URBAN MOBILITY

A NEW DESIGN APPROACH FOR URBAN PUBLIC SPACE
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Introduction

The Netherlands is considered the ideal cycling nation; with many countries taking note of its example of how cycling should be integrated. The circumstances in the Netherlands are ideally suited for using the bicycle as the transport mode of choice: many destinations are located within cycling distance, the country itself is flat, and the climate doesn’t create much of a challenge, as it’s neither too warm nor too cold.

Most of the journeys in the inner cities are undertaken by bicycle - more than by car or public transit. The diversity of human-powered vehicles is also growing at a fast rate. There are vehicles with two, three or more wheels; some accompanied by electric assist systems. This is a development that we should applaud: the upsurge of smart, clean and swift transportation that doesn’t take up much room. It should be entirely logical that the bicycle, and all those wonderful light vehicles that have more or less evolved from it, become the central focus of urban mobility space.

However, that is certainly not the case in most places. In many cities, these vehicle types, not least the bicycle, are marginalised. If you intend to allocate them their justified status, then other modes of transport will have to yield in some form or another. A new balance needs to be sought between the various modes of transport, with the knowledge that the city should remain accessible for those other modes of transport if it is absolutely essential. This demands fundamentally different choices than those currently opted for, and a different approach to spatial allocation in the city.

The Royal Dutch Touring Club (ANWB) has acknowledged this and taken on the challenge. From the viewpoint of being able to represent the interests of all travellers, the ANWB seems the most appropriate organisation to come up with proposals for a different spatial configuration. It is for this reason that we have developed an integral design approach in collaboration with four expert firms, which we will present in this report. Alongside that is an essential new classification of methods of transport, so that in the near future, each (new) mode of transport will be allocated a logical position within our traffic system.

During the research, we made a point of deliberately involving the road users themselves, together with experts from various disciplines and stakeholders of those organisations, and we mobilised as much knowledge as possible. We tested our ideas across three pilot cities: Helmond, Utrecht and Rotterdam; they provided us with insights into their methods of working and contributed suggestions about the feasibility of certain ideas.

This report provides a number of new insights and concrete approaches to arrive at alternative choices and new designs. It also indicates which matters and questions need to be further addressed and researched.

Our hope is that many cities will adopt and implement these ideas, and share their experiences to help realise a broadly accepted new approach to urban mobility. Starting with the Netherlands.

Frits van Bruggen
Managing Director of the ANWB
‘Urban Mobility’ summary

Motivation
In the city, the (electric) bicycle and other light vehicles have been experiencing a boom in popularity for some time now. Naturally, that has brought with it some major advantages for the functioning of the city, but it is simultaneously accompanied by new problems, such as a large increase in the diversity of modes of transport, vague legislation and increased congestion on cycle paths. This requires a fundamentally different approach to the designing of urban public space: a new design approach enabling us to respond in a more adequate manner to the changes of today, tomorrow, and the future.

Objective
The objective of this study is “To develop a generically applicable design methodology, with which the urban public space (including the traffic infrastructure) can be reconfigured, whilst simultaneously considering quality of life, safety, and accessibility demands and requirements.”

Principles for design and legislation
There is a growing uncertainty as to which part of the road can be used by which vehicle: the old, orderly classification in ‘carriageway’, ‘cycle path’ and ‘pavement’ no longer suffices. The first step is therefore to develop new principles for both design and legislation. The two main principles of this new foundation are:
- The permissible speed is a characteristic of the infrastructure (and will no longer be – as is the case at the present – linked to the vehicle type); in addition it will be determined per section of the infrastructure which vehicles will be admitted or not;
- The mass and dimensions of the vehicle determine where it will and will not be permitted; in addition to regulating the speeds (via the design of the infrastructure), the differences in mass are also reduced in this manner, which will lead to increased safety; moreover, smaller vehicles offer more design options for the urban public space, esp. when dealing with a confined space.

Vehicle families
This principle has been developed to determine vehicle categorisation using vehicle families, with each defined by a maximum mass and maximum width. The maximum mass of successive vehicle families always increases tenfold. Six vehicle families (A to F) have been defined in this manner.

All existing (but also future definable) vehicle types can, dependent on mass and width, be incorporated in one of the six vehicle families¹. In figure I on the following page, a number of existing vehicle types are depicted within each vehicle family as an example, and set against six other speed categories on the basis of their prevailing maximum speed.

This new classification has a number of consequences, in particular for lighter vehicle categories:
- walking (vehicle family A) is also acknowledged as a fully-fledged method of transport of getting from A to B;
- all “cycle-type vehicles” (vehicles lighter than 35 kg and a maximum of 1.5 m wide) belong to vehicle family B; that means that the same rights and obligations apply in principle for speed pedelecs and racing bikes as for ‘ordinary’ bicycles, such as permissibility on certain classifications of infrastructure;
- a new family of “light motorcycles” or LMVs (vehicle family C) includes all those vehicles between 35 and 350 kg (and max. 1.5 m in width); this family, which in terms of size and weight is basically very much suited to urban use, encompasses a wide variety of vehicle types, from light mopeds and e-cargo bikes and rickshaws up to and including motorcycles; the introduction of vehicle family C adds clarity to the light moped vs moped discussion: the current light moped can feature, depending on its weight, either in vehicle family B or C, and will therefore need to adhere to the rules that apply to these particular vehicle families.

¹ The sorting and substantiating of the exact limits of vehicle families is the subject of further research.
Figure I: Vehicle families and speeds

Figure II: Complete overview of design methodology
Basis of the design approach: balance between space and traffic
Every inhabitant of, or visitor to the city will use both its public spaces and traffic system. This notion forms the basis of the design approach: within each design phase, there needs to be a balance between space and traffic. We look for this balance at two design levels:
- at a structural level, an assessment is made for every street or area to find the balance between residential and traffic functions. This is to determine which family of vehicles is permitted and at what speeds are they allowed;
- on the locational level, concrete designs are developed, within which choices are also made with regard to the merging or separating of traffic modes.
In figure II, an overview is included of the total design methodology, within which arrows also depict the bottom-up feedback loops.

First section of the design process: the consideration between space and traffic at a structural level
In the first section of the design process, an initial examination is conducted at a structural level between the spatial and traffic-related preferred structures. Finding solutions to areas where dilemmas occur between space and traffic begins at this level.

Four urban traffic environments
The consideration between space and traffic at a structural level results in the classification of all infrastructure within the public space, into four so-called urban traffic environments. These urban traffic environments are characterised by a maximum permissible speed in a street or area: 10, 20, 30 or 50 km/h, as shown in figure III.

In each of these four urban traffic environments, the design is primarily attuned to a normative vehicle family: A, B, C and D respectively. Lighter vehicle families than the normative ones are always permitted. In addition, there is the option to perhaps allow heavier vehicle families. Whether or not this is desirable needs to be assessed per individual situation, dependent on the local situation and the embedding within the total structure. In the event that heavier vehicles are permitted, this will always be as a guest, in other words, this means that they need to adapt to the normative vehicle family in terms of speed and traffic behaviour.

Figure III: The four urban traffic environments
Result: a map with traffic functions

Ultimately, the above will lead to a map, which specifies the traffic functions per area or for corridors/routes, see figure IV. This map displays the following per area or per route:
- the urban traffic environment (1, 2, 3 or 4) with related maximum speed (resp. 10, 20, 30 and 50 km/h);
- the heaviest permissible vehicle family (A, B, C, D or E).

This however has nothing to do with ‘merging or separating’ at this point in time; this matter will not be addressed until the design at location level is reached.

Figure IV: Map showing traffic functions. Each number refers to an urban environment and a vehicle family

Second section of the design process: the consideration between space and traffic at location level

In the second section of the design process, a further consideration is made at a concrete location level between spatial quality and traffic-related demands and requirements. This process should result in a design of the public space, within which residential and traffic functions are balanced in a suitable manner. The merging or separating of vehicle families is a key design issue.

Domains: merge or separate?

Physically divided sections of infrastructure where it is possible for vehicle families to merge are referred to as ‘domains’. Each of the vehicle families permitted within a street are allocated to a single domain, but multiple vehicle families can be permitted within one domain. As far as merging/separating is concerned, the following general design rule\(^2\) has been established:
- a vehicle family that is a maximum of one category lighter (for the traffic environment concerned) than the normative vehicle family may be merged with the normative vehicle family within one domain; it may also be separated;
- a vehicle family that is two or more categories lighter than the normative vehicle family, must be separated from the normative vehicle family, and therefore accommodated in other domains, outside the normative vehicle domain.

In instances where allowing one or more heavier vehicle families as a guest is opted for, this will always be merged with the normative vehicle family and with the maximum speed relating to that traffic environment.

Where parking is concerned, the basic principle is that parking takes place within specifically designed locations within the vehicle family’s own domain. This is already standard practice for cars. In the current situation however, bicycle-type vehicles and LMVs are usually parked on the sidewalk. This is undesirable from the viewpoint of pedestrians, as walking should also be considered a fully-fledged transport mode.

Safety forms the key criterion for the configuration of intersections. From the necessity of creating better and more all-inclusively meshed walking and cycling networks, the intersections of walking and cycle routes with main car routes merit special attention.

