FUNCTIONAL ROAD CATEGORIZATION: NEW CONCEPTS AND CHALLENGES RELATED TO TRAFFIC SAFETY, TRAFFIC MANAGEMENT AND URBAN DESIGN - REFLECTIONS BASED ON PRACTICES IN BELGIUM CONFRONTED WITH SOME EASTERN EUROPEAN CASES

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ABSTRACT. The last decade functional road categorization has drawn new attention in several countries in Europe. In this paper some reflections are made on practice in the Flanders Region in Belgium, confronted with some cases in Latvia and Romania. New challenges for the road system related to spatial planning, traffic safety, transport and traffic management and urban design are inducing research for new concepts for road categorization. These new concepts can be considered as new frames for road planning (and prioritization of investments) as well as for road design.
Road networks, road categorization, traffic management, sustainable road safety, Spatial Structure Plan Flanders.

INTRODUCTION

Road categorization is often seen as the hierarchizing of roads. Though hierarchy is in common practice an important principle in road categorization it is not always the starting point, it was clearly not in the Flanders case, within the spatial structure planning process (Keppler U., Korsmit J. and Lauwers D., 1994). The Spatial Structure Plan of Flanders (Afdeling Ruimtelijke Planning 1998), adopted by the Flemish Government in 1997, has been a milestone in road categorization in Flanders. Given the binding status of the plan the far-reaching impact in the spatial planning practices in Flanders but also in mobility planning and in road design is very strong. The plan contains a functional categorization and hierarchizing of the roads. Previously in road planning and road design hierarchical classifications were used dependent or on the administrative level (region, province and municipalities) or on the traffic regulatory status of the roads (motorways, express roads and ordinary roads).

ROAD FUNCTIONS

Being one of the densest populated regions in Europe, the Spatial Structure Plan of Flanders states in the assessment of the existing line infrastructure that in Flanders as well the accessibility in the urban areas as the livability of most part of the region are at stake because of the congested road system. “For the categorization from a long run perspective, one starts from the desired (main) function with respect to the accessibility on the one hand and the livability on the other side. The categorization of the roads to the desired function does not relate to the classification of the road administrator.” (Afdeling Ruimtelijke Planning, 1998, p.475 transl.). The Spatial Structure Plan of Flanders distinguishes three main functions for roads (see fig. 1):

- connecting function (connection between origin and destination areas
- collecting function (collecting within the origin areas and distributing within the destination areas)
- the function of giving access (to the adjacent parcels)

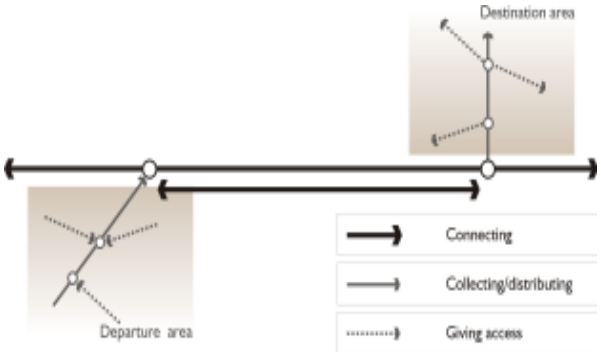


Fig.1 Scheme of the road functions. (adapted from Afdeling Ruimtelijke Planning 1998, p. 476)

A difficulty arises because the same road fulfils several functions for several users, particularly motorists, the slow traffic, the public transport and the goods transport. A complete separation of functions and users is, given the existing situation, not feasible in practice. Anyhow "for a good functioning of the road a good balance between the components function, form/layout and use characterizations is necessary" (Afdeling Ruimtelijke Planning 1998 p. 476 transl.).
Within the road network in Flanders four categories of roads are distinguished: the main road network, primary roads, the secondary and the local roads. The main roads have only a connecting function (main function connecting on European level, supplementary function connecting on Flemish -read 'national'- level). Within the primary roads two categories are distinguished: the primary I roads (main function: connect, supplementary function: collect, both on the Flemish level) and the primary II roads (main function: collect, supplementary function: connect, both on the Flemish level). Secondary roads have a connecting and collecting function on the (supra)local level, supplementary they can also give access to the adjacent parcels. The main function of local roads is giving access. For each main category the layout concept (e.g. highway according to European standards) is described.

