Smartest

Simulation Modelling Applied to Road Transport European Scheme Tests

Review of Micro-Simulation Models
Appendices A, B and C

Eric Bernauer, Laurent Breheret, Staffan Algers, Marco Boero, Carlo Di Taranto, Mark Dougherty, Ken Fox and Jean-François Gabard

SMARTEST Project Deliverable D3
Submission Date: 30 June 1997
Circulation Status: P - Public
The “SMARTEST” Project
Contract N^{o}: RO-97-SC.1059

Project part funded by the European Commission under the Transport RTD Programme of the 4th Framework Programme

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DOCUMENT CONTROL INFORMATION

Title	:	A Review of Micro-Simulation Models
Author(s)	:	Eric Bernauer, Laurent Breheret, Staffan Algers, Marco Boero, Carlo Di Taranto, Mark Dougherty, Ken Fox and Jean-François Gabard
Reference Number	:	SMARTEST/D3
Version	:	1.0
Date	:	9 March, 1998
Distribution	:	ITS, SODIT, UPC, Mizar, Transek, Softeco, CTS, CERT, DGVII(5), HIPERTRANS
Availability	:	Public
File	:	d:\users\europe\encours\smartest\delivera\d3\append3a.doc
Authorised by:	:	Ken Fox
Signature	:	

APPENDIX A: USER QUESTIONNAIRE

European Union
Transport RTD Programme

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Micro simulation of traffic — user requirements

Micro-simulation models are becoming an increasingly important tool for traffic control research and development. These models, where the movements of individual vehicles travelling round road networks are modelled using a computer, permit the traffic professional to have a bird's eye view of the traffic and an instant feel for current problems and possible solutions. Controversial or new techniques can be tested without any disruptions to traffic in a real network.

There are several important areas of application for micro-simulation models. Evaluation of transport schemes involving traveller information systems and responsive control systems requires that traffic is modelled in great detail and that their interactions with the systems are captured. As tools for short term forecasting the micro-simulation models can provide support for on-line traffic management. Assignment models and driving simulators can also profit from the detailed output of micro-simulation models.

However, today's micro-simulation models have limitations. The purpose of the SMARTEST project is to identify the most important gaps in the models, to solve the modelling problems and to calibrate the models using field data from several European cities. The models concerned are AIMSUN2, NEMIS, SPEACS, DRACULA and SITRA-B+.

In order to identify the gaps and user needs, we are sending this questionnaire to a selection of important model users throughout the world.

By answering this questionnaire you can directly affect the development of a new generation of micro-simulation models, a development that you most certainly will benefit from in your future work!

As the sample of users is limited, it is of utmost importance for us in the SMARTEST research team to get your experiences and views on micro-simulation models.

Anyone who replies to this questionnaire can receive a free copy of each of the SMARTEST public reports when they become available. If you would like to take advantage of this option then please tick here: ☐

Further information about the project can be found on the World Wide Web at:

http://www.its.leeds.ac.uk/smartest/index.html

or can be obtained from the project co-ordinator:

Ken Fox
Institute for Transport Studies,
University of Leeds
Leeds
LS2 9JT
England

Tel: +44 - 113 - 233 - 5351
Fax: + 44 - 113 - 233 - 5334
E-Mail: K.A.Fox@leeds.ac.uk

Ken Fox
ITS, University of Leeds

Please return the questionnaire to Ken Fox by 14 March 1997!

Questionnaire

You can answer the questionnaire on our WWW page:

http://www.its.leeds.ac.uk/smartest/userq.html

or you can return it by mail.

If there is not enough space on the questionnaire, please write your answers on a separate piece of paper!

1 **Name:**____

2 **Organisation:**____

Please tick

O Road authority O University or Research Institute

O Consultant O Manufacturer, please specify product ____________________

____

O Other, please specify ____

3 **City:** ____________________ **Country:** ____________________

4 **What is your main area(s) of application for traffic simulation in general?**

O On-line traffic management O Design and testing of control strategies

O Evaluation of large scale schemes O Evaluation of product performance

O Other, please specify____

Please comment____

____

____

5 **Which models do you use for traffic simulation?**

Model name	Type (macro/micro/assignment/design etc.)
______________	______________________________
______________	______________________________
______________	______________________________
______________	______________________________
______________	______________________________

The following questions concern *micro-simulation* models. These are models where the movements of individual vehicles travelling round road networks are modelled using a computer.

6 Your use of micro-simulation models

a) To what extent have you, or your organisation, used *micro simulation* for traffic modelling?

O Many applications O Some application

O Testing only O No experience

b) Please specify size of network (number of links, intersections and dimensions (km))__________

____

____

c) Have you developed your own micro-simulation models?

O Yes O No

Please comment ____

____

____

7 What is your opinion of micro simulation as a tool for analysing traffic?

O A necessary tool O A useful tool O Not sure

O An unnecessary tool O An unreliable method

Please comment ____

____

____

8 a) What are the advantages of the specific micro-simulation models you have encountered?

Model	Advantage

b) What are the disadvantages or shortcomings of the specific micro-simulation models you have encountered?

Model	Disadvantage

9 If you would start - or continue - using micro-simulation models in your work, what would be your main area(s) of application?

O On-line traffic management
O Design and testing of control strategies
O Evaluation of large scale schemes
O Evaluation of product performance
O Other, please specify____

____

Please comment ____

____

10 On what scale(s) would you be interested in applying micro simulation?

Please specify size of network (number of links or intersections or dimensions):

O Regional ____
O City ____
O Corridor ____
O Intersection(s) ____
O Single road   O Other, please specify ______________________________

Please comment ____

____

11 What planning horizon would you have in mind for your micro-simulation applications?

O On-line   O Present situation   O 1-5 years   O 5-10 years   O >10 years

Please comment ____

____

12 Micro-simulation models usually contain a very detailed description of the network and the vehicle fleet, e.g. road geometry, intersection design and vehicle types. Which additional traffic objects or phenomena do think are important to include in a micro-simulation model?

Please tick the appropriate level of importance. (Note telematics functions are covered by Q. 14)

Object/phenomenon	**Crucial**	**Important**	**Useful**	**Not important**	**Not sure**
Weather conditions	O	O	O	O	O
Search for parking space	O	O	O	O	O
Parked vehicles	O	O	O	O	O
Elaborate engine model	O	O	O	O	O
Commercial vehicles	O	O	O	O	O
Bicycles/motorbikes	O	O	O	O	O
Pedestrians	O	O	O	O	O
Incidents	O	O	O	O	O
Public transport stops	O	O	O	O	O
Traffic calming measures	O	O	O	O	O
Round-abouts	O	O	O	O	O
____________________	O	O	O	O	O
____________________	O	O	O	O	O

13 Traffic simulation is often used to evaluate how well a certain scheme, strategy or product achieves a set of objectives. Micro simulation models may produce very detailed and time-varying output that can serve as indicators of how well the objectives are achieved. Which objectives - and corresponding indicators - are important to you in your work? Please tick the appropriate level of importance.

Objective	Indicator	Crucial	Important	Useful	Not important	Not sure
Efficiency	Modal split	O	O	O	O	O
	Travel time	O	O	O	O	O
	Travel time variability	O	O	O	O	O
	Speed	O	O	O	O	O
	Congestion	O	O	O	O	O
	Public transport regularity	O	O	O	O	O
	Queue lengths	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________	O	O	O	O	O

Please comment ____

____

Objective	Indicator	Crucial	Important	Useful	Not important	Not sure
Safety	Headway	O	O	O	O	O
	Overtakings	O	O	O	O	O
	Time-to-collision	O	O	O	O	O
	Number of accidents	O	O	O	O	O
	Accident speed/severity	O	O	O	O	O
	Interaction with pedestrians	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________	O	O	O	O	O

Please comment ____

____

Objective	Indicator	Crucial	Important	Useful	Not important	Not sure
Environment	Exhaust emissions	O	O	O	O	O
	Roadside pollution levels	O	O	O	O	O
	Noise level	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________					

Please comment ____

____

13 Continued

Objective	Indicator	Crucial	Important	Useful	Not important	Not sure
Comfort	Physical comfort	O	O	O	O	O
	Stress	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________	O	O	O	O	O

Please comment ____

____

Objective	Indicator	Crucial	Important	Useful	Not important	Not sure
Technical performance	Fuel consumption	O	O	O	O	O
	Vehicle operating costs	O	O	O	O	O
	____________________	O	O	O	O	O
	____________________	O	O	O	O	O

Please comment ____

____

14 Which transport telematics or other technological functions are you interested in simulating?

Please tick the appropriate level of importance.

Function	Crucial	Important	Useful	Not important	Not sure
Co-ordinated traffic signals	O	O	O	O	O
Adaptive traffic signals	O	O	O	O	O
Priority to public transport vehicles	O	O	O	O	O
Ramp metering	O	O	O	O	O
Motorway flow control	O	O	O	O	O
Incident management	O	O	O	O	O
Zone access control	O	O	O	O	O
Variable message signs	O	O	O	O	O
Regional traffic information	O	O	O	O	O
Static route guidance	O	O	O	O	O
Dynamic route guidance	O	O	O	O	O
Parking guidance	O	O	O	O	O
Public transport information	O	O	O	O	O
Automatic debiting and toll plazas	O	O	O	O	O
Congestion pricing	O	O	O	O	O
Adaptive cruise control	O	O	O	O	O
Automated highway system	O	O	O	O	O
Autonomous vehicles	O	O	O	O	O
Support for pedestrians and cyclists	O	O	O	O	O
Probe vehicles	O	O	O	O	O
Vehicle detectors	O	O	O	O	O
______________________________	O	O	O	O	O
______________________________	O	O	O	O	O

14 Continued

Please comment ____

____

____

____

____

15 How important is a graphical user-friendly interface for *input and editing*?

O crucial O important O useful O ASCII file input is sufficient

Please comment ____

____

____

16 How important is a graphical and animated *presentation of results*?

O crucial O important O useful O ASCII tables are sufficient

Please comment ____

____

____

17 What time span would you like to simulate?

O 1 minute O 1-5 minutes O 5-30 minutes O ½-2 hours

O 2-12 hours O Several days

Please comment ____

____

____

18 What is the desired execution speed?

O >5 times faster than real time O 1-5 times faster than real time O real time

O slower than real time

Please comment ____

____

____

19 How important are the following model properties?

Property	**Crucial**	**Important**	**Useful**	**Not important**	**Not sure**
1 Should already have been validated with real world data	O	O	O	O	O
2 Sensible default values for key parameters are provided	O	O	O	O	O
3 Key parameters can be user-defined	O	O	O	O	O
4 Short lead time before use	O	O	O	O	O
5 Limited need for data acquisition	O	O	O	O	O
6 High cost-effectiveness	O	O	O	O	O
7 Easy integration with other models	O	O	O	O	O
8 Easy integration with other databases and GIS	O	O	O	O	O
9 Guidelines for use provided	O	O	O	O	O
10 Standard methods for use defined	O	O	O	O	O
11 Approved by local authority/national transportation body	O	O	O	O	O
12 Will run on a low cost non-specialist hardware, e.g. a PC rather than a UNIX box	O	O	O	O	O
13 ____________________________	O	O	O	O	O
14 ____________________________	O	O	O	O	O

Of the above properties, please rank the *three* most important (in decreasing order of importance)!
Number ______ , ______ and ______.

Please try to *specify* your needs for the three most important properties! (e.g. which parameters should be user defined, what data is difficult to acquire etc.)
____
____
____
____

20 Do you have any other requirements or comments on micro simulation models?

____

____

____

____

____

____

____

THANK YOU VERY MUCH FOR ANSWERING THIS QUESTIONNAIRE!
You may obtain free copies of the project reports by ticking the box on the first page!

APPENDIX B: SIMULATOR FORM

European Union Transport
RTD Programme

Smartest

Dear Mr. _________ ,

I have been given your name as a possible contact point for the ______________ micro-simulation model. I am searching for information about this model and hope you can help me.

Background

A European Commission funded project, called the SMARTEST project, has just begun. It is aiming to develop new road traffic microscopic simulation models to help solve short-term traffic management problems.

The idea of the project is to improve the existing models to fill the most important gaps identified by users. We are starting by carrying out a state-of-the-art review to check on what existing models can do. We are also trying to find as many users as we can to let us know about any features they want to be added. We will then have a go at adding some of these features to our own set of models (AIMSUN, SITRA-B+, NEMIS, SPEACS and DRACULA). We will then produce specifications of the new additions so that any other micro-simulation developers can add them to their own models. This will include any data we have collected to calibrate and validate the models. We are looking at both urban and freeway micro-simulators.

Further information about the project can be found at our WWW site at:
http://www.its.leeds.ac.uk/smartest/index.html

What you can do for us

We are starting off the project by carrying out a state-of-the-art review of micro-simulation models and also questioning micro-simulation users to find out what they want to see in the next generation of models. You can provide inputs for both of these.

We need information about your model so we can include it in our review. We have produced a standard information sheet for each model that you can fill in.

We also need as many users or potential users of micro-simulation tools as we can find to help us identify and prioritise the gaps in existing models. So if you know of any users or potential users then let us know so we can send them our questionnaire. You might also be willing to fill in this questionnaire yourself.

What we can do for you

- We can include details of your model in our state-of-the-art review, which will be widely distributed and will be put on the WWW

- We can also provide you with free copies of our public reports, including the review, specifications of the enhancements to the models, details of the performance of the new models including:
    - validation and calibration data
    - a manual of best practice for using micro-simulation tools.

What we need now

Please supply us with the following information **by 1st May 1997**

- whether you want your micro-simulation model to be included in our review
- whether you are the right contact person for the model
    - if so then fill the questionnaire below
    - if not please point us in the right direction if possible
- contact details (Name, organisation, fax number, E-Mail address, phone number) of any users who you think might be interested in filling in our user requirements questionnaire
- pointers to any information about your model which we may find useful. Any copies of reports or brochures or demonstration software will be gratefully received.

