Categorization versus hierarchy of networks: recent developments in road network planning and design in Flanders

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Synopsis

The aim of this paper is to present a reflection on recent trends in road network planning and design in the Flanders Region in Belgium. This reflection is based upon compilation and confrontation of recent planning documents with each other and with traffic design theories.
The Flanders Region contains the densest road network in Europe. But it also contains major congestion areas and is very badly ranked in road accident figures in the EU15.
A milestone in a way towards a structural approach of these problems has been the drawing up and the approval in 1997 by the Flemish Government of the Spatial Structural Plan for Flanders. In this plan a hierarchy on three scale levels (international + Flanders / provincial / local) but also a functional categorization of the road networks is introduced. The categorization is based on three functions of roads: connecting, collecting and giving access. As the implementation process of this plan progresses (re-)design standards on the layout of the network as well as of the infrastructure are being developed. It seems that apart from the hierarchy this functional classification is a very decisive criterion in the choice of these standards: e.g. number and typology of crossings, design speed, … . However a key question regarding traffic safety oriented design consists in the prevailing of distinguishing road typology based on the connecting or collecting or giving access function, above administrative hierarchy. It has also become clear that a unimodal car oriented approach can't solve the above mentioned problems: so the provinces have introduced a new category of roads facilitating public transport in their spatial and infrastructure plans, provinces and local authorities have focused also on biking networks (instead of biking routes). Figures are showing that in 2003 for the first time after more then 25 years the continued increase of car traffic on the Flemish roads was stopped and that on the contrary the public transport use and biking significantly increased. Furthermore two approaches can be distinguished in the restructuring of the urban and regional road networks: a hierarchical concept resulting in tree-like structures on the one hand and concepts based on spatial typologies of roads (boulevards, parkways, ...) organized in grid-like patterns on the other hand. Categorization of roads should not lead to uniform road design but to a stepwise approach of the design process starting with the definition of a requirements programmed that partially is conditioned by the functional category of the road, leading to a detailed design using a limited number of traffic engineering and spatial concepts for roads and streets.

Categorization versus hierarchy of networks: recent developments in road network planning and design in Flanders

Within the federal state of Belgium the infrastructure policy is entirely regionalised, except for the national airport and the railways. This means that the management concerning all main roads -also of the motorways- has been entrusted to one of the three regions: the Flemish, Walloon or the Brussels Metropolitan Region. Beside the regions also the provinces and the municipalities manage part of the road network. This paper focuses on the Flemish region. This region is characterised by a high population density of 430 inhabitants per square kilometre (Department Spatial Planning 2004) and by a very dense infrastructure network, concerning not only roads but also railways and inland navigation ways.

The density of the motorway network is at highest in Europe. If also the other roads (from primary roads to local roads) are considered the total length for the year 2000 is 67,984 km (FOD Mobiliteit en Vervoer 2005): on this basis the finemeshness of the road network in Flanders can be brought in picture: 5.0 km/km^2. For the whole of Belgium it amounts to 4.9 km/km^2, this is by far the densest of the EU countries. Belgium is followed by the Netherlands with a density of 3.2 km/km^2. (DG TREN 2004), for Italy this is according to the same source 1.6 km/km^2.

In spite of this dense road network - and the offer of alternative modes of transport regarding both persons - and goods transport - the congestion on road network has been very extensive for already two decades. The congestion on the main road network occurs especially on the ring roads round Brussels and Antwerp and on the main radial connections round these cities. The total number of loss times on the main road network was quantified in 2000, on 3 millions hours, that is 7.3% of the hours which were driven on these roads in 2000. On the main road network around Antwerp it concerned in 2000, 1.2 million loss hours or 4,51 % of total car hours (Mobiliteitcel 2001). This congestion is related to the high population density and the high car possession in Flanders but - seen the also high density of the road network – it also shows that the net is poorly adapted in relation to the spatial spreading of the activities which was made possible by the regional spatial plans, that were made up in the 1970s, without making a link with the development of the infrastructure (Lauwers D. 1991). Concepts for the restructuring of the road network in function of the accessibility of the urban areas in Flanders were studied decades ago (Lauwers D. 1984 and Keppler U. & Korsmit J. & Lauwers D. 1994).
Not only in the field of the level of service and flow charities does the Flemish road network scores poorly: with regard to road safety the figures are among the worst of EU15: 14.6 deadly victims by 1000 inhabitants in the year 2000, this is more than twice as much as the Netherlands and also higher than the average for EU15 and e.g. Italy, where these figures amount to resp. 10.8 and 11.1 (Administratie Planning en Statistiek 2005 and EC DG TREN 2004). The fatality rate being much higher on the regional and local roads, i.e. for the year 1999 a lethal risk or 20.7 and 21.5 by billion vehicles on those roads, compared to 6.5 for the highways (mobility cell 2001). This unsafety of the regional and local network is connected with the lack of logical network structure, coupled with design characteristics. (Engels D. & Korsmit J. & Lauwers D. 1999)

BASIC CONCEPTS OF HIERARCHIZING AND CATEGORIZATION OF ROADS IN THE SPATIAL STRUCTURE PLAN OF FLANDERS

The Spatial Structure Plan of Flanders (Afdeling Ruimtelijke Planning 1998) has been a milestone in the forming of the basic concepts of categorizing and hierarch zing of the roads in Flanders. This plan was laid down by the decision of the Flemish Government in September 1997. Given the binding status of the plan the far-reaching impact in the spatial planning but also in the sector of the road policy is very strong. The plan contains a functional categorization and hierarch zing of the roads. Previously in road planning and road design a hierarchical classifications where 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).

