Microsimulation: Workshop report of the 8th IATBR Conference, Austin, September 1997
Workshop report of the 8th IATBR Conference, Austin, September 1997

Author(s):
Axhausen, Kay W.; Pendyala, Ram M.

Publication Date:
2001-10

Permanent Link:
https://doi.org/10.3929/ethz-a-004231780

Microsimulation

Workshop report of the 8th IATBR Conference, Austin, September 1997

KW Axhausen
R Pendyala

Arbeitsbericht **92**
Verkehrs- und Raumplanung **October 2001**

Microsimulation

KW Axhausen
IVT
ETH
CH-8093 Zürich

Telephone: +41-1-633 3943
Telefax: +41-1-633 10 57
eMail: axhausen@ivt.baug.ethz.ch

R Pendyala
Department of Civil & Environmental Engineering
University of South Florida, ENB118
4202 East Fowler Avenue
Tampa, FL 33620, USA

Telephone: +1-813- 974 1084
Telefax: +1-813- 974 2957
eMail: pendyala@eng.usf.edu

October 2001

Abstract

This report discusses the results of the Workshop on Microsimulation held at the 8th IATBR conference at Austin, Texas in September 1997.

Keywords

Microsimulation; Workshop; IATBR Conference; Austin, Texas; September 1997

Preferred citation style

Axhausen, K.W. and R. Pendyala (Forthcoming) Microsimulation, Workshop report of the 8th IATBR Conference, in H. Mahmassani (ed.) Challenges and Opportunities in Travel Behaviour Research and Applications, Elsevier, Oxford.

1. Introduction

Microsimulation approaches are the potential workhorses for the application of complex and dynamic models of travel and activity behaviour. The goal of the workshop was to take stock of how close we are to this goal and what issues need to be addressed on the way to this goal. The discussion was based on the resource paper by Miller and Salvini (1997), which set the scene and defined *microsimulation* in the context of travel behaviour research as an approach for exercising a set of *disaggregate behavioural models over time*, which implies the status of the disaggregate entities, e.g. persons, is updated and their actions performed resulting in an consistent evolution of the system state and in individual trajectories/profiles for each entity. The authors highlighted that current technologies bring us closer to the promise of micro-simulation as a standard tool for analysis and forecasting, but that there are still substantial difficulties, which need to be addressed.

2. Status in simulation models of travel behaviour research

The discussion of the workshop highlighted that a number of new technologies (in particular agent-based computing, non-linear system theory or the advances in computing power) have improved the ease of development and application of microsimulation models, but that they still have not found widespread application in their full form in the modelling of travel behaviour, which is in marked contrast to traffic flow simulation were such models are dominant (see excursus below).

The sample-enumeration tools, associated with disaggregate modelling systems, are the most widely applied tools, although their lack of *real-time* and *activity-location* interaction between the simulated units and their lack of an explicit time axis puts them outside the definition provided above. Well known examples are the Dutch National Model (Gunn, van der Horn and Daly, 1988 or Van der Hoorn and van Hoek, 1989), the work of Zumkeller (1989) or the tool VISEM (Fellendorf, Haupt, Heidl and Scherr, 1997).

In recent years models have been formulated, which try to integrate the time axis and the real-time interactions in a consistent way, e.g. ORIENT/RV (Axhausen, 1990), Eurotopp (Axhausen and Goodwin, 1991) or DYNASMART (Mahmassani, Hu and Peeta, 1994) among others. The most important of these is TRANSIMS (Barrett et al, 1995), which is intended as a replacement of the standard UTPS-approach in the USA. TRANSIMS provides an iterative scheme to ensure the macroscopic consistency between the demand for travel and the performance of the network, which is evaluated using a microscopic flow simulation. This leaves the possibility for microscopic inconsistencies, but makes the approach applicable for large scale planning studies. Housing market models have been able to achieve this consistency in a slightly less complex environment then the activity-travel-regime (for a review see Wegener, 1994).

Excursus: Simulation of traffic flow

The problems of operating and designing multi-lane single-direction carriageways of motorways stimulated early on an interest in the simulation of motorway traffic flow (May, 1990) first in the US, then in Europe and elsewhere (Leutzbach, 1988). The purpose of this excursus is neither a historical review (for this see May, 1990 or Leutzbach, 1988) nor an overview of currently available models (for recent reviews see Algers, Bernauer, Boero, Breherent, Di Taranto, Dougherty, Fox and Gabard, 1997 or Reiter, 1997), but a discussion of their general structures and problem areas, in particular in relation to the state-of-the art in simulation models of travel behaviour.