\(^2\) This design principle was drawn up following experiences attained in the pilot cities, in conjunction with our own analyses of a large number of design situations.
Index

Glossary

Introduction and reader guide

Motivation and research questions
Objective
Procedure
Reader guide for this report
Background papers

1. Principles for design and legislation: vehicle families
   The permissible speed is a characteristic of the infrastructure
   Mass and dimensions of the vehicle determine where it is and is not permitted
   Definition of vehicle families
   The vehicle families in brief

2. Design approach at a structural level: urban traffic environments
   Basis of the design approach: balance between space and traffic
   Total overview of design methodology
   First section of the design process: consideration between space and traffic at a structural level
   Result: four urban traffic environments
   Further specification of traffic function
   Feedback loop to preferred structures of space and traffic
   All vehicle families are equal

3. Design approach at location level: domains
   Second phase of the design process: the consideration between space and traffic at location level
   Domains: merge or separate?
   Design of the public space
   Parking: preferably within own domain
   Intersections
   Conclusion and feedback loop to structural level

4. The next step
   Substantive plan
   Organisational plan
   Communication plan

Literature
Attachments

Attachment 1: Overview of background papers
Attachment 2: List of consulted experts and stakeholders
Attachment 3: Pilot city participants in Rotterdam, Utrecht and Helmond
Attachment 4: Summary of results from ANWB member consultations
Glossary

Design approach
By the term design approach, we are referring to the developed conceptual framework and mind-set with regard to the design of urban public space. At the core of the approach is the pursuit of an optimum balance between space and traffic (and between all traffic modes there within), both at a structural level and a locational level.

Design methodology
By the term design methodology, we are referring to the entire process of steps (content and procedure) that must be undertaken to realise a public space design whereby a suitable balance is attained, both on a structural level and location level, between space and traffic (and between all traffic modes there within). The design methodology constitutes part of the design approach.

Vehicle family
A vehicle family is defined by the maximum mass (curb weight) of the vehicles and the maximum (dynamic) width that a vehicle in motion takes up within the infrastructure. There are a total of six different vehicle families: walking (A), bicycle-type vehicles (B), light motor vehicles (C), car-type vehicles (D), truck-type vehicles (E) and tram-type vehicles (F).

Preferred structure for spatial (urban) zoning
The preferred structure for spatial zoning (or: preferred structure for urban zoning) is a patch map with an envisaged maximum speed per area, explained from the viewpoint of preferred spatial quality. The preferred spatial quality is the result of a spatial analysis of the city and the sub-regions within it. Key elements of the spatial analysis are: the desired identity of the city, user groups, how people wish to undertake journeys, and what people would like to experience in the city (the area).

Preferred structure accessibility (traffic networks)
The preferred structure for accessibility (or: preferred structure of traffic networks) presents a vision of the preferred road systems per vehicle family. This preferred structure is based on an analysis of the preferred accessibility of the city in its entirety and the sub-regions within it.

Design at a structural level
For designs at a structural level, a consideration is made between residential and traffic functions for each street, route or area. This consideration takes place at a functional level: which vehicle families will be permissible and which speeds are permissible. Further comments regarding the arrangement of public space follow at location level.

Urban traffic environment
An urban traffic environment is the result of a consideration between space and traffic at a structural level. On the basis of this consideration, the infrastructure that constitutes part of the urban public space is categorised in four urban traffic environments (1, 2, 3 or 4), which are characterised by the maximum permissible speed (10, 20, 30 and 50 km/h) within a street or area. The design of an urban traffic environment is primarily attuned to the normative vehicle family associated with the maximum permissible speed.

Design at the location level
For designs at the location level, a detailed design of the public space will be created. The public space will be divided into domains. In addition, a balance is sought between the defined residential and traffic functions at a structural level, and – within the traffic space – between the merging or separating vehicle families.
Traffic function
The traffic function of an axle/route, or an area, indicates what the maximum permissible speed is (the urban traffic environment) and what the heaviest permissible vehicle family is (A to F).

Function map
The function map indicates the traffic functions, either per area, or for streets/axles/routes. The basic principle of the function map is that one of the four urban traffic environments is allocated to each street or area, to which a speed regime of 10, 20, 30 or 50 km/h is linked, in conjunction with a vehicle family that is indicative for the design.

Domain
Domains are physically divided (by way of a physical barrier) sections of the infrastructure whereby vehicle families might or might not be merged. Each of the vehicle families permissible within a street is allocated to one specific domain, but multiple vehicle families may be permitted within that one domain.
Introduction and reader guide

Motivation and research questions
Much has changed in terms of our mobility in recent decades. Mobility has greatly increased due to demographic, spatial and economic developments. We have also managed to improve traffic safety to a considerable degree, we are cycling more kilometres than ever before, with new modes of transportation such as the electric bicycle swiftly gaining new territory. We are witnessing an ever-increasing diversity of transport modes: the range of new transport concepts and variations on existing concepts is enormous, and there is no reason to believe that this development will come to a halt anytime soon. It is for this reason that the methods of transport available change rapidly, but so does their utilisation, and – as a result – our mobility pattern.

These developments are predominantly visible within our cities; in recent years, the number of inhabitants of many Dutch cities has been rising; young adults in particular gravitate towards the cities in large numbers. This development also has implications for urban mobility. Research into the methods of transport being used has revealed that walking, bicycle and public transport are gaining in popularity, at the expense of the car. This has major advantages for the functioning of the city, as:
- more people are opting for space-saving, environmentally friendly and safe methods of transport;
- they are rewarded for this option in the shape of swift, flexible and cheap transport in the city;
- because of this choice, the quality of life and the traffic safety of the city and the community is improved.

The infrastructure and traffic laws have difficulty keeping up with these developments however. The growing popularity of the bicycle, electric bicycle, and other light motorcycles is also leading to complaints and irritation among users, which can be traced back to various causes, such as:
- the increase in the use of the bicycle leading to a growth in intensity on the cycle path network;
- not only will the number of cyclists increase, but the diversity of the ‘bicycle’ will increase, with regard to weight, speed, length and width;
- this “congestion on the cycle path” will lead to all manner of inconveniences; within the current network, often the necessary space is lacking to accommodate the various flows in an adequate manner. The flow thereby becomes too narrow, and, in combination with the mass and speed differences, causes considerable irritation and unsafe situations;
- intersections cannot handle the flows adequately; the positioning space is too limited and causes too much loss of time;
- finally, the increasing diversity in methods of transport is resulting in an increase in ad hoc legislation, causing it to be increasingly unclear for the cyclist /traveller as to what is and isn’t permitted.

The aforementioned developments are forcing a fundamentally different approach to the design of the urban public space: a new design approach that enables us to respond to the changes of today, tomorrow and the future more adequately. Research questions that should be addressed in this reorientation are:
- to what degree is it possible to integrate traffic infrastructure with the urban public space design?
- in what manner can the division of the available traffic space (infrastructure) across the variety of methods of transport be substantiated?
- in what manner can the (increasing) danger in traffic be tackled effectively?
- is it possible to arrive at an unequivocal integration of (future) new, smart transport methods?
- in what manner can the routing of the journeys be structured per mode of transport?
Figure 1: Congestion on the cycle path\(^3\) (photo: Robert Oosterbroek / DUIC)

**Objective**

*To develop a generically applicable design methodology, with which the urban public space (including the traffic infrastructure) can be reconfigured, whilst simultaneously considering quality of life, safety, and accessibility demands and requirements.*

**Procedure**

During the development of the design methodology, five pathways were followed:

*Reconnaissance (desk research)*

In the reconnaissance phase, three analysis levels were identified:
- methods of transport and modes of transport;
- networks and journeys;
- public space and traffic.

Per analysis level, developments have been itemised both in terms of demand and supply. In this manner, valuable input for the design process was obtained. For a comprehensive description of this pathway, we refer to background document 1a (see attachment 1).

*Consultations of experts and stakeholders*

One key function of these consultations is obtaining feedback on the design approach, such as addressing design dilemmas, addressing the qualities and points of improvement, and defining the follow-up process. In attachment 2, a list of participants in these meetings is included. The reports can be found in the background papers 2a to 2c (see attachment 1).

*Workshops in pilot cities*

Three pilot cities (Rotterdam, Utrecht and Helmond) have been intensely involved in the development of the design methodology. In conjunction with representatives (designers) of the pilot cities, all relevant aspects were addressed through workshops, such as: what is the current method being used, and what are key dilemmas of the design? What problems are encountered and how are they resolved? In addition, ideas regarding the

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\(^3\) Bicycle traffic jam in Utrecht, caused by an enforcement action by police against cyclists ignoring red traffic lights
approach of the integrated spatial-traffic-related design process were tested and worked out on a small-scale level in conjunction with the pilot cities. Included in attachment 3 is an overview of the workshop participants from the pilot project cities.

**ANWB member consultation**

It is important to know how the current users feel about the quality of the traffic performance in the city and where they see important/necessary improvements. Members of the ANWB were asked about their experiences with urban mobility by way of a survey. A brief summary can be found in attachment 4. A more comprehensive report of this research is incorporated in the background papers 3a to 3c (see attachment 1).

**Conception of design approach**

This conception encompasses the formulation of new principles for design and legislation, resulting in the new categorisation of vehicles into vehicle families. The design approach is subsequently formulated, both at a structural and location level. At both levels, the consideration between spatial and infrastructural preferred structures plays a key role. The description of the design approach forms the subject of this report.

**Reader guide for this report**

In chapter 1, the new principles for design and legislation are introduced. A key element in this approach is the proposal of a new classification of vehicles into vehicle families.