Categorization of roads based on the desired function

“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 categorization has been based on giving selective priority or to accessibility or the liveability. Functionally one can distinguish three main functions: the connection function, the collection function and the function of giving access” (Afdeling Ruimtelijke Planning 1998, p.475 transl.). “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 liveability on the other side. The categorization of the roads to the desired function do not relate to the classification of the road administrator.”

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 characterisations is necessary” (Afdeling Ruimtelijke Planning 1998 p. 476 transl.).

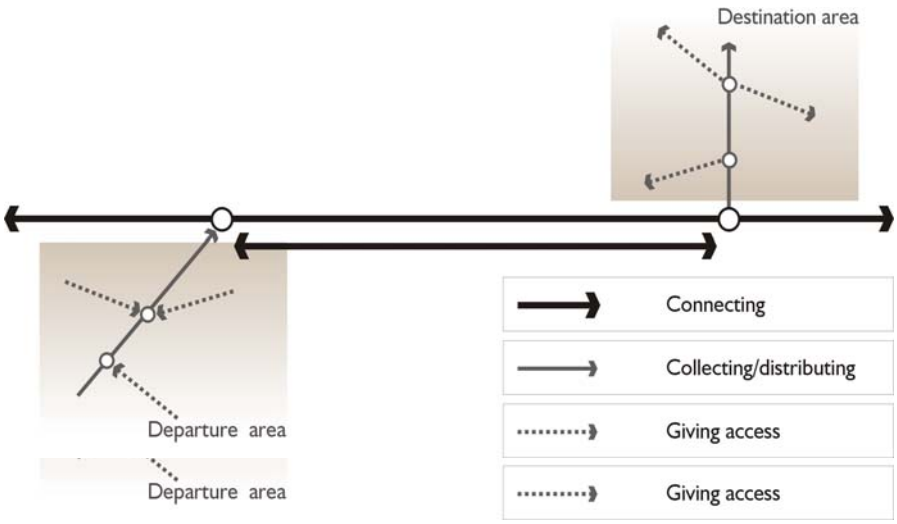

Figure 1. Scheme of the road functions. Source: adapted from Afdeling Ruimtelijke Planning (1998, p. 476)

This results in a categorization summarised in the next table.

Table 1. Overview of the different road categories according to the Spatial Structure Plan of Flanders. Source: Afdeling Ruimtelijke Planning (1998, p. 477)

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 and 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 (nodes) 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.

“Judging by the hierarchy the following principles are important 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. ” (Afdeling Ruimtelijke Planning 1998 p. 478 transl.)

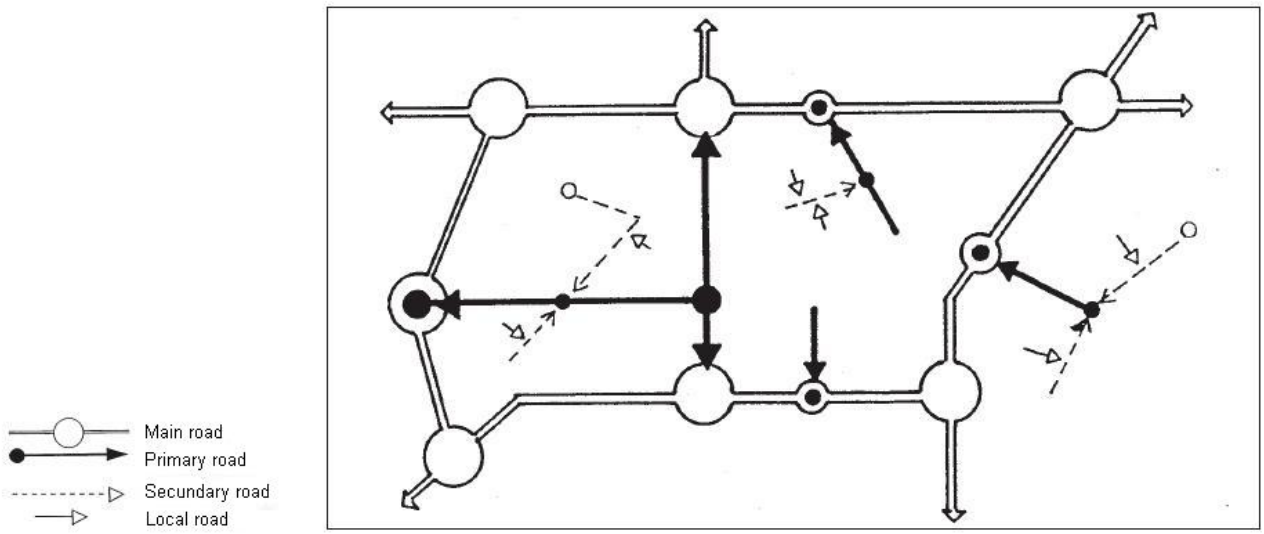

Figure 2. Scheme of different road categories. Source: Afdeling Ruimtelijke Planning (1998, p. 478)