The SMARTEST project contact points

Project coordinator:

Ken Fox
Institute for Transport Studies
University of Leeds
Leeds, LS2 9JT, UK
E-Mail: K.A.Fox@leeds.ac.uk
Tel: +44-113-233-5351
Fax: +44-113-233-5334

Project partner

Laurent Breheret
SODIT SA
2 avenue Edouard Belin
31400 Toulouse, France
E-Mail : breheret@onecert.fr
Tel : +33 (0)5 62 17 58 01
Fax : +33 (0)5 62 17 57 91

SIMULATOR FORM

1. **Objective**
   Describe briefly the objective of the simulator

   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____

2. **Application field**
   Describe what the simulator can be used for (evaluation of different strategies, simulation of route guidance, etc.) and to which organisations it is aimed at

   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____

3. **Is your model able to study the following transport telematics functions**

Functions	**Yes**	**No**
Co-ordinated traffic signals	O	O
Adaptive traffic signals	O	O
Priority to public transport vehicles	O	O
Ramp metering	O	O
Motorway flow control	O	O
Incident management	O	O
Zone access control	O	O
Variable message signs	O	O
Regional traffic information	O	O
Static route guidance	O	O
Dynamic route guidance	O	O
Parking guidance	O	O
Public transport information	O	O
Automatic debiting and toll plazas	O	O

Congestion pricing	O	O
Adaptive cruise control	O	O
Automated highway system	O	O
Autonomous vehicles	O	O
Support for pedestrians and cyclists	O	O
Probe vehicles	O	O
Vehicle detectors	O	O
____________________________	O	O
____________________________	O	O

4. Technical approach

Give a brief description of the technical approach followed in your simulator

____
____
____
____
____
____
____
____
____

5. Innovation

Describe the main innovative points of your simulator

____
____
____
____
____

6. State of the development

Give the state of development of your simulator (research or commercial product, etc.)

____
____
____
____
____

7. Useful technical features

Network size
Size of the network (number of nodes, links, vehicles, etc.) that can be simulated

____
____
____
____
____

Network details
Indicate the level of detail in the modelling of network/ movements/ etc.

____
____
____
____
____

Vehicle representation
Give the different types of vehicles that can be represented

____
____
____
____
____

Vehicle assignment
Describe how the assignment is done

____
____
____
____
____

Indicate if and briefly how the following traffic objects/phenomena are modelled

Object/phenomenon	Not modelled	Modelled	How
Weather conditions	O	O	____________
Search for parking space	O	O	____________
Parked vehicles	O	O	____________
Elaborate engine model	O	O	____________
Commercial vehicles	O	O	____________
Bicycles/motorbikes	O	O	____________
Pedestrians	O	O	____________

Incidents	O	O	____________________
Public transports	O	O	____________________
Traffic calming measures	O	O	____________________
Queue spill back	O	O	____________________
Weaving	O	O	____________________
Round-abouts	O	O	____________________
____________________	O	O	____________________
____________________	O	O	____________________

8. Control strategies and algorithms

Indicate which strategies or algorithms are included and which are external to the model (UTC, route guidance, VMS, etc.)

____
____
____
____
____

9. User interface

Describe the available interface (graphical, text files, etc.)

____
____
____
____
____

10. Do you provide indicators to measure the following objectives ?

Objective	**Indicator**	**Yes**	**No**
Efficiency	Modal split	O	O
	Travel time	O	O
	Travel time variability	O	O
	Speed	O	O
	Congestion	O	O
	Public transport regularity	O	O
	Queue lengths	O	O
	____________________	O	O
Safety	Headway	O	O

	Overtaking	O	O
	Time-to-collision	O	O
	Number of accidents	O	O
	Accident speed/severity	O	O
	Interaction with pedestrians	O	O
	___________________	O	O
Environment	exhaust emissions	O	O
	roadside pollution levels	O	O
	noise level	O	O
	___________________	O	O
Comfort	physical comfort	O	O
	stress	O	O
	_____________________	O	O
Technical performance	Fuel consumption	O	O
	Vehicle operating costs	O	O
	_____________________	O	O
	_____________________	O	O

Comment____

____

11.Limitations

Give any limitations you have identified

____

____

____

____

____

12.Validation and Calibration

Describe the parts of your simulator that have been calibrated and validated

____

____

____

____

____

13.Other properties of the simulator

	Yes	No	Which

1 Sensible default values for key parameters are provided	O	O	
2 Key parameters can be user-defined	O	O	
3 Limited need for data acquisition	O	O	
4 Easy integration with other models	O	O	______________________
5 Easy integration with other databases and GIS	O	O	______________________
6 Approved by local authority/national transportation body	O	O	______________________
7 Will run on a low cost non-specialist hardware, e.g. a PC rather than a UNIX box	**PC** O	**UNIX** O	**other** ______________________
8 Quantify the typical execution speed	[.......]	**times (faster) / (slower) than real time**	
9 ______________________________			
10 _____________________________			

14.Documentation user's guide

Indicate existing documentation and where it can be found

____
____
____
____
____

15.Distribution

If the simulator is distributed indicate the address of the distributor and the public cost

____
____
____
____

16.Designer

Name and address of the person / company who developed the simulator

____
____
____
____

17.Bibliography

THANK YOU VERY MUCH FOR ANSWERING THIS QUESTIONNAIRE !

APPENDIX C: USER REQUIREMENTS

Introduction

This technical report is an internal document of the SMARTEST project. This project is directed towards modelling and simulation of dynamic traffic management problems caused by incidents, heavy traffic, accidents, road works and events.

The results covered by this report deals with user requirements on micro-simulation models. The work area ”User requirements” is included in Work Package 2, ”Review of tools”.

This report is summarised in the project report SMARTEST/D3 Review of Micro-Simulation Models.

Methodology

General

The method for collecting the users’ views on micro simulation was a written questionnaire sent out to a selected set of users all over the world (see Appendix A). Particularly, users connected to the SMARTEST test sites were approached. The questionnaire was also available on the SMARTEST home page in the World Wide Web together with general information about the project.

Guidelines for interpretation of results

In all mailed surveys there are certain sources of error. These are important to keep in mind when interpreting the results. The most important sources of error and their implications on this survey are described below.

Non-response. Not all persons that receive a questionnaire respond to it. The most probable reasons for not responding to this questionnaire are lack of time or lack of interest. The second is the most serious since this group probably consists of non-frequent and future users whose views may well differ from those of the frequent users. The result is that the sample is biased towards frequent users, researchers and model developers with a keen interest and deep insight into micro simulation. For this reason, the following views are supposed to be over-represented in the sample:

- emphasis on model validation, theoretical soundness and documentation of algorithms
- lack of interest in cost-effectiveness, short lead-time before use
- low rating of indicators that are known to be difficult to simulate, e.g. number of accidents, physical comfort

The reason for not using micro simulation may be that the models are expensive to use and hard to calibrate. The non-users are probably less inclined to answer the questionnaire since they do not think they are competent or interested enough to answer the questionnaire.
Important note
The questions Q13 ”congestion, Q14 ”Dynamic Route Guidance” and Q16 ”Importance of graphical output” was not shown on the WWW questionnaire. Therefore these questions had a very high non-response rate. When analysed, the missing cases due to the technical problem were discarded and the percentages presented refer to the questionnaires returned by mail.

Lack of understanding of the questions. When answering a mailed questionnaire, the respondent has no one to ask if he finds some questions unclear. To unclear questions, you get unclear answers. Different respondents may also have different perceptions of the questions. An indicator of how unclear a question is, is given by the percentage of ”missing” and ”not sure”. From the result and comments made in the survey, the following questions are concluded to be somewhat unclear, and should therefore be interpreted with caution:

- Rating of the indicators for safety, especially ”number of accidents”, ”severity” and ”time-to-collision”. These are indicators seldom used in simulations which means that the definition is unclear, and there is some controversy about simulating traffic safety. This does not necessarily mean that there is a low interest in predicting the traffic safety effects of certain measures.
- Rating of the indicators for comfort. The percentage of ”missing” and ”not sure” is high. On the other hand, the percentage of ”not important” is also very high which gives a clear indication that the users find this rather unimportant.
- Views on execution speed. Many respondents comment that the execution speed should of course be as fast as possible, but that real-time simulation could be quite valuable for animation. The question should have been divided into two: ”What is the slowest execution speed you can accept?” and ”How important is it to be able to run the simulation in exactly real time?” It is easy to be wise with hind-sight!

Representativity. The sample of users that are included in the survey is not necessarily representative of the future model users. There is a clear geographical bias towards US, UK, France and Sweden, and there is a clear bias towards research organisations.

Results

0 Response data

Number of respondents:	44
by Mail	28
by E-mail	5
by WWW	11

Seven additional responses arrived too late for statistical analysis, but were considered for the conclusions. The total number of responses was therefore 51.

Response rate, mailed questionnaire: approx. 50%

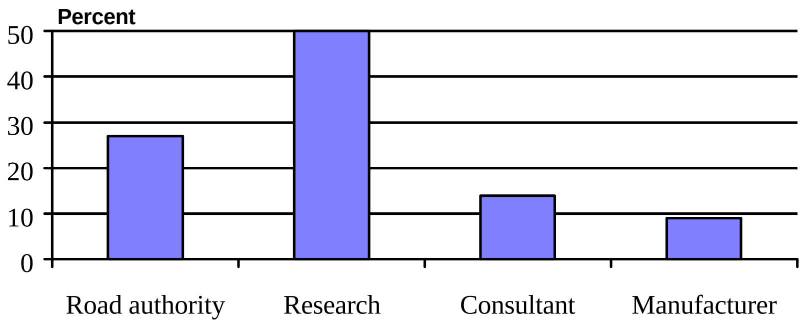
1 Name

no	name	organisation
1	Matti Pursula	Helsinki University of Technology. Espoo, Finland
2	Fredrik Davidsson	TFK. Stockholm, Sweden
3	Arne Carlsson and Rein Schandersson	VTI. Linköping, Sweden
4	Gunnar Lind	Transek AB. Solna, Sweden
5	Erik Hesslow	AB Volvo. Gothenburg, Sweden
6	Otto Anker Nielsen	Technical University of Denmark. Lyngby,
7	Torsten Bergh	SNRA. Borlänge, Sweden
8	Gösta Gynnerstedt	Royal Institute of Technology. Stockholm, Sweden
9	Stein Johannessen	Dept. Of Transportation Engineering. Trondheim, Norway
10	Subbarao V. Jayanthi	Barton-Ashman Associates. Chicago, USA
11	Ken Fox	Institute for Transport Studies. Leeds, UK
12	Georgiou George	TRIAS S.A. Thessaloniki, Greece
13	Saad Yousif	University of Salford. Manchester, UK
14	S. Shepherd	University of Leeds. Leeds, UK
15	Stephen D Clark	University of Leeds. Leeds, UK
16	Jean-Francois Gabard	ONERA-CERT. Toulouse, France
17	Michel Post	SAGEM. Cergy Pontoise, France
18	Gildas Lemaitre	CETE. Aix-en-Provence, France
19	Jean-Louis Gallego	SEA-Signalisation. Vaux-en-velin, France
20	Bernard Baradel	ISIS. Lyon, France
21	J Baptiste Lesort	INRETS, Bron Cedex, France.
22	Richard Charret	Ville de Clermont-Fd., France.
23	Gardes	CERTU. Lyon Cedex, France.
24	Joel Bomier	ASF-ICS. Vedene, France.
25	Vincent Godec	PSA Peugeot Citroën. Villacoubley, France
26	Heitz	Communauté Urbaine de Strasbourg, France
27	Qi Yang	MIT. Boston, USA
28	Vonu Thakuriah	University of Illinois. Chicago, USA
29	Vince Taranto	Road and Traffic Authority NSW. Sydney, Australia.
30	Scott Mackie	Transport department. Calgary, Canada.
31	David Costa	University College. London, UK.
32	Peter Hidas	University of South Wales. Sydney, Australia.

33	Henk Taale	Transport Research Centre. Rotterdam, The Netherlands
34	John Kerenyi	Katz, Okitsu & Associates. Tustin, USA.
35	Iisakki Kosonen	Helsinki University of Technology. Helsinki, Finland
36	Laura Skilton	Traffic design group. Lower Hutt, New Zealand.
37	Henry Lieu	FHWA. McLean, USA.
38	Catherine McGhee	Virginia Transport Research Council Charlottesville, USA.
39	Eirik Skjetne	SINTEF. Trondheim, Norway
40	Phil Spelt	Oak Ridge National Laboratory. Oak Ridge, USA.
41	Ewan Hardman	Transport Research Laboratory. Crowthorne, Berks, UK.
42	Keith Wood	TRL. Crowthorne Berks, UK.
43	Michael Cullip	CTS. Borlange, Sweden.
44	Anonymous	ATAF. Florence, Italy.

Note: The number of the respondent is shown in brackets [ ] after each comment below.

