transport model, traffic assignment, human behaviour, congestion, EURO 2008

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PREDICTED CONGESTIONS NEVER OCCUR. ON THE GAP BETWEEN TRANSPORT MODELLING AND HUMAN BEHAVIOUR

Summary. This paper presents an introduction to meso-scale transport modeling and issues of human behaviour in transport systems. Along with other examples of the human ability to learn in transport systems we look at the comparison of real life data and the prediction of modeling tools for the closure of Vienna's inner ring road during the 2008 European Football Championship (EURO 2008). Some light is shed on the scientific question, whether currently used modeling tools are able to adequately reproduce the real-life behaviour of human beings in the transport system and should be used for transport policy decision making.

ПРОГНОЗ ТРАНСПОРТНЫХ ПРОБОК НЕ ПОДТВЕРЖДАЕТСЯ. РАЗЛИЧИЕ МЕЖДУ МОДЕЛИРОВАНИЕМ ТРАНСПОРТА И ПОВЕДЕНИЕМ ЧЕЛОВЕКА

Аннотация. Эта статья представляет введение в мезомасштабное моделирование транспорта и вопросы поведения человека в транспортных системах. Среди других примеров человеческой способности к обучению в транспортных системах мы проводим сравнение реальных данных и моделирование прогноза для зоны внутри венской кольцевой дороги в течение чемпионата Европы по футболу (ЕВРО 2008). Некоторый свет проливается на научный вопрос, в состоянии ли в настоящее время использующиеся инструменты моделирования адекватно воспроизвести в реальной жизни поведение человека в транспортной системе и должны ли они быть использованы для принятия решения транспортной политики.

1. INTRODUCTION

Computer simulation of traffic flows is a rather young engineering technique, emerging in the 1960's and expanding since. Several models that are implemented today in software applications have been developed using a systematic and epistemological approach. Political decisions are increasingly based upon these software solutions.

But do these models reproduce the behaviour of human beings in complex transport systems under real conditions accordingly?

Along with the physical dimension of transporting humans or goods, a transport system comprises also of the information before, during and after the physical movement. Behavioural approaches indicate that - in contrast to classical traffic assignment models - the traffic flow is not only allocated inside the road network similar to communicating vessels but a change of basic conditions can also cause a shift in the modal split or the total avoidance of trips, even on the short-run. Hence human beings are far more adaptable to changing conditions than it is represented in the software. Transport models which do not take into consideration the impact of information and behavioural changes of the people involved in the transport system (as a result of information processing mechanisms, e.g. due to infrastructural changes) cannot represent behavioural patterns of the road users.

The ignorance of these real system effects in modeling tools could lead, via an in engineering terms absurd logic, to the argumentation, that a road closure inherently causes increased traffic and congestion in the surrounding road network and therefore has to be abandoned due to its adherent negative effects. Models close to reality have to take behavioural approaches at least rudimentarily into account to be able to reproduce realistic effects of technical and political actions in the transport sector.

In this paper we will address the question raised above by comparing the output of a traffic assignment model with actual data on private car use. We will do that by looking at a Viennese case study. During the 2008 European Football Championship (EURO 2008) a main road in the centre of Vienna was closed, forcing transport system users to change their travel behaviour. We will analyse the travel behaviour during that event.

The paper sets out with a short overview of transport modeling, followed by a description of human behaviour in the transport system and the role of information in influencing it, in section 3. This section will also present some case studies within Austria and Germany regarding the adaptive short term learning process of transport system users. Section 4 will contain the EURO 2008 case study of the inner ring road closure in Vienna. Model results will be confronted with empirical data of log points on the closed route. The paper closes with conclusions in section 5.

2. TRANSPORT MODELING

The structure of the so called "classical" transport model, or four stage model, is a result from the practice in the 1960s, and has remained more or less unchanged since, although the modeling techniques have experienced major improvements. The general form is depicted in Fig. 1 [1].

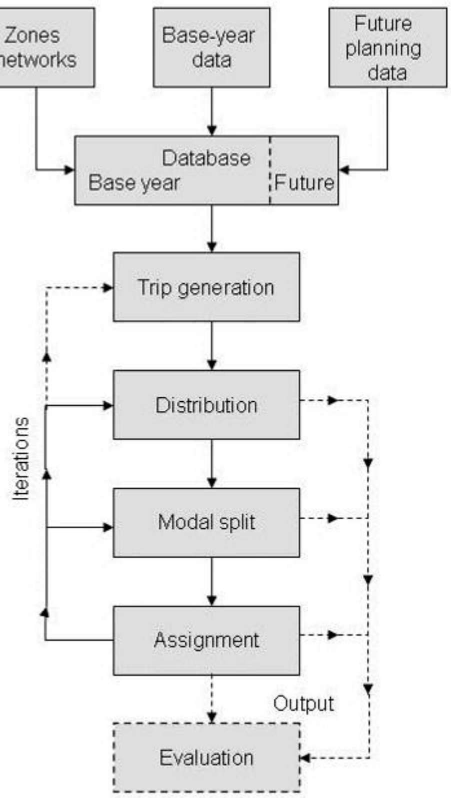

Fig. 1. The classic four-stage model
Рис. 1. Классическая четырехэтапная модель

The main parts of the four stage model are trip generation, distribution, modal split and assignment. In the trip generation step, data of population and economic activity of each zone of the model in a certain base year is used to estimate the total number of trips generated and attracted by each zone. The distribution step allocates these trips to particular destinations, hence producing a trip matrix. In the next step the trips are allocated to the different modes of travel, which results in the modal split. Finally each mode is assigned to their corresponding networks and to distinctive routes.