The motorway context allowed a relatively simple conceptualisation of the drivers, their vehicles and their environment due to the absence of other types of road users, an uniform and mostly disturbance-free environment custom-made for the motor vehicle and few flow interruptions. The core of the conceptualisation was and is the driver-vehicle unit and a set of rules and models describing the choice of the driving speed and of lateral position, implying rules for acceleration and deceleration, overtaking and interaction with surrounding vehicles. For simplicity the rules are generally specified:

- Only for the immediate neighbours of the driver-vehicle unit considered at any one time (cars in front and behind, which equals a maximum of 2 * number of lanes cars).
- The models are time-stepped treating each driver-vehicle-unit in a given order of precedence. Time steps of one second are the norm.
- The models assume that there are only n positions available in the cross-section, with n = the number of lanes.
- There are no interactions with on-coming and crossing traffic and with merging or demerging traffic only at on- and off-ramps.

This framework was then transferred to other environments, where some, but not all of these assumptions had to be relaxed: multi-lane rural roads with on-coming traffic influencing overtaking (e.g. Brilon, 1976; Leutzbach, Brannolte and Schmidt, 1989; Okura and Matsumoto, 1990; Pursula and Siimes, 1993; Botha, Zeng and Sullivan, 1993), urban traffic with crossing traffic and signal control (Leutzbach and Wiedemann, 1986 or Khasnabis, Karnati and Rudraraju, 1996) interaction with guidance and control systems, e.g. radio-based direction guidance, in-car dynamic route guidance, variable speed control etc (among many others Emmerink, Axhausen, Nijkamp and Riedveld, 1995; Hu and Mahmassani, 1995 or Reiter, 1994). The modelling idea was also transferred to other types of vehicles, such as bicycles (e.g. Wiedemann and Zhang, 1989), planes and trains (e.g. among many others VISION (British Rail), TRANSIT (Siemens) or SIMU VII (TU Braunschweig), or applications such as Reid, Sicking and Paulsen, 1995; Venglar, Fambro and Bauer, 1995 or Buck, 1992), as well as to pedestrians.

The core of each model remains the description of the choice of speed by each simulated unit and the choice of lateral position in conjunction with the rules specifying the response to the various control systems modelled. Within the speed-choice context, four main modelling traditions can be distinguished in the literature:

- Implementation of *continuous car-following models*, which describe the desired distance between any two vehicles as a function of their distance, their relative speeds and, sometimes, their relative accelerations. Assuming that a desired maximum speed is known the acceleration/speed for the next time step is then calculated to fit the desired distance. A well known example among many is Gipps' car-following model (Gipps, 1981), whioch has also been implemented widely in operational models. Well known implementations of such approaches are the FHWA models FRESIM, and NETSIM or AIMSUM2 (Barcelo and Ferrer, 1994)

- Implementations of the *psycho-physical spacing model*, which relates acceleration and deceleration to the speed- and distance-differences detectable by the driver (Leutzbach and Wiedemann, 1986; Fellendorf, 1993, Benz, 1994)

- *Cellular automata*, which simplify the description further providing only discrete positions along the roadway axis and across the cross-section and only discrete speeds, trading simplicity for speed of calculation (e.g. Nagel and Schreckenberg, 1992). Nagel (1995), for example, specifies his model of single-lane flow completely as follows:

    1) **Acceleration:** If the velocity v of a vehicle is lower then (uniform) v_{max} and if there is enough room ahead ($v \leq gap - 1$), then speed is increased by one.

    2) **Slowing down (due to other cars)**: If the vehicle ahead is to close ($v \geq gap + 1$), then speed is reduced to gap

3) **Randomization** (which is applied after rule 1 or 2): With probability p, the velocity of each vehicle (if greater than zero) is decreased by one.

- *Mixed micro- and macroscopic models,* which maintain individual driver-vehicle-units, but use aggregate relationships for the calculation of speeds, such as DYNEMO (Schwerdtfeger, 1984) or Integration (Bacon, Lovell, May and Van-Aerde, 1994).

A further alternative are discrete event frameworks, which calculate variable time-steps until the next change in behaviour (e.g. Taale and Middelham, 1997).