Table 1 Main road categories in Flanders

CATEGORY	MAIN FUNCTION	Supplementary function	LAYOUT
MAIN ROAD	CONNECT on the international level	Connect on the Flemish level	Highway according to European standards
PRIMARY ROAD Category I	CONNECT on the Flemish level	Collect on the Flemish level	Highway/urban highway Express road (2x2 or 2x1) Road (2x2 of 2x1) with traffic separation
PRIMARY ROAD Category II	COLLECT on the Flemish level,	Connect on the Flemish level	Express road (2x2 or 2x1) Road (2x2 of 2x1) with traffic separation
SECONDARY ROAD	Connect and/or Collect on local and supra-local level	Giving access	Road (2x1 of 2x2) not necessary with traffic separation Road Passages through built up areas
LOCAL ROAD	Giving access		Road (2x1) with mixed traffic

HIERARCHY WITHIN THE ROAD NETWORK

The categorization of the roads as fixed in the Spatial Structure Plan Flanders respects a hierarchy within the road network. A distinction is made between three hierarchical levels according to the importance of the road infrastructure, particularly the international level, the Flemish level and the (supra)local level. Roads, nodes and linking points are distinguished. In a node roads of the same level join and the possibility of changing road exists; these are for example interchanges on the motorway net. In a linking point roads of different level join and there is not only the possibility of changing road, at the same time also of changing level. These are for example interchanges (entrance and exit) of a motorway with other roads.

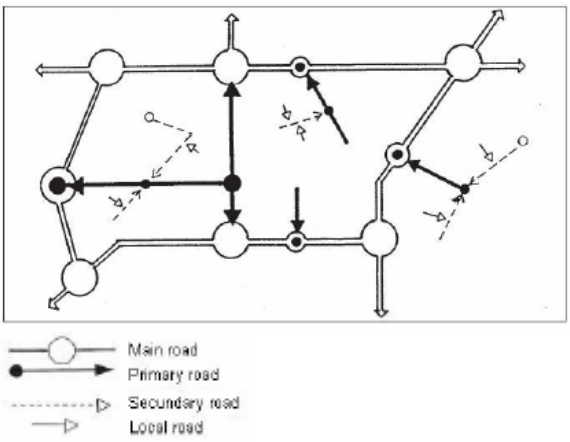


Fig.2 Scheme of the network hierarchy (adapted from Afdeling Ruimtelijke Planning 1998, p. 478)

Related to the hierarchy the following principles are put forward as important in the SSPF for the development of the road network and therefore for the categorization of the roads:

- Linking points always function between successive levels, so it is not opted to connect a secondary and/or local road to the main road network
- The road network of the highest level, this is the main road network (= international motorway network), must be coherent.
- Roads on Flemish level and on supra-local and local level need not form a coherent network on their respective level. They must form, however, a coherent network in combination with roads on a higher level to

which they have been connected by means of linking points.

- The traffic winding-off on the different levels must be in proportion to the underlying road network, so that it is not charged by through traffic and so that the road network of higher level is not charged by the traffic on a subordinate relation.

In fact these principles are a certain interpretation of the principle of hierarchy with far reaching consequences, which will be dealt with later on in this paper. First we will illustrate the strength of this Flemish approach based on the accessibility and livability of places: it can create new concepts and point of view on the road network restructuring related to a vision on the regional/urban development.

