CETRA[2016]

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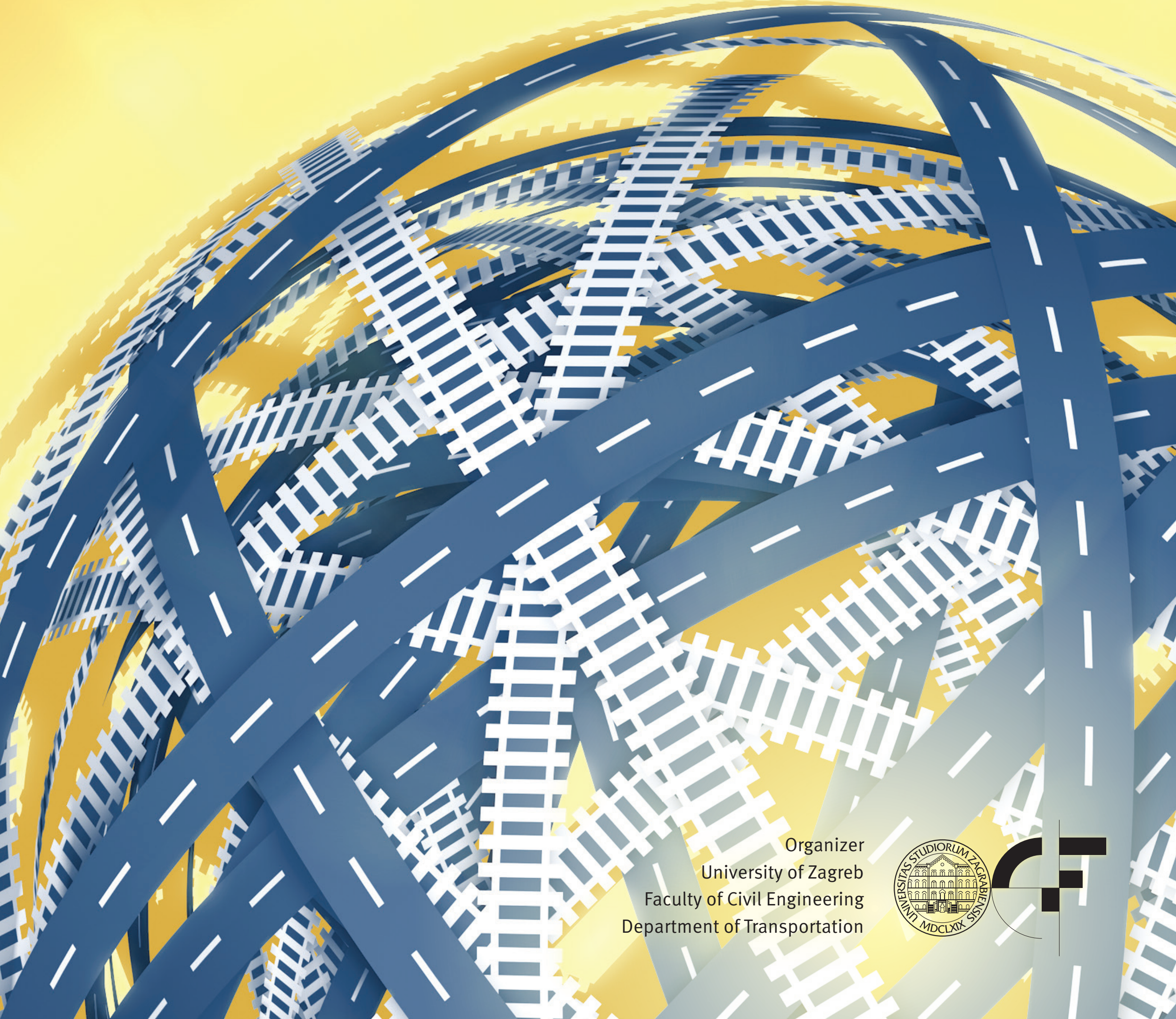
23–25 May 2016, Šibenik, Croatia

Road and Rail Infrastructure IV

Stjepan Lakušić – EDITOR



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NEW INDICATORS FOR NEW INFRASTRUCTURE

