due to other factors like traffic conditions. The second time distance is the one during which changing lanes becomes the first priority and the driver must change lanes. As traffic conditions worsen, the drivers run less risks and change lane sooner. As for acceleration lanes, there are two available models, one in which drivers begin to look for a gap as soon as they enter the acceleration lane, and a second one in which drivers first use the lane to accelerate and once they are reaching the end of the lane, they try to change lane. In fluid conditions drivers in the main lanes will try to move out of the first lane to generate space for the in-coming ones. As traffic becomes congested, their ‘friendliness’ will decrease.	fuzzy logic based car-following and lane change behavioural models can recognize these differences automatically, and will show different car-following and lane change behaviour. For example, in congested condition, a sudden shockwave may be created when both the merged vehicle and the following one try to increase their headway rapidly. If taking merging from a slip road as a type of lane change, then there are three different types of lane changes in FLOWSIM model. These are: (1) merge from slip road, (2) forced lane change, and (3) optional lane change. Merge: vehicles get the information of the need for a merge from road link attributes, and then follow the fuzzy logic based motorway merge behavioural model for a merge performance. Forced lane change: vehicles get the information of the need for a forced lane change by comparing their journey route and the road link attributes, and then follow the fuzzy logic based motorway forced lane change behavioural model for a forced lane change performance. Example of forced lane changes include: (i) a vehicle is close to its target motorway intersection but is not on the nearside lane, (ii) motorway carriageway lane loss (accidents, road works), etc. Optional lane change: An optional lane change is speed benefit oriented. FLOWSIM has a fuzzy logic based optional lane change behavioural model for the performance. In the FLOWSIM model, the section of motorway immediately upstream of the merge section has the attribute of a “pre-merge zone”. Drivers on the nearside lane of the motorway carriageway in a “pre-merge zone” will assess slip road traffic, and a proportion will change lane to the next lane offside if it is safe to do so and is in their interests. If the opportunity for a safe lane change is not available, a proportion of the drivers will gently slowdown to give way to a merging driver if necessary. Otherwise, drivers on the nearside lane of motorway carriageway follow the normal fuzzy logic car-following and lane change models. In FLOWSIM, slip road for motorway merging is divided into 3 sections. In section 1 (the	from the exit and how many lane changes must be made to exit. The vehicles then go through three stages. In the first, they are initially informed of their need to exit and are more reluctant to change lanes in the opposite direction of their exit to improve their condition. In the second stage, they begin attempting to change lanes to their exit. The closer they get the more aggressive they become. Finally, the last stage is a defined 'emergency stop' location at which point they will force a lane change regardless of the availability of a gap. In congested conditions when the traffic has completely broken down and there is queuing on multiple legs, the vehicles will take turns and each vehicle on the mainline will allow a vehicle on the ramp to enter... This is somewhat controlled through the vehicle aggressivity though. Sometimes you see a couple from the ramp slip in and other times you see vehicles on the mainline which did not give a courtesy merge.	changing score which reflects their desire to move right into other slip road lanes and onto the main carriageway. Main carriageway drivers upstream of a merge area are given a lane changing desire to move from lane 1 to lane 2 to create gaps for merging vehicles. In diverge areas, drivers are given a lane changing score which reflects their increasing desire to move into lane 1 (or a lane that continues into the exit slip road) upstream of the diverge. In all cases users can give their own values for the lane changing desires and the locations where these become active. Each merge or diverge can be configured differently. Default values can also be used.	acceleration lane and the itneractive behaviour and influernce between the merging and the motorway traffic. In the current DRACULA model, merges are modelled as priority junctions with a turn priority marker M coded in the network data file to tell the software that the junction is a merge. The merging traffic at the junction gives way to one stream (one lane) of traffic from the right. The decision to merge is controlled by the gap-acceptance model within DRACULA. This represents the critical gap (seconds) in the opposing stream of traffic that the driver feels safe to accept: if the gap is greater or equal to the critical gap, then the driver merges, other wise he slows and waits until a suitable gap is available. The key parameter for gap-acceptance is the normal acceptable gap (in secs) for the manoeuvre being contemplated. DRACULA allows the minimum gap to be reduced if the traffic is very heavy and moves slowly-a representation of frustation on the part of the waiting traffic. DRACULA uses the time a driver has been waiting to find an acceptable gap as a stimulus to induce use of a reduced gap. Values for normal acceptable gap, minimum acceptable gap and the time period over which the acceptable gap is reduced can be specified by the user. Slip roads can also be coded using a turn priority marker S. These are used on motorway slip roads to indicate that the slip road traffic has a clear exit onto the acceleration lane. In the case of a two lane slip road, the first lane of traffic has a clear exit onto the acceleration lane and the second lane of traffic merges with the motorway traffic. Because merges are treated as a form of priority junction in DRACULA, the mainline has priority in both congested and uncongested conditions, and it is up to the merging driver to find a gap in the mainline stream. With regards to lane changing, the lane changing model within DRACULA controls the driver's intention and ability to change lanes. Changing lane to prepare to exit a motorway for example is treated as a 'mandatory' lane change within DRACULA and has to be carried out by a certain position on the current link. When a vehicle wishes to change lane, it looks for a target lane, in this case the nearside lane, and moves over when a suitable gap is available. DRACULA allows drivers to anticipate the need for a change of lane using a parameter XAPPRO_JNCT, which is the	Vehicles on mainline are aware of the vehicles attempting to merge and may perform a lane change to create a gap for merging vehicles if there is an available gap in the lane to their right. Diverging is controlled by link-based signposting. Vehicles are aware of their route, however the lane choice for each path is derived to each vehicle based on a signpost distance (from the diverge) and graduated by the vehicle's awareness and the signpost range parameter. Vehicles can see beyond the next downstream diverge by using a Lanechoices feature which is a path based signposting rule and allows vehicles to arrange themselves by lane based on their routing path

				most upstream section of a slip road, where merging drivers can not see the Traffic on motorway carriageway), merging drivers obey the car-following rule to accelerate to a desired speed. In section 2 (middle section of a slip road, where merging drivers can see the traffic on motorway carriageway but can't do a merge process because of the physical separation), merging drivers adjust speed to match the speeds of traffic in nearside lane of motorway carriageway and search for gaps. In section 3 (the last section of a slip road, where merging drivers can do merge process if condition allows), merging drivers follow a gap and keep adjusting speed till he/she successfully merged into the motorway carriageway. When approaching to the end of a slip road section 3, a merging driver will take smaller gaps. In very congested conditions, drivers may have to stop at the end of the slip road to wait for a suitable gap in motorway carriageway. But, there is no requirement that drivers on slip road have to merge in turn.			distance upstream of a stopline where a vehicle starts to react to junction control. This can be defined by the user.	