LATVIAN CASE OF NETWORK RESTRUCTURING

The Kurzeme Region, located between the Baltic sea and the Riga Region in Latvia is looking for a better connection with the capital city of Riga and the north south TEN corridor through the Baltics, passing Riga. The existing concept is to develop new highways parallel to the existing national roads connecting the main 'economic

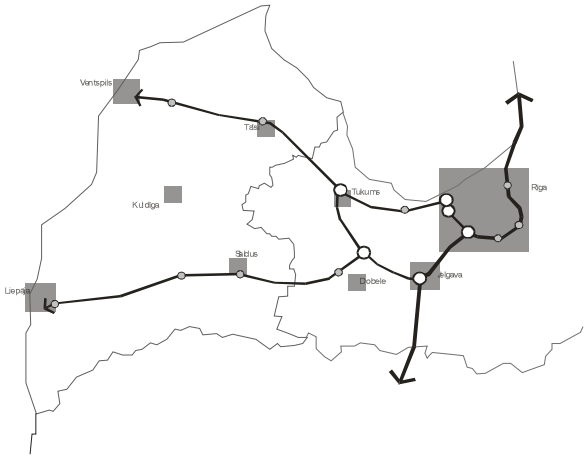


Fig 3. Existing concept for main road network in Kurzeme, parallel to existing roads

engines' of the region – the port cities of Liepaja and Ventspils with Riga (see fig.3).

Within the frame of the regional development planning process a new concept was created, based on the methodology of the road categorization of the SSPF (Adams N., Lauwers D. and Steenwegen L. 2004).

The concern for the improvement of the accessibility of the centrally located city of Kuldiga (the historic regional capital town) and the importance of a good road link between the the port cities lead to a new concept based on Y form. This concept is aiming at creating synergy between the cities concerned, whilst the first one is only based on competition between them. (see fig.4). Moreover, the investment cost of the second concept is lower then the first one.

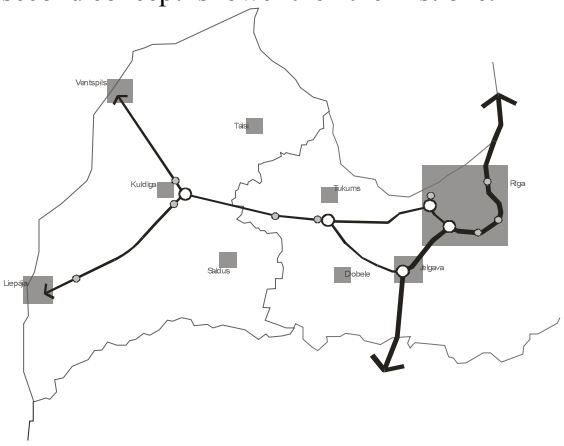


Fig 4. New concept for main road network in Kurzeme, created in spatial planning process

FACTOR MULTIMODALITY

The lack of multimodality in the categorization introduced by the Spatial Structure Plan Flanders became apparent both at the selection of secondary roads and at studying the relation between road design and road categorization. In an accompanying study for the provinces this was stated as follows: "At Flemish level the line infrastructure has been purely spatially examined as a physical infrastructure and then on the basis of its appearance has been classified in road, rail, waterway, pipeline, air-traffic, For the roads it is assumed that car use can be considered as the only traffic mode to decide on the categorization. Because of this one does not have to take into account neither the mixed use of roads at Flemish level, for example by car and by bikes, or by car and by public transport, neither the nodality between the different modes. However, also at Flemish level express buses should be able to use the main road network, i.e. where the connecting quality of rail transport is too poor or where no rail connection exists." (Engels D., Korsmit J. and Lauwers D. 1998. p. 5).

In this study contrary to the Spatial Structure Plan Flanders it was proposed to introduce in the selection process a specific category of secondary roads dedicated as 'main public transport connection with restricted car function ' and also as` bicycle routes. Eventually this suggestion has been taken over by the five Flemish provinces and so they selected a specified category

(secondary road type III) to take up these function in the provincial structure plans.
In spite of a lack of attention in the SSPF, on the main roads in Flanders facilities for the public transport have been implemented. Particularly this has happened as a result of the 'less hindrance programme', implemented on the occasion of the reconstruction of the Antwerp ring road, where the capacity of 2x3 lanes (locally 2x4) was brought back during several months to 2x2 narrowed traffic lanes. In order to be able to organize a qualitative alternative, express buses can use preserved routes in the city but also the surfaced verges of the highways (formally only to be used for emergency stop), dedicated as bus lane.
This focus on the alternative traffic must be seen within the recent trend shift mobility policy that the Flemish government has adopted, targeted to bring about among other things a slow down of the yearly increase of car traffic and a modal shift to other transport modes (Mobiliteitscel, 2001). Figures are showing that though the continued increase of car traffic on the Flemish roads hasn't been stopped the public transport use and biking significantly increased more (FOD Mobiliteit en Vervoer, 2008).