In chapter 2, the new design approach is formulated/described at a structural level. In this phase of the design process, an initial basic consideration is made between the spatial and traffic-related preferred structures. The result of this consideration is the classification of all infrastructure that makes up part of the urban public space into four urban traffic environments; this on the basis of the maximum permissible speed in the street.

In chapter 3, the new design approach at location level is formulated and described. In this phase it is determined how the street (cross section) is further divided into domains (physically separated sections of the infrastructure) and where vehicle families can or can not merge.

Within each section of the description there is always an indication of the following:

- ✔ The resolving capacity of the proposed approach (referring to the original issue)

- ⚫ Which research questions need further elaboration?

In chapter 4 (“The next step”), a description is provided as to which subsequent steps are needed. We thereby distinguish between the following pathways:
  - further formulation and validation of the design methodology in pilot projects;
  - further research on certain aspects (legal, traffic management related, behavioural, ...);
  - development of a roadmap for the implementation of the design methodology.

**Background papers**

Accompanying this final report is a number of underlying documents, records and presentations. These can be found at www.anwb.nl/verkeerindestad. In attachment 1, an overview of these background papers has been incorporated.
1. **Principles for design and legislation: vehicle families**

There is not only a strong increase in the use of bicycles, but mainly also a large increase in the diversity of methods of transport that move throughout the city. In between the traditional bicycle and the car, a wide range of transport methods has emerged, with major differences in mass, speed and dimension. The result is that the old, orderly classification in ‘carriageways’ (for ‘fast-moving traffic’) and ‘cycle paths’ (for ‘non-motorised traffic’) no longer suffices, and that there is an increasing amount of ad hoc legislation for all of these methods of transport. This is leading to an increasing lack of clarity as to which vehicle must occupy which section of the road. The result is irritation at the very least, but often also dangerous situations ensue.

As a first step in the development of the new design methodology, we cannot escape creating an entirely new foundation, namely: developing new principles for both design and legislation. The two basic principles of this new foundation are:

- The permissible speed is a characteristic of the infrastructure;
- A vehicle’s mass and dimensions determine where it will or will not be accepted.

These two principles are to be elaborated upon further, in the following passages.

**The permissible speed is a characteristic of the infrastructure**

In the current situation, speed limits are often linked to the vehicle type. Because various vehicle types often use the same infrastructure, the result is that various speed limits apply simultaneously within this infrastructure. By setting the permissible speed depending on the infrastructure within which a vehicle is located, and no longer determining it by the vehicle itself, we can create less hectic and safer traffic (less speed differences) and more clarity as to what is and isn’t permitted. The permissible speed is first necessitated by the design of the infrastructure, and second by legislation and enforcement.

In addition, it is determined per section of the infrastructure which vehicles are permitted or not. The same maximum speed applies to all vehicles that are permitted to use a specific section of the infrastructure. For instance, those areas where a speed limit of 20 km/h is applicable, a cyclist may only travel at a maximum of 20 km/h. In essence, a principle that is commonplace for cars, is generalised to include other vehicles: a car that can attain speeds of up to 180 km/h is welcome to use the urban infrastructure, providing it adheres to the applicable maximum speeds of 50 km/h or 30 km/h. The principle also works vice-versa: if a maximum of 50 km/h is permitted in a certain area, then every vehicle that is permitted to be there may maintain a speed of 50 km/h, even if that vehicle is lighter, for instance a speed pedelec or light moped.

One key starting point is also, that there is never a minimum speed that is applicable within the urban public space: there must always be the option to ride or drive slowly, or come to a standstill within an urban street. No traffic participants can therefore be excluded from using a street for the sole reason that they cannot or are not willing to travel fast enough. Outside of the city (or within an urban infrastructure that is not a part of the public space, such as a motorway) this might be different, but that will fall outside the scope of this project.

✔ By setting the permissible speed depending on the infrastructure within which a vehicle is residing, and no longer according to the vehicle itself, we create a less hectic and safer traffic image (less speed differences) and more clarity as to what is and isn’t permissible.
**Mass and dimensions of the vehicle determine where it will or will not be accepted**

The second central principle is, that mass and dimensions of the vehicle determine where it will or will not be accepted. In addition to regulating the speeds (‘enforced’ by design and layout of the infrastructure) the differences in mass are also reduced in this manner, which will lead to increased safety. In addition, smaller vehicles offer more design possibilities within a limited cross section, and smaller vehicles will take up less parking space.

<table>
<thead>
<tr>
<th>Kinetic energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic safety is a basic prerequisite when designing public spaces. Traffic safety is especially linked to the kinetic energy (movement energy) of vehicles: the greater the kinetic energy, the greater the impact of a collision. The kinetic energy is determined by the formula:</td>
</tr>
<tr>
<td>$E = \frac{1}{2} m v^2$</td>
</tr>
<tr>
<td>whereby $m$ represents mass and $v$ represents speed. Both quantities take up a central position in the design approach: the permissible speed is linked to the infrastructure, while the mass of the vehicle determines where it is or is not permitted.</td>
</tr>
</tbody>
</table>

Figure 2 illustrates the large diversity in the kinetic energy of vehicles in the city. The speed maintained here is the standard maximum speed within the city; sometimes this is the legal maximum speed (such as the 50 km/h limit), sometimes it’s a ‘common’ speed (such as the speed of a standard bicycle).

Please note: the kinetic energy (y-axis) is displayed on a logarithmic scale, taking into consideration that differences in speed count quadratically in the formula for kinetic energy. This can only mean that the impact of differences in vehicle mass is much greater than the impact of differences in speed. Indeed, the difference in mass between a bicycle (18 kg) and a car (1200 kg) is approximately a factor 60, while the squares of the speeds (resp. 20 and 50 km/h) only vary by a factor of 6.

![Kinetic energy: $E = \frac{1}{2} m v^2$ (at ‘maximum’ speed)](image)

Figure 2: Kinetic energy of vehicles in the city during ‘standard’ maximum speed
Definition of vehicle families
This second principle has been developed into a new classification of vehicles in vehicle families, whereby each vehicle family is defined by a maximum mass (curb weight) and a maximum (dynamic) width, that is to say the width that a driving vehicle takes up on the infrastructure; thereby incorporating the ever-present deviations from the straight line (the ‘side motion’). The maximum mass of successive vehicle families increases each time by a factor of 10. Six vehicle families (A to F) have been defined in this manner, see figure 3.

![Figure 3](image-url)

The six vehicle families from A to F

<table>
<thead>
<tr>
<th>Family</th>
<th>Mass</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt; 35 kg</td>
<td>&lt; 1,00 m</td>
</tr>
<tr>
<td>B</td>
<td>&lt; 350 kg</td>
<td>&lt; 1,50 m</td>
</tr>
<tr>
<td>C</td>
<td>&lt; 3500 kg</td>
<td>&lt; 2,00 m</td>
</tr>
<tr>
<td>D</td>
<td>&gt; 3500 kg</td>
<td>&gt; 2,00 m</td>
</tr>
<tr>
<td>E</td>
<td>Guided</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Track-like vehicles</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Truck-like vehicles</td>
<td></td>
</tr>
</tbody>
</table>

Looking into and substantiating the exact boundaries of the vehicle families (mass, width, and possibly also length) is the subject of further research. This also applies to the correlation between the dynamic width and physical width of vehicles.

All existing vehicle types can, dependent on their respective mass and width, be incorporated in one of the six vehicle families, as displayed in figure 4. In this figure, a number of existing vehicle types within each vehicle family are depicted as an example, and set against six speed categories on the basis of their prevailing maximum speed. A vehicle can of course travel more slowly: a racing bicycle can also travel at 20 km/h, or come to a standstill. It is visible that all vehicle families (with the exception of A, walking) are represented within all speed categories within the city (from 0 to 50 km/h), but that within the lighter vehicle families (A, B and C) there are representatives that do not rise above a certain (technical) maximum speed, such as the traditional bicycle.

The maximum permissible speed in this philosophy is therefore no longer determined by the vehicle (such as maximum cylinder capacity, or a speed limit per vehicle type), but by the infrastructure that a vehicle finds itself in. This is analogue to what we are already used to with the car. It is possible though that in the future, the speed limit that is assigned to a certain type of infrastructure is imposed upon the vehicle by way of electronic means (ISA, intelligent speed adaptation). This principle can be applied to all vehicle families (naturally with the exception of A).

Legislation applies to an entire vehicle family as much as possible; some examples of legislation are the license plate requirement, driving license requirement, minimum age requirement etc. In some instances, such as obligatory helmet requirement, this is somewhat more subtle, and may well be linked to the actual speed being driven or to the infrastructure that is used (therefore not to the technical maximum speed of the vehicle).

The legislation that will apply to the vehicle families is the subject of further research.
Figure 4: Vehicle families and speeds

An accompanying advantage of the classification into vehicle families is that every newly developed vehicle will always belong to one of these families, which means that the relevant legislation for this new vehicle will automatically apply, and a vacuum in legislation is avoided.

✔ The vehicle family to which a vehicle belongs, defined by the mass and dimensions of the vehicle, determines where it will or will not be accepted. In addition to regulating the speeds (‘enforced’ by design and layout of the infrastructure), the differences in mass are also reduced in this way, leading to an increase in safety.

✔ A newly developed vehicle will always belong to one of these families, which means that the relevant legislation for this new vehicle will automatically apply, and a ‘vacuum’ in legislation is avoided.