4. Matrices and Assignment								
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
Traffic Input **(Matrices/Turning Proportions/Both)**	BOTH Traffic input may be by matrix or by a fixed route. S-Paramics also has a matrix estimation module which is used to refine an OD matrix if link and turn counts are available	BOTH	BOTH	MATRICES	MATRICES	MATRICES	MATRICES	BOTH An Estimator tool is available to generate OD matrices from observed turning/link/ screenline/cordon data. This process can be applied to the dynamic assignment as well as AON and Stochastic assignments.
Can matrices be profiled over the model time period?	YES 1) Separate demand matrices may be used for different time periods 2) More detailed trip departure profiles (5 minute intervals) may be used and assigned individually to a trip, set of trips or to an origin zone These aspects are graphically linked and edited to give a clear view of the data. A reporter is available which will flag any out of bounds values and any large changes in demand values indicative of a data entry error.	YES Matrices have a time interval for which they are valid. Several matrices may overlap in time.	YES Separate matrices. Those matrices can be imported from other applications (Excel, Emme/2, Saturn…)	YES Separate Matrices	YES Individual matrices are developed for each time slice	YES An O/D matrix is required for each 5-minute period and for each vehicle class	YES Demand levels can be profiled over the model time period within DRACULA. Temporal distribution of demand is represented by step functions indicating the level of demand for each time period (step). It is necessary to specify the number of time steps within the model time period, the duration of each time step and the number of trips in each time step as a proportion of the total demand in the parameter file.	YES Demand can be varied using various techniques, features and methods. Demand can be periodic, demand can contain OD specific profiles, demand can be profiled from single level demand matrix demand can be factored by period or single level demand can be split by user class, journey purpose, vehicle type etc., intervals of 5 minutes can be profiled
Routing Control **(Fixed Routes / Dynamic Assignment)**	BOTH	BOTH	BOTH	BOTH	BOTH	FIXED	FIXED	BOTH
Generalised Cost Options (Time / Distance / Surcharge (Tolls) / All)	ALL	ALL	ALL	TIME	DISTANCE, TOLLS 'TRIGGERS'	NONE	NONE	YES
Please describe the assignment methodology which should be adopted for your software	This is of course very dependent on the topology of the model. In a simple case with no route choice: Use all or nothing assignment. Route congestion feedback and route cost perturbation are irrelevant if no alternate route is available. Traffic may be assigned through an OD matrix or by defined paths. In both cases, multiple profiles and vehicle groups may be used. In a complex network with route choice and congestion. First a hierarchy of major and minor routes which are perceived differently by familiar and unfamiliar drivers is required. The coefficients of the generalised cost equation are then set for the model although these may also be set individually for each vehicle type. Other adjustments to cost perception may be set by link category or set for a specific link. • Route cost perturbation will then ensure that multiple routes are chosen. • Route congestion feedback to the familiar drivers will adjust the cost for a trip to include the known congestion on that trip and vehicles will reroute if necessary. • Variance in cost due to congestion – the learned element of the cost- may be scaled by the awareness and aggression of the driver such that an aggressive and aware driver will change route to take advantage of small variation in cost whereas a less aggressive	Dynamic assignment by iterated simulations to reach a stochastic user equilibrium	There are different options according to the type of network. For a Highway model with no route choice variation during the simulation period, Fixed Routes. For a mixed model with dynamic route choice according to traffic conditions along the day, then 1. Evaluate de mean time distance between origin and a destination. 2. According to that distance choose a value for the 'shape factor' parameter of the logit function. 3. According to the attractiveness that high capacity enjoys over low capacity, choose a value for the 'Capacity penalization' parameter. 4. Fine-tune those values to improve results.	Traffic is assigned to the 'shortest route' with flow applied to the network in 8 iterations with consideration of the varied journey times after each assignment	Users may limit routes as they wish. Routes may be limited until only one is available if they wish to define the routes explicitly. The simulated vehicles are trying to reach their destination and are trying to improve their condition locally as well as for the trip overall. 'Triggers' may also be defined where the traffic can be routed locally based on some perceived congestion or queuing on the upstream portions of the network or based on information given to the vehicle via some other outside influence (ITS Technologies).	No assignment	DRACULA models usually take their network structure, demand and routing patterns from a SATURN model, so the assignment methodology should be considered at this stage of the modelling process.	Vehicle's routing is calculated 'on the fly' from routing tables that take into consideration vehicle position, destination zone, familiarity, link restrictions at the basic level. Stochastic assignment includes variation in perceived cost and Dynamic Assignment adds congested costs to familiar drivers for route selection. All vehicles store their path based on the next two downstream intersections only, as this allows routing to change dynamically with the simulation time.

	less aware driver will only take a fraction of the difference in cost into account. • Waypoints may be used to split a route into multiple independent sections linked at the major junctions on the entire route. Feedback and perturbation operate as described on both the macro network linking the waypoints and on the micro network between the waypoints. This mimics a driver's view of "to get to D, first go to A then B then C". The route sections are handled as sub journeys in their own right. A paper presented in Delft in 2004 is attached to expand on vehicle assignment in S-Paramics.							