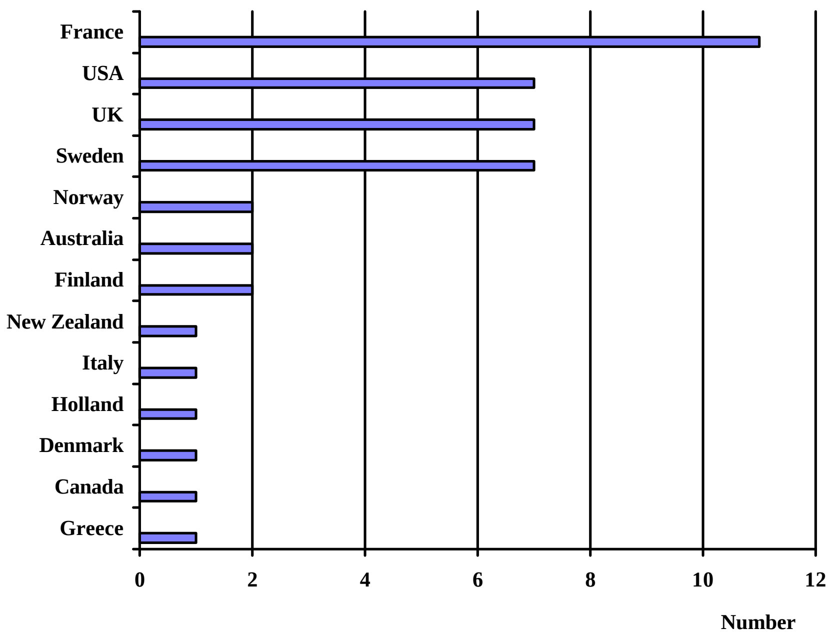
2 Organisation:



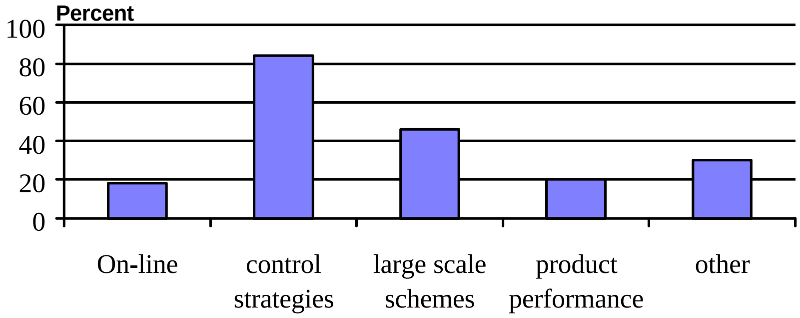
Research organisations are dominant, but all categories are represented by at least 4-5 interviews.

3 Country

The number of answers is 44. Most answers come from France (11) followed by Sweden, UK and USA (7)



4 What is your main area(s) of application for traffic simulation in general?



All kinds of application areas are represented, including research oriented applications.

Other areas
Theoretical work on traffic flow and driver behaviour [1]. Research [3, 6, 38]. Strategic assessment of ITS and Impact analysis of road and rail infrastructure [4]. Motorway traffic and inter urban two-way single carriage way road traffic [8]. Education, tutoring - for last year students (5th year) at NTNU [9]. Comparison between models [21]. Design of traffic information system on board [25]. Test new ideas and algorithms in dynamic traffic management [27]. Mostly ATIS modelling [28]. Training in integrated traffic management [40]. Alternative junction layouts and ATT [41].

Comments
- SNRA, so far, use the VTI 2-lane rural simulation model for evaluation of product performance. We are interested in using simulation models for all the purposes above. Specifically, we have started to implement the CONTRAM in Stockholm and Gothenburg [7].
- I have developed a micro-simulation model to look into drivers behaviour especially when changing lanes on motorways or merging at roadwork approach sites [13].
- Studies including one or a few intersections (main roads) [17].
- Management of a peri-urban motorway network in Marseilles (other services: urban studies) [18].
- The company does not own any simulation software, but the need exists [19].
- We are only in the development/testing/calibration/validation stage [32].
- Our largest network (for the university of California, San Diego) was built to evaluate differences between proposed parking garage alternatives. All other use of micro simulation models has been to evaluate traffic signal timing strategies [34].
- The FHWA has developed several models for different applications such as CORFLO, a macroscopic model for integrated networks, both freeways and surface streets. ROADSIM, a microscopic simulation model for rural roadways and CORSIM, a microscopic simulation model for both freeways and urban streets. This questionnaire will focus on CORSIM only [37].
- As the research organisation for the Virginia department of transportation, we focus on determining how simulation may be used to help the department in its daily tasks [38].
- Based more on future applications as my past applications have been limited [43].

5 Which models do you use for traffic simulation[1]?

No of users	Model name	Type
10	NETSIM [1, 2, 3, 8, 9, 10, 34, 36, 38, 42]	micro
6	INTEGRATION [1, 21, 23, 43..]	micro/meso
4	CORSIM [10, 37, 38, 39]	micro
4	**NEMIS [2, 11, 14, 15]**	**micro**
3	**AIMSUN2 [11, 14, 44]**	**micro**
3	HUTSIM [1, 2, 35]	micro
3	TRANSYT [6, 7, 15]	micro
3	TRARR [1, 29, 36]	micro
3	VTI (Swedish two-way…)[3, 7, 8]	micro, two lane roads
2	**DRACULA [14, 15]**	**micro**
2	FLEXSYT [2, 33]	micro
2	FRESIM [38, 10]	micro
2	SIGSIM [7, 31]	micro, sign. intersection
2	**SITRA B+ [16..]**	**micro**
1	CTR [8]	micro, (under development)
1	German model [7]	micro, unsign. inters..
1	MICRO-SINTRAL [30]	design/intersection
1	MITHRA-SIMRES	
1	MITSIM [27]	micro
1	SIM2 [28]	micro/assignment
1	SIMDAC [16]	micro
1	SIMIR [21]	micro
1	SIMUL GERTRUDE	micro
1	SIMULATEUR [17]	micro/design
1	SISTM [41]	micro
1	SITRAS [32]	micro/assignment
1	STEP [42]	micro
1	TOLLSIM [10]	micro
1	TRANSSIM [10]	micro
1	VISSIM [20]	micro
1	WATSIM [40]	micro
6	EMME/2 [1, 4, 6, 7, 30, 44]	assignment
4	CONTRAM [7, 8, 30, 41]	meso/assignment
3	TRIPS [6, 14, 44]	assignment
2	DAVIS	assignment
2	SATURN [12, 14]	simulation/assignment

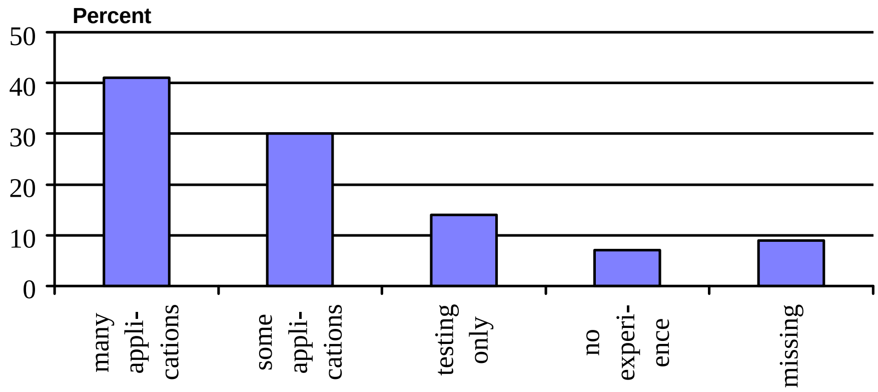
[1] The total number of answers (51) has been used for statistical analysis on this question.

2	SIMRES [16, 20]	macro
1	ARC/INFO [6]	GIS, data management.
1	ARIANE	assignment
1	Car behaviour simulator [25]	
1	DSD-VTI [3]	assignment
1	FREDRIK [4]	macro demand model.
1	HYPERPLAN [44]	assignment
1	INFRAPLAN [6]	traffic model
1	INSECT [29]	intersection performance
1	MCONTRM [41]	meso/assignment
1	MEDPLAN [6]	macro
1	MOTORS [6]	traffic model
1	OPERA	assignment
1	SOPHIA [24]	neural networks, traffic forecasting
1	START [14]	strategic
1	STRADA [21]	macroscopic flow
1	TESS-programs [39]	
1	TP-VIEW [6]	traffic model
1	TRAFF	flow theory
1	TRAFFIC Q	micro/meso
1	TRAFFIX [43]	assignment
1	TRANSCAD [6]	traffic model, GIS.

A very wide range of models is applied, a fact that is probably related to the dominance of research organisations.

6 Your use of micro-simulation models

a) To what extent have you, or your organisation used *micro-simulation* for traffic modelling



The respondents are fairly experienced with micro-simulation. Exactly half of the respondents are model developer themselves. About three quarters have used simulation for some or many applications. Only 3 out of 44 have no own experience of micro-simulation. Users and consumers of micro-simulation results seem to be under-represented in the survey.

Comments to Q6a

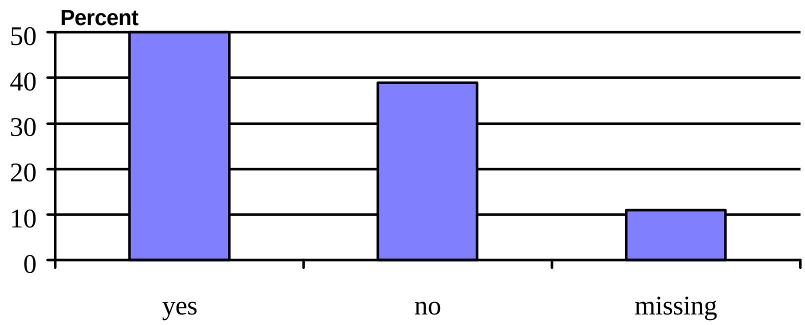
- The models developed range from small applications (few intersections) to city-wide areas. [44]

b) Please specify the size of network!

- 5-10 intersections, 3 km of freeway, 20 km of two-lane/three-lane road, inner parts of Helsinki (>100 intersections) [1]
- 1-16 intersections [2].
- Rural roads and limited urban networks [3].
- Small networks, in connection with larger networks. ~ 40 links, 40 nodes [6].
- Rural roads without intersection, co-ordinated signals, isolated signalised and unsignalised intersection [7].
- 500 links, 250 nodes, 12 signalised junctions [9].
- 1-10 intersections [35]
- Trondheim, 400 links, 70 nodes, 5x5 km. Oslo, 70 links, 10 nodes, 15 km [39].
- Links 100, Intersections approximately 50, dimension 10x10 km [10].
- Kingston, 318 links, 156 nodes, 3x2 km. Kent motorway, 993 links, 867 nodes, 23x20 km [11].
- 53 zones, 110 buffer nodes, 601 links, 34212 trips [12].
- Turin, 117 nodes/intersections, guess 2000 links?, 6x2 km? Kent motorway? [14]
- From 3 to 75 nodes [15].
- 1 to 30 intersections, 20 to 80 links, 3x3 km [16].
- 1 to 3 intersections [17].
- 30 km of motorways. Small urban networks (10 intersection with traffic lights) [18].
- 1 intersection, a few intersections at the maximum [19].
- 1 to 20 intersections (urban). [20]
- 10-5000 links. 1 to ten or so junctions. [23]
- 300 km, 30 interchanges, 3 tolls (cities: Montpellier, Vienne, Langon) Highway: A7, A9, A8, A54. [24]
- Boston Central Artery and Tunnels, 182 links, 210 nodes, 82 km. A10 beltway Amsterdam, 310 links, 196 nodes, 130 km. [27]
- ADVANCE arterial network, NW Chicago, 660 links. [28]
- Overtaking/auxiliary lanes up to approx. 3 km. [29]
- Silver Springs - Calgary, 967 links, 209 nodes, 6x6 km. Avenue SW - Calgary, 661 links, 131 nodes, 3x6 km. Chinook - Calgary, 882 links, 165 nodes, 4x4 km. Inglewood - Calgary, 872 links, 203 nodes, 3x7 km. [30]
- Simulated (up to) 40 links, 10 nodes and 36 links, 9 nodes. [31]
- hypothetical, 90 links, 60 nodes, 2x2 km. [32]
- A10-west Amsterdam, 2 intersections and on-ramps. Benelux junction (Rotterdam), 2 merging motorways (about 10 km). Schiedam (Rotterdam), 2 merging motorways and an on-ramp (about 7 km). [33]
- Costa mesa, CA, 20 links, 7 nodes, 2 km long roadway. Pasadena,CA, 8 links, 3 nodes, 20x100 m. Los Angeles, CA, 8 links, 3 nodes, 40x500 m. San Diego, CA, 80 links, 20 nodes 2x2 km. [34]
- Largest network to date is 2.8x2.8 km with 135 nodes. Other models include corridor models with up to 10 intersections or single intersection models. [36]
- 350 freeway nodes, 250 street nodes, 600 freeway links and 600 street links. [37]
- Route 3 Fredericksburg VA, 30 links, 5 nodes, 4 km. Tysons corner VA, 40 links, 10 nodes, 5 km. Military highway Ft Lauderdale, 50 links, 15 nodes, 5 km. I64 VA, 250 links, freeway, 40 km. [38]

- West Knoxville, TN, 75 links, 35 nodes, 1x8 km. [40]
- Up to 16 km length of uni-direction motorway with 4 entry and 4 exit slip roads. [41]
- Typical size for SCOOT modifications using STEP would be 2 to 6 nodes, one way system. [42]

c) Have you developed your own micro-simulation model?