Consequence: ‘maturing’ of drivers of vehicle families B and C
Due to the strongly increased traffic intensity (impact of ongoing urbanization) and differences in speed and mass within these vehicle families, it is inevitable that these traffic participants will also be confronted with rules of behaviour and restrictions that will lead to a more tranquil and safe traffic image. It concerns rules of behaviour and restrictions that have been commonplace for cars for a considerable time, such as:
- speed limits on certain sections of the infrastructure;
- being considerate of other traffic participants;
- parking legislation in certain areas.

Educational and information campaigns need to be developed to aid the maturing process of vehicle families B and C.
The vehicle families in brief

**Vehicle family A: acknowledgement of walking as a fully-fledged transport mode**

By considering ‘walking’ as a fully-fledged method of transport for getting from A to B, it will be more appealing to walk instead of cycle for very short distances. This will reduce the congestion on the cycle path as well as the storage problem of bicycles.

Acknowledging ‘walking’ as a fully-fledged method of transport demands drawing up design requirements for the flow function of pavements, determining walking networks, etc.

**Vehicle family B: one family of bicycle-like vehicles**

This vehicle family comprises all vehicles lighter than 35 kg, which are a maximum of 1.5 metres wide. It is one family, so for speed pedelecs and racing bikes, the same rights and obligations apply in principle as for standard bicycles, such as those relating to access to certain sections of the infrastructure. The fact that speed pedelecs and racing bikes can travel faster than standard bicycles doesn’t mean that they are always permitted to travel faster (analogous with a luxury business car versus an ordinary city auto), and vice versa in

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*Photo figure 6, above right: http://oranje-kinderen.nl/*
those areas where high speeds (for instance > 30 km/h) are permitted, certain rules can also apply to the bicycle family with regard to traffic behaviour and safety. For instance, the safety helmet requirement can be linked to the speed that is permitted within the infrastructure where someone is riding or driving, instead of the technical maximum speed of the vehicle. This will create more clarity over what is and is not allowed.

The legislation that is applicable to vehicle family B is the subject of further research.

Vehicle family C: a new family of ‘light motor vehicles’ (LMV)

This vehicle family (C) includes all vehicles between 35 and 350 kg, with a maximum width of 2 m (plus possibly also a maximum length). By far, most of the cases will feature vehicles with some manner of propulsion. This family encompasses a wide variety of vehicle types, from light mopeds, e-cargo bikes and rickshaws to motorcycles. The LMV family actually fits in very well in the city in terms of its size and weight. This is also a category within which a lot of innovation is taking place.

The introduction of vehicle family C brings clarity into the light moped and moped discussion: the current light moped will fit, dependent on its weight, either into vehicle family B or in C, and will therefore need to adhere to the rules applicable to these vehicle families. Note that motorcycles also belong to this family; even the
heaviest is well under the 350 kg mark. One consequence can therefore be that motorcycles obtain other rights and obligations than cars.

The restrictions of the size of vehicles within vehicle family C (mass, width, possibly also length) and the legislation applicable to vehicle family C is the subject of further research.

As far as legislation is concerned, it is recommended that the same rights and obligations should apply to the entire LMV family; this will increase both clarity and safety. Just as is the case with the bicycle family, also some rules will apply that can be set independently of the type of infrastructure that someone is travelling on, such as safety helmet requirements.

**Vehicle family D: the family of car-like vehicles**

![Examples of vehicle family D](image)

This vehicle family encompasses all vehicles between 350 and 3500 kg that are less than 2 m wide; roughly all those vehicles that may currently be driven with a standard driving license. This also incorporates light vans that can fall within these restrictions.

The restriction to a width of 2 m can (where no truck-type vehicles are permitted) offer possibilities in the cross section for a better division of the available space.
**Vehicle family E: truck-like vehicles**

![Examples of vehicle family E](image)

This family includes heavy road vehicles (weighing over 3500 kg and/or wider than 2 m), such as trucks and buses. In a transport-related sense, although a public transit bus is very different to a truck that supplies retail stores, they are comparable from a traffic-related perspective (mass, speed, impact on the public space).

The degree with which the same legislation could be applied to the entire vehicle family E, is the subject of further research.

**Vehicle family F: tram-like vehicles**

![Examples of vehicle family F](image)

This vehicle family includes all guided vehicles that move within the urban public space. This comprises trams in the first instance: they are physically guided via rails that are integrated in the road surface, which make their movements extremely accurate to predict, thereby enabling them to fit relatively efficiently within a cross section. In addition, this family also includes automated guided vehicles (people movers - see the central photo). Rail vehicles that do not move within the public space (subway/underground, train) fall outside of this category.
✔ ‘The ‘maturing’ of vehicle families B and C will lead to a situation in which these traffic participants also will be confronted with rules of behaviour and restrictions. This will lead to a more tranquil and safe traffic image.

✔ By acknowledging walking as a fully-fledged mode of transport, it will become more attractive to walk instead of cycle for very short distances. This will reduce congestion upon the cycle path.

✔ By introducing uniformity into the legislation within the vehicle families B and C, there will be more clarity about what is and is not permitted. This will benefit safety.

✔ The introduction of a new family of light motor vehicles will add clarity to the light moped discussion: dependent on the weight, the current light moped will be classified as vehicle family B or C, and will need to adhere to the rules applicable to these vehicle families.

✔ Working out the LMV-attuned design principles will decrease the necessity to deal with the LMV on the cycle path.

✔ The restriction of car-type vehicles up to a width of 2 m can offer possibilities within the cross-section for a better division of the available space.
2. Design approach at a structural level: urban traffic environments

**Basis of the design approach: a balance between space and traffic**

Every inhabitant of or visitor to the city uses both the public space and the traffic system. This notion forms the basis of the design approach: in each design phase, there needs to be a balance between space and traffic, which entails that we are searching for a balance between the optimum quality of the public space and the optimal functioning of the traffic system.

In practice, we often see that preferred structures are developed for space and traffic, which are only actually confronted with one another when a concrete design of the public space is being realised – which often sheds light on irreconcilable requirements.

We therefore differentiate between two design levels within the design approach:

1. The structural level: at this level, a consideration is made for every street or area between residential and traffic functions; this level focuses on functionality: which vehicles are permitted, what speeds are allowed; at this level, no statements are made about the grading of the public space (such as the merging or separating of traffic modes);

2. The location level: here, a concrete design is realised within which a balance is sought between the residential and traffic functions as defined at the structural level, and - within the traffic space - between the merging or separating of traffic types.

There is a constant exchange between space and traffic (and vice-versa) and between the structural and the location level (and vice-versa), see figure 10 which illustrates the design methodology.

![Figure 10: Main characteristics of 'Urban Mobility' design approach](image)

Only within the built-up area

The developed design approach is limited to the design of public space within the built-up area.

Possible expansion of the design approach to outside of the built-up area is the subject of further research.
Total overview of design methodology
In figure 11, an overview of the complete design methodology is provided: this displays both the distinction between space and traffic, and the distinction between structure and location level. The chart initially suggests a top-down approach (from preferred structures of space and traffic, via integration at a structural level, to formulation at location level), but arrows also indicate the bottom-up feedback loops.

In chapters 2 and 3, we provide a further description of all elements from the chart. We will elaborate on the top section of the chart in this chapter (2): the consideration between space and traffic at a structural level.

First section of the design process: the consideration between space and traffic at a structural level
In the first section of the design process, an initial principle consideration is already made between the preferred spatial and traffic-related organisation at a structural level. By considering space and traffic before a concrete design for public space is to be realised, this lowers the risk of irreconcilable requirements being demanded of the design at location level, which at that stage can only result in a sub-optimal solution, at best. Think for instance of a narrow street within which a strong residential function must be combined with a flow-through function. A dilemma of that nature can usually be anticipated at a structural level and it is better to tackle it at that stage.

A condition for the consideration between space and traffic at a structural level is of course that a spatial and traffic-related preferred structure is available.

Spatial preferred structure
The spatial preferred structure is ideally realised from an analysis of the preferred identity of the city as a whole and the sub-regions within it, resulting in a set of preferred spatial qualities per section of area.

Often a spatial structure vision will already be available, within which framework similar analyses have been carried out. Within the scope of this design approach, one analysis step must be added, namely a translation of the preferred spatial quality into speed regimes per section of area. These speed regimes are therefore
argued from the spatial quality of an area: which speeds fit the identity of an area (definition, activities and experience), see figure 12.

Figure 12: Spatial analysis of the city and sub-regions

The result is a preferred structure for urban zoning: a patch map with the desired maximum speeds per area, rationalised from a viewpoint of spatial quality, see figure 13.

Figure 13: Preferred structure for urban zoning, with speed regimes per area

Drawing up a preferred structure for urban zoning (with accompanying speed regimes) has not yet been executed in this form within the framework of this project. This will need to be further tested in various pilot situations.
**Traffic-related preferred structure**

The traffic-related preferred structure will ideally be realised from an analysis of the desired accessibility of the city as a whole and the sub-regions within it, resulting in a set of preferred networks per vehicle family.

Often an accessibility vision will already be available, within which framework the preferred set-up of the traffic network is defined. Generally, an analysis will be at the basis thereof, such as displayed in figure 14.

![Figure 14: From accessibility of activity locations to preferred structure of traffic networks.](image)

It is standard practise for the traditional grading in modes of transport to be applied such that it results in networks for cars, bicycles and public transport. Within the framework of this design approach, the translation over to road systems per vehicle family needs to be added. This implies extra attention to the following in particular:

- walking networks (vehicle family A);
- hierarchy in cycling networks (vehicle family B) due to higher top speeds;
- networks for LMVs (vehicle family C);
- integrating urban logistics and public transit (bus) into networks for vehicle family E.