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Abstract

The share of people living in cities is increasing worldwide. This makes public space in cities a scarce good. Subsequently not only the challenges in the transport system are increasing but also the availability and distribution of public space is a crucial aspect. Pedestrian priority zones, strolling or encounter zones and road designs such as shared space are a first attempt to tackle the exclusive claim of space by one single transport mode, which was predominantly the car in the recent decades. For example the concept of public long-term parking contradicts the flexible use of public space by reserving it for one mode; therefore space reserved solely for the car should consequently be reduced.
One attempt to promote walking as a transport mode is the claim for minimum widths of newly constructed or rebuilt pavements. This is already established in the current Viennese planning guidelines. Still the question remains if this quality indicator is sufficient and how it should be dealt with for spaces where no physical cut-off by a kerbstone between road and pavement exists. Therefore in this paper we recommend the adoption of a new indicator – called "space-time" (space multiplied by time, m^2h). This new indicator takes into account a more flexible allocation of space for new road designs that consider the needs of non-motorized traffic such as shared space. We show that a short temporal impairment of quality for some road users can be accepted if a significant increase of space efficiency and traffic quality for the eco-modes (walking, cycling and public transport) is achieved overall. Depending on the occupancy rate and quality of infrastructure, the efficiency of "space-time" can serve as an empirical basis for prioritizing transport modes and urban transport policy measures.

Keywords: Public space, indicators, efficiency, space-time

1 Introduction

In the past, public space was perceived as transitory space to operate the maximum possible traffic flow of individual motorized traffic [1]. In order to plan traffic infrastructure, different modes of transport have been and are still calculated into "car units". For example one cyclist equals 0.25 car units [2]. According to this school of thought streets were designed and planned for decades for the use of cars, which led to the understatement and insufficient consideration of active modes.
The allocation of public space is the key factor to enable "mobility for all". In Vienna 65 % of street space are used for the moving individual motorized traffic or as parking space [1]. This restricts the possibilities for a multifunctional use of public space. Additionally growth of the urban population is increasing the challenges in the transport system and the demands for the usage of public space. In order to enhance sustainable and active modes of transport, the availability and accessibility of public space is essential [3].

2 Indicators and description of complex systems

It is solely possible to determine the behaviour of complex systems through indicators. Indicators are pathfinders in describing system behaviour. They need to be simple, easy to determine, sensitive to policy measures, goal oriented and need to capture the characteristics of the structure. Indicators can give information about the state of complex circumstances and reduce complexity of phenomena due to the reduction of several dimensions into one figure or number. They are used to give a good overview of the status of an actual situation, trace developments and make trends visible [4].
The main indicators in the transport system should be derived by "higher-level" objectives in ecology, resource depletion, sociology, economy, etc. Hence indicators, which capture the efficient use of public space or the body's own energy investment, etc. are necessary and should be seen as "first level" indicators. Typical transport indicators like volumes of traffic flow or the level of service for car traffic play a minor role and should follow superior objectives in order to measure the impact of planned policy measures [4]. Measurements based on wrong or defective indicators can increase problems especially in the long-term (e.g. reduction of congestion by building additional lanes) [5]. Understanding of system behaviour is necessary to choose and interpret the indicator accurately.

2.1 Design and planning of transport systems based on "wrong" indicators

In the past the transport system was designed and planned car-oriented, based on car-centred indicators. The conversion of various road users and different types of vehicles into "car units" has led to an insufficient dimensioning of road space. Physically active modes were allocated on the remaining areas of the road space not reflecting the higher capacity of pedestrians, cyclist and public transport (compared to car traffic) at a constant availability of space. Traffic infrastructure serves the purpose of transporting people and goods. Despite the higher capacity of pedestrians, cyclists and public transport, they are often insufficiently represented in planning guidelines. As a result, physically active forms of mobility, such as walking and cycling, were allocated on "remaining areas" at the roadside.

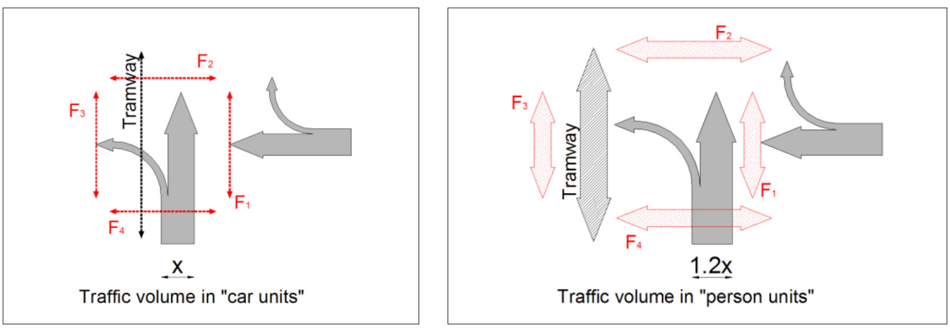
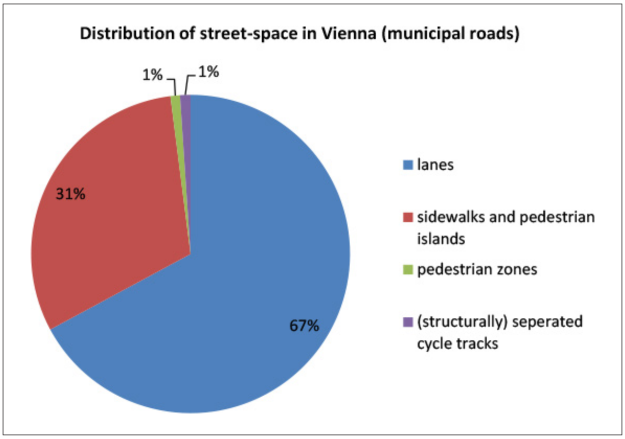