A popular software solution used by both public authorities and private planning institutions is PTV Vision by the German PTV. Its components allow for the calculation of all steps of the four step model. Basically, behavioural changes due to feedback (congestion, etc.) can be implemented via causal loops. However, this process needs a considerable amount of data (homogeneous behavioural groups, activity chains) which is rarely at hand and quite expensive to obtain.

A common solution to this dilemma is to refrain from collecting and computing the data but to simply estimate the OD (origin-destination)-matrices according to the number of inhabitants and work places and to calibrate the assignment with a few log points. Once this calibration process is finished, the OD-matrices are factored to some future year and are used to assess all infrastructure measures in question. The problem in this practice lies in the ignorance of possible system effects like the change of trip destinations, frequencies and modes [2].

3. HUMAN BEHAVIOR IN TRANSPORT SYSTEMS

3.1. Overview

A lot has been written about traffic congestion, mainly in a theoretical or speculative manner. Empirical and causation related works are rather rare [3]. Both, in the whole transport system and in congestion phenomena, we have to deal with human beings and their evolutionary settings. Knowledge of human behaviour legalities provides the foundation for understanding cause-effect mechanisms in transport systems.

The process of awareness raising started with the SACTRA report, which stated that *'induced traffic can and does occur (…) though its size and significance is likely to vary widely …'* [4]. A substantial literature review and synopsis of generated and induced traffic can be found in Noland *et al.* [5] and Litman [6]. Goodwin *et al.* concluded that *'by symmetry, it might be expected that a reduction in capacity would lead to some overall reduction in traffic volume'*, called *'suppressed traffic'* by Kane *et al.* [2, 7]. A multitude of examples is presented in Cairns *et al.* [8].

Congestion research [2, 7, 8] shows two basic phenomena. Firstly, if congestions are announced in advance via information systems, they only appear with strongly reduced magnitudes or not at all. Secondly, at places where strong congestion occurs, it usually flattens dramatically in a rather short time. A new steady state – a socially accepted congestion or none at all – can be observed within just a few days after the congestion inducing action started.

This behavioural responses to a reduced capacity range from immediate term (in the first few days) changes in driving styles (driving slower and closer together) to the rerouting of trips or the rescheduling of departure times in the short term (in the first few months) and to changed modes, frequencies and destinations in the long term [2].

Transport economists ascribe a lot of costs like external diseconomies to congestion. But they do like to forget to account for its benefits like the systematic educational effect for transport users to behave more socially and sustainably. As the transport system shows a stability of individual travel time budget [9-11], no time savings can be monetised.

A survey by Knoflacher [3] shows that within a few week of reducing a street's capacity by 40%, car drivers readjust their driving behaviour and the congestion reaches prior levels, if not less. Fig. 2 [3] shows the record of the first two weeks' congestion delay which follows a mathematical learning curve (see equation 2 with negative exponent). Four days after the capacity reducing measure was taken, the motorists had already adjusted to the new situation as there was no evasion route at hand.

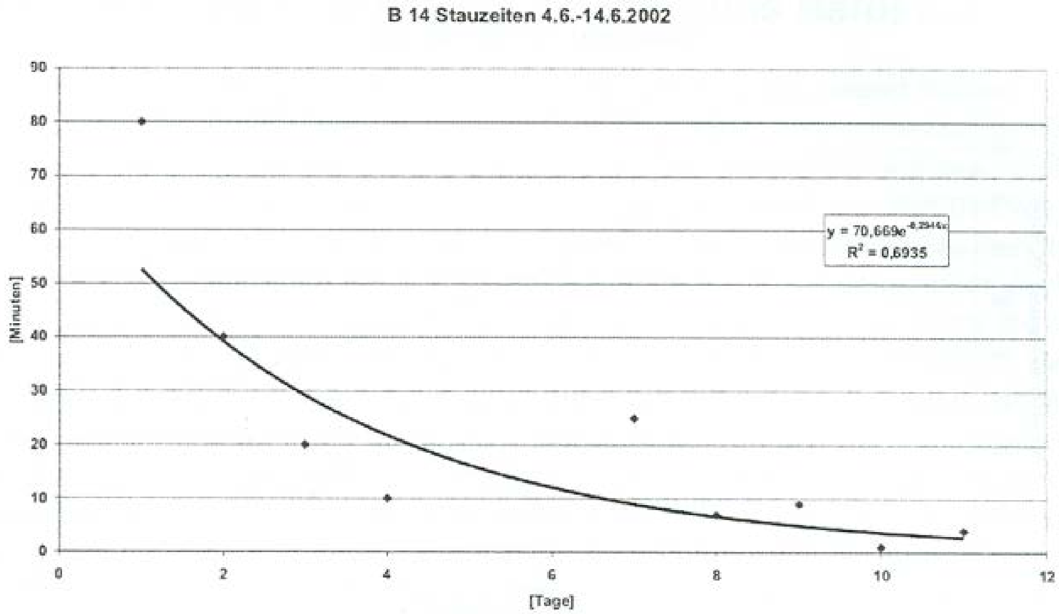

Fig. 2. Reduction of congestion times over a time period of a few days
Рис. 2. Сокращение заторов в несколько раз в течение нескольких дней

3.2. Information and learning

Transport comprises the movement of people, goods and information. Information itself is utterly important in the process of moving people and goods physically on two levels of impact:

- pre-trip (make trip or not, at which time, which mode to choose), and
- on-trip (conditions during trip, which route to take, which connection/link to take).