This does not mean to say that each vehicle family also has its own network within a physical sense, but it means that the networks must be constructed in such a manner that each vehicle family must be able to move safely and swiftly from A to B. It is essential to carry out this step correctly for all vehicle families, because the logic of routes, and cohesion within the networks needs to be guaranteed.

The result is a preferred structure for traffic networks: a map with urban infrastructure and its envisaged traffic functions, with related functional requirements. In the preferred structure for traffic networks, traffic networks for various vehicle families and various hierarchical levels can be overlaid, such as in figure 15.
Consideration at a structural level
Both preferred structures (from a spatial and traffic perspective) are subsequently confronted with one another, see figure 16.

Where dilemmas occur, solutions are sought at the structural level. This can be illustrated by figure 17, where a conflict is present between an urban zone with a (from a spatial quality viewpoint) preferred speed regime of 10 km/h, and a flow route with a (from an accessibility viewpoint) preferred speed regime of 50 km/h.
In the case of a dilemma of that nature, various solution options are conceivable, such as
- taking the flow route around the residential area;
- taking the flow route through the residential area and accepting that the preferred spatial quality
  and/or traffic safety will not be realised;
- taking the flow route through the residential area, but at a greatly reduced speed, and accepting
  that the preferred traffic flow quality will not be realised.

It is important that choices of that nature are made in this early stage, at a structural level, in order to prevent
unfeasible design specifications occurring later at location level. Sometimes it will be unavoidable that within
certain sections, a reconsideration will need to take place of the spatial and traffic-related starting points
(preferred spatial identity of areas and preferred accessibility of areas).

Principle choices concerning parking will also already have to be made at a structural level. This will then
concern questions such as:
- will parking be permitted in the area, or must parking be conducted outside of the area?
- will parking be clustered at a certain number of locations or not?
- will parking take place within the public space or in purpose-built facilities?
- will there be a charge for parking?
These questions apply to all vehicle families, in other words to bicycle-type vehicles and LMVs, and equally
to car and truck-type vehicles.

✔ By making a principle consideration between spatial and traffic-related preferred structures as a first step
within the design process (at the structural level), this will prevent unfeasible design specifications coming to the
fore at location level at a later stage, whereby either spatial quality and traffic safety, or accessibility is
compromised.

Result: four urban traffic environments
The result of the consideration between space and traffic at the structural level is the classification of all
infrastructure that belongs within the urban public space, into four so-called urban traffic environments.
These urban traffic environments are characterised by the maximum permissible speed within a street or
area: 10, 20, 30 or 50 km/h.

In each of these four urban traffic environments (with speed regimes of 10, 20, 30 and 50 km/h), the design is
primarily attuned to a normative vehicle family: resp. A, B, C and D. Lighter vehicle families than the normative
are always permitted, but are catered for in separate domains where necessary. In addition, there is the
option of possibly permitting heavier vehicle families. Whether this is desirable or not has to be assessed per
case, dependent on the local situation and the embedding within the total structure. In the event of heavier
vehicles being permitted, this will always be as a guest, which means that they will need to adapt to the
normative vehicle family in terms of speed and traffic behaviour. This is summarised in chart 1.
Chart 1: Urban traffic environments

<table>
<thead>
<tr>
<th>urban traffic environment</th>
<th>maximum permissible speed</th>
<th>normative vehicle family for design</th>
<th>lighter vehicles: always permitted</th>
<th>heavier vehicles: not permitted or permitted as guest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10 km/h</td>
<td>A: walking</td>
<td></td>
<td>(B, C, D, E, F)</td>
</tr>
<tr>
<td>2</td>
<td>20 km/h</td>
<td>B: bicycle-like vehicles</td>
<td>A</td>
<td>(C, D, E, F)</td>
</tr>
<tr>
<td>3</td>
<td>30 km/h</td>
<td>C: light motor vehicles</td>
<td>A, B</td>
<td>(D, E, F)</td>
</tr>
<tr>
<td>4</td>
<td>50 km/h</td>
<td>D: car-like vehicles</td>
<td>A, B, C</td>
<td>(E, F)</td>
</tr>
</tbody>
</table>

The definition of the exact speed limits and their substantiation is the subject of further research.

By allocating an urban traffic environment to the public space, the consideration between space and traffic at the structural level is effectively 'sealed': both the spatial quality and the traffic function are defined in broad outlines. Each of the four traffic environments possesses a unique, recognisable balance between spatial functions and traffic functions, such as displayed in the figures 18 to 21. This does not detract from the fact that all manner of consequences are possible within each traffic environment in the design of a specific situation. The allowing or disallowing of heavier vehicle families as a guest is a key factor in that sense.

By bestowing a unique character to each urban traffic environment in design and signposting, its recognisability is increased, and traffic participants are more aware of what is expected from them. This increases traffic safety.

Further study is necessary to assess how each urban traffic environment can obtain its own character in terms of design and signposting.
Figure 18: Urban traffic environment 1

Traffic environment 1
Dominant vehicle family: A (pedestrians)
Figure 19: Urban traffic environment 2

Traffic environment 2
Dominant vehicle family: B (bicycle-like vehicles)
Figure 20: Urban traffic environment 3
Figure 21: Urban traffic environment 4
Further specification of traffic function
By allocating an urban traffic environment to a street or area (1, 2, 3 or 4), it is thereby defined what the applicable maximum speed is there: 10, 20, 30 or 50 km/h. It is then defined per street or area, which the heaviest permissible vehicle family is there: A, B, C, D or E (the possible acceptance of F is determined individually per street or area). Per street or area, there is therefore a combination of the heaviest permissible vehicle family and the maximum permitted speed. This traffic function can be indicated by a letter and a number, for instance D3: a 30 km/h street (traffic environment 3), where anything up to car-type vehicles (vehicle family D) are permitted. Therefore in this street, no truck-type vehicles (vehicle family E) are allowed.

Specifying the traffic function in fact denotes whether vehicles heavier than the normative ones are permitted (as a guest), and, if so, which ones, see chart 2.

Chart 2 Possible traffic functions per urban traffic environment

<table>
<thead>
<tr>
<th>urban traffic environment</th>
<th>maximum permissible speed</th>
<th>traffic function if the normative vehicle family is permitted as a maximum</th>
<th>possible traffic functions if heavier vehicle families are permitted 'as a guest'</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10 km/h</td>
<td>A1</td>
<td>B1, C1, D1, E1</td>
</tr>
<tr>
<td></td>
<td>20 km/h</td>
<td>B2</td>
<td>C2, D2, E2</td>
</tr>
<tr>
<td>2</td>
<td>30 km/h</td>
<td>C3</td>
<td>D3, E3</td>
</tr>
<tr>
<td>3</td>
<td>50 km/h</td>
<td>D4</td>
<td>E4</td>
</tr>
</tbody>
</table>

Result: a map with traffic functions
Ultimately, the above will lead to a map, which specifies the traffic functions per area or for corridors/routes, see figure 22. This map displays the following per area or per route:
- the urban traffic environment (1, 2, 3 or 4) with related maximum speed (resp. 10, 20, 30 and 50 km/h);
- the heaviest permissible vehicle family (A, B, C, D or E).

Figure 22: The function map with traffic functions allocated to corridors/routes
In fact, the map with traffic functions supplies the basic materials for setting up design specifications at location level. Once the consideration at a structural level has taken place satisfactorily, it can be expected that the design specifications at location level are realistic.

By allocating a traffic function to a street, it is therefore defined which vehicle families are permitted there, and which maximum speed applies to the street in its entirety.

This however is not indicative of any 'merging or separating': the question of which vehicle families may be merged among one another, and which are dealt with in physically separated parts of the infrastructure will be answered during the design at location level.

By defining urban traffic environments and allocating a unique characteristic to each, the identification factor is increased and traffic participants are more aware of what is expected of them. This will increase traffic safety.

Functional classification of intersections
At an intersection, there might be streets that belong to the same traffic environment (equal intersections), but it might also be the case that various traffic environments join one another. In figure 23, all possible functional intersection types are displayed that can be present within an urban environment; they are arranged on the basis of the traffic environments of the intersecting streets (based on two intersecting streets).

![Classification in intersection types on the basis of the traffic environments of intersecting streets](image)

At an intersection of streets that belong to the same traffic environment, we can speak of an equal intersection. These are four intersection types, one per traffic environment (indicated in green). The four intersection types are indicated in yellow, with a speed difference between the intersecting traffic environments of a maximum of one level. Connections are also included of urban roads with roads outside the built-up area (indicated as traffic environment 5, > 50 km/h).

From the viewpoint of traffic safety, it is not desirable that the speed difference between the intersecting traffic environments constitutes more than one level (the six intersection types are indicated in red within the chart). In such instances, it is preferable for the speed difference to be reduced to a maximum of one level through additional measures. In this manner, it is equally feasible to create an equivalent intersection between a 50 km/h road and a walking route (10 km/h). The condition is that the speed of the 50 km/h road is reduced to 10 or 20 km/h via speed-restricting measures in a timely and incremental manner. A solution of
that nature can of course have consequences for the preferred structure for traffic networks. One idea to be considered is the implementation of a grade-separated crossing; and sometimes there are concealed qualities within existing networks (for instance in existing grade separations), which could be utilised in a better manner.

**Feedback loop to preferred structures for space and traffic**

After determining the function map, a feedback loop needs to take place concerning steps that were taken earlier:
- urban zoning: do the areas still have the envisaged identity?
- traffic networks: do the traffic networks still maintain the envisaged cohesion?