Figure 1 The traditional representation of "traffic" only occurred in car-units which massively deformed the view on real capacities and traffic volumes. Using the indicator of "person units" shows a complete different picture [6].

2.2 "Space efficiency"

The mass motorization has dramatically changed the availability and distribution of public space. Before that road space was a used as multifunctional space not solely dedicated to the motorized individual traffic. With an increasing share of the population living in cities the demands for the usage of public space are increasing and available public space is a scarce good.



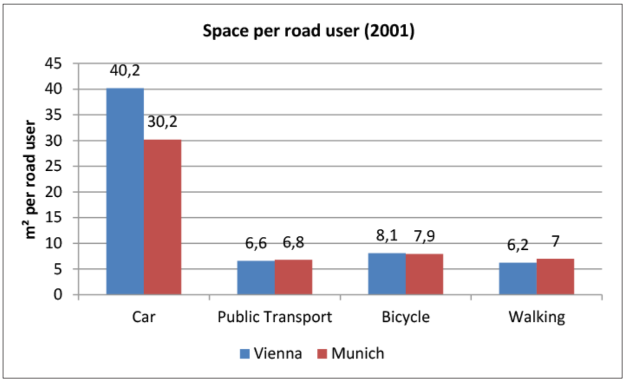


Figure 2 2/3 of street space in Vienna is used for lanes [7]. Car drivers use 6-times more space compared to other road users [8].

The share of pedestrian zones in Vienna is roughly 1 % of the municipal roads (despite an increase by 20 % since 2003). Taking into consideration pavements and divisional islands the share of traffic space mainly used by pedestrians, increases to 30 % [7]. Comparing the space consumption (in m^2/person) of pedestrians and cars (as a function of car occupancy and speed) the result is a ratio of 1:60 [9].

2.3 Influence of the speed on "space efficiency"

Hitherto existing publications to the topic of "space efficiency" have taken into consideration comparisons between the consumption of space for different modes of transport as a function of speed [10] [9] [6]. In doing so the advantages of the non-motorized modes as well as the public transport can bee shown. Pedestrians and public transport, such as bus, tram and underground with a high occupancy rate are the most efficient transport modes [6]. Héran et al (2008) [11] are indicating the disproportionately increasing space consumption with increasing speeds.
The introduction of pedestrian priority zones and shared space are first attempts to set off the paradigm of space dedication to solely one transport mode. The rededication of road space to a multifunctional use corresponds to the long tradition in cities and villages. Precondition for this multifunctionality is a suitable infrastructure, e.g. design elements, which make a road a shared space.

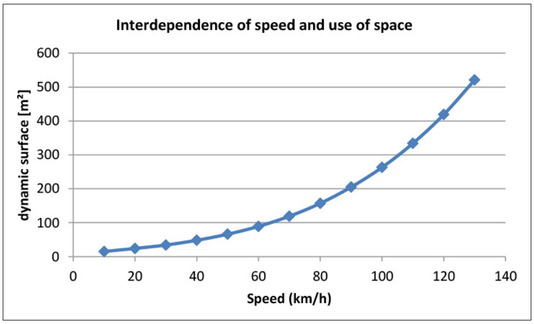


Figure 3 Length of the vehicle, braking distance of a car, reaction time and lateral distance determine the amount of (required) surface with increasing speed [11].

For concepts such as shared space common used indicators such as space consumption as a function of speed are not suitable any more. New solutions are necessary for the assessment of quality parameters in cases where no physical cut-off between pavement and road space exist, for example in the case of a minimum width for pavements. If the time dimension is considered, the efficiency of multifunctional space, such as in shared space, temporary markets, bus lanes, pavement cafés and temporary road blockages in front of schools, should not be neglected in planning.
As pointed out beside the space efficiency the temporal demand of public space is significant for a quantitative assessment. The indicator measuring the usage of public space has to be enriched by the time component making it "space-time" (space multiplied by time, m^2h). The foundation of this indicator can be found in the works of Marchand [12] [13]. He differentiates between "space-time" for parked vehicles and the moving traffic [12].