Comments to Q6c

- HUTSIM [1, 2, 35]
- VTI-traffic simulation model for two-lane traffic on rural roads [3, 8].
- Car assignment model using Monte-Carlo simulation for varying purposes, including intersections and turns (semi-micro simulation about 20.000 pseudo-links, 2000 intersections) [6]
- Developed a micro simulation model to handle four-way stop controlled intersections. [10]
- I would like to and I intend to make a trial, as a part to my Ph.D. (How changes in traffic characteristics and traffic flow/volume affect safety of vulnerable road users.) [12]
- I have developed my own micro-simulation to study and assess the effects on capacity and delay caused by driver behaviour, mainly the merging behaviour at the approaches to motorway roadworks. [13]
- Added blocking-back to NEMIS, helped in DRACULA. [14]
- TRAFF based on shockwave flow theory. Run on a SUN 386i. [15]
- SITRA B+ and SIMDAC. [16]
- Roundabout calculation. [18]
- Vehicle flow on highway A7-A9 from geographic database for the simulation of travel-time. [25]
- SIM2 was developed as a part of my Ph.D. dissertation because I found existing micro models too computationally expensive for my purposes. [28]
- SIGSIM: it is a micro-simulation model for simulating individual vehicles on a signal-controlled road network. It can model a number of different signal-control strategies, e.g. fixed-time, system D. [31]
- The model developed is FLEXSYT-II-[33]
- CORSIM: The model is a very sophisticated one which simulates vehicle movements and signal control on a second-by-second basis. Car following logic, lane changing logic, look ahead features all included in the model. It is a very useful tool for researchers and practitioners doing their traffic operational analysis and research studies. Also, the model is designed in such a way so that third party's logic or algorithms can interface with the simulation model through the API's design. However, some detailed drivers behaviour and logic still need to be improved and more features are needed. [37]
- As part of the subcontract with KLD, they adapted TRAF-NETSIM to a wide-area integrated corridor micro-simulation. [40]

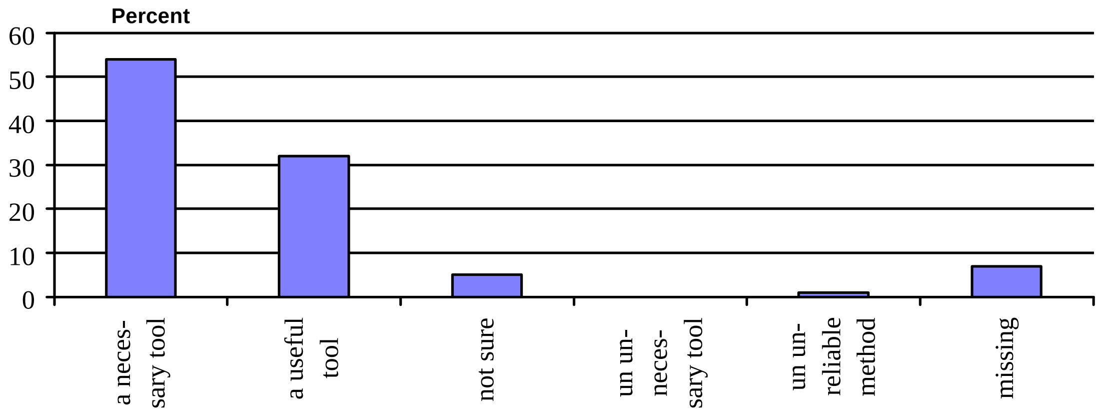
- SISTM, a linear motorway microscopic simulation. [41]
- STEP has been used extensively throughout the research and development of SCOOT. [42]

General comments to Q6
- We earlier used NETSIM, but are now testing the new version of the same program system called CORSIM. It is still a beta-version. [39]

7 What is your opinion of micro simulation as a tool for analysing traffic?

Most respondents seem to be very positive towards micro-simulation. Twenty-four (24) find it a necessary tool and fourteen (14) a useful tool. As twenty-two (22) are model developers themselves it seems that most other users have a somewhat temperate attitude to micro-simulation.

The comments may be more enlightening than the actual question. A good summary is probably that micro simulation ”is useful but dangerous”. Also, interesting comments are that ”short time parking, very frequent marginal behaviour and pedestrian integration are difficult”, and that ”they are not suitable for large travel time and large distance networks”.



Comments
- New traffic control technology (telematics) and increasing congestion make it necessary to be able to analyse dynamic situations [1].
- I am not sure how useful micro simulation is for strategic issues [2].
- A useful tool for cases where traditionally traffic models are too limited [6].
- Useful but dangerous. Validation extremely important if used for traffic engineering. Very good for illustration. [7]
- It is a necessary tool if validated. It is an unreliable method if not validated. The aim of the model is essential as well as it’s limitations. [8]
- The only way to study possible effects of (some) control measures, information strategies and use of new in-car and road side technology. [9]
- Micro simulation tools are necessary to handle several complex traffic scenarios. [10]
- Simulation is a useful tool in understanding the behaviour. [13]
- Can be helpful, but unsure in over-congested periods or when junctions block up - some calibration needed. [14]
- They do not give the full picture. Do not rely on them. No replacement for field trials. [15]
- Difficult for the physical description of the network, and for specific parameters integration: very short time parking, very frequent marginal behaviour, pedestrian integration. [18]
- They seem to be useful as a reference tool for small size networks in comparison with macroscopic models that would be most used for large size models. [21]

- Do not suit to networks where there is a large travel time and a large distance. Too complex, little support, problems to update with recent data, rapid loss of performance, of relevance and so loss of credibility. [24]
- More complicated (network-wide) traffic situations cannot be evaluated by any other means. [32]
- Simulation is useful to study all kinds of traffic management measures, before they are implemented. [33]
- Model calibration is very crucial to the success of using the simulation model. The model users should be aware that calibration is the first task they have to do before make any production runs. [37]
- In the US, most traffic analysis has traditionally been conducted using the methods prescribed in the Highway Capacity Manual. The difficulty with this is that under congested conditions or situations with complex geometric conditions, these procedures do not accurately reflect the conditions seen in the field. Microscopic simulation models have the ability to overcome the limitations of traditional methods. [38]
- Running either faster than real time, or in the ”wee small hours of the nights” (slack traffic times), they can be EXTREMELY useful for developing traffic plans etc. [40]
- Not fully aware of the abilities and limitations of the simulation. [42]
- Definitely necessary for future on-line applications where individual vehicle information and reactions will be required. [43]
- In general, the data entry and model calibration activities are time consuming, data is not easy to acquire, some phenomena are difficult or impossible to model. [44]

8a) What are the advantages of the specific micro-simulation models you have encountered?

Model	Advantage
NEMIS	• well validated, includes assignment [11] • access to source code [15] • route guidance/en route diversion/connects to SPOT/SCOOT [14]
AIMSUN2	• excellent, graphical interface [11]
DRACULA	• very good representation of real traffic through a wide range of parameters[12] • day-to-day variability [14] • access and ability to import SATURN files [15]
SITRA B+	• a wide range of vehicle types, urban network layouts and sensors is available, communication interfaces with control strategies and algorithms, user-friendly animated interface during the running phase [16]
TRAF-NETSIM	• large network available [1] • animation [9] • best tool to handle arterial street operations [10] • stochastic features, animation [32] • excellent simulation of traffic signal operation [34] • better replication of the variability of on-street traffic conditions, animated and static graphics invaluable for calibration and for presentation [36]

Model	Advantage
HUTSIM	• modern input and animation, good output files [1] • can be run in real time connected to an external control device. User friendly [2]. • possible to model the interactions between vehicles and to calculate number of stops, time gaps, speed variance etc. [4] • detailed simulation, suitable for signal control evaluation [35]
VTI (Swedish two-way model)	• flexible, fairly good validation, estimation of many effects, travel time [3] • mutual dependence traffic, alignment, sight profile [7]
TRARR	• flexibility [1] • better than stochastic models, can assess small variations [29]
INTEGRATION	• telematics included, large networks [1]. • wideness of the functions provided, models are of a high scientific level [23] • uses OD matrix, not turning percentages [43]
SIGSIM	• impact of traffic control strategy [7] • specification and control of traffic demands and occurrence of incidents to test the dynamic response of control strategies [31]
CORSIM	• arterial and highways [10] • allows system wide analysis of freeway and arterial [38] • graphic animation, very flexible, problem size, price, supported by a solid organisation (FHWA) [39]
FLEXSYT	• specification of all possible control strategies [33]
TRANSYT	• impact of co-ordination [7] • ”established” software [15]
VISSIM	• efficient (easy calibration), can be connected to complex control rules [20]
TOLLSIM	• handles toll plazas [10]
TRAFF	• sole control of the model [15]
SIMULATEUR	• own development, based on own needs [17]
SIMIR	• simplicity [21]
MITHRA-SIMRES	• allows to evaluate a traffic plan assignment [24]
MITSIM/ SIMLAB	• supports integrated networks and integrated ATMS and ATIS operation, explicit modelling or driver behaviour [27]
SIM2	• large networks possible to simulate, re-produces link travel times with accuracy (the model has been validated using actual arterial link travel time data collected by ADVANCE probe vehicles) [28]
SISTM	• able to test a wide range of strategies with different parameter settings, able to test sensitivity of results with respect to changes in traffic demand, HGV proportion, geometric factors. [41]
STEP	• intelligent use, but some conditions [42]
WATSIM	• integrated corridor (freeway + arterial + surface streets), good graphics, show signal phases, turn queues etc. [40]
In general	• detailed modelling of intersections, fluctuations in traffic, differences

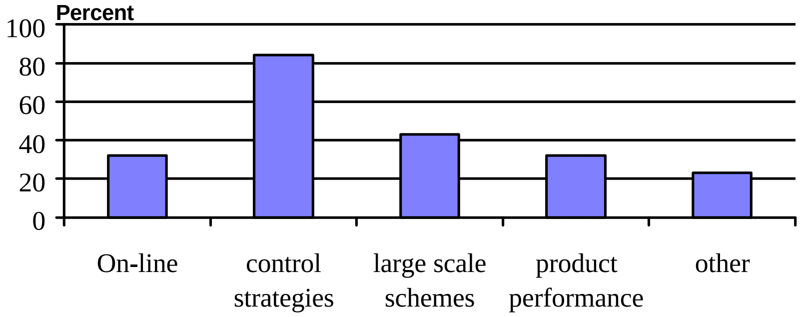
Model	**Advantage**
	in drivers preferences and knowledge of the network [6] • To classify the links. (In order to find rapidly the generating link which will jam the other ones). • detailed simulation of the ”field” behaviour, thus realistic (detection of vehicles by loops, blockage and spilling back of queues) → a priori reliable evaluation [41] • The microscopic simulation model can provide insight information and complicate interaction of vehicle, control, roadways, and drivers which can not be provided by analytical models [37]

8b) What are the disadvantages or shortcomings of the specific micro-simulation models you have encountered?

Model	**Disadvantage**
NEMIS	• poor user interface, runs under OS/2 [11] • not user-friendly yet - had to write graphics [14] • lacking UK features (roundabouts + flaired approaches) [15]
AIMSUN2	• assignment model not included [11] *(not correct, authors remark)* • difficult to specify exact measurements with interface - needs a program to correct loop width or link length [14]
DRACULA	• lack of many forms of variability (parked cars, roadwork’s etc.), lack of graphical representation (as I tested DRACULA two years ago I am sure that many changes already have been implemented, therefore many problems have been overcome) [12] • not user-friendly yet [14]
SITRA B+	• no user-friendly interface for data input, extended validation needed, motorway traffic modelling to be improved [16]
HUTSIM	• small models [2] • limited in scope, route choice not included, global results questionable [4] • no dynamic route assignment [35]
TRAF-NETSIM	• traffic signals are not functioning the European way [1]. • difficult to collect and enter data, no route choice behaviour [3] • It is always a challenge to adjust model parameters to local/national driving habits/behaviour, because of - lack of research data and use of special made (and not universal) sub-models within the main model [9]. • gives a lot of details which are critical for some applications [28] • lack of route choice modelling [32] • cannot simulate all-way stop control, modifying model to produce different alternatives is difficult [34] • no left-hand drive version, roundabouts difficult to code, incomplete simulation of interactions between turning vehicles at intersection [36]

Model	Disadvantage
	• more data intensive, more time required to learn to apply the models correctly [38]
TRARR	• hard to calibrate and validate [1] • need for large amounts of data which is not always readily available [29]
INTEGRATION	• calibration and validation [1]. • lack of conviviality (!) and of users requirement consideration [23] • not extremely user friendly, non-windows environment [43]
FLEXSYT	• no assignment [33]
SIGSIM	• limits to capacity in order to achieve real-time operation [31]
TRANSYT	• complex coding [15]
TRAFF	• slow [15]
SIMULATEUR	• too limited [17]
SIMIR	• limited to 1 or 2 intersections [21]
CORSIM	• very limited graphical printout, no gateway to spreadsheets [39].
MITSIM/ SIMLAB	• currently the graphical version works on SGI workstations only. [27]
SISTM	• Ideally needs to be calibrated for each motorway being studied. Large amount of data required (e.g. 5 minute O/D matrices). Needs thorough knowledge of software before being able to use it effectively [41]
WATSIM	• needs considerable CPU horsepower (kilowatts?) to do heavy traffic smoothly [40]
In general	• The results can change significantly when making small adjustments of the premises. The results can differ between two runs with the same premises unless large number of iterations/time-spans are used. The models usually needs a lot of data making their use expensive. Decision makers will only support old well known models with low budgets, therefore the technique has only been used for research and in very simple traffic information systems, but not in real size traffic models (in Denmark) [6]. • a lot of input data, a lot of output data, needs expertise. Expensive [7]. • not user-friendly design, lack of validation [8] • Detailed input data requirement, some data may be difficult to obtain, it may be difficult for the user to explain some of the simulation results (i.e. the model is a black box for the user), calibration is important but most of the users just do not do it because of many field data are not available [37]

9 If you would start - or continue - using micro-simulation models in your work, what would be your main area(s) of application?