For the Primary Roads II and the Secondary Roads several sub-types are described. From the further discussion it will become clear that a far-reaching impact of this subdivision has not been realised in practice. We nevertheless reflect them below as a reference for the further comments on the restrictions of spatially-functional classifications as a basis for road design and even for the selection of the nets.

The primary roads II can be subdivided in several types according to their specific function:
- Type 1: Connection - or collection function for metropolitan area or gate
- Type 2: Collection function within medium-sized or regional town area
- Type 3: Collection function for small-sized town or regional urban area or tourist-recreative node on Flemish level
- Type 4: Connection (entrance - and exit complex) on higher categories as collection function for small-town area, remaining economic node or an urban or economic network on international and Flemish level (Afdeling Ruimtelijke Planning 1998 p. 479-480 transl.)

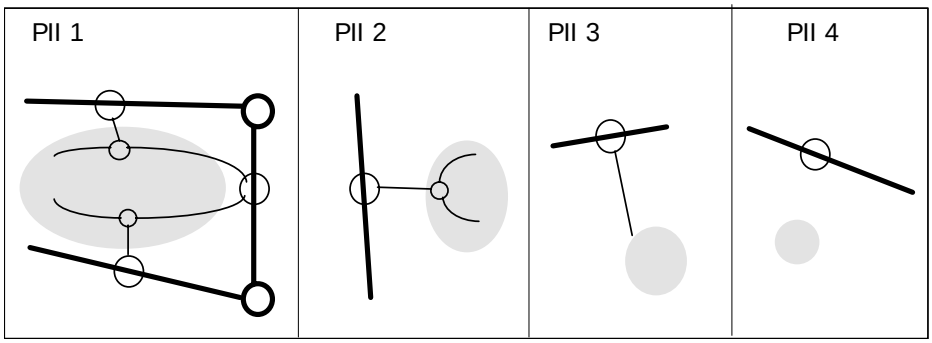

Figure 3. Primary roads II, types. Source Afdeling Ruimtelijke Planning (1998, p. 480)

Secondary roads are roads which play an important role in opening up of areas to the primary roads and to the main roads (= collection function on supra-local level) and which are at the same time important for the accessibility of the several activities along these roads to (= give access) on local level. These roads are not of regional importance.

It are particularly the roads which:

- have indeed a collection function to the main road network and to the primary ways I, but which can be used if primary roads II because of the spatial characteristics (e.g. ribbon building development, passages);
- fullfil the collection function to the main road net and the primary roads for the economic nodes outside the urban areas and outside economic networks
- Fullfil the collection function to the main road net and the primary roads for a minimum number of centres in the rural area;

On the basis of these functions four types of secondary roads can be distinguished:
- Type1: The road fulfils a connecting function and reduces a mesh, but does not function as a connection on Flemish level, and is therefore not indicated as primary road I.
- Type 2: The road fulfils the collection function for the small-town area to the main road network, but cannot be selected as primary road II. The existing structure of the road cannot be adapted to the criteria for primary roads II within the existing route and it is, judging by the spatial criteria, irresponsible to choose a new route.
- Type 3: The road fulfils collection function for an area that is not selected as an urban area, gateway or tourist-recreative node on Flemish level and can therefore not be selected as primary road II.
- Type 4: The road initially had a connecting function on Flemish level as "paved road". This function is taken over by a motorway (main road). At present the road has a connection - and collection function on (supra) local level and frequently also an access giving function. (Afdeling Ruimtelijke Planning 1998 p. 480-481 transl.)

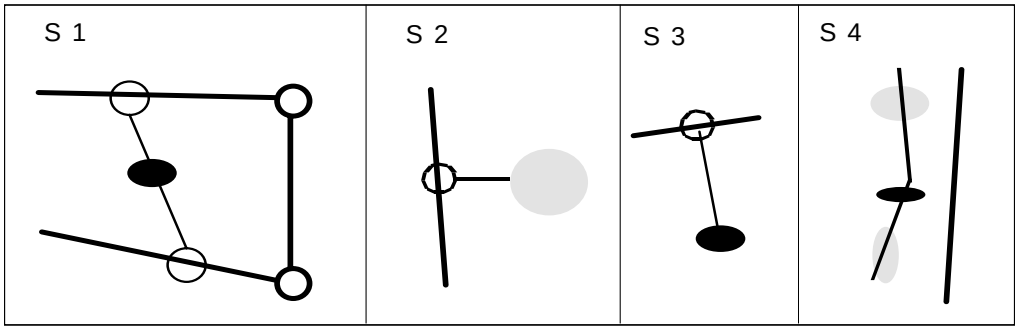

Figure 4: Secondary roads types. Source Afdeling Ruimtelijke Planning (1998, p. 481)

Selection and development perspectives

“The selection of the roads has come about in several steps. On the basis of the spatial principles for the desired spatial structure the connections are assigned specific functions (connecting, collecting, giving access) (e.g. connection with the regional urban area of Brugge to the main road network). In a second step every connection with a specific function is assigned to a road section.