In the question at hand the information is brought to motorists pre-trip by means of media. The on-trip information comprises of the congestion experience perceived by the motorists. The information system of TV, radio and print media are in matters of transportation mainly aiming at motorists. As Vienna's modal share for cars is about one third, their respective information content should not exceed this fraction – if system matching information needs to be provided. The remaining information hours need to be distributed to public transport, pedestrian and cycling matters. In fact 90% of broadcasting time is dedicated to cars, mainly for quick information of motorists on congestions due to crashes or overload. Only in recent years indications to use public transport have been included into reports of highly likely congestions due to well in advance announced demonstrations or construction works.

The congestion itself represents an intensity of stimulus to the driver, which causes a negative sensation. The law of Weber-Fechner maps the interplay of stimulus and sensation in human beings, see equation (1) [12, 13]. Weber-Fechner's law of sensation represents the depiction of the surrounding physical reality on the behaviour of human beings. Stimulus I being the physical reality (the environment) and sensation E standing for the behaviour: the adjustment of external reality and inner reality a human being has to deal with permanently [3]. [1]

$$\pm E = \ln I \qquad (1)$$

$$I = e^{\pm E} \qquad (2)$$

The curve of decreasing congestion duration concisely depicts the nature of preventive learning of humans. In Fig. 3 the effect of affirmation and disappointment when learning is shown in dependency

[1] Due to the stability of the logarithmic and exponential functions these legalities are valid for particular cases as well as for the system.

on the experiment duration and the relative frequency of affirmation or disappointment. The lowest curve represents the learning behaviour where negative sensations are being avoided [14].

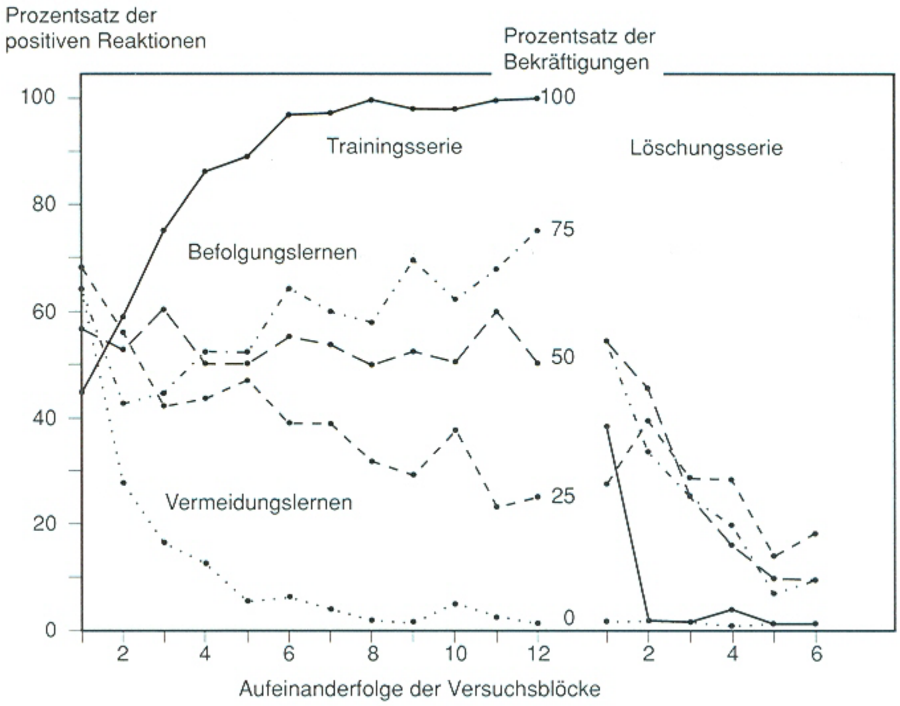

Fig. 3. Typology and success rate of human learning. X-axis shows number of attempts, y-axis shows percentage of positive reactions. The lowest curve (Vermeidungslernen) is preventive learning, the highest (Befolgungslernen) is abidance learning

Рис. 3. Типология и коэффициент успеха человеческого обучения. Ось X показывает число попыток, ось Y показывает процент положительных реакций. Нижняя кривая (Vermeidungslernen) отвечает отсутствию обучения, верхняя кривая (Befolgungslernen) отвечает достижению обучения

Preventive learning of motorists can easily be achieved in situations of periodic trips and stable motorist populations. In situations where trips occur on a less frequent basis, the use of additional information is advisable, so that drivers that don't often use the affected links can adjust to the changed situation. A predicted congestion normally doesn't occur [3]. Congestion can be regarded as a temporary condition when looked upon under consideration of evolutionary adaptive and preventive learning. Furthermore congestion can be used as key variable for controlling the transport system.

3.3. Case studies for transport system reserves regarding capacity and the adaptive short term learning of transport users

Redesign of one car lane of a main thoroughfare as bike lane in Heidelberg, Germany, 1993

Initially the city administration stood in strong opposition to the idea of redesigning one of the 3 car lanes into a bike lane, because a prominent transport consultancy's study calculated a permanent congestion length of over one kilometre, which was appraised as “unacceptable for motorists”. Nevertheless the bike lane was implemented. The maximum congestion length before implementation was approximately 200 m during morning's rush-hour and ranging up to 700 m during the afternoon. Right after the implementation the rush hour congestion length shot up to 1,400 m. But briefly afterwards considerable changes could be observed. The congestion returned to normal pre-implementation levels, sometimes being even shorter than before the street's redesign [15], see Fig. 4.