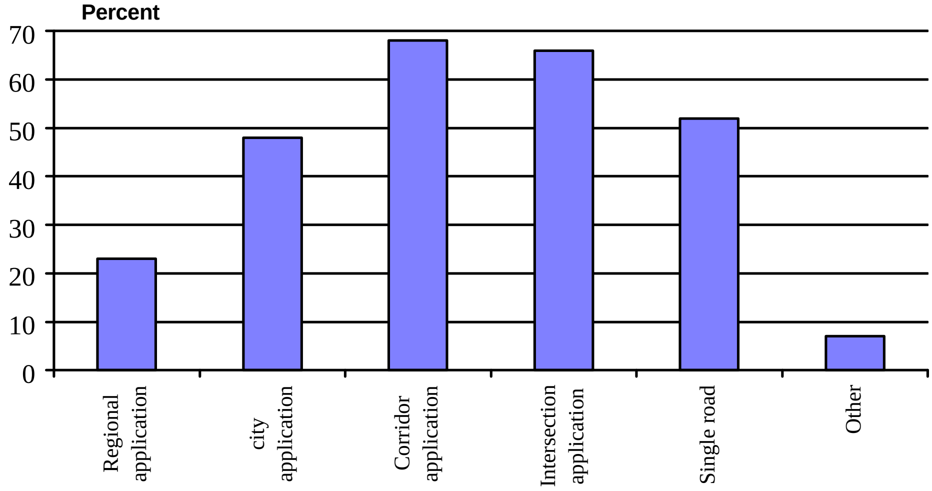
Specify other…

- Driving patterns, effect studies, exhaust emission, road pricing [3].
- Researching models [6].
- Evaluation of small-scale schemes. [12]
- Mainly traffic signal control. [14]
- Comparison and evaluation of different network /intersection layouts, roundabouts management (with or without traffic lights) [16]
- Air quality modelling (I am involved in a project to study land-use, transportation and air quality connections), also ITS applications, especially for real-time travel time forecasting methods. [28]
- Traffic impact and capital planning. [30]
- Alternative geometry design analysis, test of incident detection and management strategies. [37]

Comments

- For design and testing of control strategies more detail is necessary [4].
- Simulation in smaller parts of large-scale models. In the long run also for large scale schemes [6].
- Priority: a) product performance b) design and testing c) evaluation of large schemes [7].
- Education: all topics. Research: mostly “design and testing” [9].
- I must have used simulation models in approx. 40 projects to resolve complex traffic problems [12]
- I think that a microscopic analysis and assessment of small-scale schemes (e.g. one-way streets and pedestrianisation in small-scale) is crucial, especially in terms of environmental (noise, pollution) as well as safety aspects (peds or car collision). [10]
- Taking part of the development of a simulation model, I looked at possible applications such as the use of special traffic management schemes and traffic control devices. [13]
- I do not trust give ways/roundabouts as much as signals. [14]
- Real time evaluation of a programmed traffic controller. [19]
- Comparison between models. [21]
- Currently we are working on modelling traffic incidents in urban arterial networks for the development of incident response plans. [32]
- The data input requirements for TRAF-NETSIM, together with its unwidely card input structure and quirky input/editing program and the inability to model all-way stop control, made our UCSD evaluation a failure - we gave up and used a simpler program, TRAFIX (not a micro simulator). [34]
- Potential to investigate the network effects of lowering city speed limits to 30 km/h. [43]

10 On what scale(s) would you be interested in applying micro simulation?



Specify ”other”…

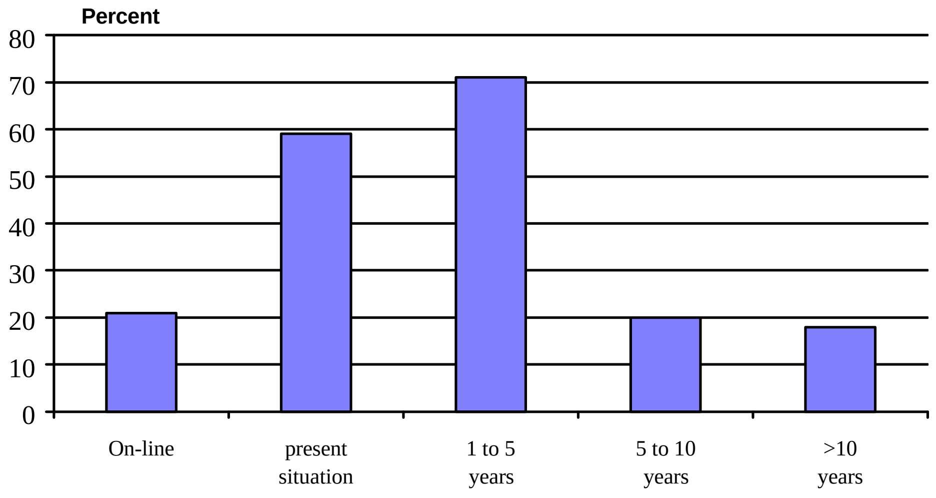
- Car to car interaction [5].
- Grid type systems. [10]

There is a great expectation that micro-simulation can assist in evaluating corridor (30) and intersection (29) applications. Single road applications are also of great interest (23) for micro-simulation. Almost the half are interested in city applications, but only a quarter of regional applications.

Comments

- The main scales are regional or corridor, but it is also interesting to connect a micro simulation model for the city to an assignment model for the region [4].
- Intersection and single road, as part of larger models [6].
- Priority: a, intersections b, corridor c, city [7].
- Corridor, traffic characteristics: width, categorisation of traffic (% cars, % lorries), no of lanes, speed etc. Intersection, traffic characteristics: flow, signalling, no of lanes entering from each direction etc. [12]
- Trying several alternatives of controls to assess performances in term of capacity, delay etc. [13]
- Very large network may be too time consuming to set up and calibrate? + long run times at present. [14]
- A whole city may be too big to cope with (depending on its size). A part of a city network (suburb, sub-area) may be more realistic as the maximum size. [32]
- I do not believe it is useful to study regional and city networks with micro simulation, because the level of detail is too high in comparison with what one likes to know. So, the suggested accuracy is fake. [33]
- Need considerable CPU power. [40]

11 What planning horizon would you have in mind for your micro-simulation applications?

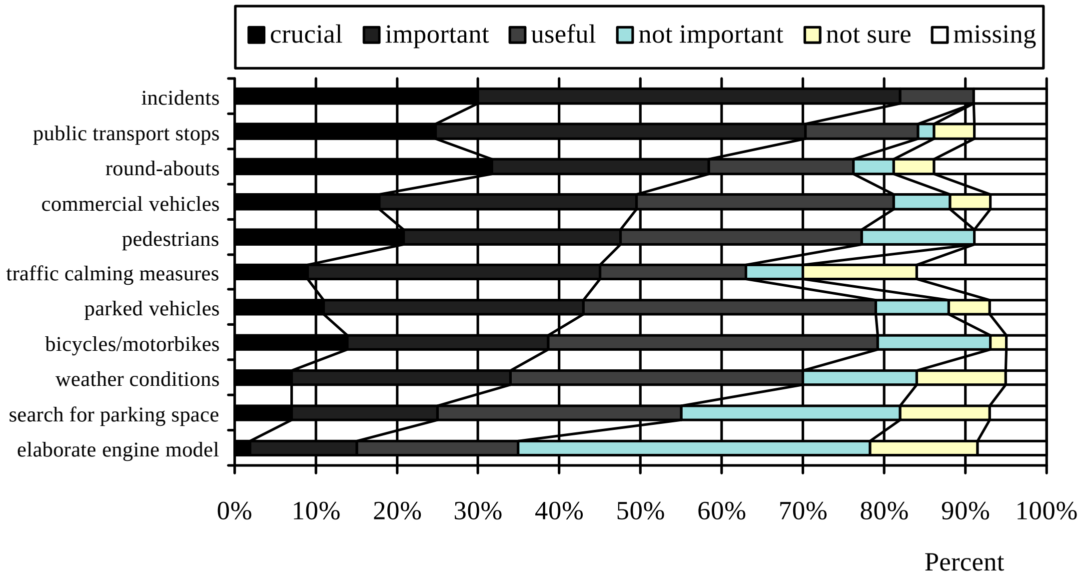


Emphasis is on short term applications, but interest in longer term is also there. Most respondents want to use micro-simulation for investigation of the present situation (26) or the near future (31). Less than a quarter are interested in applications five years or more ahead.

Comments

- Although the techniques are very detailed, I do not see any problems using it on a long planning horizon [6]
- Evaluation of new techniques means investigation of new infrastructures in different planning horizons [8].
- Long term planning horizon only seems relevant for studies of new technology applications with implementation horizon > 5 years [9].
- We use models to handle existing and as well as future scenarios. [10]
- As traffic conditions and characteristics change rapidly, it would be risky to plan policies and take decisions for a period of more than 10 years from the current situation. [12]
- The model we use is structured in a way that it can be altered easily to incorporate any future changes in driver, vehicle and road characteristics. [13]
- > 10 years would be difficult to calibrate? Too much extrapolation. [14]
- Essentially theoretical and ”timeless” use. [21]
- Question unclear. Common application for micro simulation is off-line simulation for several hours (i.e. peak period), although the demand levels and the systems to be simulated can be in long time. [27]
- Do not see much point in using micro-simulation on-line for ITS applications. [28]
- We use simulation for the economic assessment of proposals, using a 30-year evaluation span. [29]
- It could be used for longer horizon, but there would be too many factors to predict, therefore model accuracy would become questionable. [32]

12 Which additional traffic objects or phenomena do think are important to include in a micro-simulation model?



There is a great expectation in including incidents and public transport in micro-simulation models. Round-abouts seems to have been a problem and should be included too. The interaction with pedestrians and the specific behaviour of commercial vehicles are also of importance. Concerning those items not explicitly mentioned, road geometry is the most frequent one, followed by several driver categories, traffic signal operation and road surface condition.

Comments

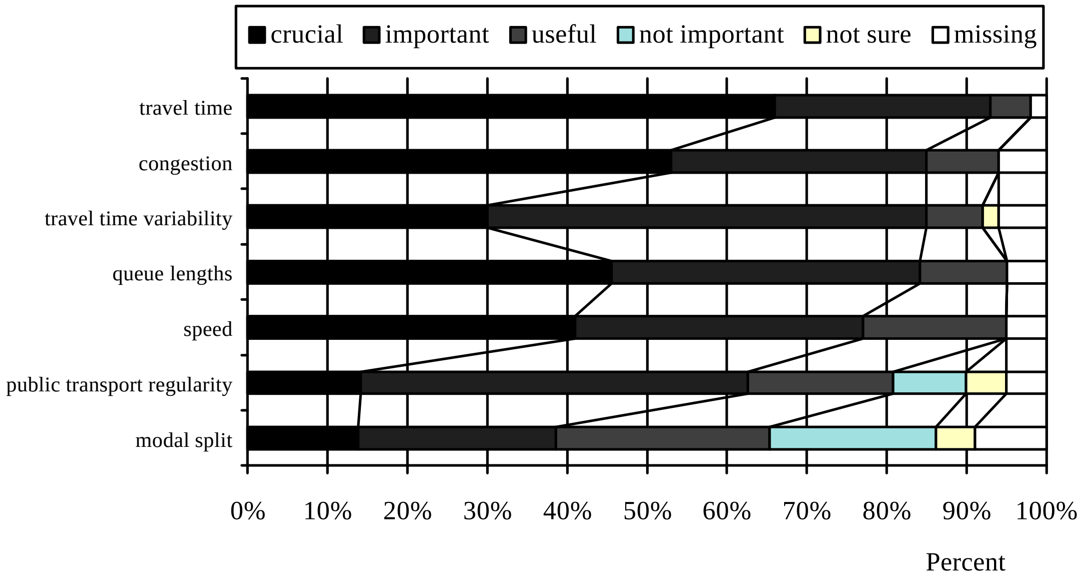
- Here, I think you assume we consider car-traffic only. However walk, bus, rail etc. could be relevant as well. A comprehensive micro simulation model for walk has been developed in one Danish case as an example [6].
- Pedestrians, useful if signals [7].
- Micro simulators should be combined with defined decision models which determine which phenomena have to be taken into account [8].
- Parked vehicles, in NEMIS if you like. Bicycles, useful - depend where. Pedestrians, important - for demand of stages. [14]

Other object/phenomena and level of importance *Crucial or important (number of responses in parenthesis):*

road geometry (5), several driver categories (3), Traffic signal operation (3), Road surface condition (2), road types (1) several vehicle types (1) En route diversion (1). Mode choice (1). Gradients (1). Flaired approaches (1). PT,HGV (1). Traffic plans (1). Information (radio + VMS) (1). Response to lane control systems (1). Congestion Management (1). Stop and Yield signs (1). CMSs (1). Emergency services dispatch (1).
Generation of shock waves (1). Stop/start behaviour in queues (1).

13 Which objectives - and corresponding indicators - are important to you in your work?

Efficiency

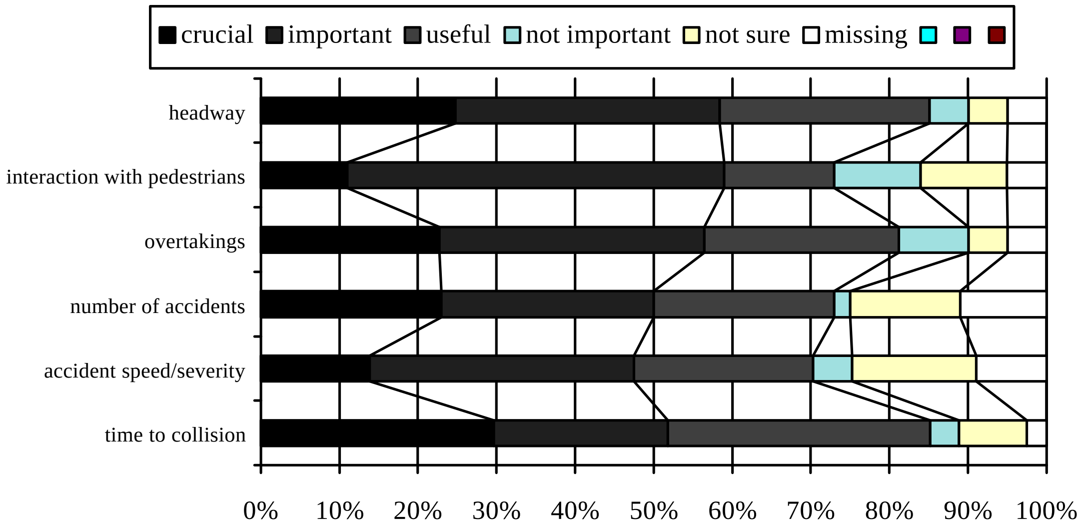


Except for modal split, all listed factors are considered as crucial/important by over 50 percent of the respondents. Of those factors not listed, the number of stops is the most frequent answer.