On Flemish level this assignment to a road section is only carried out for the Main Roads and for the Primary Roads (= selection). The selection is limitative for the Main Roads and the Primary Roads I. The selection of the Primary Roads II is not limitative. The Secondary Roads are selected in the provincial spatial structure plans. After testing with the provincial multimode traffic model-the eventual selection for the Primary Roads II can still be adapted and/or completed, as far as the impact in the field of multimode accessibility, road safety, traffic liveability, the environment and the spatial development were quantified, studied and the construction or the upgrading seems appropriated after structured consultation with the administrations concerned. For every category the general principles to alignment and spatial design are indicated each time as development perspectives.” (Afdeling Ruimtelijke Planning 1998, p. 482, transl.)

The selection of main - and primary roads is reflected in figure 5 (see next page). It is striking that only the main roads and the primary roads I form a closed network, the primary roads II and a fortiori the secondary roads act as feeder to the closed network.

The development perspectives for the main roads have thus been aimed at the bundling of the traffic on a well-equipped main road network. The level of service must lie there higher than on the primary and secondary net. The main roads are carried out as motorways with European level design standards. The design speed has to be higher than 100km/h and the chance on traffic-jams for the long distance traffic has to be smaller than 5 percent. Those main roads, which also serve as major transport routes, may have a traffic-jam chance for the lorry traffic of up to 2 percent. The number of intersections has to be kept limited; the distance between intersections is at least 8 to 10 km (Afdeling Ruimtelijke Planning 1998, p. 486)

From the introduction of this paper it should become clear that these quality standards are not obtained at present in and around the metropolitan areas of Antwerp and Brussels.

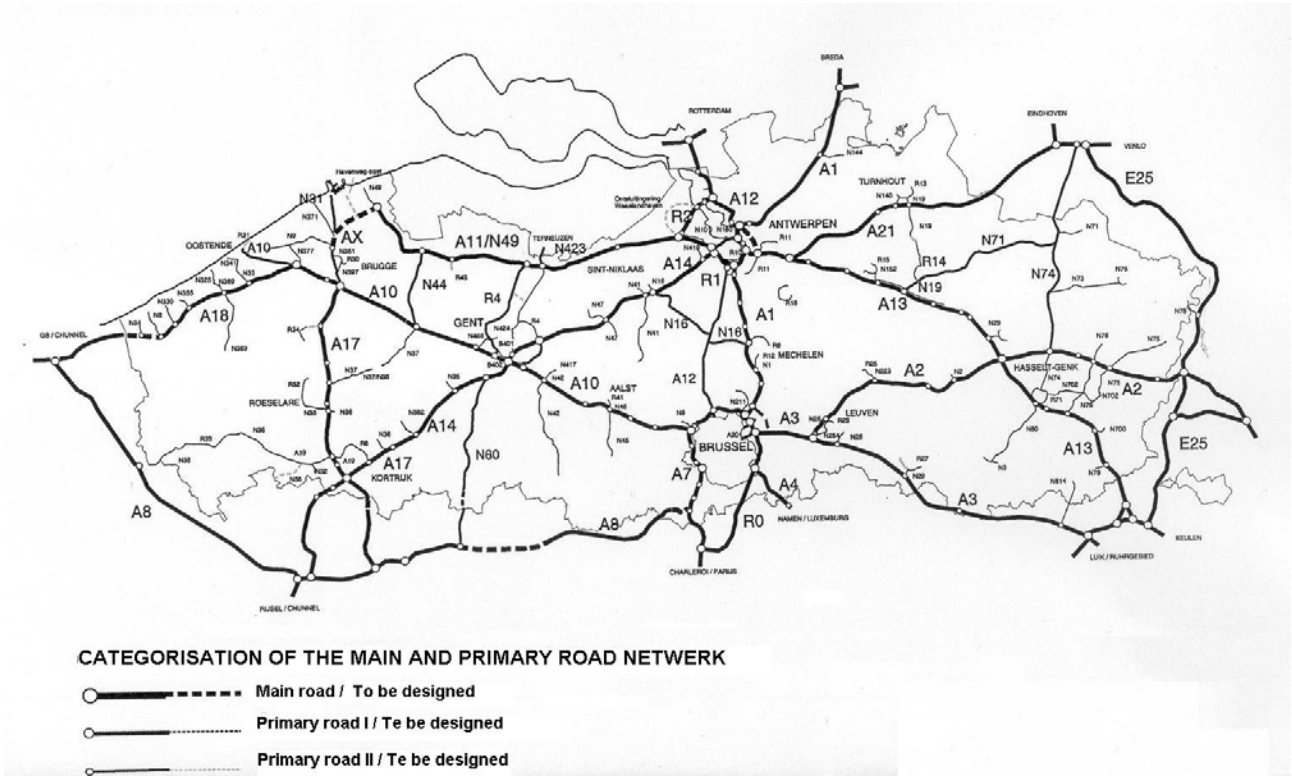

Figure 5. Selection of Main and Primary Roads. Source: Afdeling Ruimtelijke Planning (2004, p. 484)