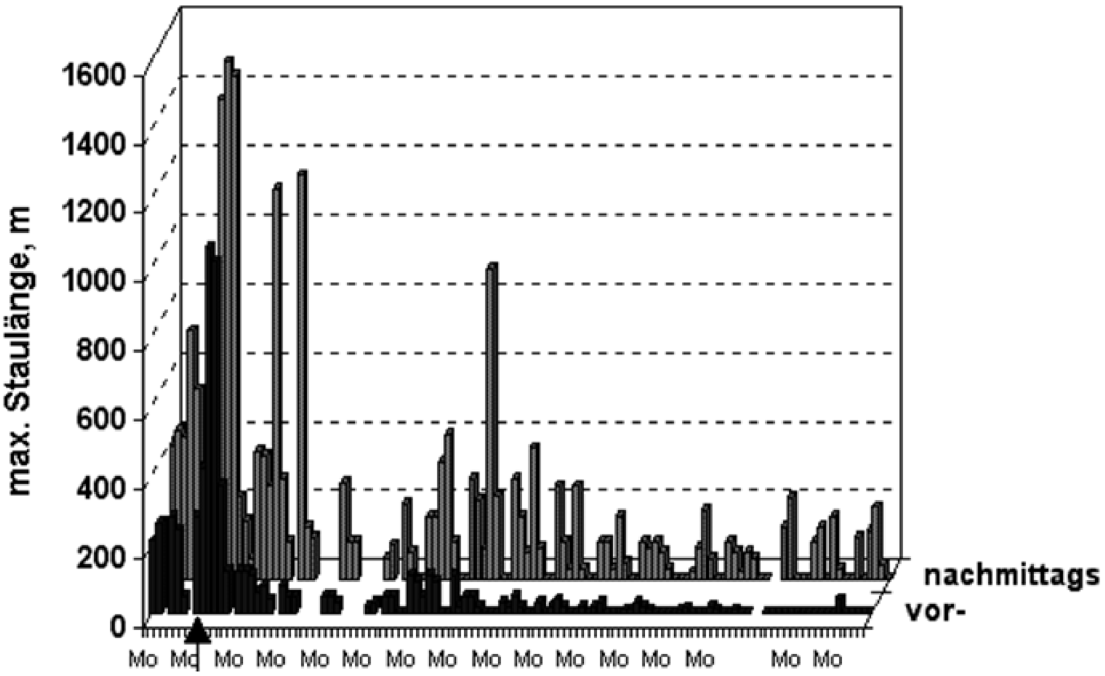

Fig. 4. Timeline of maximum morning (front) and afternoon (back) congestion lengths on Bismarck street, Heidelberg. Black triangle indicates time of reconstruction. Congestion lengths decrease exponentially

Рис. 4. Время заторов максимальной длины на улице Бисмарка в Гейдельберге в утренние часы (спереди) и днем (сзади). Черный треугольник указывает время реконструкции. Длина затора убывает экспоненциально

Closure of the river Inn bridge, 1990

In the early summer of 1990 the highway bridge over the river Inn in Tyrol next to the town of Kufstein subsided due to a washed out pillar foundation. Thus this major European route through the Alps, heavily used by freight transport, had to be closed on the verge of the main summer holiday season. The goods transporters reacted quickly to this new situation. A large proportion of the inevitable trips was diverted to the parallel running railroad. The avoidable trips were refrained from until the obstruction's duration. Afterwards normal transit traffic set in [3].

Collapse of Reichsbrücke bridge in Vienna, 1976

On August 1st of 1976 the main bridge for cars over the river Danube collapsed, thus producing a massive traffic bottleneck over the Danube, as 18,000 cars passed over it during the peak hour [16]. The advice was given to improve the car occupation by means of ride sharing. The average pre-collapse occupation was at 1.21 persons per car. Within hardly a week – the period of learning – the average occupation climbed up to 1.72 persons per car and remained that high until a backup bridge was built. Also the congestion on the remaining bridges subsided to pre-collapse levels within a short time [3]. After the backup bridge was opened for traffic the occupation quickly fell back to 1.2 persons per car. The number of car trips rose and the congestion level remained the same.

The strike days of 2003 – An example of behavioural adaptation due to information in public transport

Vienna's cycling traffic is being automatically measured on four major cycling tracks since May 2002 and on four peripheral cycling facilities since June 2003 [17]. In late spring of 2003 two large strikes held by public service agencies and authorities also halted Vienna's public transport (excluding federal railways and commuter trains) for half a day and a day respectively [18]. These strikes have been advertised by the unions well in advance via TV, radio and newspapers. Vienna's public transport share of about 34% of the city's trips is as high as the share of private motorized traffic [19]. As road transport especially in the morning runs close to capacity, this meant that large numbers of people had to find other transport alternatives. Cycling, which normally has a share of only about 4%, played a major role on these two days – on the second even more than on the first one. The advance information before strike day one and the advance information together with the good experience from day one, led even more people to choose the bicycle for strike day two. Fig. 5 and Fig. 6 shows the factors of these days' cycling traffic in comparison to the average daily traffic (ADT) and the maximum value (MAX) of 2003 – the strike days not included [20]. On day one, the ADT was exceeded by a factor of about 4 to 6. That year's MAX was topped by a factor of 1.5 to 3. On day two, these astonishingly high figures were even excelled. The 2003 MAX values themselves were registered in the aftermath of the strike day two cycling experience: June 4th to June 8th. Thus the strike-induced apex led to even more cycling in the following days. As the eight counting spots cover only a few radial cycle network backbones, it can safely be assumed, that even more people were cycling aside of these routes.