TAKING INTO ACCOUNT THE COLLECTING FUNCTING OF THE MAIN ROADS

On the main ring roads 'around' (read: 'through', because of spread urban development since the construction of this roads) the metropolitan areas of Antwerp and Brussels it was assessed that, though they were selected as main roads, not the connecting but the collecting and distributing function is prevalent or at least interfering. It in not a coincidence that they are concentration routes for car accidents. This has lead to the development of a new, adapted concept of bundled but separated parallel international and urban highways. The planned international ring highway has only few interconnections, i.e. with the radial international highways, and no interconnection with the urban roads. Possibly this concept is also adapted for other congested highways in the metropolitan areas. Awaiting the implementation of these concepts the operating standards (levels of services) of the ring roads, indicated in the SSPF are by far not reached. This is leading to cut through traffic on the 'underlying' network of secondary and local roads (Keppens M., Lauwers D. and Rotiers K., 2007).

FACTOR TRAFFIC SAFETY : AVOIDING TOO ADMINISTRATIVE - HIERARCHICAL APPROACHES

As already stated above, four main categories are distinguished in the SSPF: main roads and primary roads (to be selected by the Flemish Region), secondary roads (to be selected by the provinces) and the local roads (to be selected by the municipalities). Although this classification is also functional (see table 1) it appears in practice that other classifications could be more adequate both for the elaboration of the networks as for the road design. This criticism has been discussed on the international forum already for some years (Lauwers D., 2005) but has been put explicit in the professional world in Flanders only very recently (Lauwers D., 2008). Indeed, it appears that both approaches based on the commonly and historically most used classifications and on recently developed approaches referring explicitly to sustainable safety criteria, assume a threefold division: arterials, collectors and local (US Department of Transportation 1968), (Baerwald, J.E.,1976) or similar: 'flow roads', 'area serving roads' and 'land access roads' (CROW 2002).

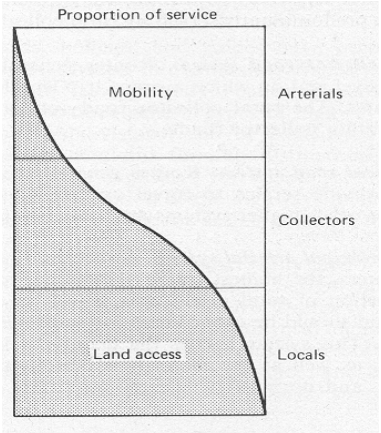


Fig. 4 Road types.
Source: US Department of Transportation, FHA 1968, p. II-6

Last mentioned categorization is a basic concept structuring a recent Dutch road design handbook. (CROW 2002) It considers two basic traffic configurations within the traffic function:

- to flow: to move on itself or to move vehicles in a purposeful way , in a more or less constant direction and with a more or less constant (relatively high) speed.
- to exchange: to move on itself or to move vehicles in a purposeful way, with changing speed and/or direction. It also covers

collecting, dividing and crossing of traffic, as well as departing, turning around, turning back, stopping and parking of vehicles.

The practice shows that combining these two traffic functions increase traffic unsafety. The message of sustainable traffic safety design thus implies that they must be strictly separated. This separation returns in three road categories to be distinguished (see table 2)

Table 2 Essence category-division sustainable traffic safety, Source CROW (2002), adapted

Road category	Traffic function	
	Road section	Intersection
'flow road', (arterial)	flow	flow
'area serving road' (collector)	flow	exchange
'land access road' (local)	exchange	exchange

To obtain a sustainable safe road system it is extremely important that road users are informed about traffic behavior which is expected from themselves and which they can expect from other road users on the different road categories. This learned patron must be supported by the optimization of recognizability of the categories. (CROW 2002)

For each category a number of conditions have been indicated among which can prevent conflicts. The following groups of conflicts are being distinguished: longitudinal conflicts, to converge and to diverge, lateral conflicts and frontal conflicts.