The development perspectives for the Primary Roads I and II both start from the principle of separated traffic flows. Given their connecting function the requirements for traffic flow conditions lie higher on the Primary Roads I: only for these roads the maximum traffic-jam chances (particularly 5 percent) and minimum distances between the nodes are indicated (particularly 3 up to 5km).

The development perspectives for the secondary roads do not only start from traffic requirements but also explicitly from the requirements of liveability and spatial accordance. In general they consist of mixed traffic flows and a passage concept within the built-up area, design speed within the built-up area is 50km/h or less. Provision of new routes for secondary roads are bound to strict conditions, among other things it will have to be shown that the new route leads -more than other alternatives-to a higher environmental quality. (Afdeling Ruimtelijke Planning 1998, p. 493-494)

REFLECTIONS ON THE BASIS OF COMPARATIVE LITERATURE AND OF THE IMPLEMENTATION IN FLANDERS

Since 1997 the implementation of these concepts in Flanders on a lot of areas has been carried out or is in execution:
- the five provinces have carried out a selection of the secondary road networks, more than 80 percent of the municipalities have categorized the local roads in their municipal structure plans or mobility plans
- road design refers more and more explicitly to the categorization, for that purpose general principles and specified design guidelines for secondary roads - commissioned by the Road Department of the Flemish Ministry – have been formulated.

Lack of multimodality

The lack of multimodality in the categorization introduced by the Spatial Structure Plan 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 there is no development of a network of high-quality bus/tram connections. Bicycle routes and pedestrian routes are pushed through explicitly to the provincial and municipal structure plans.

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. The slow traffic modes and in a large degree also the public transport are pushed through as a responsibility at provincial level. 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.

Summarizing one can say that the link between the different modi does not clearly appears within the Spatial Structure Plan for Flanders, because the classification is based in advance on the physical type of line infrastructure and not on to the different transport modes. The functional categorization of secondary roads must take into account however several modi, their reciprocal influence and their nodality". (Engels D. & Korsmit J. & Lauwers D. 1998. p. 5).
In this study contrary to the Spatial Structure Plan for 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 provinces and so they selected in the provincial structure plan a specified category (secondary road type III) to take up these function. So the didn't follow the above mentioned suggestion of four subtypes of secondary roads, mentioned in the Flemish Spatial Structure Plan.

On the main roads in Flanders - up to now – only tempory facilities for the public transport have been implemented. Particularly this has happened as a result of the ` Less Hindrance Measures' programme, implemented at 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 temporary bus lane. An evaluation of these measures can lead possibly to permanent incorporating the collective transport function in the planning and design of the highways in Flanders. (Wild A., 2004)
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 (Mobiliteiscel, 2001). Figures are showing that in 2003 for the first time after more then 25 years the continued increase of car traffic on the Flemish roads has been stopped and that on the contrary the public transport use and biking significantly increased. (FOD Mobiliteit en Vervoer 2005)

Too administratively inspired category classification

As already stated above four main categories are distinguished: 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 possibly could be more adequate both for the elaboration of the networks and for the road design. This criticism has not yet been put explicit in the profession world in Flanders until now, but it offers possibly an explanatory framework for a number of evolutions in the implementation process of the imposed categorisering by the Structure Plan for Flanders. 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 (Baerwald, J.E.,1976) or similar: 'flow roads', 'area serving roads' and 'land access roads' (CROW 2002)

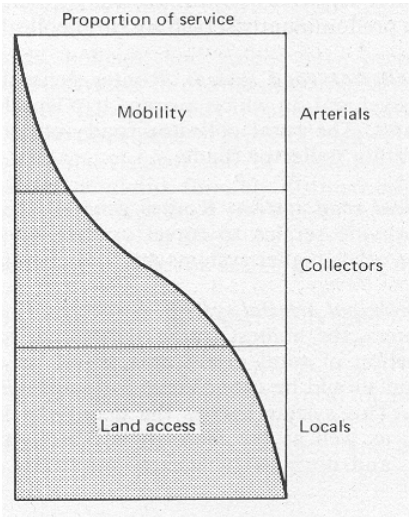

Figure 6. Road types. Source: US Department of Transportation, FHA 1968, p. II-6

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)

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 recognizably 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)

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 recognizabilty of the different road categories (Engels D. & Korsmit J. & 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 (wished) difference in traffic behavior 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 provinces have used. Before we already stated that because of the multimodality the categories presented by the Structure Plan for Flanders were not used in the provincial structure plans: 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 the bipartition of connecting versus collecting, so that the bipartition flow roads – area serving roads possibly is implemented if the less hierarchy and the more road using categories prevail in the design.

