Traffic Management – The Key to More Efficiency in Road Traffic

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Abstract

Traffic management can broadly be divided into the two fields of travel demand management (TDM) and traffic control. Also, traffic management depends largely on data, which enables the development of purposive strategies and their efficient realization. In these three areas the changes will take place. Generally speaking, traffic management will undergo a main-streaming process, basing the singular approaches of the present on more substantial and reliable information, using more sophisticated technology to gather data, to develop strategies, and to inform and influence travellers. Environmental aspects will gain more importance. Modern technologies will enable a dynamic and tailored infrastructure operation, getting the most out of existing roads and transport facilities. The shift of trips in time, space and transport mode will be the key to a more efficient infrastructure operation. Balancing travel demand and spare capacity of the given transport infrastructure will be improved by advanced data availability, traveller information and control measures. Mobility pricing will play a major role not only in finance, but in influencing travel behaviour, too. However, not only due to financial constraints, the ex post evaluation of measures will bear an increasingly significant impact on the planning and realization process in the future, leading finally to the implementation of a comprehensive quality management.

Introduction

The working group on traffic management and traffic engineering consisted of 25 selected experts from research, industry, consultancies, and local authorities, representing 8 countries, (Austria, China, Germany, India, Japan, Turkey, USA, Vietnam). During the discussions eleven statements on the traffic management and traffic engineering in 2030 emerged, covering traffic control, traffic demand management, data acquisition and processing, and quality management. These statements and the related research needs are listed and explained in the following sections.

Until 2030, traffic will be increasingly analyzed considering a broad perspective, taking the network hierarchy, all transport modes, and all impacts of traffic into account. The traffic management will be more balanced between the different transport modes and the different road categories. Safety will remain the top priority, while environmental aspects will gain more importance in the future.

While better models and a more substantial data availability will enable a better planning of traffic management (traffic management plans), the funding of systems and measures will play a major role in the realization of traffic management. However, the role of the demographic change, while significant, is hard to predict yet.

It is apparent, that the situation in developing countries varies from most developed countries, e.g. because of the heterogeneity of the traffic and the lower standard in traffic education. The development is hard to predict yet, since quite different scenarios are possible. However, the most probable development is sketched in Statement 11.

Statements

1) Traffic management will increasingly focus on dynamic infrastructure operation

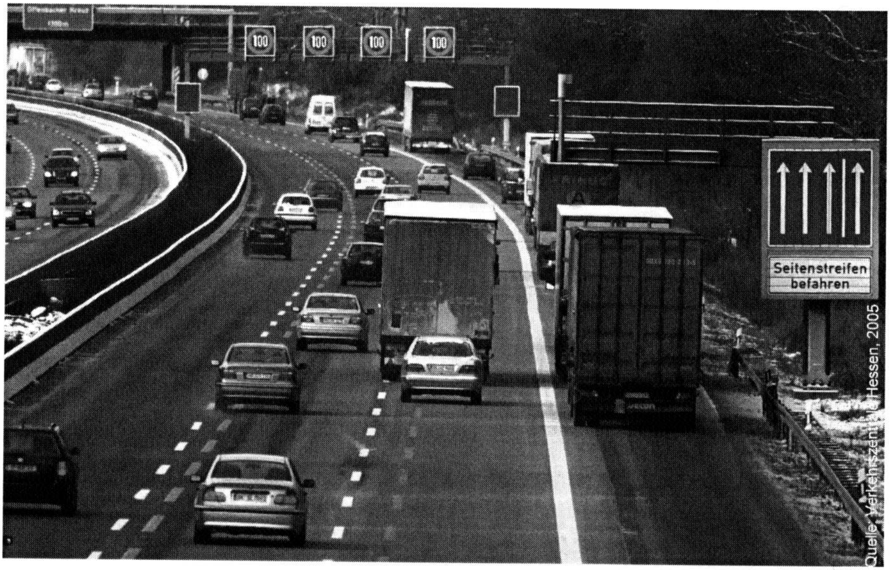
The need to influence traffic more dynamically is justified by the high cost of new infrastructure and the available resources in off-peak time, on less travelled roads, and in transport modes not used to their capacity. Time and space (road and parking space) will be used more efficiently if the traffic infrastructure is managed time-dependant, situation-dependant and with consideration to all transport modes. Current examples of such flexible adjustments are variable shoulder lane usage on motorways, dynamic lane allocation at merges and diverges and contraflow systems on motorways as well as urban arterials. A closed loop control will be realized in the future which incorporates environmental and traffic conditions. Thus, in 2030 the suitable infrastructure for different kinds of traffic will be used more efficiently than today.

Of course, operational measures are closely linked to travel demand management (Statement 2).