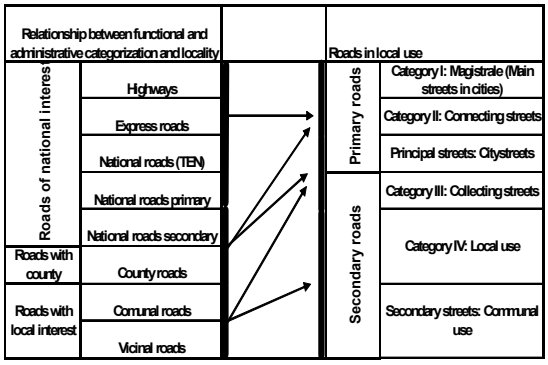
Table 3 Essence category-division sustainable traffic safety, Source CROW (2002), adapted

Road category	Traffic function	
	Road section	Intersection
'flow road', (arterial)	longitudinal conflicts	to converge/diverge
'area serving road' (collector)	longitudinal conflicts	to converge/diverge lateral conflicts with slow traffic modes
'land access road' (local)	all conflicts	all conflicts

Also the recommendations for road design in Flanders assume - because of both the promotion of the efficient use of the road system, this means the use according to the meant functionality, and of traffic safety – the necessity of the recognizability of the different road categories (Engels D. ,Korsmit J. and Lauwers D. 1999). Since the design recommendations are however made up by a functional-administrative category the danger exists to descend too far from actual traffic conditions to stand the (desired) difference in traffic behaviour in the different traffic environments and that them thus is less structurally safely based. Partially this has been overcome by the derogatory category classification which the Flemish provinces have used. Eventually three categories were distinguished: secondary I (connecting for car), secondary II (collecting for car) and secondary III (itineraries for public transport and/or bicycle). Also the municipalities generally followed a classification which is based on a bipartition of connecting versus collecting. So in the end also in Flanders a tripartition flow roads – area serving roads and land access roads can possibly be implemented if less hierarchy and more traffic function categories prevail in the design.

The same counts for the Romanian road category system, introduced in 1998. Though this system is even more hierarchical inspired, this system also offers some pretext to emphasize a more traffic functional – read also traffic safety – inspired design approach (see table 4).

Table 4 : Relationship between functional and administrative categorization and locality in Romania, Source Monitur Official 1998, transl.



FUNCTIONAL NETWORK STRUCTURES: TREES VERSUS GRIDS

The mesh width and the cutting through of the meshes by line infrastructures have not been explicitly treated by Spatial Structure Plan of Flanders. However in some schemes (e.g. as presented in fig. 2) tree like structures are being proposed as the basic concept to build up the road network. The underlying principle to promote these tree structures, directed towards the main roads, is however to avoid the cutting through of the meshes of the main road network by roads that would be functioning on the national level. Though the mesh width within the main road network in Flanders is mostly rather large in proportion to the high density of functions in

those areas, reducing of the mesh width is not seen as a good solution. By reducing the mesh width spatial dynamics comes about which support spatial spreading out of activities. “More traffic, fewer chances for collective transport and more traffic nuisance are the consequence.” (Korsmit J., Serbruyns M.. 1996) p. 15)

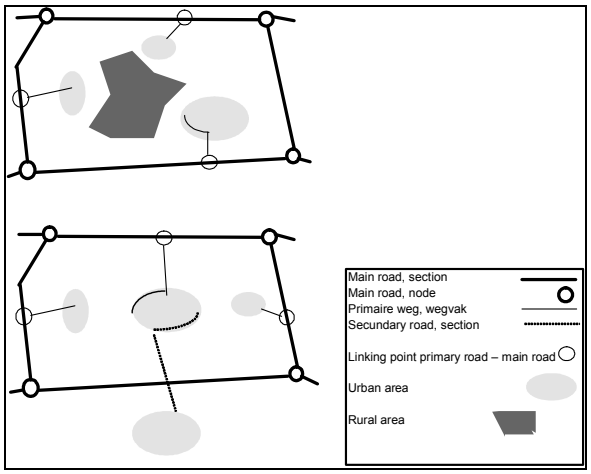


Fig 5 Avoiding cutting through of meshes at the provincial level
Source: Engels D. & Korsmit J. & Lauwers D. (1998, p.6)