Starting from recent tendencies within spatial planning a critical comment can also be made at the used categories. In the Strategic Spatial Structure Plan for the city of Antwerp, that at present is been elaborated, a threefold division can be recognized: local land access roads (not discussed explicitly in this plan) and the so-called higher network and lower network. The higher network consists of the ring road (highway) and the (radial) highways and is being described as 'tubes'. But also the improvement and strengthening of the lower network has been conceived as the proper structural device to help solve congestion, to which serves specially the urban area the higher level infrastructures will cooperate. These elements don't define an accentuated hierarchy but an interconnected network and differ from one another in the kind of traffic flow and in design qualities. (Secchi B. &Vigano P. & Lauwers D. 2005)

So, in an implicit way the above mentioned three basic road categories are being used in this plan. It will become clear later in this paper that within each of these categories distinctive concepts for the layout of the networks and distinctive design principles have been developed.

Tree structures as a too dogmatic network concept

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 figure 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 Flemish level. These cuttings through the meshes are mostly relevant for the lower network and have their consequences at the provincial and municipal level.

Though the mesh width within the main road network 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)

This choice for avoiding mesh reducing means that within a mesh at provincial level no continuing connections with high flow quality can be created either, among others because of attracting car traffic from the highways and boosting car mobility. This point is of particular importance at possible connections between middle sized city areas. By the manner of interconnecting these roads a high resistance has to be created in order to discourage the trough traffic in these areas. Capacitance must connect be built in which has an advising against impact on through movement. (See figure 7). By the nature of the connection the accessibility of the central area is assured, but the through traffic is kept out. In practice a good assessment of the different

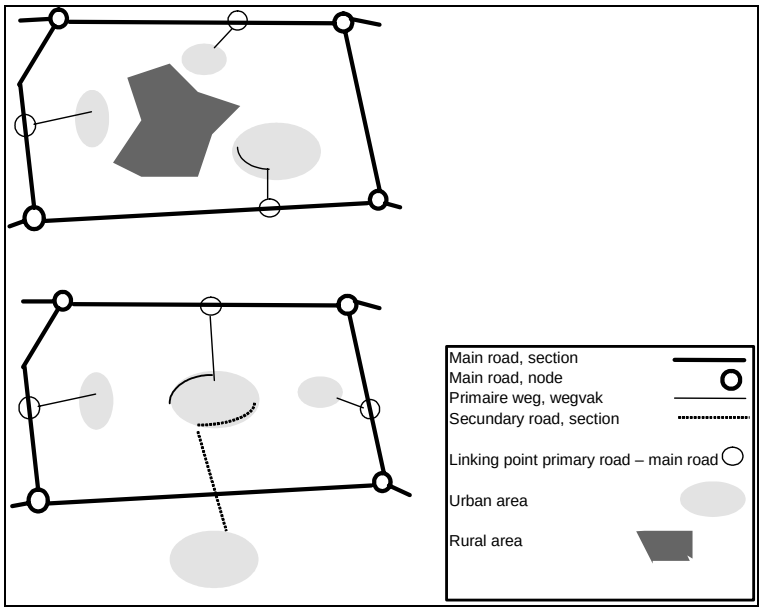

Figure 7: Avoiding cutting through of meshes at the provincial level. Source: Engels D. & Korsmit J. & Lauwers D. (1998, p.6)

speed levels will be necessary in order to assure the relations within the area. The design of the roads, which give connection within a mesh, must be this way that the connection produces for the user a more favorable time path along the main road network. This is particularly demanding where the form of the meshes is triangular, a form, which frequently occurs in Flanders. Summarizing one can say that within the selection process at provincial level, however, mesh reducing can come about at provincial level, but that thereby must be avoided that those connections would function at the Flemish level. (Engels D. & Korsmit J. & 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 and in spite of the fact that in neighboring countries the secondary networks, however, clearly exist as continuous networks of their own (Engels D. & Korsmit J. & Lauwers D. 1998) the recommended tree structures have been the last decade almost incorporated as a standard in the road plans and on secondary and local roads frequently local capacity - and speed reductions were introduced to run down their functional continuity.