Does this allow a converged assignment to be achieved in all conditions?	The question of "convergence" is not applicable to micro-simulation models.	No. This is not a good question, because there are no models that converge in all conditions besides those that are mathematically forced to do so, like MSA. Convergence does not mean that the reached solution is a realistic state.	Yes.	Yes	Depending on the simulation. If there are extreme events being simulated (Random Incidents or Lane Closures) convergence may not be achieved.		A converged assignment should have been achieved during the SATURN stage of the modelling. DRACULA assignments terminate when all of the drivers from the main model period have finished their journey.	As a dynamic model Quadstone Paramics does not run iterative loops. Every vehicle determines routing as they pass through an intersection that offers a route choice.
Can vehicle paths be influenced by Route Guidance / Familiarity?	YES An ITS sign which is either a roadside Variable Message Sign or a network wide broadcast unit may be used to inform vehicles of delays at route choice waypoints or of amended speeds on road sections. Lane restrictions or speed limits may be implemented the same way. Hard shoulder running is also possible. Each message has a visual or audible component – this is as seen or heard by the driver, one or more behaviour modifications in response to the message and one of more response profiles to describe which drivers actually take the message into account when choosing a route or adjusting speed or lane choice etc.	YES Familiarity: the network available to a vehicle class can be restricted in order to model incomplete knowledge of the road network. Route Guidance: - Variable message signs can be modelled by so called partial route decisions, i.e. a network element that overrides a part of the route of vehicle. The partial route decisions can be programmed to reflect the control logic of the VMS. - driver information systems can be modelled by defining a part of the vehicles as equipped vehicles and rerouting them in defined time intervals according to the current traffic conditions.	YES A wide range of global/local Route Guidance/Familiarity phenomena can be achieved in all vehicles or just a subgroup through the use of guided vehicles, ITS elements like VMS and parameters like compliance percentage. Familiarity can be directly modelled with the use of detectors' data and/or statistics from previous simulations(driver's memory).	YES Route guidance is considered by vehicle route re-assignment/change. All drivers are assumed to have the same familiarity of the road network	YES Triggers may be set simulating route guidance technologies. Available routes may be limited simulating user familiarity of different user classes.	PARTLY Routeing is fixed, but user can influence the lanes that drivers use	NO	YES Routing can be modified/influenced by: Major/Minor link hierarchy, Routing category/hierarchy, Link cost factors, Familiarity/unfamiliarity, VMS/route guidance/ITS etc using API (Programming) tool
How does this model deal with 'abnormal blockages'?	A vehicle attempting to change lanes and finding that it cannot get into the required lane for the turn will proceed at reduced speed in the wrong lane. It may be offered a gap to move into by another vehicle but if no courtesy lane change opportunity is available it will eventually get to the point where it has to make the turn and will do so from the wrong lane. This is as observed in normal congested driving conditions. A vehicle that finds its path across a queued stream of traffic is blocked will eventually force its way across. Although S-Paramics does not make the very small adjustments in the position of the crossing vehicle and those it is passing it is assumed that in reality small adjustment are made to in effect allow a vehicle to proceed and in some case break the normal priority rules. Once again this is as observed in normal congested traffic conditions.	"I do not fully understand that question." There is a possibility in VISSIM to define a maximum waiting time for a vehicle in a lane changing process, and after that time the vehicle is removed from the simulation. However, this is only a last resort and should be not necessary with proper modelling.	In case of congestion the vehicle has to wait. In case of acceleration lane, give-way or stop the vehicle becomes increasingly aggressive. In case of intersection the vehicle might even beremoved.	There are two different conditions. In motorway merge, when approaching to the end of a slip road, a merging driver will take smaller gaps. In very congested condition, drivers may have to stop at the end of slip road to wait for a suitable gap. However, to make forced lane changing on motorway carriageway in very congested conditions, when approaching to the target exit, drivers will take smaller gaps to change lane. If satisfied gaps do not exist, driver will give up lane change and keep going ahead to leave in the next junction.	Vehicles are always able to change lanes. As they are in real life. If a vehicle reaches it's defined emergency stop location and couldn't work out the lane change, it will they force a merge into the traffic. If for some reason and 'abnormal blockage' did occur, it is flagged by the simulation and reported to the user. This is generally a result of improper network coding.	In such a situation the vehicle will just sit there until a gap arises	In DRACULA, the abnormal blockage is minimised by two explicit behavioural models of drivers' lane-changing. Firstly, DRACULA models the cooperation behaviour of drivers in the major flow or the target lane who provide courtesy yielding to create gaps for the lane-changing vehicle. Secondly, the variable gap-acceptance model in DRACULA represents the in-patient factor in driver behaviour in that the accepted gap values decrease as a function of wait-time of the driver. In the event of an abnormal blockage, the model will continue simulating the other traffic in the network with the blocked vehicle staying in the blockage infinitely until it either find a gap to change-lane or the time of the simulation is, by default, three times of the pre-set demand time period..	User controlled option to reroute exists - vehicles in the wrong lane for a turn have the option to take another exit and detour to reach destination Critical lane changing exists for vehicles which are outside their correct lane
Can vehicles overtake others on the same lane? eg car passing motorcycle	NO	YES	NO	NO	YES	NO	NO	NO

5. Junction Control								
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