Other important efficiency indicators *Crucial or important (number of responses in parenthesis):* Number of stops (6), delay (6), level of service (2), Density (PCU/km/lane) (1), Throughput (1), Queue time versus total time (1), Signal co-ordination efficiency (1), Weave operation (1), Control indicators e.g. cycle time, green time (1).

Comments
- Can change according to application. Is the project operational, tactical or strategic? [6]
- The decision model determines which of the indicators are relevant. If there is no defining decision model you can wish everything between heaven and earth! [8]
- From my point of view modal split regarded useful in strategic models. Micro simulation is rarely useful for strategic studies. [9]
- Ability to adopt or add new indicators easily depending on the problem. [14]

Safety



Safety indicators are also considered crucial/important to a large extent. However, the comments reflect scepticism or uncertainty about how such indicators may be incorporated in micro simulation models.

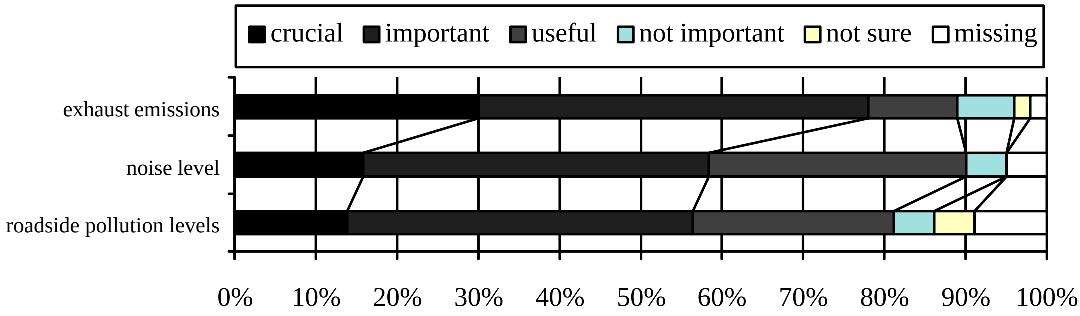
Due to a less exact wording of the factor ”time to collision” in the French survey, these have been removed from the statistics for this particular factor.

Other important safety indicators *Crucial or important (number of responses in parenthesis):* Acceleration/deceleration (1), Interaction with bikes (1), Traffic conditions (1), Number of stopping vehicles (%) (1), Traffic conflicts (1), Volume (1).

Comments

- Hard to meet modelling requirements for safety [2].
- Is it possible to simulate number of accidents and accident speed?[3]
- Acceleration noise has been found to have a close connection to safety in Japan, see ITS ‘96. [4]
- Not really my field of research. Here models for pedestrians and bikes are crucial. [6]
- I do not believe in simulation of accidents. [7]
- Is it possible to get accidents from traffic simulation? Evaluation of RTI-functions needs a new complementary traffic safety concept. [8]
- Detailed modelling of headway and overtakings is crucial also for efficiency studies! [9]
- Traffic conditions (weather, rain/or not, road condition - old or new, good or bad etc.) could be taken into consideration, (e.g. low values (0-1) when values are good and high values (4-5) when conditions are bad). [12]
- Most simulations only have safe drivers/pedestrians: safety is usually based on aggregate measures. [14]
- Except for the first two indicators, I do not know how microscopic model could estimate the indicators. [21]
- Only required to a limited extent in our studies. [40]

<u>Environment</u>



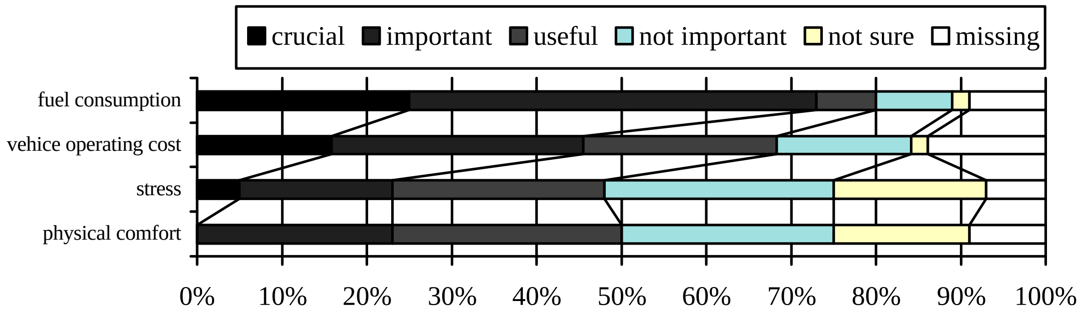
All the environmental factors are considered crucial/important by more than 50 percent.

Other important environmental indicators *Crucial or important (number of responses in parenthesis):*
Fuel consumption (2), Barrier effects (1), Vibrations (1)

Comments

- Acceleration/deceleration and number of stops are important to calculate exhaust emissions [4]
- Environmental issues are becoming more important. Modelling needs to acknowledge this fact. [29]

<u>Technical Performance and Comfort</u>



Only fuel consumption is regarded to be crucial/important by over 50 percent of the respondents.

Other important <u>comfort</u> indicators *Crucial or important (number of responses in parenthesis):*
Grade of aggressiveness in driving/variations (1)**,** Stops (esp. For trucks) (1).

Comments

- Calculated from the driving pattern of each vehicle [3].
- Cost factors can be calculated in step II based on simulation results [9].
- Secondary objectives for a traffic manager. [24]
- These measurements should be measures by vehicle types or types of fleets. [37]

General comments to Q13

- It was difficult to answer these questions. For optimal performance you should mark crucial everywhere [39].
- It all depends on the purpose of the exercise... [32]
- I do not know of any traffic safety simulators that can predict causes, types, severity etc. of accidents. I would be interested in hearing more about these. [34]

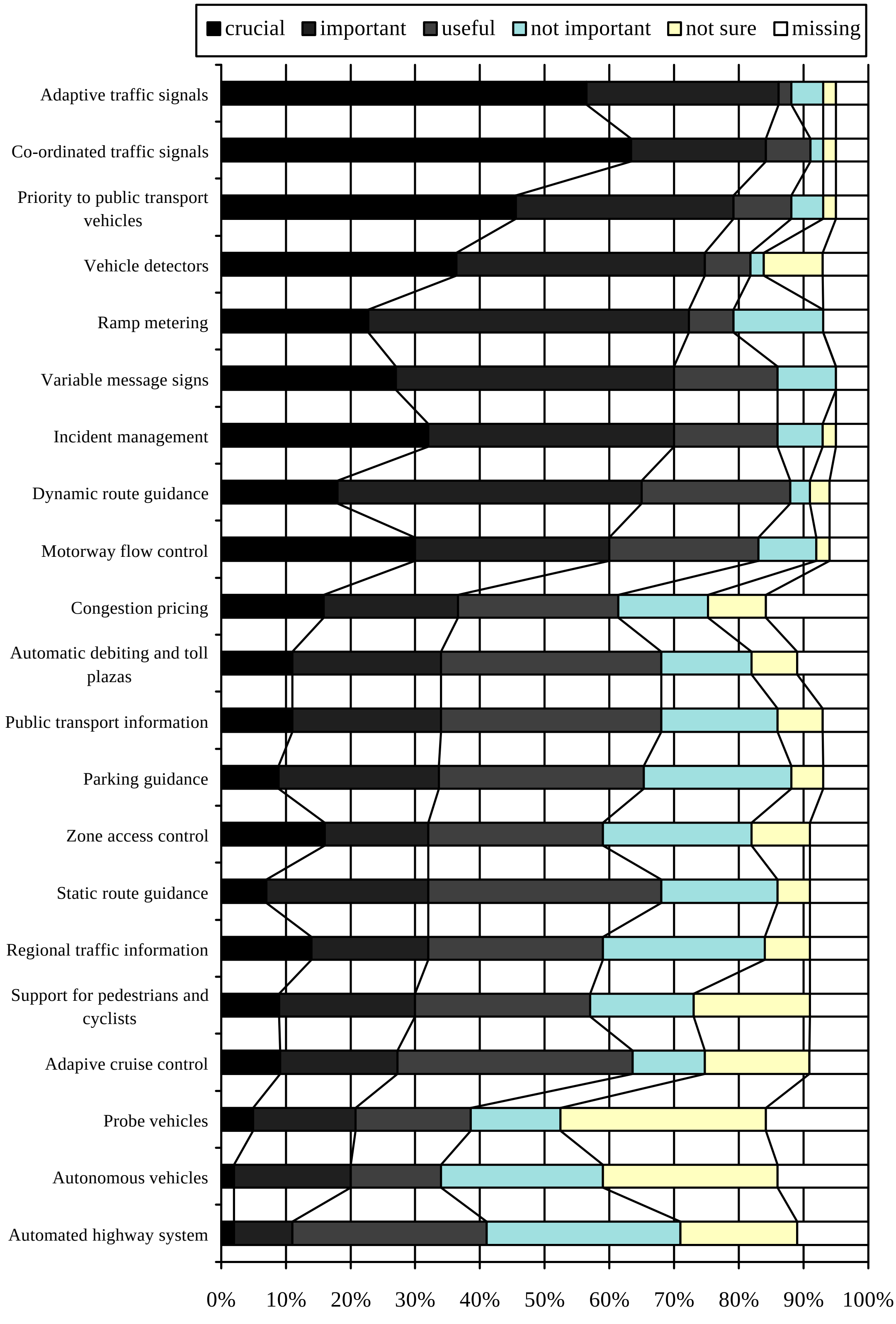
14 Which transport telematics or other technological functions are you interested in simulating?

Other important telematics functions *Crucial or important (number of responses in parenthesis):* Variable speed signs (2), Collision warning/avoidance systems (1). Use simulation results to replace traffic sensors (1). ETC/HOV (1). Emergency vehicles (1). Vehicle/pedestrian actuation of traffic signals (1). All kind of traffic controls strategies (1). Drivers response to different types of information such as prescriptive information/guidance or descriptive information/guidance (1). Types of vehicles (1). Objectives could change (1).

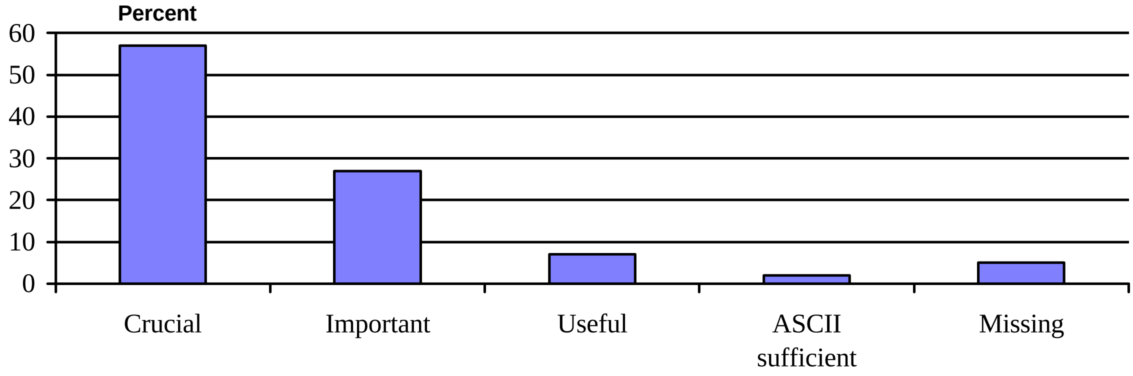
Micro-simulation seems, according to the answers, to be especially valuable for the assessment of applications related to signals (adaptive and co-ordinated signals, PT priority and ramp metering) or incidents and congestion (detectors, incident management, VMS, DRG and motorway flow control). Urban traffic control seems to be the main application. Information systems, Automatic debiting, Cruise control and automated highway systems seem to be of less importance.

Comments

- Implementation rates, quality of information, behavioural adaptation and other factors defining the systems should be user defined as validated behavioural data mainly is lacking and new results from field tests continuously will be available during the next 10-20 years [4]
- These alternatives are dependent on application: Zone access control (could be relevant in the future), automatic debiting and toll plazas, congestion pricing, automated highway system, autonomous vehicles, probe vehicles and vehicle detectors. Static route guidance - Why use micro simulation? [6]
- I would like to have full flexibility all over [39]
- Management of a major event (output flows from a big meeting). [18]
- The biggest problem I see with using simulations of any kind to model ITS is the lack of fundamental behavioural data. [28]
- How different drivers respond to different ATIS-information or out-of-vehicle information and guidance is very important to en-route diversion and pre-trip analysis. [37]
- At least on this side of the pond, AHS and autonomous vehicles are fading from the future... I do not think they will happen, past ACC and collision warning systems. [40]


crucial
important
useful
not important
not sure
missing
Adaptive traffic signals
Co-ordinated traffic signals
Priority to public transport vehicles
Vehicle detectors
Ramp metering
Variable message signs
Incident management
Dynamic route guidance
Motorway flow control
Congestion pricing
Automatic debiting and toll plazas
Public transport information
Parking guidance
Zone access control
Static route guidance
Regional traffic information
Support for pedestrians and cyclists
Adapive cruise control
Probe vehicles
Autonomous vehicles
Automated highway system
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

15 How important is a graphical user-friendly interface for *input and editing*?



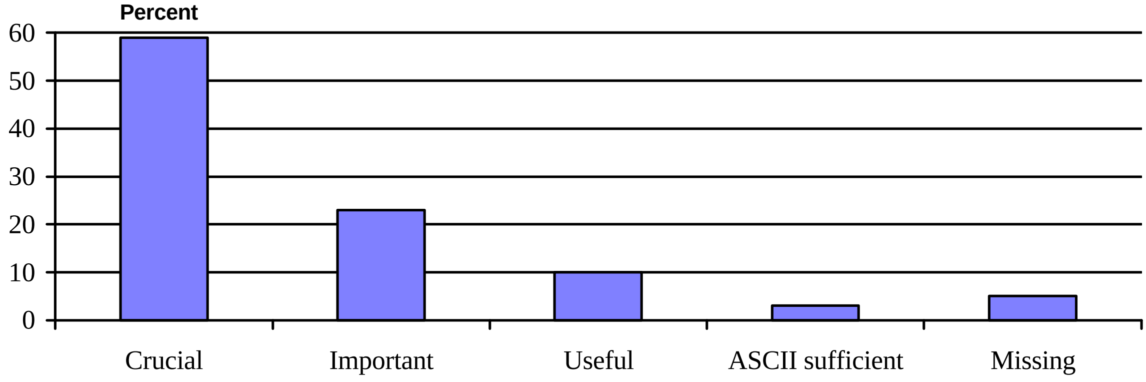
A graphical user interface is regarded to be crucial by close to 60 percent.