Agents of the transport system informed well in advance reacted twice to major transport system disruptions by behavioural change. As these automatic countings show, Vienna's cyclists' numbers are on a constant rise. But due to the very limited improvements in the boundary conditions of cycling, the peak numbers of 2003 are still a long way to come on a normal basis.

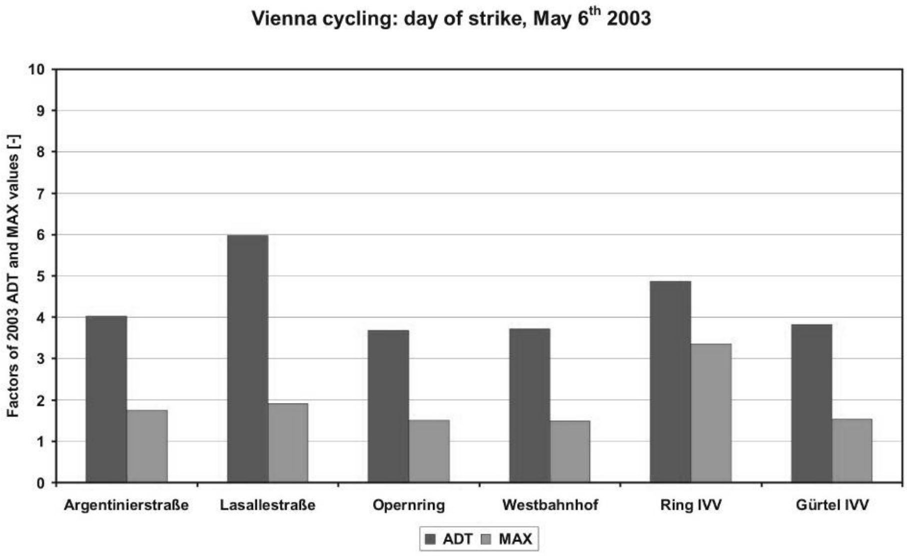

Fig. 5. Factors by which the figures of May 6th exceeded the year's values; IVV...measurements by TUW-IVV's staff

Рис. 5. Факторы, вследствие которых столбцы на диаграмме 6 мая превысили годовые значения; измерения проводились сотрудниками TUW-IVV

4. CASE STUDY UEFA EURO 2008

In June 2008 Austria and Switzerland hosted the EURO 2008. Besides Bern, Zurich, Geneva and Basel in Switzerland, the Austrian cities of Salzburg, Innsbruck, Klagenfurt and Vienna have been venues for the matches. In the case of Vienna, the city council decided to set up a fan zone for the football fans to watch the matches and consume beverages and food. Based upon experiences from the UEFA World Cup 2006 in Germany, the fan zone was built near the city centre. The "Burgring" (part of the inner ring road) was blocked from "Babenbergerstraße" and the "Dr. Karl Lueger Ring" (also part of the inner ring road) was blocked until "Schottentor". Fig. 7 shows the area of the fan zone [27]. The blocking affected private cars as well as cyclists and public transport.

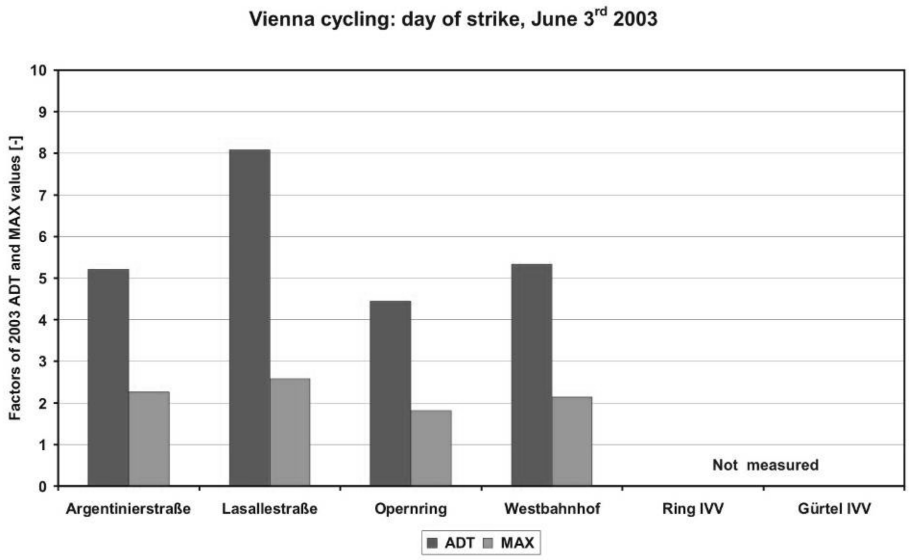

Fig. 6. Factors by which the figures of June 3rd exceeded the year's values
Рис. 6. Факторы, вследствие которых столбцы на диаграмме 3 июня превысили годовые значения

Fig. 7. Aerial photo and montage of the Viennese fan zone during EURO 2008 encompassing parts of Heldenplatz, Ring and the city hall park
Рис. 7. Аэрофотосъемка и монтаж венской зоны болельщиков во время ЕВРО-2008 охватывающая часть Хельденплац, центрального кольца и парка городской мэрии

Ahead of the EURO 2008 several discussions about the possible effects of the closure of the ring road took place. The discussions focussed on the restrictions for the individual car traffic flow. Some politicians and the Austrian automobile club ÖAMTC [21-24] were fearing congestions on the routes that bypassed the closure. The actual blocking of the described route took place ten days before the championship started and lasted the whole duration of the event.