What parameters/options are available for priority junction / roundabout control?	Turn priority to establish major and minor movements. Lane choice for a turn Locus points for the vehicle trajectory Stop lines to describe where a vehicle waits for a gap in traffic Kerb points to describe road geometry Visibility to describe where vehicles are able to see oncoming traffic and hence can react to it Gap acceptance modifiers for junction specific conditions Link end stop times, suitable for simulating toll collection Link end speeds to prescribe turn speed or to simulate traffic calming measures. Signpost distance to inform vehicles where it is appropriate to consider moving on to the correct lane for the turn to be made at this junction.	For each conflict point, gap acceptance can be defined.	There are several options. The simplest one is just priority sings; it is even possible to define a matrix of priorities for complex intersections. Then there are fixed-time control plans for traffic signals which can be manually edited or imported from tools like TRANSYT. Then it is possible to set an actuated system following NEMA standards (FHWA) or public transport pre-emption through the use of two dozens of elements like parameters minimum green time, passage time and delay, methods like complementary Rings or affected phases, and elements like detectors or bus-line identification. Furthermore it is possible to integrate any particular control system into AIMSUN using the software development tools of the AIMSUN NG environment. More detail on this can be requested.	Gap size (time), vehicle types, etc. For example, a Bus or HGV will need a larger gap than a car.	Any type of junction may be modelled. Priority of vehicles is established through the use of different priority objects placed in the simulation.	SISTM cannot model all purpose road junctions	For roundabouts, parameters are available to define circulating speed, the acceptable gap (sec) used upon entering the roundabout and the distance on a roundabout which the entry traffic would look back for potential conflicts. For priority junctions, several parameters are available including: acceptable gap (secs), miniumum acceptable gap (secs), waiting time before reducing acceptable gap (secs), waiting time (secs) before taking on the minimum acceptable gap, and a courtesy factor (the fraction of traffic who are willing to give way to minor flow cars). Also the distance (per 30kph) upstream of a stopline where a vehicle starts to react to junction control and the distance upstream of a stopline where a vehicle starts to look for gaps in the approaching junction can also be specified.	Turn priority to establish priority hierarchy. Visibility is used to determine how far from the stopline/give way a vehicle can see conflicting vehicles in order to identify an acceptable gap. Patience, an internal parameter to replicate a driver's willingness to take a smaller gap if there is no acceptable gap in a designated time frame. Stopline location and gap acceptance criteria to adjust the positions of the give way locations and the acceptable gaps criteria. Roundabout behaviour to replicate more realistic gap acceptance/merging at roundabouts. Entry/exit lane specification to replicate the designated lanes, circulating and entry, for the desired exits. Link stop time to replicate any position where vehicles stop completely before considering a gap. Link end speeds to represent points where vehicles slow down before considering a gap. Signposting distance to replicate the distance drivers become aware of which lane to choose for their desired exit and signposting range to show variance in the signposting parameter. Nextlanes to replicate the preferred downstream lane.
Are the values associated with these parameters variable (e.g. by vehicle type)?	YES	?	YES	YES	YES		?	SOME
							Some of these parameters can be defined for specific junctions and links, eg the gap acceptance parameters can be defined for individual junctions. They can not be defined by vehicle type, as they are applied to all vehicles.	
Are there any standard parameter sets available which would produce results comparable with empirical programs such as ARCADY / PICADY?	NO	NO	YES/NO	YES	NO		NO	YES
			Believes it is possible, but is checking.	Yes. For example, a Bus or HGV will need a larger gap than a car. Yes. For, example: delay, queue length, journey time, etc.	However users have created their own in other areas. This is just a reflection of the software being new to the UK and parameter set not having been published yet.			Documents available that provide comparison results between ARCADY, PICADY, TRANSYT and Quadstone Paramics
Can lane specific parameters be defined?	YES	YES	YES	YES	YES		NO	YES
Can 'Yellow Boxes' be included (at least the behaviour can be modelled)?	YES	YES	YES	NO	YES		YES	YES
Can network elements be linked to specific vehicle types?	YES	YES	YES	YES	YES		YES	YES
Can variable cycle times be modelled?	YES	YES	YES	YES	YES		NO	YES
Can selective vehicle detection be modelled? (e.g. bus priority schemes)	YES	YES	YES	YES	YES		YES	YES
Can different signals plans be	YES	YES	YES	YES	YES		YES	YES

called during model periods?							Different signal plans can be called if modelling schemes such as bus priority. Traffic signals can vary between two alternative fixed plans in response to detection of a selected type of vehicle, typically bus. The alternative plan is called in at the detection of a bus upstream, and cancelled at the detection of the bus downstream.	
How are saturation flows treated in the software? Are they an input parameter? Does lane width / gradient / geometry etc. influence saturation flow?	Saturation flow is used in S-Paramics only during the “Equisat” signal time optimisation process where it may be calculated from the geometry of the junction and the opposing turn counts or it may be input for each signal phase. It is then used to calculate optimised signal times. Saturation flow is not used as an input parameter to determine junction capacity within the model. Saturation flows may be measured for junctions by observing the headways of vehicles as they cross a signal stop line and processing that data externally.	Saturation flows are an outcome of the settings of the driving behaviour parameters. In the manual, parameter settings are given to achieve certain saturation flow values.	Saturation flows are a result, but Level of Service (Standard) can be visualized and statistical results can be compared to Capacity (input parameter). Characteristics like continuous lines or reserved lanes and parameters like gradient or zones of the section will affect saturation flow. Part of the geometry affects.	1.) No special treatment required for saturation flows in FLOWSIM. 2.) Influence of lane width may be considered by defining different speed limits of link/lane attributes. 3.) Influences of Gradient/geometry etc. on saturation flow are not considered.	The achieved saturation flows are a result of the vehicle definition, mix, network geometry, and control. Certainly this is a primary calibration parameter that should be checked and verified.		Saturation flows are not input into DRACULA. Instead, junction or turn saturation flows are determined by the car-following rules used by the car-following model. The rate of flow of vehicles through a junction therefore depends on the speed and position of the preceding vehicle.	Saturation flow is not an input. Saturation flow or throughput is an output that is based on the car-following algorithms and simulation engines Comparative calculations are available for signalised intersections
Can different junctions/nodes be controlled by a single controller?	YES	YES	YES	NO	YES		YES	YES