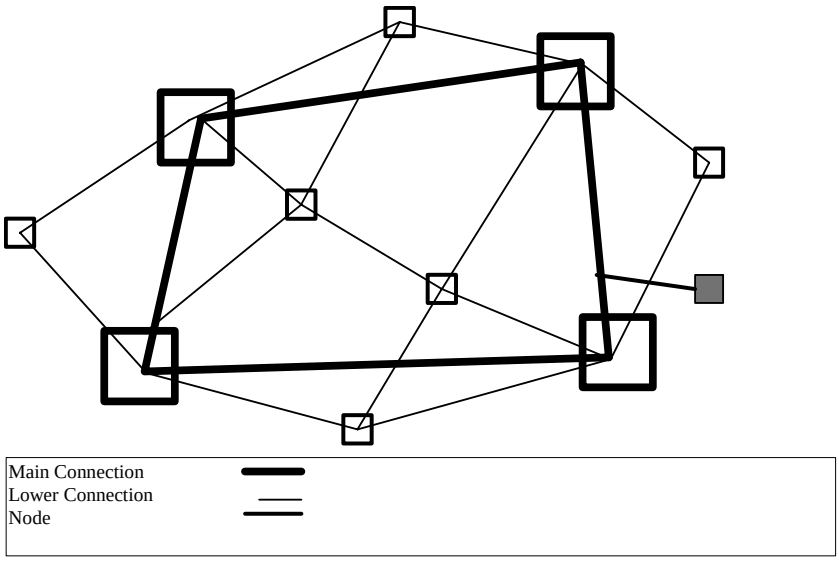

Figure 8: Networks standing on their own. Source: Engels D. & Korsmit J. & Lauwers D. (1998, p.16)

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 with the urban highways, with which this grid is interlinked, the collecting and dividing network at the level of the city. The existing highways must become for that purpose split up into two parallel highways, respectively for the international and urban traffic. 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. 2004)

Categorization may not cause completely uniform road design

The design task is at present in the traffic engineering theory regarded as the shaping of the road infrastructure and regulating the use of it starting from the man - vehicle - environment relation. The fundamental problem that arises with uniform designs on the basis of functional road categorization is that the starting point (function-use-layout relation) is not correctly interpreted. The (desirable) traffic behavior of a road user depends on the relation between the road layout, the road and of the relation with the other road users (vehicles and drivers). In this respect the momentaneous, actual situation is important. The road user is informed by the image of the road and has not necessarily an idea of the network function of the road he is using. On new roads this not so much a problem, there one can bring network function in agreement with the desirable road image, but on existing road this is, however, important.

To offer an answer to the dangers which are linked to fixing uniform road design standards by category such as they have been fixed in the Spatial Structure Plan of Flanders, an approach which assumes several entrances modifying the road categorization, should be presented. The relation between function, layout and use of a road is very important. It is however necessary to link this relation to other than purely functional design requirements. Thus three entrances can be considered to obtain a road categorization. (Engels D. & Korsmit J. & Lauwers D. 1999)

The Spatial Structure Plan of Flanders limits to a single entrance for categorization: the functional classification on the basis of the network function. The functional structuring of the road network is important, especially from the point of view of spatial planning and the traffic planning, particularly to be able to define the relation between the spatial development, the development of the mobility and the structure of the road network. The implementation of this categorization belongs to the responsibility of the concerned road administration. This contains that the road design must be adapted to the road function.

A second entrance for categorization, which must affect likewise the road design, is related to the traffic management function. The task of the road administration is not limited to the elaboration of a functionally well-structured road network. The administration also has to take care of the quality of traffic flow (also at irregular circumstances and for particular transports and convoys), of the traffic safety, of the restriction of the traffic nuisance on the environment and of the road maintenance.

A third entrance for categorization has to do with the road use function. At issue in this respect is the nature of the traffic flow in relation to the restricted capacities of the road users to carry the driving task safely. The nature

of the traffic environment, as the road user perceives it, plays an important role. For this reason the road designer will always assume the real traffic behavior.

The design requirements, following from these three entrances can in practice create tensions. These tensions are being recognized in the applying road design recommendations in Flanders and the entrances for road categorization are incorporated all three systematically in the design process. (Engels D. & Korsmit J. & Lauwers D. 1999)
Instead of defining a direct link between functional category and road layout a structured step-by-step design process design process is presented. The above-mentioned three entrances as well as other transport modes (for example bicycles) and (existing or desirable) environmental qualities define a set of design requirements that have to be translated into a traffic engineering design in a next step.

Traffic engineering and spatial concept elements as a basis for the layout of the road network

Recognisabilty and foreseeability of the traffic behavior 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 presented recommendation in Flanders couples by category a range of specific traffic engineering concept elements. (Engels D. & Lauwers D. 2003).