The design of the roads, which give connection within a mesh, must be this way that the connection produces a more favourable time path along the main road network for the user. This is particularly demanding where the form of the meshes is triangular, a form, which frequently occurs in Flanders. (Engels D. ,Korsmit J. and Lauwers D. 1998)
The above-mentioned concept is in contrast to the existing structure of the underlying net in Flanders, forming a historically grown network of its own. In spite of this deviation from the existing structure the recommended tree structures have been almost incorporated as a standard in the road plans the last decade and on secondary and local roads frequently local capacity - and speed reductions were introduced to run down their functional continuity .
However in the Strategic Spatial Structure Plan of the city of Antwerp a completely different approach is applied. The `lower network consists of a grid of boulevards, parkways and the historical ‘’paved roads’, and forms the collecting and distributing network on the level of the city, together with the urban highways, with which this grid is interlinked. This approach defines not only a scenario that much more than the tree-structured feeder system deals in a flexible way with the high pressure of traffic in the metropolitan context. It also offers a concept that because of the continuity and recognizability can contribute to the structuring of the city and to the legibility of the city. It forms an important spatial support of the urban structure. (Secchi B., Vigano P., Lauwers D. et al. , 2005).
However the tree like structure stands in less densely populated areas, where it can overcome through traffic in smaller towns and guarantee a higher lever of street liveability and traffic safety in this places. In that perspective a consideration of the Flemish design principles is worthwhile being studied in the Calarasi County, where the actual interpretation of the Romanian functional categorization is inducing through traffic in the smaller towns. (Adriaenssens J., Dewinne P, Gillis D. and Lauwers D. 2008)

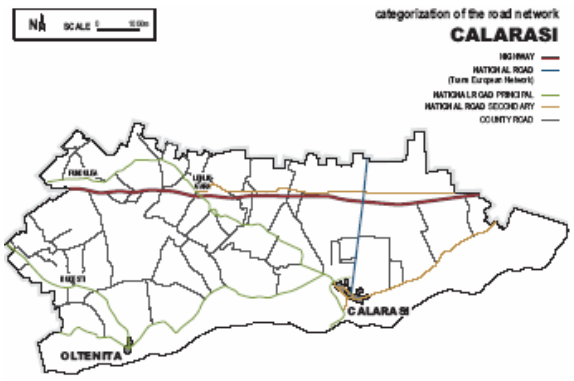


Fig 6. Actual interpretation of the Romanian categorization in Calarasi County

NEW NETWORK CONCEPTS FOR AREA BASED TRAFFIC MANAGEMENT

Cut through traffic on the lower network and streets are an engraving problem in several areas in Flanders. Though this problem can partly been solved on local level, it is important to assess the impact on a higher scale level and to evaluate the measures also on this higher level. Indeed, local measures may shift problems to neighbouring communalities. In a recent study on the cut trough traffic in the south east fringe of the Antwerp metropolitan area the concept of the ‘carrying network’ is introduced. (Keppens M., Lauwers D., Rotiers K., 2007). This is a new concept for Flanders and is defined in the study area for car traffic, public transport and bike routes. For car traffic it constitutes together with the higher network and the lower network the road system. The function lower network is limited to local access; the higher network

consists of main roads and primary I roads (i.e. connecting roads on the highest scale levels) and has to facilitate the through traffic and to give access to the main traffic poles (e.g. main industrial zones, shopping centres). The carrying network collects the internal traffic and traffic with origin or destination in the area. In order to avoid 'overpressure' of traffic on the carrying network traffic management measures (such as traffic dosage installations near towns and green waves related to limited design speed) to keep traffic within limits of liveability of streets and to facilitate safe and fluid traffic conditions. The carrying network for car traffic is categorized in three levels (see fig. 7).