6. Network Strategies	Can the following strategies / operations be modelled?							
	S-Paramics 2005 Release 1	**Vissim 4.10**	**Aimsun NG 5.0**	**Flowsim 2.0**	**Cube Dynasim V.1.4.15**	**SISTM v6.0.005**	**DRACULA**	**PARAMICS V5.1**
Road works	YES This depends on the nature of the work. Options include: 1) A simple road closure 2) Lane closure with speed and perceived link cost changes 3) Closure with delay warning via an ITS system Note that route choice and modification of choice will be automatic through the route assignment module.	YES If lanes are closed, this can be modelled directly. Different driving behaviour in roadwork areas can be modelled by assigning modified behaviour parameter sets to the road works link types. (e.g. larger car following headways) Dynamic assignment will react on capacities changes by road works.	YES Incidents. 'Incidents' is a feature used to model road works and accidents. The spot for the incident is set with the mouse and a dialog window gives access to edit several other parameters, like the area affected by the incident.	YES Treated as lane(s) drop	YES New network scenarios can be added modifying the 'existing' condition and comparisons can be made. Modifications for construction generally deal with altering speeds, number of lanes, lane widths, available turning movements, etc.	YES Lane closures, obstructions	YES DRACULA can model planned road works and other regular incidents (eg illegally parked vehicles), where location and duration can be specified. Such incidents are modelled as lane closures for the specified period and locations of the lane involved. To model a lane closure or blockage, the lane should be specified as a reserve lane and then reserved for the DUMMY vehicle class.	YES Lane closures can be modelled, contra flow lanes can also be modelled Link speed should be manually adjusted for behaviour effect of road works/narrow lanes Options exist to prevent lane changing and restriction of wide vehicles from narrow lanes. Congestion created by road work may avoided by familiar drivers using dynamic routing algorithms.
Accidents	YES The nature of accidents is such that they cannot be predicted. However, Paramics measured the effect of user input "accidents" in the form of "incidents", and can also determine the propensity to accidents at points of potential conflict (e.g. weaving sections). Incidents are modelled by specifying a rate at which they happen (one vehicle in N) or specific times at which they occur and a location, type of incident and duration. A vehicle will stop at the specified time and place and subsequently vehicles will slow to pass if possible or will adjust their routes. ITS information may be applied if required. Note the Edinburgh bypass study in 1999 made use of this to investigate the cost benefits of a third lane Vs a hard shoulder on the A720. The cost savings from better management on incidents on this road was higher than those due to conventional widening. Similarly a study which implemented a MIDAS controller showed the benefits of automatic incident detection and subsequent speed control.	YES Same method as with road works	YES Accidents are modelled with the 'incidents' feature, as mentioned in the previous (Road works) item.	YES It is treated as lane(s) drop, but has a pre settled start time and time period of road blocking	YES Accident vehicles are generally modeled as an additional type. These may be scheduled at a certain time/location or the time/location may be allowed randomly within a certain area.	YES Obstructions which block one or more lanes for a specified time period and (if brought to drivers' attention using VMS) encouraging drivers out of the affected lane(s)	NO DRACULA does not model irregular incidents, such as accidents, whose location, duration and frequency of occurrence can not be pre-defined.	YES Incidents can be simulated and defined by the user API can be used to simulate rerouting or route guidance changes 'rubbernecking' option available with other incident specific parameters
Ramp Metering	YES S-Paramics was used in Glasgow on a project funded by the Scottish Executive to calibrate it using an existing Ramp metered junction. An ACI based ramp metering controller was built to implement ALINEA based ramp metering. This was then further tested on the A720 Edinburgh bypass simulation model. A paper about this project was presented at Traffex in 2003. This software is available for use by any S-Paramics licence holder	YES Ramp metering can be modelled with the functionality provided for vehicle actuated signal control. E.g. the Alinea-Algorithm is implemented in VISSIM's programming language VAP.	YES There's a 'Ramp Metering' icon that, when activated, allows to set the control point with the mouse. A dialog window from the control plan gives access to other complementary parameters like the type of control or the time-of-the-day / set-of-conditions that will activate the metering.	YES Different ramp metering algorithms, e.g. ALINEA, may be simulated on motorway, expressway intersections. Ender users may decide which metering algorithm to use.	YES This is no problem using the default tools provided in the signal control module. Detectors may be placed on the mainline altering the timing of the ramp meters.	YES The user must define the following: (1) A switch on/switch off mechanism (e.g. time or speed/flow based) (2) Parameters for the algorithm (e.g. ALINEA, fixed) that determine the metering rate (3) A queue override mechanism (4) A co-ordination mechism if the switch on/off is to depend on other RM sites or Controlled Motorways and if the metering rate is to depend on other sites (5) A driver reaction time to the signal settings (e.g. ignore amber, treat red+amber as green)	NO	YES Either using fixed time traffic signals or vehicle actuated ramp metering APIs have been used to implement existing algorithms and real time ramp metering projects
Variable Speed Limits	YES Variable speed limits may be imposed in two ways depending on how they are deemed to vary.	YES Desired speed decisions can be controlled externally by Vissim's programming language VAP, so the control logic can be modelled	YES There is a feature called 'Action' that allows to model initiatives for dynamic traffic management, like variable	YES Varied speed limit on different motorway sections.	YES Vehicle's desired speeds may be altered based on detector inputs.	YES Can be implemented as either: (a) a stand-alone system where flow, speed or occupancy levels govern the speed limit		YES Speed controls can limit maximum speed on link API can be used to link this to external control or data

	If the restriction is by time of day then use time periods and adjust the limit in the link description. If the restriction is due to incident detection (i.e. MIDAS) or to congestion then an ITS controller may be produced to implement the restrictions based on information derived from dynamic journey time monitoring, speed detection or loop occupancy monitoring.	there.	speed limits or vehicle re-routing. Variable speed limits are implemented in a similar way as metering: a point in which to take place, a time-of-the-day / set-of-conditions to become active and, if necessary, the type of vehicles/drivers which is going to affect.			(b) a Controlled Motorways system with the same parameters as the real M25 system		(pollution or congestion for example). Link speeds can be controlled during a simulation by periodic file changes.