It should be noted, that the last two alternative do not allow meaningful disaggregate analyses of driver behaviour or interactions, as their base models are either too crude (cellular automata) or not disaggregate (mixed models). Certain other aspects, for example route choice if included in the model, can be meaningfully traced and analyzed on an individual level.

The models of lane-choice and overtaking are rule-bases of differing complexity, depending on context and degree-of-realism sought. Further rule-bases to describe the interaction with traffic control and traffic information are easily implemented, but generally difficult to validate.

The available commercial models (see Algers et al., 1997) are intended for smallish networks with a concurrent number of simulated vehicles in the low thousands, which is completely suitable for the normal tasks to which they are put: analysis of specific freeway sections or parts of signalized urban networks. In both cases the work involved in the aggregate validation of the model and the acquisition of the detailed description of networks and flows prohibits larger networks. Due to the expensive specialized data required a new validation of the disaggregate rules and assumptions is hardly ever undertaken during an application. The default parameters are accepted and may be fine tuned. The inclusion of complex rule-bases for interactions with control and information systems makes a disaggregate validation even less likely in a typical application.

The commercial models respond in their development to the pressures of their market place, which currently is mostly interested in the simulation of various high-tech driver support, traffic control or traveller information systems. These development enrich the range of applicability of the models, but do not challenge the basic framework set out above. The rather non-commercial work on pedestrians and bicyclist and traffic flow in less-developed countries has shown that the lane- and immediate vicinity orientation of nearly all current models also limits the description of the driver-vehicle-unit. The incorporation of more explicit models of the exact choice of lateral position and of the strategic and tactical driving decisions can expand the behavioural core of the models, while requiring a much richer description of the drivers and their plans in comparison to the currently blindly responding simulated drivers. Still, this expansion of behavioural complexity could until now not be justified for real-life applications, although congested urban networks with interactions between car, trucks, trams, busses, cyclists and pedestrians might do so in the future.

The second major development direction of the current model generation is their transfer to large networks with 100,000's of concurrently simulated driver-vehicle units for both planning and real-time control applications: simulation of a whole urban area including detailed simulation of emissions production and distribution (e.g. TRANSIMS (Barret et al., 1995) or DYNEMO (SIMTRAP, 1997)), simulation of complete motorways networks of large-scale regions (e.g. the Ruhr-Region or Scottish Midlands) (PLANSIM-T (in Algers et al., 1997) or PARAMICS (McArthur, 1995), or the optimization of traffic control for large networks using simulation to evaluate different control strategies in real-time. A variety of directions are currently pursued to achieve the necessary computational speeds and behavioural realism. Parallel computers are one approach of speeding up the calculation. The more important approaches concern the reformulation of the model to simplify the conceptualisation of the driver-vehicle units and their interactions: e.g. cellular automata or mixed microscopic/macroscopic models.

The relative success of this microsimulation tradition is based on the relative simplicity of modelling task at hand, the lack of credible alternative tools, which could address the same questions and the relatively simple starting conditions and relatively low validation requirements[1]. The progress in this area is important, as fully fledged microsimulation models of travel behaviour require a model of traffic flow to ensure consistency between the time-space regime and the experiences of the individual travellers and to allow for time-space specific interactions, such as parking search or response to traveller information systems.

[1] In many cases only the reproduction of known macroscopic speed-flow relationships

3. Issues and challenges

While the implementation of microsimulation models of travel behaviour is making progress on the well established basis of consumer choice theory and its extension to dynamic processes, as well as on the new results about network learning, there are a range of issues, as identified by the workshop, which need attention.

Microsimulation models of travel behaviour have ambitious scales in time and space and scope in their coverage of human choices. Next to the practical problems of the large amounts of computing time required and file storage required for the intermediate outputs, the main conceptual problem for the user is to maintain the understanding of how the model reacts, in particular for the various nested rule structures, which make this rather difficult. In the face of this challenge the workshop suggested to separate the definition of the "agents" and of their "processes" as strictly as possible and to document the model and the application as comprehensively as possible.

A single run of a microsimulation model of travel behaviour is a challenge in itself, especially as the run needs to be prefaced with the creation of a consistent starting solution against which any policy might be tested. A bigger challenge is the necessary and proper experimentation to remove the effects of the random-number seeds, which are known to have potentially substantial impacts in microsimulation models of all kinds. Researchers in the field will have to adopt best practises in experimental design, if they want to keep the effort manageable and if they want to obtain valid results.