This feedback loop can lead to a revision in choices that were made earlier.

**All vehicle families made equal**

A key starting point for the consideration at a structural level is that all vehicle families are incorporated in a fully-fledged manner. This has a number of consequences:

**Better walking networks**

By incorporating walking as a fully-fledged mode of transport, it will become more appealing to walk instead of cycle for very short distances; this will reduce the congestion on the cycle path, as well as the bicycle parking bottleneck.

The points of focus for the design are:
- designing a walking network as a separate network;
- ensuring sufficient meshing within the walking network; in some locations, the walking network must be further completed;
- ensuring the ease of crossing for main routes, where there is now often an obligatory detour via ‘enforced points of transit’ (mostly major intersections with traffic lights);
- retaining the flow function on pavements, which currently have to compete with residential functions, and bicycle and LMV parking.

Design principles at a structural level need to be developed for walking networks.

**More meshed cycle networks**

Main cycle routes through the city are often located alongside main car routes. Although these offer fast connections, the network is basically too rudimentary for the bicycle, resulting in an excess of bicycle short-cuts against the flow of traffic and across sidewalks. In addition, these routes are positioned via the major traffic light-monitored intersections in the major car networks. At these intersections, there is only a limited green time allotted to the bicycle, with long waiting times as a result (or riding through a red light) and queues for cyclists turning left, of which the tail end sometimes ends up on the carriageway, see figure 24. This leads to dangerous traffic situations.

Figure 24: Insufficient positioning space for cyclists turning left at key intersections
By creating new cycle routes (in addition to the cycle routes along the car network) within the meshes of the urban major road network, a more robust, safe and intricate cycle network with more route alternatives can result, see figure 25.

![Diagram of cycle network meshes]

**Figure 25:** Narrowing of cycle network mesh width

This offers the option of cycling through quiet streets with few traffic lights, and provides for less congestion on the cycle paths along the major network and less strain upon the major intersections. Points of focus for the design are:
- The ‘passability by bike’ of 30 km/h zones (‘completing’ the network in certain places);
- The ease of crossing urban main roads (in between the major intersections);
- These ‘in between’ routes travel mostly through 30 km/h areas; this entails that speed pedelecs will have to hold back their speed; on the other hand however there will be relatively little loss of time at traffic lights.

**Design principles at a structural level must be developed for cycle routes within the meshes of the main car network**

**Separate network for the LMV family**

The consequence of the introduction of a separate LMV family is that a separate LMV network must be determined at a structural level, as an ‘in-between level’ between bicycle and car-type vehicles. This is not to say that this must also represent a physically divided network; often LMVs will be merged with the bicycle family and/or with the car family. This will be defined further in chapter 3.

**The introduction of vehicle family C means the development of a separate LMV network at structural level.**

**Consequences for the car network**

As a consequence of the above, extra intersections with cycling and walking routes will be formed within the major car network, in between the major intersections. Sometimes it will be possible to execute this at a grade-separated level, but usually it will be level crossings. These can be carried out as traffic lights, as a roundabout, or as an unregulated intersection. An unregulated solution is only possible in a road-safe manner, if, on the car route to the intersection, speed-reducing measures are undertaken which reduce the speed incrementally to a crawling pace. This means that sometimes concessions must be made to the ideal envisaged strict hierarchical increase and decrease of the speeds of car mobility.

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5 Also called the ‘Monderman stairs’, as described in background document 1b (see attachment 1)
In balancing user needs, this can lead to the driving time increasing slightly for urban car journeys; this will be elaborated upon further in chapter 3. When doing so, the general accessibility objectives must be taken into account. Sometimes this can lead to choices at a structural level having to be reconsidered.

- Design principles must be developed for safe intersections of cycle routes with main car routes.

Other vehicle families (E and F)
Vehicle families E (truck-type vehicles) and F (tram-type vehicles), also determine a separate traffic network at a structural level. These traffic networks are partly the result of underlying service networks (city logistics and transit-related):
- the line network of public transit (which influences networks for both vehicle families E and F);
- urban logistics, refuse collection services, fire services (particularly for vehicle family E, but perhaps in the future also increasingly including smaller vehicles in the family D, or even B/C);
- tourist coaches;
- other traffic from trucks.

- ✔ By creating a separate walking network, walking as a mode of transport will become more appealing, and will reduce the strain on the cycle network.
- ✔ Creating new cycle routes meshed with the urban major road network will result in a more robust, safe and integrated cycle network, thereby reducing the strain on the existing cycle paths along the main car network and ensuring less congestion at the major intersections.
- ✔ By making main car routes easier to cross at more intersections for walking and cycle routes, a key barrier to creating a more intricate walking and cycling network is removed.
3. Design approach at the location level: domains

In the previous chapter, we presented the general guidelines of the design methodology (see figure 11) and we have described the first section of the design process: the consideration between space and traffic at a structural level. This consideration at a structural level has culminated in a function map, within which the traffic functions are specified per area, or for axles/routes, see figure 22. The basis of this function map is that one of the four traffic environments is allocated to each street or area, to which a speed regime of 10, 20, 30 or 50 km/h is linked, plus a vehicle family that is normative for the design, see chart 2. No statements have been made yet at a structural level regarding the arrangement of the public space (such as merging or separating traffic modes).

In this chapter, we make a translation of the functional approach at a structural level to the design approach at the location level. Here, a balance is sought in the design of the public space between the residential and traffic functions, and - within the traffic space - between the merging or separating of various types of traffic.

Second phase of the design process: consideration between space and traffic at the location level

In the second phase of the design process, a further consideration is made between spatial quality and traffic-related requirements and preferences relating to the vehicle type at a specific location. This process should result in a design of the public space, within which both residential and traffic functions are harmoniously balanced with one another. A first step is to conduct an analysis at location level, analogous to the already conducted analysis at a structural level. The result is a collection of spatial design treatments, which should be allocated a place in the integrated design of the public space, see figure 26.

Figure 26: Spatial analysis at the location level (street or route)
Domains: merge or separate?
It is determined at the structural level which vehicle families and speeds are permissible (urban traffic environments, traffic functions) in an entire street or area. It is subsequently determined at the location level how the street (cross section) is then divided further. Physically divided sections of the infrastructure are called domains. Within each domain, multiple vehicle families may be merged.

Each of the vehicle families permitted within a street are allocated to a domain, but within one domain multiple vehicle families may be permitted. For example, urban environment 3 uses the LMV as a design vehicle, but the carriageway in this street design may also cater for bicycles and allow passenger cars to use the street, as guests. So a domain may host more (merged) vehicle families. Determining the domains therefore means answering the question of which vehicle families are to be merged, and which are to be physically separated. Physically separated entails a separation in the shape of a physical barrier. Two sections of the traffic space that are only divided by way of road markings or by the application of various materials, are therefore considered to be one domain.

An anomalous situation will result if a street fulfills two (physically separated) functions, such as a carriageway function (50 km/h) separated from a residential function (‘service road’) with 20 km/h limits. In such instances, one can in fact speak of two separate streets, which in and of themselves may or may not be divided into domains.

The central dilemma when determining domains
The central dilemma when answering the question of whether to ‘merge or separate’ can be defined as follows:
- On one hand, from the viewpoint of traffic safety, differences in mass and speed must be prevented as much as possible; this calls for the separate handling of vehicle families in separate domains;
- On the other hand, it is often desirable to merge vehicle families in as few domains as possible from the perspective of a lack of space, because the space will be handled more efficiently, and more possibilities will emerge to help form both residential and traffic functions within the design; this can only be done safely at relatively low speeds; this will simultaneously improve the possibilities for crossing the street.

Moreover, there is also a self-re-enforcing effect at work within this dilemma:
- The separate handling of traffic flows primarily has a speed-enhancing effect, which increases the necessity to separate and partially voids out any safety gains; this is an undesirable feedback effect;
- Merging can only be done in a safe manner at relatively low speeds; but merging will in itself lead to a higher attention level and temper the speed; this is a desirable type of feedback, if it is shaped in a safe manner.

The speed regime (and therefore the defined urban traffic environment in a street or area) is therefore a crucial factor.

General rules for merging/separating
It is determined at a structural level to which urban traffic environment a street belongs (the speed categories 10, 20, 30 and 50 km/h) and, linked to those, what the normative vehicle family is within the design (A, B, C and D respectively). In addition, it is determined whether heavier vehicle families than the normative are permitted there as a guest; this has taken place by allocating a traffic function to the street, such as D3: a 30 km/h street (in this street the LMV family is therefore normative for the design), within which vehicle family D is permitted as a guest. See also figure 22, the map with traffic functions.
With regard to merging/separating, the following general design rule\(^6\) is defined:
- a vehicle family that is a maximum of one category lighter than the normative vehicle family may be merged with the normative vehicle family within one domain; it may therefore also be separated;
- a vehicle family that is two or more categories lighter than the normative vehicle family, must be separated from the normative vehicle family.

Where the option has been taken for one or multiple heavier vehicle families to be permitted as a guest, these will at all times be merged with the normative vehicle family, and with the maximum speed applicable to the related traffic environment.

**Development of the four traffic environments**
The application of these general design rules to the four traffic environments will lead to a design framework per traffic environment, such as displayed in figures 27 to 30.