To summarize the available experience of transport professionals internationally, and to derive best practice recommendations, is the first step to foster this development. Possible solutions to improve efficiency and safety have to be examined. There is a need for

- technical studies to quantify the benefits, and
- institutional studies on legal orientation of schemes, accident liability, acquisition of user acceptance, etc.

Algorithms using direct feedback from the environmental and traffic situation have to be further developed with regard to the available technologies.



Adjusting infrastructure flexibly by dynamic shoulder use

2) Travel Demand Management (TDM) will play a major role.

Travel demand can be influenced concerning the time of travel, the transport mode, the route and the destination. Travel demand represented by destination choice, departure time choice, mode choice and route choice has to be influenced, since the total supply capacity cannot be extended according to demand only. By controlling the travel demand, the existing infrastructure can be operated most efficiently with regard to costs, social and environmental impacts. Information systems will contribute significantly to this demand management.

However, the analysis of travel behaviour has to be stimulated. Constraints in the choice of time, mode, route and destination must be known to allow an effective demand management. On the other hand, travel demand management has complex effects, which should be researched more thoroughly. The effectiveness of different kinds of information and the efficiency of different dissemination technologies have to be assessed.

3) Integrated pricing schemes will be used extensively as a tool for travel demand management

Pricing will include road pricing, public transport pricing, and parking fees. It will save travel time and improve its reliability for the user. On the other hand, it raises expectations of the users on traffic quality with some impact on the acceptance of the pricing schemes. Pricing strategies together with other travel demand management will be more effective.

Road user charging will be a widely used tool for TDM. It will be dynamic concerning space, time, and vehicle type to support the dynamic traffic management. Moreover, road user charging will be environment-responsive. The standard technology for road pricing will be electronic toll collection (ETC). Pricing schemes offering incentives to flexible travellers are advantageous, because travellers will perceive charges as a measure to save costs by thorough planning. Imposing penalties to inflexible travellers will lead to lower to lower public acceptance of road pricing.

Differing pricing systems evolved in the past. In the future these systems have to be assessed with regard to their suitability for dynamic, highly differentiated pricing schemes in complex networks. Moreover, the impacts of comprehensive intermodal pricing schemes on the user behaviour and on commercial traffic have to be researched. The acceptance by the users and by the decision makers (politics) and the reliability of pricing schemes has to be part of such studies. Traffic control, transport pricing schemes and the reliability of travel times (transport quality) have to match without contradictions.

4) Traffic control will be more environment-responsive.

Traffic control will focus on reducing energy consumption and environmental impacts of traffic (e.g. Pollution and noise will be distributed more favourably throughout the network). This will be realized by, for instance, an optimization of traffic signal control, route and departure time guidance to users, admittance regulations, speed control, and charging based on engine type or vehicle class. Pollution and noise levels will be monitored continuously, also using online traffic flow data (direct feedback control).

To improve the effectiveness of environment responsive measures, the dynamic estimation and prediction of local and area-wide emission levels must be established. Reliable microscopic emission models with consideration of different engine types may be a possible solution. Based on emission models, control algorithms have to be developed, which take user preferences and behaviour into account. Finally, the experiences gained in successful projects should be condensed into guidelines and best practice recommendations.

The traffic condition at a glance: Monitoring of traffic flow in the Traffic Control Centre Hessen

5) Dynamic traffic management can prevent or react quickly to incidents and recurrent breakdowns.

A fast response to incidents and recurrent breakdowns will be possible thanks to more detailed online surveillance of traffic flow by combining data from various sources. Systematic planning and assessment of traffic control actions (documented as dynamic traffic management strategies) and advancements in resilient network design will support prevention and response. However, the increasing automation will lead to legal issues.

Online incident prevention control algorithms have to be developed and fed into systematically planned strategies (traffic management plans). Part of these strategies should be disas-ter recovery measures. The impacts of the strategies have to be thoroughly assessed con-cerning not only the user behaviour.

6) Traffic Signal Control will still have major importance.

Adaptive signal control and „electronic platooning", supported by car-to-car (C2C) and car to infrastructure (C2I) communication, will increase the capacity of signalized intersections. En-vironmental and traffic quality parameters will be integrated into control algorithms. Both, sophisticated control algorithms and fundamental issues, will be understood and improved. Signalized intersections in networks and the different road users will be assessed and controlled by integrative systems.