Comments

- It is crucial that the interface helps the user not to make mistakes. Efficiency in input and editing is also crucial as well as the possibility to control reasonableness of input data [4]
- The graphical interface is useful in the development of the model to get a face-validation. It is a necessary tool for tutoring (and convincing politicians) [8].
- The user-friendly interface is taken into consideration from a potential user, especially if he/she is not very keen on computers. [12]
- Depends on design, but e.g. AIMSUN2 it is hard to input exact link/loop lengths. Give the user an option where possible. Start with interface that may use data file for edits. [14]
- Joint use of graphics and ASCII. [15]
- Initial parameters setting can be very simplified (ASCII-files), modification must be very user-friendly. [17]
- Avoid reasoning about a great amount of data, difficult to check and to modify, but about simple data, visible and accessible. [18]
- A user-friendly interface gives to the traffic manager, beyond ”technical performances”, a good view for a real-time use. [24]
- Fast batch mode is also important. [27]
- Hogs too much memory. Not important. [28]
- I would rather see the bulk of programming effort go into robust algorithms and credible results than a flashy screens. [29]
- The worst part about inputting nodes into a graphic interface is that the user often has to incorporate artistic layout skills in building the layout. I'd rather manually input co-ordinates. However, if one were to allow combination of a graphic base map etc. with the network, entering the network would be much easier. An example of this is the new version of Synchro by Trafficware in Berkeley. The old version required one to precisely position nodes using the mouse, which is more difficult than simply entering link lengths. The new one has the same input requirement but allows one to draw the network over a digitised map of the area. If one could somehow use GIS information (for example , we have ArcView coverages of all the road in California) that would be ideal. [34]
- With experience, ASCII file editing is more efficient. [36]
- From a research standpoint, ASCII files are sufficient but for widescale use, a user friendly GUI is crucial. [38]
- Our customer wishes us to enhance the facilities for inputting and creating networks. [41]

- ASCII file input adequate for small research networks area-wide simulation of on-line traffic control. [42]

16 How important is a graphical and animated *presentation of results*?

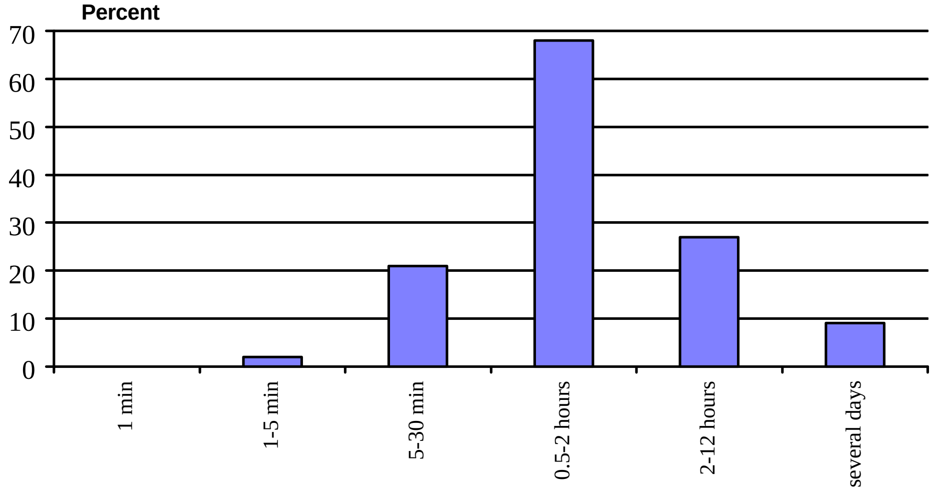


Both a user-friendly interface for input and editing and a graphical and animated presentation of results are crucial for users of micro-simulation models. Only one (1) respondent finds ASCII tables sufficient.

Comments

- This is crucial in order to communicate the results to decision makers. Graphical results often makes it easier to control reasonableness of results. [4]
- Very useful in the calibration and validation process [9]
- Crucial, majority of the times we present results to highly non-technical professionals or policy makers. [10]
- Decision makers and politicians are influenced from the results and the way these are represented (using graphics, animation, diagrams etc.). [12]
- For development crucial, for presentation of results important. [14]
- Joint use of graphics and ASCII. [15]
- Crucial for a good representation and visualisation of the effects. The freeze analysis is made using files. [17]
- We are in 1997! [18]
- A good graphical animation is as good as many formula and numbers. [24]
- Depends on the end-use. From ITS operators perspective, it may be useful, not for research and development of algorithms. [28]
- May persuade the non-expert decision-maker. [29]
- The only way to make the results meaningful and easy to understand. [32]
- Our graphical TRAF-NETSIM output is often the only thing our clients are interested in seeing. I almost never reduce the tabular data given to me by the model. [34]
- From a research standpoint, ASCII files are sufficient but for widescale use, a user friendly GUI is crucial. [38]
- Again, our customer considers this very important. [41]
- Important to impress politicians and help operators for area-wide on-line work. Potentially counter-productive for research when results. [42]

17 What time span would you like to simulate?



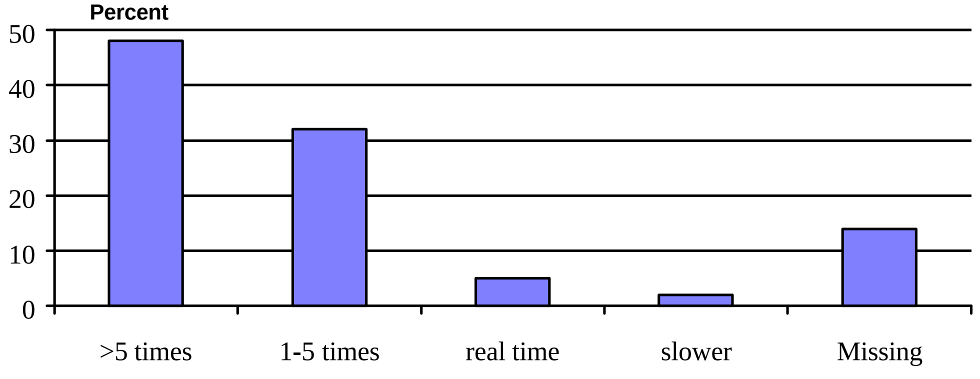
Other alternatives:
24 hours (1)

The most frequent time span for micro-simulation runs will be 5 minutes up to 12 hours, with the rush hour (0,5-2 hours) as a very marked median. Only one (1) will run the model for less than 5 minutes. Four (4) respondents wish to use a time span of over 12 hours.

Comments

- For low traffic flows longer time span could be needed [3].
- We would like to use micro simulation together with an assignment model [4]
- 1, Rush hours. 2, One day. 3, Fluctuations over several days [6]
- Differs with the situation [7, 39]
- Continuos simulation over the rush-hour should be possible [9]
- Our standard period is for one hour. [10]
- I would like to have the possibility to choose between a ”very” microscopic analysis (e.g. 10 minutes intervals) and a more macroscopic one (e.g. every hour). [12]
- 12-24 hour simulation can be useful for calculating benefits for economic evaluation. [36]
- It is really dependent on size of network and application. [37]
- Typical time period for testing control algorithms. [42]

18 What is the desired execution speed?

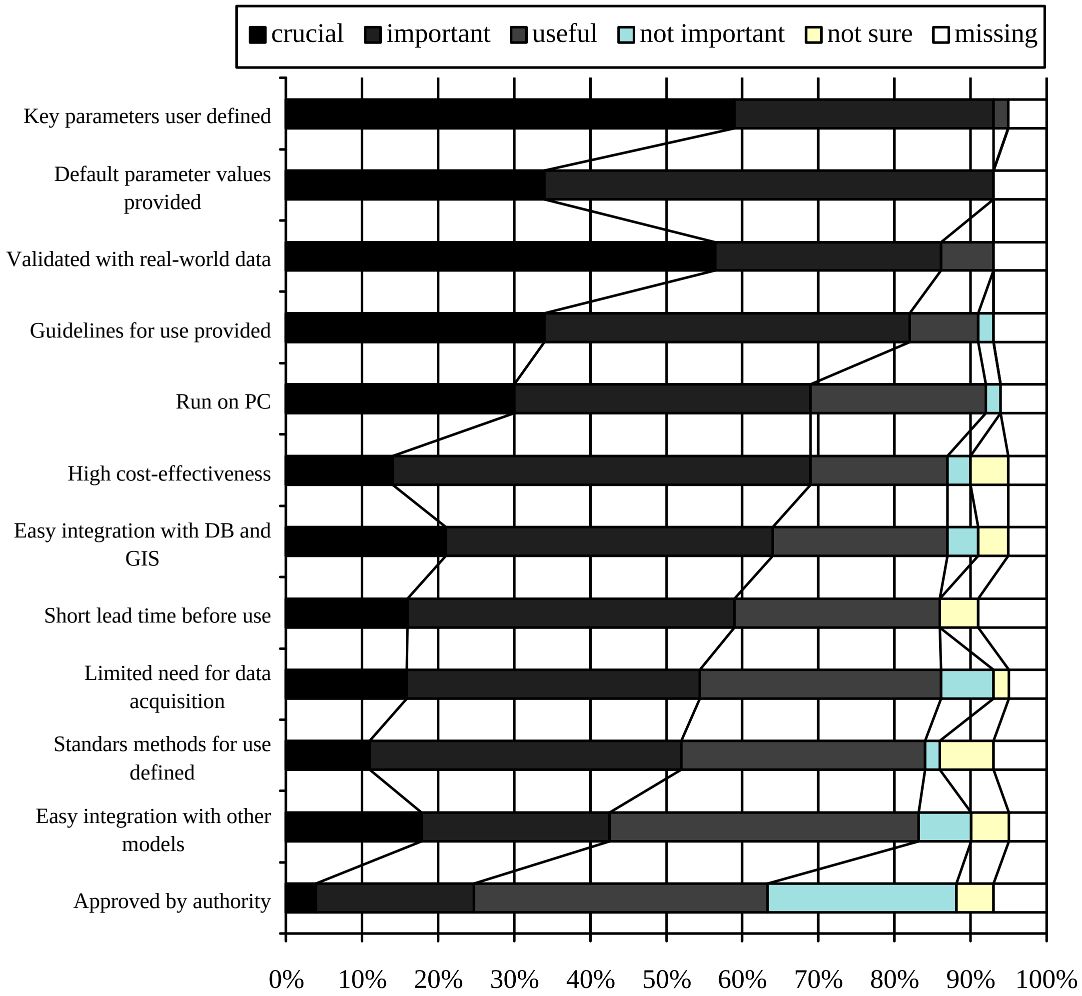


The required speed of micro-simulation models is faster than real time. About half (21) require an execution speed of over 5 times real time, and another fourteen (14) are satisfied with a speed of 1-5 times faster than real time. Six (6) has no definite opinion.

Comments

- Depend on application; if real controller devices are a part of the system, then real time is the only possibility [1]
- As fast as possible. Min 3 times faster than real time [2]
- Execution speed should be variable [3]
- For planning as fast as possible [6]
- It depends of the application - on line applications or not [8]
- All of these must be options [39]
- The current packages would go at least 20 times faster to real time. [10]
- Usual constraint is traffic control system or size of network. If small network then fast! If large network then overnight will do. (E. Not in between, if it's going to take > 1 hour it may as well be 10 hours). [14]
- But possibility of added delays so the graphics can be monitored. [15]
- In any case faster than real time, specially for short-term applications. [17]
- Need for an interface providing a real time dialogue between a traffic controller and a simulation. [19]
- User-defined speed. [22]
- Possibility to play back scenario with a step by step run. [24]
- You may ask for expected execution time. Desired execution speed is as fast as possible. But expected may be in real-time to the best. [27]
- The faster the better, although I recognise that some analysts may wish to see what is going on at less then real time speeds. [29]
- Although we do not currently use real time simulation, the interest in this feature is increasing among some and proving to be quite a sales feature. [30]
- Depends on the purpose again. [32]
- As long as the animation speed can be controlled, I do not care how fast the modelling takes place. [34]
- Do you mean for simulation? (As fast as possible) or graphics? (A variable scale is useful). [36]
- 1-5 times faster for batch mode of operation, real time for interactive use. [41]
- Obviously the faster the better, but for off-line applications it is not so important. [43]
- The model should allow both running simulation faster than real time (for e.g. off-line experiments) and running/presentation of results at a slower pace, simulating and presenting traffic dynamics realistically. [44]

19 How important are the following model properties?



Other important properties

- Algorithms documented [6]
- Run stable (do not crash) [6]
- Easily adapted for new problems [14].
- Clear description of the working, Weaving modelled [21].
- Multi-platforms, Easy installation [27].
- Source code must be available, Algorithms clearly documented (possible peer-reviewed) [28].
- Data checking [29].
- Good documentation [33].
- Good quality graphics, User controllable output facilities [41].