Section 3 described the important role of information and the learning process of humans, in adapting their travel behaviour to new situations in the transport system. Despite the fact that there are several case studies (see section 0) which proof the capability of humans to adapt to new situations, the prevalent opinion beforehand the championships was that severe traffic congestions would occur.

As addressed in the introduction, this section will focus on the gap between transport model results, the prevailing opinions described above and real human behaviour. To be more precisely we will look at the assignment step of a common used transport model in Austria (VISUM), simulate the traffic "situation" in Vienna during the EURO 2008 and compare the model results with actual data collected during that time. We will restrict this analysis only to private car use and the centre of the city.

In our common understanding information politics in advance of such big events as the football championships play a major role in influencing the behaviour of the transport system users. The city of Vienna communicated the closure of the ring road several months ahead of the event. If private car users get the information that their route will not be available some time in the future, respectively, that there will be capacity restraints on the route, they change to a comparable attractive mode of travel, like public transport. This described behaviour is exactly what took place during that time, leading to the result that there was hardly any congestion. On the contrary, even less traffic occurred. Simultaneously 200,000 passengers more were transported on non-match-days and 500,000 more on match-days by the public transport operator "Wiener Linien". This shows the enormous capacity reserves of the public transport system in Vienna, which can be achieved by improving headway times.

In the following paragraphs we will present the model output and compare the model results with the actual data of private car traffic flows, collected during that time period. The aim of this exercise is to proof, that "pure" assignment models lack the taking into account of behavioural changes of humans.

Unfortunately the administration omitted the chance to order this interesting data but thanks to the initiative of the transport organisation department we can at least access the collected data of one log point. We thus have access to the Viennese manual traffic census of 2005, and we have the data of one log point at "Karlsplatz" (Canovagasse) for 2007 and 2008.

We have implemented the above mentioned blockade of the inner ring road between "Grillparzerstraße" and "Heldenplatz" in VISUM. Via the difference net we can illustrate the changes between the pre- and the during-EURO 2008 traffic. The light grey (green) sections experience a decrease of traffic, esp. the closed "Ring"-sections lose all of their traffic, while the dark grey (red) sections face a traffic growth. The thickness of the respective sections corresponds to the magnitude of change. One can deduce from Fig. 8 that about half of the blocked traffic is rerouted via the thick dark grey (re)d route, while the rest is diverted in the disperse net. However, the sum of blocked trips is equal to the sum of increased trips in the whole net by definition, as VISUM only calculates the assignment of trips for a previously determined OD-matrix and mode.

We can now see how planners oblivious to behavioural change expected a traffic chaos. According to the VISUM assignment step the bypass route, which is only a two-lane route, had to additionally cope with the rerouted traffic from the closed three-lane section.

We will now compare the calculated VISUM result with the observed behaviour. The calculation produces an increase of over 3,000 vehicles per day (equal to 8.3%) at the log point during the EURO 2008 phase compared to the pre-EURO 2008 status. The effect of this growth (on the basis of year 2007 data) is shown in Table 1 and Fig. 9.

Table 1

Comparison of observed (average daily traffic on workdays, average daily traffic) and calculated values for the pre (2005, 2007) and during EURO 2008 phase. * values are AADT for 2005, ** values are ADT for the period of the road closure in 2008 and the equivalent period in 2007

Log point "Karlsplatz bei Canovagasse"			
	2005*	**2007****	**2008****
ADTw [veh./24h]	42,469	46,159	45,340
ADT [veh./24h]	37,547	41,578	42,001
VISUM calculation	-	46,159	49,972