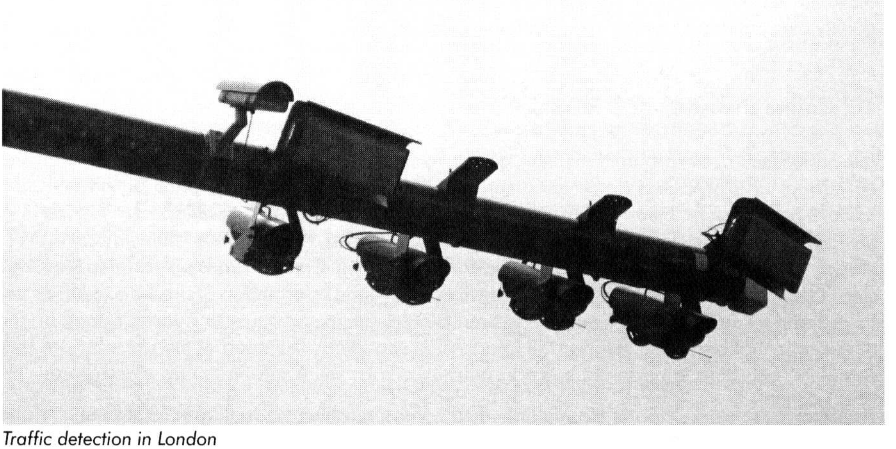
An important step towards a more efficient signal control will be the understanding of fundamental issues (e.g. intergreen design, loss time evaluation). Sophisticated control algorithms have to be improved, including research on opportunities provided by automated cruise control (ACC , "electronic platooning"), C2C, and C2I.

The need for open-source globally valid designs, timing methods and analysis methods for signalized intersections becomes more and more apparent. The methods used today should be investigated internationally.

7) All elements of the intermodal transport system will be connected.

Currently traveller information is split by regions and mode. Cross-border long-distance travel as well as multimodal detailed local traveller information will be the long term goal. However, not only traveller information but also information about traffic control will be shared across large areas. Cars will communicate with cars (C2C) and the infrastructure (C2I). This will allow partly automated driving, and add capacity and improve safety. Traffic control centres will be interconnected. Control strategies will be communicated both between control centres and to traffic signals and navigation systems. Strategy managers will be part of sophisticated traffic management centres.

The research has to focus on the standardization of communication technologies. Cost reductions of C2C and C2I will, thus, be achieved leading to a widespread deployment. The penetration rate has a major impact on the system implementation, influencing thus the implementation strategies. Furthermore, sensor technologies for Advanced Cruise Control (ACC) systems have still to be researched. And as for other fields of traffic management, safety and legal aspects of such advanced technologies have to be solved.



Traffic detection in London

8) Significant advances in traffic data and environmental data availability can be expected.

Image processing, probe vehicle data (FCD), mobile phone tracking, positioning technologies, and dedicated shortrange communication (DSRC) will play a major role in data acquisition. The wide spread use of modern technology and data fusion will reduce the cost of data acquisition. A precise and traffic-related monitoring of the environment will be realized.

In 2030, data from manifold sources will be fused. The resolution of information in time and space will improve significantly. Reliable short time predictions and a good coverage will be realized.

New data acquisition technologies have to be researched, and the existing ones have to be further improved. Research needs are apparent not only concerning the data acquisition, but also concerning the methodology on estimating detailed traffic flow profiles by combining multiple data sources of varying reliability and precision, concerning funding models to operate and finance the data acquisition and data fusion, and concerning the data management.

9) Improved evaluation methods and a comprehensive quality management system will be applied to the road transport system.

Thorough evaluation methods will help to avoid the installation of inefficient systems. Microscopic simulation and real-time observations using image processing and other advanced technologies will be used for the evaluation and optimization of measures. Road operators will gain certification according to ISO quality management standards, dealing thus with the demand for a guaranteed performance of their transport infrastructure and services.

Prerequisite for these developments is an accurate description of the traffic flow in connection with traffic management measures. User oriented quality assessment using consistently defined levels of service (LOS) is desirable. The objectives, criteria and critical values of the quality assessment have to be specified and clearly documented. Efficient methods for a comprehensive quality management have to be investigated further.

10) Comprehensive information on the transport system will be available.

Individualized, accurate, unified, intermodal, integrated, and even cross-border information on current and predicted traffic conditions, parking space availability, price of infrastructure use will be available. Nearly all trucks and passenger vehicles will be equipped with individual navigation systems with C2C and C2I communication. These systems will allow the consideration of diversions recommended by traffic control centres. Certain roadside variable message signs (VMS) may be substituted by in-car devices. Real-time information on traffic conditions will be realized through various media. This prediction depends, however to a large extent, on the development of business cases for the information provision. The need of the users for not only complete, but more importantly, correct information, has to be satisfied in an efficient way.

The information provision is closely linked to communication technologies (Statement 7) and data acquisition (Statement 8). The research into communication technologies is therefore important for the information provision, too. Moreover, the necessary infrastructure and vehicle

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