User defined key parameters and validated with real-world data are crucial to over 50 percents of the respondents. Only easy integration with other software and authority approval are considered to be crucial/important by less than 50 percent.

Comments

- Alternative 5 and 6 are unrealistic [6]

- Alternative 5 is useful but rarely possible.

Explicit ranking of the features above
(Calculated as the sum of respondents for each alternative weighted with 2 for "most important", 1.5 for "second most important" and 1 for "third most important")

1. Should already have been validated with real world data *(45% ranked as most important, 14% as second most important, 14% as third most important)*
2. Key parameters can be user defined *(14% ranked as most important, 18% as second most important, 18% as third most important)*
3. Will run on a low cost non-specialist hardware, e.g. a PC rather than a UNIX box *(16% ranked as most important, 2% as second most important, 9% as third most important)*
4. Sensible default values for key parameters are provided
5. Guidelines for use provided
6. Easy integration with other databases and GIS
7. Easy integration with other models
8. Limited need for data acquisition
9. Short lead time before use
10. Standard methods for use provided
11. Approved by local authority/national transportation body
12. High cost-effectiveness

Specification of the needs for the most important features

- Local model validation is always needed when a model is transferred to another country. Guidelines for the key parameter functions are needed. [1]
- Driver parameters variable, vehicle characteristics also variable. [3]
- User specification see comments below. Lead time before use should be less than one month. Integration with assignment and travel demand models should be possible. [4]
- Formulas written, references, sufficient documentation. No parameters at all should be hard-coded into the software, e g coefficient of distribution of the simulation etc. Without validation the model is only a theoretical construct with no guarantee of its usefulness. [6]
- Appropriate statistical methods for validation purposes. Appropriate technique for data collection. Adequate models for evaluation. [8]
- Data describing basic national/local behaviour in traffic: adaptation to legal speeds, type of driving (i.e. aggressiveness, dependent on drivers and vehicle types), time gaps (in car-following) [9]
- Car-following and lane changing parameters should be preset. Yielding parameters can be user defined [35]
- Differences in driver behaviour and vehicle characteristics. Road geometry horizontal/vertical. Traffic control systems [39]
- It is often not possible to calibrate the models for local conditions, so default values are important. [10]
- Some key issues that need sorting out on the use of micro simulation models include-, how to deal with variability, spreading congestion over different time periods, using common indicators. Integration with assignment models and route models is also important. [11]
- It is very important for the model to be error-free and to have been tested with real world data in order to become reliable for the future uses. In Greece there are many problems with data collection (lack of data, different data in different authorities which are very difficult to be collected etc.). Therefore, the less the need for data acquisition, the better. [12]
- As a user of any model, I would need to know the specification of the model, limitation capability etc. A sample of the data and output file could be useful. [13]

- 1: if validated then is more reliable, I do not have to do it! 5: car following data, road geometry, network topology (pinch existing). 12: makes it cheap and easy to run. [14]
- 1: indicating which kind of data were used for validation, and the statistical confidence degree. 2: giving the physical significance of the key parameters. 9: including a network example illustrating the main features of the simulation. [16]
- Typical profiles, behaviour dispersion, tools for network drawing (design). [18]
- 1: could be interesting to define an index representing the degree of reliability of the model. 3: saturation flow, OD matrix, speed of stopping and starting waves. 8: automatic transfer of topologies GIS - simulation. [19]
- Weaving model, exact validation of this aspect. Clear description of the working, so that user can understand the model working in its whole. 1: in many experiments. [21]
- Use validated, correct models. Parameters can be customised to local driver behaviour and networks. Simulation details are transparent to the model users, probably also need to make the source code available. [27]
- Model must be calibrated to local fleet characteristics, road surface types etc. and approved by expert body. Some sample applications should be included, so that the novice user can customise for specific project. [29]
- 12: Networked PC operation is a must in order to provide access to all sizes of jurisdiction. 8: Data portable from common data bases and GIS systems for manipulation of data. Do not reinvent these tools, but remain compatible. 7: Data transferable between models for data sharing and conversion. [30]
- Models should be validated, although I am aware that validation is a continuing process, which costs a lot of effort. [33]
- 12: latest spec PC. 3: headway gap acceptance. 8: free form. [36]
- Headway distribution for car following logic, headway distribution for vehicle discharge at intersections, gap acceptance for lane changing logic, longitudinal distance at which drivers start reacting to guidance and control (such as freeway off-ramps warning signs, variable speed signs, VMS etc.). How drivers respond to information and control. [37]
- Validation of model performance is critical. User definable parameters include driver behaviour characteristics, vehicle mix and performance characteristics, car following parameters, lane changing parameters, headway's etc. Knowing under what circumstances a model is applicable would be useful for the everyday practitioner. Examples of conditions where the model should and more importantly, should not be used would be useful. [38]
- I do not understand this question! [40]
- Probably a good understanding of the modelling is the most important requirement for our normal use. [42]
- 3: vehicle specific information and pollution inf. should be user defined to account for various fleet compositions. 2: all values should have a default to allow simulations without complete data collection by the user (especially if such data is not available or difficult to get) of course, default values should be based on actual studies and figures. 12: simplicity of use and availability of PC as opposed to UNIX allows average person to use models in office, at home, or wherever (laptops) as UNIX systems are usually not so prevalent. [43]
- Parameters which should be well under control of the user include: flow and speed characteristics, manoeuvres, control strategies. Data difficult to acquire include all driver behaviour-related information. [44]

Do you have any other requirements or comments on micro simulation models?

- Building a simulation model is a learning process. Blind use of models can be dangerous. So, model principles should always be well documented, and the effect of key parameters should be easily seen from documents or by testing the model. [1]
- The cost should be reasonable, access to source code is desirable [3]
- Micro simulation models have to be open and transparent in order to take advantage of future findings regarding the relation between quality of information and behavioural adaptation of ITS [4]
- Our primary interest is safety aspects of car to car interaction with different kinds of driving support systems like ACC, collision warning etc. Secondary interest is traffic flow effects of the above mentioned systems [5]
- For traffic modelling purposes the models should ideally consider all ‘steps’ in the traditional models: Whether to travel, mode choice including sharing car, choice of destination, time of trip (day, hour etc.), route, trip chains, mode chains. Otherwise the micro simulation model should work together with a more traditional traffic model. Why do you not concern Metropolis, which on the long time spans is quite interesting. [6]
- If used for traffic engineering - traffic behavioural models based on reasonable assumption on the impact of geometry and so on important. [7]
- Future traffic simulation models should be adapted for the development of a new road infrastructure composed by road geometric design parameters and telematics tools. The prospective model system must include a new traffic safety concept which is predictive [8]
- We will probably need families of simulation models to cover different environments (i.e. town networks and motorways) and different levels of detail (small areas/junctions - larger areas/networks). Why is the CORSIM/NETSIM - family not included in the study? Because of its US origin? [9}
- I would have liked to have pedestrians included in the simulation. [9]
- A package that can handle toll plazas and freeway weaving is very useful. [10]
- Most of the available models have limited use. Some are not calibrated and validated with appropriate field data. Others do not specify the main assumptions used in developing them. Users of such models should be careful when making use of the results obtained to describe or assess traffic performance. [13]
- Usually models have internally specified parameters and in say lane changing logic, if there are changed then the results can vary significantly - a risk/sensibility analysis should be carried out to all parameters! [14]
- Interesting subject. When will a web site be available, which will demonstrate the results of various simulations. [18]
- Provide a tool not too sophisticated: I prefer it simple but more robust (long term performances and credibility related to regular forecasting) rather than sharp, originally accurate and then rapidly not credible because of its variable forecasting and regular deterioration with time (and with a great difficulty for updating parameters). [24]
- Good on-line help systems. Good diagnostics if a run crashes. [29]
- Question of validity of vehicle-following models still remains. [30]
- More specific model description should be published. Otherwise any model is just ”a black box” - no one really knows what’s happening inside and how the results were obtained. [32]
- Make it like TRAF-NETSIM, but with a better input interface. [34]
- The model should provide how each internal logic was calibrated? What type of data set was used for calibration? How to calibrate the model to meet the user’s needs? I think that providing a set of standard calibration procedures for key parameters and data sets for typical areas or scenarios will be helpful. [37]
- I would like to have pedestrians included in the simulation. [39]

- Micro simulation is a useful tool to be treated with respect. But, it is easy to draw the wrong conclusions if not fully familiar with the model. [42]

Conclusions

The sample of users

In total, 44 completed questionnaires were received. Of these, six are users of one or more of the models included in the SMARTEST project. Half of the respondents work for a university or a research organisation.

Users from France, USA, UK and Sweden are well represented in the sample. From Italy, one response was received whereas no Spanish user answered the questionnaire

Main areas of application for micro simulation models

More than 80% of the users use traffic simulation for design and testing of control strategies. The second most common application for traffic simulation is the evaluation of large scale schemes (45%). 20% of the users use traffic simulation for on-line traffic management or for evaluation of product performance. Other areas of application are research and education.

As for the future use of micro simulation, the same percentages as above applies for testing of control strategies and evaluation of schemes. For on-line traffic management and evaluation of product performance, the use of micro simulation increases to 30%.

Use of micro simulation models

The users in the survey have a very positive opinion of micro simulation. 55% believe that it is a necessary tool, and 32% that it is a useful tool. Only one respondent thinks of micro simulation as an unreliable method.

Over 70% of the users in the sample have used micro simulation in applications, e.g. not only for testing, and as much as 50% have developed their own micro simulation model.

The network sizes in the applications varies from single intersections up to city networks of 500 links and 100 intersections.

User requirements

65% of the users say that they would use micro simulation for corridor and intersection level applications respectively. Using micro simulation for city application attracts 50% of the users, so does using it for single roads.

Regional traffic analysis is today only possible on a macroscopic scale with models such as EMME/2 or SATURN. But nevertheless, 23% of the respondents are interested in using micro simulation for regional applications.

The predominant planning horizon among the users seems to be from the present situation and five years ahead.

The most important traffic phenomena to be included in a micro simulation model are incidents, public transport stops, roundabouts, commercial vehicles and pedestrians, in decreasing order of importance.

Efficiency indicators

The highest ranking among the efficiency indicators is given to travel time, congestion, travel time variability, speed and queue lengths.

Safety indicators

The safety indicators are not given the same importance as the efficiency indicators. This possibly reflects a scepticism against the possibilities to simulate traffic safety. Some of the comments indicate this. Headway, interaction with pedestrians and overtakings are the most important indicators.

Environmental indicators

Environmental effects seem to be as important as efficiency.

Telematics functions

Micro-simulation seems according to the answers to be especially valuable for the assessment of applications related to signals (adaptive and co-ordinated signals, PT priority and ramp metering) or incidents and congestion (detectors, incident management, VMS, DRG and motorway flow control). Urban traffic control seems to be the main application. Information systems, Automatic debiting, Cruise control and automated highway systems seem to be of less importance.

General conclusions

The sample of users that are included in the survey is not necessarily representative of the future model users. There is a clear geographical bias, and there is a clear bias towards research organisations. Therefore, the results should be interpreted more in an indicative than in a conclusive way.

Bearing this in mind, the user requirements could be summarised in the following way:

Users would like to be able to do analysis in a variety of specific applications, including on-line applications, control strategies, large scale schemes and product performance tests. The scale of applications ranges from regional applications to single road cases, and the time horizon ranges from on-line to several years. The requested time span of the simulation is 5 minutes to 12 hours with an emphasis on the rush time period.

There is then demand for

functionality - which should include possibilities to model incidents, public transport stops, round-abouts and commercial vehicles,

relevance - which should give the user possibilities to express results in terms of

efficiency

- travel time
- congestion
- travel time variability
- queue lengths
- speed
- public transport regularity

safety
- headway
- interaction with pedestrians
- overtakings
- number of accidents

environment
- exhaust emissions
- noise level
- roadside pollution levels

technical performance
- fuel consumption

telematics modelling ability
- adaptive traffic signals
- co-ordinated traffic signals
- priority to public transport vehicles
- vehicle detectors
- ramp metering
- variable message signs
- incidence management
- dynamic route guidance
- motorway flow control

user friendliness
- graphical user interface for input, editing and for presentation of results

execution speed
- execution times several times faster than real time

high quality performance, including
- default parameter values provided
- key parameters user defined
- validated with real data
- guidelines for use provided
- runs on a PC
- high cost-effectiveness
- easy integration with DB and GIS
- short lead time before use
- limited need for data acquisition
- standard methods for use defined

This is of course a tall order, and it is unlikely that all these requirements can be fulfilled within one single system. The questionnaire has nevertheless in many cases given clear indications concerning the relative importance of different factors, which may be helpful in future system development.

It is according to the questionnaire important that the most significant factors are taken into account and are based on *validated* field studies. The emphasis on validation is a reflection of the uncertainty concerning behavioural relationships. New knowledge about the effects of intelligent traffic systems will emerge continuously during many years to come. New functions which meet new demands will be developed. This indicates that the system should be as open as possible to changes in functional relationships. Driving behaviour that is concealed in the model system source codes and cannot be changed by anyone apart from the programmer is therefore not desired by the user and makes the system conservative and impractical. It must therefore be possible for the user to control the behavioural relationships that are used in the model and add new relationships based on newly-acquired knowledge. The model system must therefore function as an "*open toolbox*".