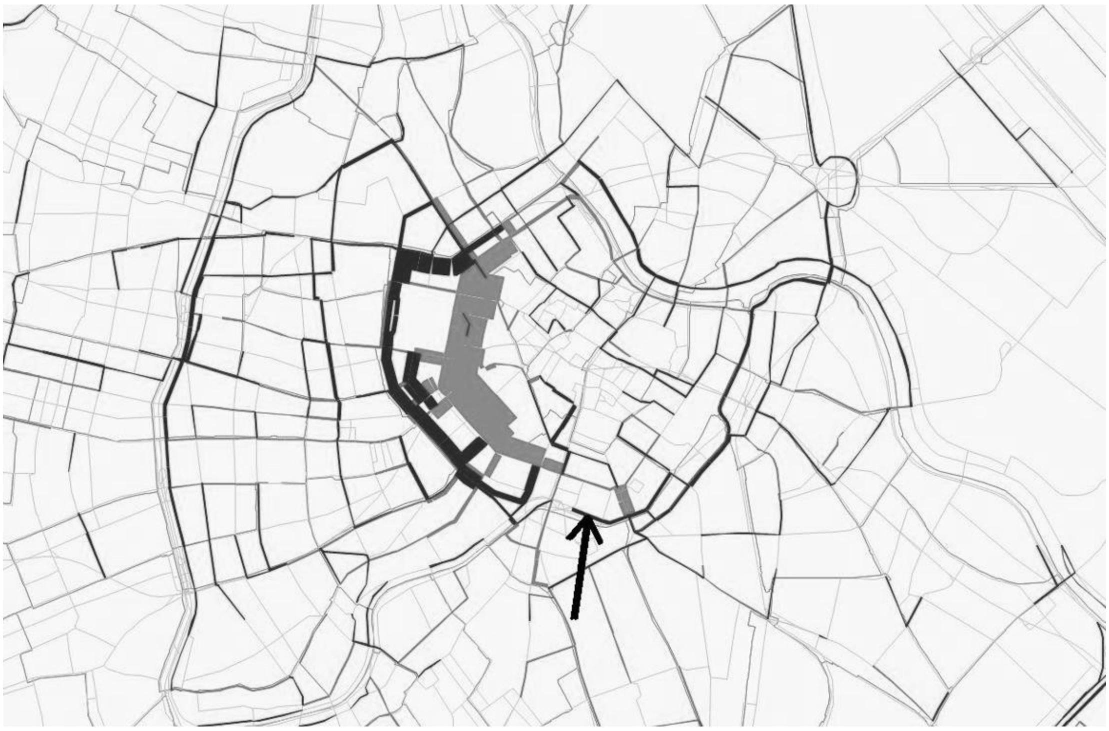

Fig. 8. Differential net of pre- and during-EURO 2008 traffic; light grey = decrease, dark grey = increase, black arrow = log point

Рис. 8. Дифференциальная сеть движения в центральной части Вены до и во время на ЕВРО-2008; светло-серый = уменьшение, темно-серый = увеличение, черная стрелка = контрольная точка

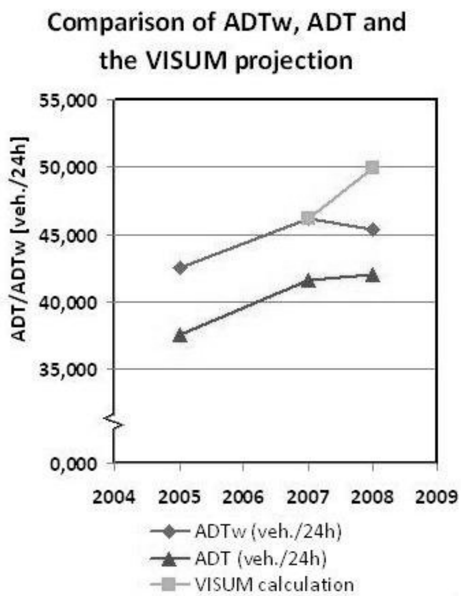

Fig. 9. Visualisation of the average daily traffic (ADT = all days, ADTw = working days), see comment in Table 1

Рис. 9. Визуализация среднесуточного объема движения (ADT = все дни, ADTw = рабочие дни), см. комментарий к табл. 1

Altogether the observed data does not confirm the predicted traffic growth in the net directly bordering the closed road sections. On the contrary, on working days even a reduction of traffic could be detected that may be due to the large information campaign carried out by the UEFA EURO 2008 organisational committee.

Our findings are supported by various press releases citing astonished so-called traffic experts who wonder that no congestion has occurred [25]. (Compare with Goodwin *et al.*: '*the traffic has disappeared and we simply don't know where it has gone to*' [7].)

At the same time the public transport operator “Wiener Linien” has reported a total of 7.3 million additional passengers during the 23-day period of the EURO 2008, thus proving the feasibility of a quasi-permanent Ring-closure [26].

5. CONCLUSIONS

Traffic adjusts relatively quickly to new conditions. Practical experience and implemented policies to reallocate public space (lane closure, etc.) show, that there is a huge elasticity in urban road networks (partly because of the over-dimensioning of the car-infrastructure, partly because of minimal occupancy rates, etc.) and the transport infrastructure in total. It is obvious that the infrastructure currently in use is inefficient. The examples often shows that traffic seems to disappear. Cities notice a short period of traffic disruption, but the frequently conjured (mostly by the media) traffic chaos rarely appears or never lasts longer than a few days.

Car drivers change their behaviour and adapt to the infrastructure more easily than always presumed. Those compensation measures range from changes in driving styles (e.g. smaller headways) via the shift to alternative routes or times (e.g. off-peak), changes of mode, frequencies and destinations, the consolidation of trips, car-sharing and the substitution of trips (e.g. tele-working) [8].

In our case study of the EURO 2008 in Vienna, the basic conditions were clear: the closure of the inner ring road would only be temporarily. Thus, we can not expect to see any long-term behavioural changes of the road users. However, the short-term effects were quite remarkable: the predicted traffic jam failed to materialise, and the public transport reached a historical high of passengers.

The absence of the traffic chaos can quite clearly be traced back to the wide information campaign prior to this mega-event, leaving the affected road users enough time to mentally prepare for and to pick their individual coping strategy. Obviously pre-trip information is crucial, whereas on-trip information can only divert the already underway trip (but has crucial influence on future transport related decisions, as congestion is just another form of information).

Despite the importance of information we showed the inability of classical assignment models to adequately reproduce human behaviour. This finding should initiate contemplation about the reasonableness of the utilisation of such models for specific settings and the deception they can cause. We must be aware that a lot of interesting and useful measures have been delayed or blocked because of wrong assumptions of their effects.

Discussions and plans for reassigning major traffic routes to conditions more friendly to slow-modes have all too often been stalled due to the cut-off argument that such a measure would produce unbeareble and unsolvable traffic jams and unrelievable burdens on the other parts of the transport network. Examples for such stalled ideas from Vienna are:

- an often arising discussion about a permanent, only section-wise closure of the inner ring road and redesign of the surfaces with improved functions for all citizens, not just car traffic;
- the re-design of one of the inner ring road’s car lanes as a high quality cycling lane;
- the temporal, section-wise closure of the inner ring road for cultural or societal events.

The notion of practical transport policies implementation that some measures will lead to unbearable consequences in car traffic and therefore cannot be implemented, show a discrepancy to scientific results and therefore urgently need a reevaluation.