Narrow Lanes	YES	YES	YES	YES	YES	NO	NO	YES
	Physically the road is narrowed or the kerb points are moved. The visual look of the road is consequently updated. Speed modifications or changes to perceived costs can be entered separately by the user, but since we have little research data available, no automatic adjustment of these factors is applied.	The simplest way is to define modified driver behaviour parameter to the narrow lane links. But it is a swell possible to choose a simulation mode where lane width and vehicle with are explicitly considered in the driving model.	A narrow lane model is not explicitly included, but the same effect can be easily achieved changing the values of a few local parameters	By different speed distributions	Lane width is set as a parameter of the roadway trajectory. Vehicles automatically adapt to the given width and react appropriately.		Not explicitly, but only through the effect of narrow lanes on free-flow speeds.	Quadstone Paramics is lane based and takes little direct account of vehicle or lane width. Effect can be simulated visually and by reducing speed on link via link speed, speed controls or API

7. Model Outputs

In terms of the direct output from the model, what can be produced? The list below provides some basic examples of output. Indicate if any outputs require additional modules over and above are provided with the basic software package

	S-Paramics 2005 Release 1	Vissim 4.10	Aimsun NG 5.0	Flowsim 2.0	Cube Dynasim V.1.4.15	SISTM v6.0.005	DRACULA	PARAMICS V5.1
Classified link flows	YES	YES	YES	YES	YES		YES	YES
…by lane	YES	YES	YES	YES	YES		YES	YES
Flows by specified time periods	YES	YES	YES	YES	YES		YES	YES
Classified turning flows	YES	YES	YES	YES	N/A		YES	YES
Queue length measurements	YES	YES	YES	YES	YES		YES	YES
…by vehicle numbers	YES	YES	YES	YES	YES		YES	YES
…by queue length	YES	YES	YES	YES	NO		YES	YES
…by lane	YES	YES	YES	YES	YES		YES	YES
Vehicle Speed measurements	YES	YES	YES	YES	YES		YES	YES
…by vehicle type/class	YES	YES	YES	YES	NO		YES	YES
…by lane	YES	YES	YES	YES	YES		YES	YES
Travel time measurements	YES	YES	YES	YES	YES		YES	YES
…by vehicle type/class	YES	YES	YES	YES	YES		YES	YES
…by time period	YES	YES	YES	YES	YES		YES	YES
…by specific route	YES	YES	YES	YES	YES		YES	YES
Vehicle Emissions	YES	YES	YES	YES	NO		YES	YES
	Carbon Monoxide / Carbon Dioxide / Total hydrocarbons / Oxides of Nitrogen Fuel consumption / Particulates Each vehicle type is linked through its engine class to a pollution database which was derived from a study on the M25 in 1997. Emissions are output by location based on link and may also be graphically displayed as a 3D surface to help identify hotspots	There are two emission models: - a detailed model based on engine maps for CO, CO2, HC, NOx - a simpler aggregated emission model EnvPro that implements the models resulting from the EU research projects QUARTETT and MODEM. EnvPro was developed at the TORG in Newcastle.	CO2, NOX, HC (un-burnt hydrocarbons) + User defined	The total amount of emission by type of major pollutants	CO2, CO, hydrocarbon, NOX and particulates		The programme outputs for each link and for the whole network time averages for the following pollutant emmissions: carbon, hydro-carbons and NOx	Any input by user - Monitor module allows user defined emission data standard are: CO, CO2, Total Hydrocarbons, NOXs, Particulates, Fuel consumption
Delay Measurements	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
Traffic signal timings	Basic Package	Basic Package	Additional	Basic Package	Basic Package			Basic Package
…saturation flows	Basic Package	Basic Package	Basic Package	(not required)	Basic Package			Basic Package
Individual vehicle records	Basic Package	Basic Package	Basic Package	Basic Package (by specification)	Basic Package	Basic Package	Basic Package	Basic Package
Overall network data	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
…by time period	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
…by vehicle type	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
…by travel time	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
…by distance	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
Zone to zone data	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
…by time period	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
…by vehicle type	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package	Basic Package
…by travel time	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
…by distance	Basic Package	Basic Package	Basic Package		Basic Package	Basic Package	Basic Package	Basic Package
Developer Comments	A monte-carlo simulation such as Paramics will produce variation on results depending on the initial			i) FLOWSIM was developed over 10 years ago as a research model for use with				The Analyser tool, a module in the basic package will allow comprehensive

	random seed it is assigned. This variation is inherent in the simulation process and also in the natural behaviour of road traffic. The Data Analysis Tool, which is part of the standard S-Paramics package, makes the task of analysing multiple runs of one model simple and it will also compare multiple runs of a model and its design variants highlighting the differences between them. When evaluating simulation model outputs it is important not just to ask what outputs are available but also to look at how readily the processed and summarised output for the client can be produced Note that S-Paramics will also output economic assessment in accordance with the DoT WebTAG guidelines via the PEARS module which is included in the Data Analysis Tool			motorway traffic. The focus was, and is, on quality of representation of traffic conditions rather than functionality. ii) Substantial funded and student research has continued with many applications and peer reviewed publications. Although the model is relatively straightforward to use it is not yet a commercial package, although substantial progress has been made towards this by extending the range of situations which can be modelled and rewriting software to a commercial standard. iii) Key to the success of the model has been the unique integration of information from our instrumented vehicle. The resulting fuzzy logic approach has enabled a much better representation of high flow/flow breakdown situations than the more simple mechanistic representations usually used. iv) The fundamental assumption in any simulation model is that it is possible to represent and combine the individual behaviour of vehicle/driver combinations. However, these are not fundamentally fixed and vary with location and conditions. For example, the capacity of roadwork sites varies hugely although site conditions may be very similar. Rigorous calibration and validation processes are key. v) Because it is easy to define functionality, but not performance and, because users of models often do not want to admit inadequacies in representation, there have been few rigorous independent checks on the performance of microscopic simulation models. Also, it is easy to adjust model parameters in a calibration process to "justify" the model but which will give a very false indication of the effects of change in control, layout or traffic. vi) The simplest approach to understanding the ability of a model to represent conditions would be as follows: a) Select a series of applications e.g. lane loss/ramp metering. b) For each application and for each model, provide data for the model to be calibrated and validated on a "before and after" basis. c) Select a new site or conditions and provide "before" data with each model used to predict the "after" outcome "blind".				display and reporting of data from a simulation run. In addition several simulation datasets can be loaded in addition to different networks allowing different networks to be directly compared as well as different simulation runs.