**Vehicle families E and F**
A consequence of the above is that vehicle family E (truck-type vehicles) is always a guest within the urban public space and must therefore adapt to lighter vehicle families. There is an exception for dedicated, separated infrastructure (such as a designated lane for scheduled buses or a special logistics lane), which are then basically withdrawn from the urban public space.

Tram traffic (vehicle family F) is dealt with inside its own domain in many instances (free tramways within the public space). In addition, trams, due to their predictable route, can be merged into any traffic environment with lighter vehicle families relatively safely. There too, the speed limit will also apply to trams in the traffic environment concerned.

✔ When dividing the public space into domains (physically divided sections of the infrastructure within which vehicle families might or might not be merged), an optimal balance is sought between traffic safety, accessibility, and the quality of the public space.
✔ Mass and speed differences within a domain are restricted as much as possible.

**Static or dynamic?**
In general, this design process leads to a physical design of the public space whereby the divide between residential and traffic functions, and - within the traffic space - the divide between the traffic modes, is static (invariable over time). However, there are always situations whereby it can be advantageous to opt for a dynamic configuration: the arrangement of the public space can then be adapted to current requirements. There are already various practical examples of this:
- dynamic arrangement of the traffic space: for example, a flexible arrangement of road lanes, reversible lanes, etc.;
- dynamic balance between traffic and residential functions: for instance, adapting a 'change-around' on certain days within a street with a clear traffic function (such as traffic environment 3) into a market place (traffic environment 1).

🔍 Further research is needed concerning the possibilities of dynamic layouts and the use of the traffic and/or residential space.

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\(^6\) This design principle was drawn up on the basis of experiences in the pilot cities, combined with own analyses of numerous design situations.
**Figure 27:** Design framework for traffic environment 1 (maximum of 10 km/h)

**Figure 28:** Design framework for traffic environment 2 (maximum of 20 km/h)
Figure 29: Design framework for traffic environment 3 (maximum of 30 km/h)

Figure 30: Design framework for traffic environment 4 (maximum of 50 km/h)
**Design of the public space**
Essentially, the foundation for formulating the design specification for the public space has been laid, namely:
- The conclusions of the location analysis, resulting in spatial design components (such as the relation between traffic function and residential function);
- The design frameworks for the four urban traffic environments (general rules for the subdivision in domains, see figures 27 to 30).

One key design question remains however: if a street is divided into various domains, then what is the speed regime for each of those domains? And, what are then the design requirements for each domain, in light of those vehicle families that are permissible within the domain and the permissible speed within that domain? Here lies another important dilemma, which the following explanation will clarify.

**Speed regime per domain**
Each street is allocated to one of the four traffic environments on the basis of the consideration at a structural level; in each street the related speed regime of 10, 20, 30 or 50 km/h is therefore applicable. Due to the fact that the permissible speed is a characteristic of the infrastructure (and not of the vehicle), all vehicle families that are permitted in the street on the basis of the assembled function map (figure 22), need to adhere to this speed regime. The speed regime that accompanies a traffic environment, as set in chapter 2, is applicable to the entire street, regardless of the subdivision into domains. The consequence of this is for example that in urban traffic environment 2 (20 km/h), an e-bike, scooter or car may not travel faster than 20 km/h.

But does the reverse consequence then become applicable, namely that the fast representatives of vehicle family B (riders of racing bikes or speed pedelecs) should be allowed to ride at 50 km/h on an urban 50 km/h route? And, if we allow that, do they do so within the B domain (therefore merging with slower cyclists), or would we consider that undesirable and refer these fast cyclists to the ‘carriageway’ (where they would then be merging with the heavier vehicle families C, D and E)? Or would we rather subject vehicle family B (cycle-type vehicles) to a general speed limit of 30 km/h for example within the city?

We should first pose the following question: suppose we permit a fast bicycle to cycle at 50 km/h, what would then be preferable: merging with slow bicycles within the bicycle domain, or merging with heavier vehicles (C, D and E) on the carriageway? We reconsider this dilemma from a traffic safety perspective (kinetic energy, as shown in figure 2). In the first instance, there is a danger that a slow bicycle will be hit from behind by a fast bicycle, let’s say with a speed difference of 30 km/h. In the second instance, there is a danger that the fast bicycle might be hit from behind by a car on the carriageway. As a car (vehicle family D) is heavier than a bicycle (vehicle family B) by an approximate factor of 100, so a much smaller difference in speed is required to generate the same kinetic impact. The formula for kinetic energy $E = \frac{1}{2}mv^2$ shows that the same ‘impact energy’ is already generated at a speed difference that amounts to ten time less, so at a mere 3 km/h.

We see here a key consequence of the formula $E = \frac{1}{2}mv^2$: because of the differences in mass generally being many times greater than the differences in speed, it is better from a traffic safety perspective to arrange vehicle families according to mass rather than to speed.

Theoretically speaking, it is therefore safer to manage fast cycling within the cycling domain rather than merged with cars. This does not yet mean however that we should always just allow a 50 km/h speed within the cycle domain along a 50 km/h route. This is only acceptable if the bicycle domain is designed in such a manner that the likelihood of a collision between a fast and a slow bicycle is minimised, and that the riders of traditional (slow) bicycles feel comfortable and at ease, despite the fact that the same domain is also used by fast bicycles.

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7 This applies despite the fact that the speed is quadratically included in the formula $E = \frac{1}{2}mv^2$, see also the ‘Kinetic energy’ box in chapter 1.
This can only happen if this bicycle domain adheres to stringent requirements, for example with regard to width, turning radii and intersection distances. Outside of the built-up area, there are incidentally already examples of such ‘bicycle motorways’, see figure 31. Although these design requirements still have to be developed, it is already clear in the run-up that, by far, most of the existing cycle paths along 50 km/h routes within the built-up area will not meet these requirements. Because traffic safety is a prerequisite, we will in the first instance reduce the maximum speed of a cycle domain to 30 km/h, or even 20 km/h. A possible solution of referring those bicycles that wish to go faster to the carriageway (where they then must merge with the car traffic), is rejected precisely because of the reasons of traffic safety that we elaborated on earlier. In addition, this is at odds with the starting point that vehicle mass and dimension determine where it is or is not permitted.

Reducing the permissible speed within the cycling domain may be seen to be a short-term solution, which is at least in accordance with the basic requirements of traffic safety. But we will subsequently have to consider, for long-term solutions, whether a maximum speed of 50 km/h can be realised within the cycling domain or via another division of the public space (in a responsible and safe manner). The route concerned was after all designated at a structural level as a traffic environment 4, and why would the accompanying speed regime of 50 km/h then be restricted to the heavier vehicle families? It is the case though, that realising a maximum speed of 50 km/h in the bicycle domain will generally only work with a rather rigorous reclassification of the cross section, for instance reducing the carriageway from 2 carriageways to 1 carriageway, and redesigning the remaining carriageway as a bicycle fastway. This must of course be acceptable from both a traffic-related (capacity) and spatial viewpoint.

It is expected that there are only a few routes within a city within which this is feasible. For the remaining routes we had designated as traffic environment 4, we have the following options:

- Either to maintain the ‘unequal’ speed division (maximum of 30 km/h for vehicle family B for instance, and heavier vehicle families at 50 km/h); This is in the first instance the easiest solution, but will create inequality between the vehicle families: actually, the bicycle domain no longer belongs to traffic environment 4 and a check needs to take place to consider what the consequences are for the earlier envisaged quality of the bicycle network;

- Or downgrade the entire route to traffic environment 3; this will require a feedback to the integral consideration at a structural level: an upgrade of another route will then probably have to take place, up to traffic environment 4.
Design requirements per domain
The subdividing of the urban traffic environments into domains will lead to a major diversity in domain types for the entire city. In a traffic-related sense, these domains can primarily be arranged according to:
- permissible vehicle families;
- permissible speeds;
- traffic volumes.

In addition, there are of course those spatial design components that stem from the location analysis, such as the relation between traffic and residential function.

As came to light in the paragraphs above, it is of great importance that design requirements are drawn up for all of these domain types, in such a manner that the traffic performance within a domain can take place in a safe and comfortable manner. These design requirements are related to matters such as:
- width;
- turning radii;
- use of materials and road surface types;
- minimum intersection distance;
- speed-reducing measures;
- etc.

The vehicle families A, B and C merit extra attention in this context.

There have not yet been any general design requirements drawn up within the framework of this study concerning a safe and comfortable traffic performance per domain (in view of the permitted vehicle families and speeds, and traffic volumes). This is a matter for further research, whereby existing guidelines that have been developed can of course be developed further.

Where the LMV family is merged with car-type vehicles on the “carriageway”, this places other demands upon guideline designs for the carriageway, which feature the car less as a starting point, and allow more flexibility of vehicles (such as those present in the LMV family). For example: it’s preferable to have a slightly wider lane (such as the example on the Erasmus Bridge in Rotterdam) than two narrow ones. Another possibility is the implementation of an LMV suggestion lane. All in all, the necessity to manage LMVs on the cycle path will diminish.

The introduction of vehicle family C means the development of design principles attuned to LMVs.

What if it doesn’t succeed?
It will often be the case, that it will not be possible initially to design the public space in such a manner that each domain fully meets the design specifications, often due to there simply not being enough available space to meet the entire range of requirements. The starting point must then be that the design is amended in such a manner that a design emerges that does adhere to the design requirements, and whereby the spatial design ingredients are simultaneously taken into account (originating from the location analysis).

This can only take place if earlier design choices are reviewed.