Given these difficulties the workshop concluded that microsimulation models should be applied only, if their specific strength are called for: description of system evolution over time, modelling of interactions in time and space, complex non-linear decision rules, non-equilibrium situations.

4. Research directions

The workshop was not able to cover the whole range of possible issues in its definition of research directions, but could only focus on a small number. The following were identified

- Development of tools for the construction of consistent scenarios out of individual - not necessarily - internally consistent building blocks

- Execution of proper experiments with the scenarios, i.e. construction of experimental designs, conduct of sufficient simulation runs, extractions of required results from each run and proper statistical meta-analysis (response surface regressions etc.)
- Correct integration of flow simulation and higher level traveller choices in the context of traffic control, road side information and in-vehicle and pre-trip information systems.
- Formulation of models of environmental learning (updating of mental maps) and of the process of abstracting by which travellers generalize from the specific to the general, e.g. how experiences become general expectations about the performance of types of environments and services.
- Experimentation with the formulation of discrete rule systems and their comparison with choice models or non-linear classifiers, such as neural networks or fuzzy neural networks.
- Analysis of the meaning and identification of equilibrium and steady state for such models and of the paths they describe (true system evolution vs iterative convergence)
- Analysis of the general stability of such systems and of the effects of the dimensionality of the choices considered and described.

The number and difficulty of the research problems indicates that large scale application of microsimulation models as a matter of fact is some way in the future. Still, the workshop felt that even now microsimulation models offered the best tool available to test and explore research hypotheses through their formulation as rules and their animation in simulation models (see also Axhausen, 1991).

5. References

Algers, S., E. Bernauer, M. Boero, L. Breherent, C. Di Taranto, M. Dougherty, K. Fox and J.-F. Gabard (1997) Review of micro-simulation models, *SMARTEST Deliverable*, **D3**, Institute for Transport Studies, University of Leeds, Leeds.

Axhausen, K.W. (1990) A Simultaneous Simulation of Activity Chains, in P.M. Jones (Ed), *New Approaches in Dynamic and Activity-based Approaches to Travel Analysis*, 206-225, Avebury, Aldershot.

Axhausen, K.W. (1991) The role of computer-generated role-playing in travel behaviour analysis, paper presented at the 70th Transportation Research Board Meeting, Washington, D.C.

Axhausen, K.W. and T. Gärling (1992) Activity based approaches to travel analysis: Conceptual frameworks, models and research problems, *Transport Reviews*, **12** (4) 323-341.

Axhausen, K.W. and P.B. Goodwin (1991) EUROTOPP: Towards a dynamic and activity-based modelling framework, in *Advanced Telematics in Road Transport*, 1020-1039, Elsevier, Amsterdam.

Axhausen, K.W. and R. Herz (1989) Simulating Activity Chains: A German Approach, *ASCE Journal of Transportation Engineering*, **115** (3) 316-325.

Bacon, VW Jr., D.J. Lovell, A.D. May and M. Van-Aerde (1994) Use of Integration model to study high-occupancy-vehicle facilities, *Transportation Research Record*, **1446**, 8-13.

Barcelo, J. and J.L. Ferrer (1994) Microscopic simulation of vehicle guidance systems with AIMSUN2, paper presented at the 23rd Euro-Conference, Glasgow.

Barrett, C., K. Berkbigler, L. Smith, V. Loose, R. Beckmann. J. Davis, D. Roberts and M. Williams (1995) An operational description of TRANSIMS, *Working Paper*, **LA-UR-95-2393**, Los Alamos National Laboratories, Los Alamos.

Benz, T. (1994) Traffic flow effects of intelligent vehicles, in *Traffic Technology International 1994,* 118-120, UK and International Press, Dorking.

Botha, J.L., X. Zeng and E.C. Sullivan (1993) Comparison of performance of TWOPAS and TRARR models when simulating traffic on two-lane highways with low design speeds, *Transportation Research Record*, **1398**, 7-16.

Brilon, W. (1976) Warteschlangenmodell des Verkehrsablaufs auf zweispurigen Landstraßen, *Schriftenreihe Straßenbau und Verkehrstechnik*, **201**, Bundesministerium für Verkehr, Bonn.

Buck, A. (1992) Simulation von Fundamentaldiagrammen bei Eisenbahnen, dissertation, Universität Karlsruhe, Karlsruhe.

Dixon, K.K., A. Lorschneider and J.E. Hummer (1995) Computer-simulation of I-95 lane closures using FRESIM, *Proceedings of the 65th Annual Meeting*, ITE, Washington, D.C.