8. Random Seed	S-Paramics 2005 Release 1	Vissim 4.10	Aimsun NG 5.0	Flowsim 2.0	Cube Dynasim V.1.4.15	SISTM v6.0.005	DRACULA	PARAMICS V5.1
Do you recommend the use of various seed values? If so, how many?	It depends on the model – you are trying to get a reasonable confidence interval around your results. You need more results in a congested model with traffic on the cusp of flow breakdown than you need on a model where everything is flowing freely. Same as in reality – A journey on an empty road has a predictable duration. A journey across a city in the peak hour hasn't. Having said that the good practice guide mentions 10 as a reasonable start point	Yes, for a reliable result multiple runs with different seed values are necessary. This is due to the stochastic nature of the models used in VISSIM (and probably most other micro-simulation tools). The question about the number of required runs can be answered in a scientificaly correct way and maybe in a more pragmatic way. (I assume that you know about the statistic theories, but for the questionnaire I will explain it once more.) The correct answer is based on the fact, that due to the stochastic nature of the simulation any result value is a random variable with certain characteristics. Lets take the example of the travel time for a defined route. If you perform several simulations with different seeds, you will see different travel time values. From these values you can estimate the standard deviation of the travel time. Formally, your simulation experiments will estimate the real value of the travel times within a given confidence interval with a certain probability. If you increase the number of simulations, the probability that the average of the simulated travel times lies within the given confidence interval increases. In order to determine the number of simulation runs, you have to choose the confidence interval and the error probability. E.g. you want the simulated average value to lie within a +- 10% interval of the real value with a probability of 95%. (vice versa this means that there is still a probability of 5% that the real value and the simulated result differ more than 10%.) The formula then is: required no of runs = $\varepsilon^2 * t^2 / e^2$ with ε = variance coefficient = standard deviation / mean of the simulated travel times t = value from t-distribution for the chosen confidence level (e.g. 95 %) e = relative confidence interval (e.g. 10%) I assume that users only rarly do it that way. But what shold be done at least, is to simulate several times and to compare the results. If the differences are high, a larger number of runs must be performed and averaged than if the values are all close together. In general, more runs will	Yes, it is not a recommendation but a necessary condition to produce focused statistics The number of replications is a function of different factors like the size of the model or the traffic state, and the number of replications has to be increased until the desired standard variation of statistics has been reached The user manual includes a full explanation on these necessities and the associated evaluation process. Anyhow, experience indicates that an average of 10 replications produce significant results.	Yes. The FLOWSIM uses varied seed values, which are randomly selected by computer in a simulation. There is no limit of the number of seeds.	Yes, the software is designed so the only way to get numerical data is if a user does at least three replications However many are needed to reach the desired statistical confidence level.	Yes, we usually combine the results from various seeds and produce average values. Traffic demand files in SISTM usually define flows for each O/D pair and each vehicle class with a temporal resolution of 5 minutes. When individual vehicles are generated at the upstream ends of the model, they are not spaced equally within this 5 minute slice, they are bunched more realistically. The algorithm that creates the bunching uses a pseudo random number generator function to create the realistic bunching pattern. A pseudo random number generator needs a starting value, which the user supplies at the start of a simulation run, but then will always produce the same values in the same order. By changing the starting value, a different set of random numbers is obtained, and so a uniquely ordered and spaced set of vehicles is generated. Driver characteristics (aggressiveness and awareness) are also assigned to vehicles in a random way using the seed. The way these drivers and vehicles then go on to interact with each other can cause large differences in the results obtained. 6 is common, but more may be used if the results vary greatly. A limiting factor in the past was the number of simulation runs that could be carried out in the time available, now the limiting factor is often the amount of simulation output that has to be post processed	Yes. DRACULA is a stochastic simulation model; there are many random processes used/occurring during the simulation (e.g. vehicles' random parameters and drivers' random behaviour). Given the same network and demand inputs and the same simulation control options, the results from two or more runs with different random number seeds may differ. To get some confidence in the simulation predictions, it is a good practice to run the simulation several times with differentrandom seeds NSEED and to look at the averages and variances of any result from the number of simulations. The number of simulation runs depends on the level of accuracy required. It should consider the level of variance introduced to the model (such as variance used in describing the distribution of vehicle characteristics) when considering the level of accuracy required. In practice, ten simulation runs may be a practicable number but the user should ensure that the level of accuracy required has been achieved.	We usually recommend between 5 and 15 simulation runs during the final stages of the calibration to prove that the simulation and network are robust. From these tests it is acceptable to analyze and report on a seed value that provides a near median value for Vehicle Time/Distance traveled.

		be needed in highly saturated situations.						
If multiple seeds are used for the base model development should the same seeds be used for the design testing?	There is an economic assessment methodology that requires that the same vehicles are released into the base and design networks. If you are constrained to use this methodology then using the same seed will get you the same releases despite the subsequent different behaviour in the changed network (This does of course assume the zone scheme and release rates are unchanged) However, in general we do not recommend using the same seed for testing and there is no correlation between seed and network performance.	No. There is no theoretical reason for that. If the number of runs is determined correctly, any seed values can be used.	From a theoretical point of view, yes, in order to eliminate an unnecessary variation at the time of data comparison. From a practical point of view it is not necessary, because the design will have introduced a variation with an impact orders of magnitude larger than that that different seeds will produce.	No, not necessary. In each simulation run, seeds are randomly generated by the computer/simulation model, FLOWSIM.	We do not recommend this. A true 'statistical analysis' of both should be performed using randomly generated seed values	Yes, If there are large differences in the results between seeds, then it may mean that traffic demand is running close to the capacity of the motorway, and liable to flow breakdown. A certain combination of vehicles interacting with each other may just be enough to cause a greater amount of braking and so reduce speed and flow. If this is the case, then it may be advisable to run the model with even more seeds, say 20 for example (for the base as well as each of the design options) to obtain more confidence in the average values.	Yes, we recommend so.	In Quadstone Paramics is it possible to separate the seed streams, allowing the same profiles of generated vehicles to be released onto he network if no zoning or OD parameters are changed. Therefore it may be appropriate to use the same seed values if the demand and release profiles are not to change. If this is not the case then there will be no significant difference between using the same seed values or a new series of seed values.