In order to deal with future challenges, also relevant for the transport sector (climate change, urbanisation, etc.), it is necessary to reallocate urban space. The reduction of road capacity is one of the most effective ways of encouraging people to behave more sustainably.

Acknowledgements

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References

1. Ortuzar J.D.D., Willumsen L.G.: *Modelling Transport*. 3rd Edition ed, John Wiley and Sons, 1994.
2. Kane L., Behrens R.: *The traffic impacts or road capacity change: A review of recent evidence and policy debates*. 19th South African Transport Conference. Pretoria 2000.
3. Knoflacher H.: *Grundlagen der Verkehrs- und Siedlungsplanung: Verkehrsplanung*. Verlag Böhlau 2007.
4. Wood D.A., Stewart R.H., Coombe, D., etc.: *Trunk Roads and The Generation of Traffic*. Standing Advisory Comitee on Trunk Road Assessment, 1994, p. 242.
5. Noland R.B., Lem L.L.: *Induced Travel: A Review of Recent Literature and the Implications for Transportation and Environmental Policy*. European Transport Conference, Proceedings of Seminar D: Appraisal of Road Transport Initiatives. Cambridge, 2000, p. 183-210.
6. Litman T.: *Generated Traffic and Induced Travel - Implications for Transport Planning*. VTPI - Victoria Transport Policy Institute, 2010.
7. Goodwin P., Hass-Klau C., Cairns S.: *Evidence on the Effects of Road Capacity Reduction on Traffic Levels*. http://www.worldcarfree.net/resources/freesources/Evide.htm, 1998.
8. Cairns S., Atkins S., Goodwin P.B.: *Disappearing traffic. The story so far*. Proceedings of the Institution of Civil Engineers - Municipal Engineer, 151 151(1), 2002, p. 13 –22.
9. Schäfer A.: *The global demand for motorized mobility*. Transportation Research Part A - General, 32(6), 1998, p. 455-477.
10. Schäfer A.: *Regularities in travel demand: An international perspective*. Journal of transport and statistics, 12, 2000, p. 1-31.
11. Mokhtarian P.L., Chen C.: *TTB or not TTB, that is the question: a review and analysis of the empirical literature on travel time (and money) budgets*. Transportation Research Part A - General, 38, 2004, p. 643-675.
12. *Weber-Fechner-Law*. The Encyclopedia Americana. International Edition, Americana Corporation 1975.
13. Knoflacher H.: *Landschaft ohne Autobahnen. Für eine zukunftsorientierte Verkehrsplanung*. Böhlau 1997.
14. Riedl R.: *Biologie der Erkenntnis. Die stammesgeschichtlichen Grundlagen der Vernunft*. 3. Auflage ed, Verlag Pare 1981.
15. UPI: *Scheinlösungen im Verkehrsbereich - Kontraproduktive und ineffiziente Konzepte der Verkehrsplanung und Verkehrspolitik*. in: *UPI-Bericht*. http://www.upi-institut.de/upi23.htm. Umwelt- und Prognose-Institut e.V., 1993.
16. Wikipedia: *Reichsbrücke*. http://de.wikipedia.org/wiki/Reichsbr%C3%BCcke. wikimedia.org. 2010.
17. Snizek + Partner: *Radverkehrserhebung 2002 - 2005*. in: *Stadtentwicklung - Werkstattbericht Nr. 79*. Magistrat der Stadt Wien, MA 18 – Stadtentwicklung und Stadtplanung 2006, p. 84.
18. MA 18: *Sonderauswertung "Streiktage" 2003 - Radverkehrserhebungen*. http://www.wien.gv.at/stadtentwicklung/projekte/verkehrsplanung/radwege/erhebungen/streiktage-2003.html. Magistrat der Stadt Wien, MA 18 – Stadtentwicklung und Stadtplanung 2003.

19. Wiener Stadtwerke: *Modal Split*. http://www.nachhaltigkeit.wienerstadtwerke.at/daseinsvorsorge/oepnv/modal-split.html. Wiener Stadtwerke 2009.
20. Snizek + Partner: *Radverkehr in Wien 2002 - 2010 – Automatische Dauerzählungen*. http://www.snizek.at/radverkehr/dauerzaehlung2.php, 2010.
21. Maresch, R.: *26.05.2008, Grüne Wien: EURO-Verkehrskonzept mit großen Schwächen*. http://www.ots.at/presseaussendung/OTS_20080526_OTS0181/gruene-wien-euro-verkehrskonzept-mit-grossen-schwaechen. APA, 2008.
22. ORF: *05.06.2007: Fanmeile ohne Fans in der City*. http://oesterreich.orf.at/wien/stories/197929/. ORF., 2007.
23. ORF: *11.06.2007: Politiker wenig begeistert über Ringsperre*. http://oesterreich.orf.at/wien/stories/199240/. ORF., 2007.
24. ÖAMTC: *27.06.2008, ÖAMTC: Dauerhafte Ringsperre nicht machbar - Vorschlag ist einseitig und unseriös*. http://www.ots.at/presseaussendung/OTS_20080627_OTS0073/oeamtc-dauerhafte-ringsperre-nicht-machbar-vorschlag-ist-einseitig-und-unserioes. APA, 2008.
25. Die Presse: *Verkehrschaos nach Ringsperre ausgeblieben*. in: *Die Presse*, 02.06.2008.
26. Wiener Linien: *Jahresbericht 2008*. http://www.jahresbericht2008.wienerlinien.at/euro-2008.html. Wiener Linien 2009.
27. *Fanzone Wien.* http://www.fanzone-wien.at

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