Emmerink, R.H.M., K.W. Axhausen, P. Nijkamp and P. Rietveld (1995) Effects of information in road transport networks with recurrent congestion, *Transportation*, **22** (1) 21-53.

Fellendorf, M. (1993) Beurteilung des innerstädtischen Verkehrsgeschehens mittels Simulation, *Fortschritte in der Simulationstechnik*, **6**, Vieweg-Verlag, Wiesbaden.

Fellendorf, M. (1997): Public Transport Priority within SCATS - a simulation case study in Dublin, In: *Compedium of the 67 Annual ITE Meeting*, Boston, August 1997 (CD-ROM)

Fellendorf, M., T. Haupt, U. Heidl and W. Scherr (1997) PTV Vision: Activity-based demand forecasting in daily practice, in D. Ettema and H. Timmermans (eds.) *Activity-based approaches to travel analysis*, 55-72, Pergamon, Oxford.

Fellendorf, M., C. Mac Aongusa and M. Pierre (1997) LRT priority within the SCATS environment in Dublin - a traffic flow simulation study, in L. Sucharov and G. Bidini (eds.) *Urban Transport and the Environment for the 21st Century*, 53-62, Computational Mechanics Publications, Southampton.

Gipps, P.G. (1981) A behavioural car-following model for computer simulation, *Transportation Research*, **15B** (2) 105-111.

Gipps, P.G. (1987) Simulation of pedestrian traffic in buildings, *Schriftenreihe*, **35**, Institut für Verkehrswesen, Universität Karlsruhe, Karlsruhe.

Gunn, H., T. van der Hoorn and A. Daly (1989) Long-range, country-wide travel demand forecasts from models of individual choice, in IATBR (ed.) Travel Behaviour Research - Proceedings of the Fifth International Conference on Travel Behaviour, 119-137, Gower, Aldershot.

Hesselfeld, M., V. Kahn and K. Weisbrich (1997) Computer-aided planning of rural train runs in Lower Saxony, in L Sucharov and G. Bidini (eds.) *Urban Transport and the Environment for the 21st Century*, 23-32, Computational Mechanics Publications, Southampton.

Hu, T.Y. and H.S. Mahmassani (1995) Evolution of network flows under real-time information: Day-to-day dynamic simulation assignment framework, *Transportation Research Record*, **1493** 46-56.

Khasnabis, S., R.R. Karnati and R.K. Rudraraju (1996) NETSIM-based approach to evaluation of bus preemption strategies, *Transportation Research Record*, **1554**, 80-89

Leutzbach, W. (1988) *Introduction to the Theory of Traffic Flow*, Springer, Heidelberg.

Leutzbach, W., U. Brannolte and M. Schmidt (1989) Untersuchung des Verkehrsablaufs auf einbahnigen Strassen unter besonderer Berücksichtigung langsamer Fahrzeuge, *Schriftenreihe Forschung Strassenbau und Strassenverkehrstechnik*, **551**, Bundesministerium für Verkehr, Bonn.

Leutzbach, W. and R. Wiedemann (1986) Development and applications of traffic simulation models at the Karlsruhe Institut für Verkehrswesen, *Traffic Engineering and Control*, **27** (5) 270-278.

Liu, R., D. van Vliet and D.P. Watling (1995) DRACULA: Dynamic route assignment combining user learning and micro-simulation, *Proceedings of the 23rd European Transport Forum*, **E**, 143-152, PTRC, London.

Mahmassani, H.S., T.Y. Hu and S. Peeta (1994) Microsimulation-based procedures for dynamic network traffic assignment", *Proceedings of the 22nd European Transport Forum*, **H2**, 53-64, PTRC, London.

May, A.D. (1990) *Traffic Flow Fundamentals*, Prentice-Hall, Englewood Cliffs.

McArthur, D. (1995) The PARAMICS-CM behavioural model, *Proceedings of the 23rd European Transport Forum*, **E**, 219-231, PTRC, London.

Nagel, K. and M. Schreckenberg (1992) A cellular automaton model for freeway traffic, *Journal of Physical Institute of France*, **2**, 2221.

Nagel, K. (1995) High-speed microsimulation of traffic flow, dissertation, Universität zu Köln, Köln.

Nökel, K. (1997): Specification of the Traffic Model, Deliverable D6 of the SIMTRAP-Project, PTV System, Karlsruhe.