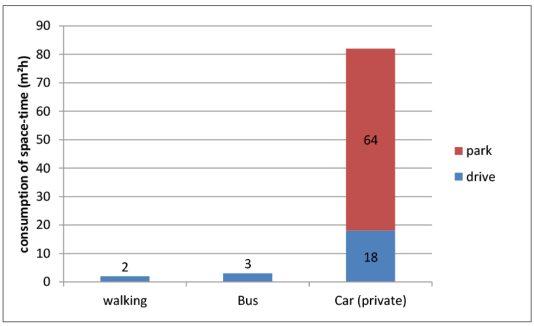


Figure 4 Area x time consumption for a 5 km length trip (total: 10km) and 8 hours of parking ($8m^2$). For the trip purpose "work" Marchand calculated the usage of road- and parking space for walking, public transport (50 people/Bus, no bus lanes) and individual motorized traffic (1.25 persons/car).

Table 1 "Space-time" from Merchand [12] and Héran [11] (supplemented for tram)::

Mode	space-time *) (m^2h/pers.km)	speed	Occupancy rate (pers./vehicle)
Pedestrian	0,2 – 0,3	4	1
Two-wheels	0,5 – 0,75	12-15	1
Car	1,2 – 1,8	18	1,25
Bus	0,3-0,07	10-12	50
Tram	0,07-0,11	12-14	100

**) as a function of the dynamic space-time*

Knofacher presents the consumption of space for different modes of transport as a function of speed. In doing so the advantages of the non-motorized modes as well as the public transport can bee shown. Pedestrians and public transport, such as bus, tram and underground with a high occupancy rate are the most efficient transport modes [6].
Beside the high space consumption for the individual motorized transport in moving traffic, especially the space consumption of parked cars needs to be considered. Long-term parking in public space totally contradicts the flexible use of road space and therefore needs to be reduced consequently [14].

3 Planning guidelines interpreted as guidelines not as dogma

A feasibility study for an inner city tramway line in Vienna showed that for a small section of the road new built pavements would be smaller than 2.00 meters width. In the current situation the space distribution equals a typical inner-city cross-section with traffic lane, parking spaces and pavements. In order to accept the necessity of undercutting the minimum pavement width for newly built pavements, it was proposed that this road section should be closed for individual motorized traffic, allowing just tramway and non-motorized modes and would be designed as a shared space. This would have led to temporal impairments in the case of encounters between tramway and pedestrians, but would have increased the overall situation for the active modes and public transport.
Looking at the distribution of space at a typical cross-section (2.00 meter sidewalk on both sides, 2.00 meter parking spaces on both sides, 6.50 meter road, total width 14.50 meter, length of the section 500 meter, 8,000 average daily traffic (ADT) the “space-time” potential for this section is 174,000 m^2h. 48,000 m^2h are reserved for parking, 9,000 m^2h are occupied for moving traffic with cars (with an occupancy rate of 1.25 people/vehicle, resulting in 10,000 people). The road itself consumes 78,000 m^2h. Roughly 12% of time the road is used.
With an (low) occupancy-rate of 50 people per tramway only 200 trams would be necessary to transport the same number of people through this section. This would consume only 1,000 m^2h. The road would be used for transporting purposes for only 1.2 % of the time. For the remaining time the space could be used for other purposes or the active modes. Figure 5 shows space efficient designs for inner-city streets following the principle of pedestrianized areas with tramways.

Figure 5 Road cross-section with tramway and pedestrian zone (Vienna, Austria & Gent, Belgium) as examples for a effecient and human-oriented design of transport infrastructure and public space.

4 Conclusions

Pedestrian zones or shared spaces combined with public transport are a suitable instrument to achieve efficient inner-city transport capacities in passenger traffic and an efficient usage of the public space. Side roads should in general be designed in the principle of shared space. These roads often have small traffic volumes of individual motorized traffic. Long-term public parking contradicts the efficient and human centred design of space. Furthermore the permanent occupation of space for public long-term parking is not reflected by market prices. The potential of using public space in a human centred way is enormous. Especially children are occupying "their" space as soon as it is available. The precondition is the removal of parking spaces from the road space. "Space-time" is a good indicator which should be used to illustrate the enormous occupation of public space by cars over a time period. It makes obvious, that a more flexible allocation of space and new road designs are necessary that consider the needs of non-motorized traffic in a more appropriate way.

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