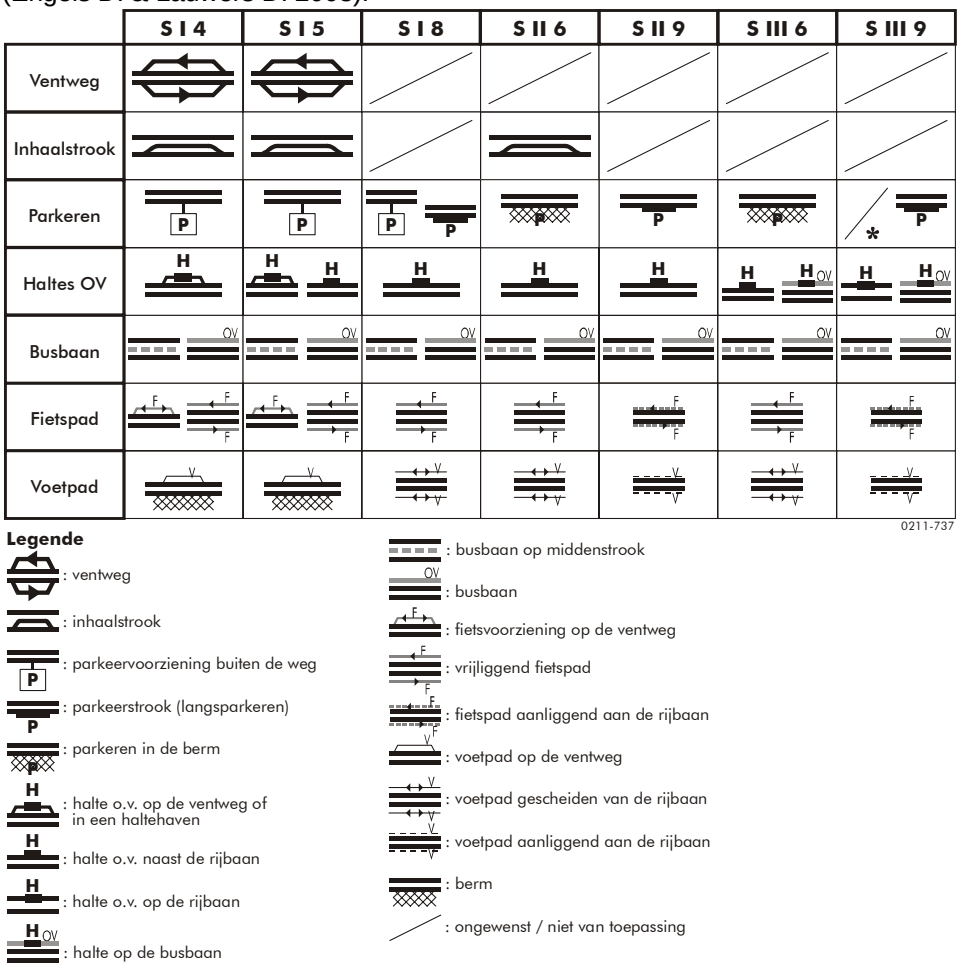

Figure 8: Example of traffic engineering concepts on secondary roads. Source: Engels D. & Lauwers D. (2003, p.84)

In the Strategic Spatial Structure Plan for the city of Antwerp it is - in line with recent literature – the starting point for the design of the urban streets that are not purely traffic engineering concepts but urban design concepts.
Concepts that is 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. Some research is confirming this assumption (Jacobs A.B. & Macdonald E. & Rofé Y 2002 and CERTU 2000).

CONCLUSIONS

The road categorization system since 1997 introduced in the Flanders region in the Spatial Structure Plan is based on three functions of roads: connecting, collecting and giving access. As the implementation process of this plan progresses (re-)design standards on the layout of the network as well as of the infrastructure are being developed. It seems that apart from the hierarchy this functional classification is a very decisive criterion in the choice of these standards: e.g. number and typology of crossings, design speed, … . However a key question regarding traffic safety oriented design consists in the prevailing of distinguishing road typology based on the connecting or collecting or giving access function, above administrative hierarchy. It has also become clear that a unimodal car oriented approach can't solve the above mentioned problems: so the provinces have introduced a new category of roads facilitating public transport in their spatial and infrastructure plans, provinces and local authorities have focused also on biking networks (instead of biking routes). Figures are showing that in 2003 for the first time after more then 25 years the continued increase of car traffic on the Flemish roads was stopped and that on the contrary the public transport use and biking significantly increased.

Furthermore two approaches can be distinguished in the restructuring of the urban and regional road networks: a hierarchical concept resulting in tree-like structures on the one hand and concepts based on spatial typologies of roads (boulevards, parkways, ...) organized in grid-like patterns on the other hand. The hierarchical treelike concept is most commonly used in Flanders at the moment, in such a way that it tempts to develop into a dogma. Practice is showing that lack of flexibility that is introduced by these concepts is threatening the accessibility of the densest urbanized areas. An alternative approach base on grid like patterns has been studied recently, only as a theoretical model for Antwerp. However, this case should be followed very close and administrations should put aside their dogmatic attitude. Categorization of roads should also not lead to uniform road design but to a stepwise approach of the design process starting with the definition of a requirements programme that partially is conditioned by the functional category of the road, leading to a detailed design using a limited number of traffic engineering and spatial concepts for roads and streets.

Attention for multimodal categorization instead of unimodal individual car based concepts (getting through in practice at provincial and local level in Flanders for some years), applying grid like patterns in urbanized areas as an alternative for the too inflexible treelike networks (the grid only as a conceptual model re-introduced in Flanders very recently) and the setting up of networks based on limited number of design concepts, avoiding uniform standard type designs, (some studies that offer a basis for this approach are presented in this paper) are - in my view – the tree most important lines along which a renewing approach in Flanders has to be built, offering a sound basis for the organization and design of road networks adapted at contemporary requirements of traffic engineering and spatial planning in view of sustainable development.

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