Nökel, K. and A. Rehkopf (1996) Betriebsfuehrung von Nahverkehrssystemen mit dem Simulationswerkzeug TRANSIT, *Signal+Draht*, **88** (3) 15-18.

Miller, E.J and P.A. Salvini (1997) Activity-based travel behavior modeling in a microsimulation framework, paper presented at the 8th IATBR Conference, September 1997, Austin.

Okura, I. and K. Matsumoto (1990) Traffic simulation study for two-lane rural highway overtaking improvements. *Proceedings of the 15th ARRB Conference*, **15** (5) 43-56, Darwin, August 1990.

Pursula, M. and H. Siimes (1993) A simulation study of a high-class three-lane rural road, in *Compendium of Technical Papers from ITE 63rd Annual Meeting*, 16-20, ITE, Washington, D.C.

Reid, J.D., D.L. Sicking and G.W. Paulsen (1996) Design and analysis of approach terminal sections using simulation, *Journal of Transportation Engineering*, **122** (5) 399-405.

Reiter, U. (1994) Simulation des Verkehrsablaufs mit individuellen Fahrbeeinflussungssystemen, dissertation, Universität Karlsruhe, Karlsruhe.

Reiter, U. (1997) Kapitel E: Verkehrsflussmodelle, in U. Brannolte and C. Theis (eds.) Situationsanalyse über den Stand der Simulationsmodelle im Verkehrswesen, report to the Bundesministerium für Bildung, Forschung, Technologie und Wissenschaft, Fakultät für Bauingenieurwesen, Bauhaus-Universität, Weimar.

Rickert, M., K. Nagel, M. Schreckenberg and A. Latour (1996) Two lane traffic simulations using cellular automata, *Physica A*, **231**, 534.

Schwerdtfeger, T. (1984) DYNEMO - A model for the simulation of traffic flow in motorway networks, in *Proceedings of the 9th Symposium of Transportation and Traffic Flow Theory*, 65-87, VNU Science Press, Utrecht.

Taale, H. and Middelham, F. (1997) FLEXSYT II - A validated microscopic simulation tool, *Proceedings of the 8th IFAC/IFIP/IFORS Symposium on Transportation Systems*, 923-928, Chania, June 1997.

Van der Hoorn, T. and H. van Hoek (1988) Translation of results from the Dutch national model into practical information for policy recommendations, *Proceedings of the 16th PTRC Summer Annual Meeting*, **D,** 165-182, PTRC, London.

Venglar, S.P., D.B. Fambro and T. Bauer (1995) Validation of simulation software for modeling light rail transit, *Transportation Research Record*, **1494**, 161-166.

Wegener, M. (1994) Operational urban models: State of the art, *Journal of the American Planning Association*, **60** (1) 17-28.

Wiedemann, R. (1991) Modelling RTI-elements on multi-lane roads, in *Advanced Telematics in Road Transport*, **2**, 1007-1019, Elsevir, Amsterdam.

Wiedemann, R. und X. Zhang (1989) Verkehrssimulation mit Radfahrern, Final report to the Deutsche Forschungsgemeinschaft, Institut für Verkehrswesen, Universität Karlsruhe, Karlsruhe.

Zumkeller, D. (1989) Ein sozialökologisches Verkehrsmodell zur Simulation von Maßnahmewirkungen, *Veröffentlichungen des Instituts für Stadtbauwesen*, **46**, Technische Universität Braunsschweig, Braunsschweig.

Die *Arbeitsberichte Verkehrs- und Raumplanung* dienen der schnellen Verbreitung der Ergebnisse der Arbeit der Mitarbeitenden und Gäste des Instituts. Die Verantwortung für Inhalt und Gestaltung liegt alleine bei den Autor/innen.

The *Working Papers Traffic and Spatial Planning* are intended for the quick dissamination of the results of the members and guests of the Institut. Their content is the sole responsibility of the authors.

Eine vollständige Liste der Berichte kann vom Institut angefordert werden:

A complete catalog of the papers can be obtained from:

IVT ETHZ
ETH Hönggerberg (HIL)
CH - 8093 Zürich

Telephon: +41 (0)1 633 31 05
Telefax: +41 (0)1 633 10 57
E-Mail: hotz@ivt.baug.ethz.ch
WWW: www.ivt.baug.ethz.ch

Der Katalog kann auch abgerufen werden von:

The catalog can also be obtained from:

http://www.ivt.baug.ethz.ch/veroeffent_arbeitsbericht.html