Should a single seed value from the base assessment be used for the design option testing?	No Not unless you are constrained to the same releases. You should be using multiple runs and any seeds	No For design testing, several seed values must be used as well.	No A single seed will produce equivalent results to those that could be gathered during a randomly selected single day. Such low reliability makes necessary to run several replications.	No No. Seeds for any distributions in FLOWSIM simulation are randomly generated by the computer/simulation model	No No. A statistical analysis should be performed on the options as well.	No No, usually the same set of seeds should be used, and the results averaged in the same way	No No, we recommend use of multiple runs for all scenarios and evaluate the scenarios from the means and variances of the runs.	This option is left to the user, although there is no reason not to do this providing the network is robust and has undergone sensitivity testing with multiple seeds.
Do these only affect the traffic input or do they also impact on the speed distributions, acceleration rates etc assigned to vehicles?	Both	In Vissim, the seed value affects all of the mentioned values and many more.	All those magnitudes (vehicles' parameters, decisions, demand generation, ...) are produced with the random seed, so different random seeds have a direct impact in the parameters and an indirect one in the statistics	As long as a simulation period is adequately long (e.g. > 60 minutes), different seeds shouldn't cause statistically significant difference on simulation results	The seeds do not change the distributions. They only are changing how individual vehicles parameters are drawn from a defined distribution	The overall speed and acceleration distributions of the vehicles generated will be the same, but individual vehicles will be different	In DRACULA, the random processes apply both to the input (for example in representing day-to-day demand variability, distributions of vehicle characteristics such as acceleration and desired speed) and during the simulation (for example, a random decision as to whether to proceed or stop when the amber light is on).	Using the Separate Seeds option the release profiles will maintain a single seed stream and will therefore not be influenced by network operation. With a single seed simulation traffic behaviour can affect release proportions.
What variation would you expect in: traffic flows? queue lengths? vehicle speeds? journey times? If there is significant variation in the results, how can these be used for economic assessment when small performance improvements can lead to significant economic benefits?	It all depends on the network. On an uncongested network I expect low variation. On a near capacity network, a larger variation. You have to do the statistics and use the confidence intervals. If you are basing your economic assessment on small variations in a single run of a simulation then you are at risk of making errors when you factor them up. To put in another way if the difference between assessments is less than the spread between individual runs you can't state anything about the performance of the design This is why we designed DAT and PEARS to cater for multiple runs and to handle these variations.	See the explanation above. This is a stochastic experiment. There are sound mathematical methods to separate random variations from systematic variations (at least with a user defined confidence level).	Quality of results will depend on data quality, and the desired minimum standard deviation of results will determine the necessary number of replications.	There shouldn't be statistically significant differences on the above outputs when different seeds used in FLOWSIM. FLOWSIM is a stable simulation model. Many applications have shown that, for the same input data, outputs will not be significantly different.	+/- 4% Queue, Speeds, and Travel Times are a result of the simulation and depend heavily on the level of congestion and the parameters defined within the model. For example, in uncongested or heavily congested networks, the variation will be quite small as there is a consistent level of congestion. But in a network which is reaching capacity and the flow may be free or may break down, the variation seen between runs may be larger. This is no different than the variation that is observed on an existing highway system. There may be some sections which on some days it may flow fine through the peak. On other days it may be congested. This may be a function of volumes, incidents, or just different vehicle behaviours It is critical that a statistical analysis be performed and the confidence level of the results be taken into account. Using t-paired or Welsh	This will depend on how close the flows are to the capacity of the motorway, or how close the speeds and flows are to any thresholds used in automatic traffic management systems that might be activated. If for example, a variable speed limit is activated in a run with one seed, but not another, then traffic conditions could be very different in the two simulations. By taking the average of many seeds and quoting the mean values with standard deviations, you can have more confidence in the values obtained.	If you mean the level of variation, then the variation in the simulation results depends on the level of variation in your input data (for example, the variance used in the generation of the distribution of acceleration and desired speed) and the level of congestion in the network. We recommend the use of the null hypothesis test to demonstrate that the estimated economic benefits are statistically significant compared to the variation found within the simulation.	Variance will depend on the individual network however tests on networks delivered the following variations: traffic flows + or - 4% queue lengths + or - 5 % Vehicle speed + or - 5 % journey times + or - 5 %

					methods, the answer may fall into one of three categories: We are 'confident' that the results are 'better' or 'worse'. Or we must say that statistically we show no difference between the options at some confidence level. The same goes for calculating differences. You must perform a statistical analysis and say that: 'at a certain confidence level, the benefits are…' With Dynasim, the entire system is built to perform these types of analysis. You simply tell the software how many replications you would like. It compiles all the results from individual runs and generates the statistical parameters. If in the end, you wish to do more replications in order to narrow your confidence interval, you tell the software how many more you would like and it performs the simulations, appends the additional runs, and recalculates all the statistics.			
Given the potential concerns re-economic assessments, would you consider it appropriate to use 1 seed value to develop a calibrated/validated?	No – use several	No. It is _never_ appropriate to use only 1 seed value. (If someone does, he shows a basic lack of understanding what he is doing.)	No. Again, like 3 questions before, it is like evaluating a network's behaviour based on a single day phenomena. That single day may have been an exceptional one. Averages should be generated.	For a stable simulation model, simulation results should not be sensitive to seed variations and random selection is a much more robust approach. We would not consider it useful to use 1 seed value.	No. Never	No, the same approach should be used for calibration and validation, use the average from a number of seeds. Start with 6 seeds, and if there is a large variation between them consider using more.	No.	It is acceptable to use 1 seed value for basing economic assessment upon, provided that sensitivity testing has shown the seed value run to be robust and a run close to the median of a series of seed runs. It is equally acceptable to base the economic assessment on an average of several runs, although this will not provide an individual simulation run that can be analyzed separately.