Fig 7 Carrying network for car traffic in SE area of Antwerp

The lower the level, the lower the proposed environmental capacity and design speed for the road concerned. A new style of traffic management is introduced: the objectives are not limited to car traffic level of service measures but aiming at sustainable traffic system conditions, including environmental quality standards and road safety.

ROAD DESIGN AND URBAN DESIGN CONCEPTS AS BUILDING STONES FOR NETWORK CONSTRUCTION

Recognisability and foresee ability of the traffic behaviour that is desired and is to be expected is promoted by using a limited number road concept elements for both the road sections (for example concerning parking facilities, lane separators...) and the junctions (for example roundabouts, elevated junctions...). The proposed design recommendations in Flanders couples a range of specific traffic engineering design concept elements by category (Engels D. & Lauwers D., 2003).

In the Strategic Spatial Structure Plan for the city of Antwerp (SSPa) the starting point for the design of the urban streets are not purely traffic engineering concepts but- in line with recent literature – urban design concepts (see e.g. fig. 8). Concepts that are central not only to mobility but too many other issues that are also central to urban life, including liveability, safety, economic development and open space. It concerns concepts such as shopping streets, boulevards, park avenues, ramblas....They are aimed at mixed use of the streets, assuming traffic behaviour adapted to urban life. Research is confirming this assumption (Jacobs A.B., Macdonald E. and Rofé Y., 2002 and CERTU, 2000).

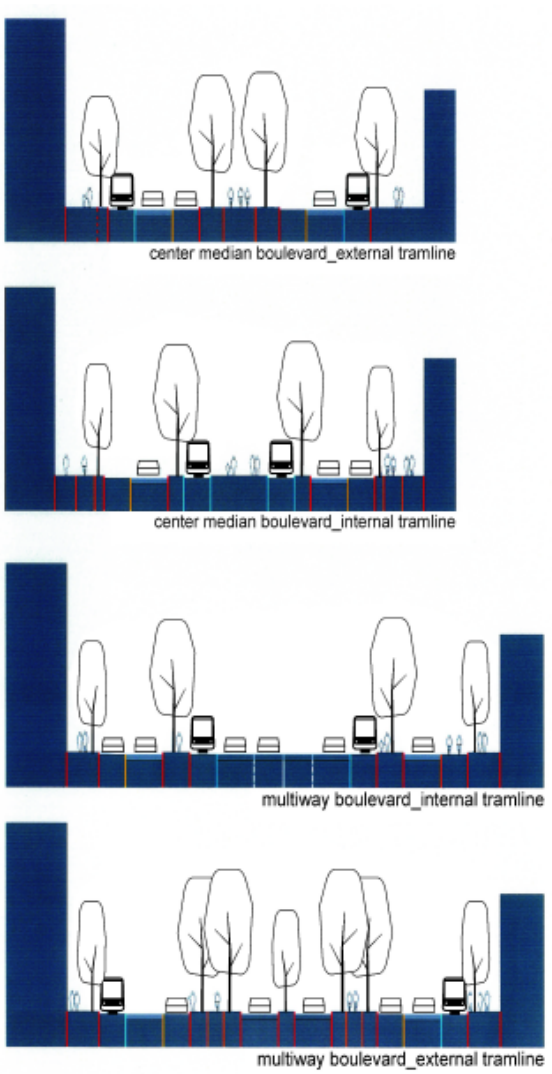


Fig 8. Some morphological and functional types of multiway boulevards (SSPa)

TOWARDS A NEW INTERPRETATION OF ROAD CATEGORIZATION

Mainly based on practice in Belgium, but also referring to some cases in Eastern Europe, this

paper suggests some tracks for a new interpretation of road categorization. The uni-modal - car oriented - approach has to be changed in a multimodal approach aiming at sustainable mobility and sustainable regional and urban development. More flexible systems optimizing traffic conditions by area based (i.e. on network level) traffic management demand for new more robust network configurations, whilst tree-like structures seem to be adapted in less densely populated areas. Functional use of the road system is one of the preconditions for traffic safety, but also for accessibility and livability. More research is needed to find out adapted network systems to different land use patterns.

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