The following prioritisation can generally be utilised in this instance; see the earlier discussed example of a key urban approach road (traffic environment 4, therefore 50 km/h) whereby the bicycle domain in the first instance offers insufficient space for a safe performance of fast cycling up to 50 km/h.
1. **reduction in the maximum speed in the relevant domain**
   By lowering the maximum speed in the relevant domain, the basic requirements concerning traffic safety will at least be adhered to. It could however be that the street is no longer in line with the envisaged traffic function of the street for the vehicle families that use that specific domain.

2. **allocate one domain more space at the expense of other domains**
   This is only possible if the consequences (such as capacity reduction) are acceptable in the other domains.

3. **lowering of the maximum speed for the entire street**
   This will create a different urban traffic environment with more possibilities for merging, enabling the confined space to be utilised more efficiently. The flipside is that the street may no longer be suitable for the envisaged traffic function within the total structure.

4. **feedback to consideration at a structural level**
   Each of the abovementioned interventions can influence the functioning of the relevant street or route within the total structure. If it is found that this effect is not acceptable, then this will be reason to reconsider choices made earlier at a structural level (dilemmas between space and traffic). In actuality, this can for instance result in the seeking out of another route for the traffic function concerned, and therefore the amendment of the traffic function map (figure 22).

5. **back to the preferred space and traffic structures**
   If no solution can be found with regard to the consideration at a structural level, then the only remaining option is to return to the preferred space and traffic structures that form the basis for the consideration at a structural level. In actuality, this is a signal that the ambitions at the heart of these preferred structures (preferred spatial identity and preferred accessibility of areas) must be amended within certain modules.

The design approach at location level described above is summarised in the flow chart in figure 32.

- Designing public space according to the approach described above has not been carried out in this form within the framework of this project. This will need to be brought into practice further and tested in various pilot situations.

- For each domain, the same maximum speed applies as for the street as a whole, which is linked to the urban traffic environment allocated to the street. This will create clarity (there is only one maximum speed within the one street) and a balance between modes of transportation (why should one vehicle family be allowed to travel faster than another).

- Design requirements are drawn up for domains in such a manner that the traffic performance within each domain (in view of the permitted vehicle families and speeds, and the occurring traffic volumes) can take place in a safe and comfortable manner.

- If it does not prove possible to address these design requirements, the design choices made at an earlier stage must be reviewed at location and/or structural level so that the design requirements are actually met and full justice is simultaneously done with regard to the spatial design ingredients.
Parking: preferably within own domain

Leaving a vehicle for a short or longer period of time (whether monitored or otherwise), or to use another term: parking, is something applicable to all vehicle families. In as far as it is determined at a structural level that parking in the public space is permitted for a certain vehicle family, the starting point is that parking is conducted in specifically realised spaces within the own domain as much as possible.

This is already the norm for the car. The remaining vehicle families are not usually parked within their respective domain. It is for instance commonplace that vehicle families B (cycle-type vehicles) and C (LMVs) are parked on the sidewalk. This is undesirable from the viewpoint that walking is also a fully-fledged mode of transport.

In figure 33, an example is provided per vehicle family of parking in clearly marked and arranged plots within the own domain. These parking plots can sometimes be extracted from sections of the street that at first belonged to another domain, such as the transformation from car parking spaces to bicycle parking spaces (see figure 33, example B).
<table>
<thead>
<tr>
<th>A</th>
<th>“Parked” pedestrians</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Bicycle-like vehicles</td>
</tr>
<tr>
<td>C</td>
<td>LMVs</td>
</tr>
<tr>
<td>D</td>
<td>Car-like vehicles</td>
</tr>
<tr>
<td>E</td>
<td>Truck-like vehicles (including buses/coaches)</td>
</tr>
<tr>
<td>F</td>
<td>Tram-like vehicles (normally only in purpose-built facility)</td>
</tr>
</tbody>
</table>

**Figure 33:** Examples of parking within their respective domain

- For vehicle families B and C, design principles must be developed for the arranging of parking, preferably within their respective domain.
Intersections
Safety is the most important criterion when realising an intersection. Safety is enhanced by good ‘legibility’ of the intersection by the road user. This legibility is supported further by the application of certain logic in the arranging of the various types of intersections, defined by the traffic environments of the intersecting streets, see figure 23. The road user can immediately grasp what is expected from them by the layout of the intersection.

1. The further formulation of design principles for the various types of intersections (defined by the traffic environments of the intersecting streets), dependent on usage (types and volumes of intersecting traffic) and the available space, is the subject of further research.

From the necessity to create better and more intricately meshed walking and cycling networks, the intersections of walking and cycle routes (traffic environments 1, 2 and 3) with main car routes (traffic environment 4) merit special attention. Here, two paths of thinking are important:
- The better utilisation of concealed qualities within the existing network (such as the smarter use of existing “grade separations” within the network);
- The development of design principles for the safe at-grade intersecting of walking and cycle routes (traffic environments 1, 2 and 3) with main car routes (traffic environment 4).

2. Research must be done into the possibilities of the better utilisation of concealed qualities within the existing network from the necessity of creating a better and more intricately meshed walking and cycling network (such as the smarter use of existing “grade separations” within the network)

3. Design principles need to be developed for the safe at-grade intersecting of walking and cycling networks (traffic environments 1, 2 and 3) with main car routes (traffic environment 4).

Traffic speed and road capacity
Sometimes it will be necessary to lower the maximum speed on a road, for instance in a location where a footpath or cycle path intersects the road. To what extent does this lowering of speed result in consequences for the capacity of the road? The study of the car-following model can provide an answer. The car-following model shows how the behaviour of a driver is determined on the basis of the driving characteristics of the vehicle in front. A key hallmark of the driving characteristics of a driver is that the distance headway becomes greater as the speed of the vehicle is increased; the time headway remains roughly the same. This entails that if the speed is lowered, the distance headway with regard to the vehicle in front will decrease. The driver is therefore less apprehensive about driving at a closer distance to the vehicle ahead due to the lower speed and the correlating braking distance. This will result in an increased density of the traffic flow. This phenomenon also entails that lowering the speed of a traffic flow does not represent major consequences for the capacity of the road; the effect of a lower speed is compensated for due to cars driving closer together. Lowering the speed does impact travelling time, albeit in a minor way. The delays caused by intersections are particularly relevant in determining average travelling times.

In urban car networks, the permitted maximum speed therefore does not exert a large influence on the capacity of the network. The capacity of an urban car network is to a great extent determined by the (limited) capacity of the intersections of the main routes. In particular the layout/configuration and the arrangement of the level intersections (four-way intersection, T junction, roundabout) represent key factors for defining capacity and the average journey time within a route. By adapting the traffic control (right of way ruling, green wave) and by increasing the number of positioning spaces at intersections, one is able to increase the capacity of the intersection and thereby the capacity of a route/corridor.

4. Further research is needed concerning the impact of the speed of car traffic on the traffic performance capacity and the circulation of urban infrastructure.
**Conclusion and feedback loop to the structural level**

The key when designing public space is to opt for a suitable speed regime, which offers the optimum for both spatial quality and traffic function. In those locations where this is not successful, the remedy is often to reduce the design speed a notch or two, whereby more merging becomes possible and opportunities arise for a more efficient utilisation of space. The effects of this upon accessibility must be viewed in a realistic manner. If it turns out that accessibility of specific locations is thereby compromised, then considerations made earlier between space and traffic at the structural level need to be reconsidered.

Ultimately this can lead to the preferred structures for space and/or traffic needing some amendment.

This is displayed by way of the feedback loops in the design methodology; see the chart in figure 34.

![Design methodology with feedback loops](image)
4. The next step

This chapter describes which subsequent steps are needed to take the “Urban Mobility” design approach a step further, and to render it suitable as a handy and useful aid for the (re)arrangement of the urban public space. These subsequent steps are part of a roadmap for implementation that is to be drawn up for that purpose. This roadmap encompasses a content-related programme, an organisational plan and a communication programme.

Content-related programme
In order to take the design approach a step further, first, a substantive in-depth look and further development are needed in many aspects. Pilots will need to be set up in order to test the methodology in practice.

Towards practical application
Admittedly, the design approach is substantiated and developed according to a phased plan. The actual application in a practical situation will prove whether it is possible to attain a fully-fledged design of the public space with the use of the developed approach. To that effect, the design methodology must be worked out to include a number of analytical phases and implementation phases. The application of the design methodology will provide an answer to the following questions: are the design steps logical and comprehensible for the designers? Is there enough expertise and information available to set up a preferred structure for both the spatial zoning and traffic networks? Can the vehicle families and traffic environments be handled adequately? How does the consideration proceed at the structural level and the location level? To what extent do the results force the issue of returning the feedback to earlier design phases?

Choosing between implementable pilots
This choice will take place after consultation with the pilot cities that are to be selected. We expect that it will be necessary to work in phases in the case of the pilots. In that respect, the size of the area where the methodology is to be applied plays a major role. We propose to start in a smaller area (corridor, residential area) and then scale up incrementally to an urban district, for instance, and finally to an entire city. The generic nature of the approach demands that the methodology is implemented in various types of cities.

Further research of partial aspects
This step concerns further research regarding a number of partial aspects (legal, traffic-related, behavioural...). In this research, questions will have to be answered that are related to the sections of the design approach below:

<table>
<thead>
<tr>
<th>For all of the distinguishable vehicle families:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- exact borders (mass, width and possible also length) of the vehicle family, as well as the correlation between dynamic width and physical width of vehicles;</td>
</tr>
<tr>
<td>- regulation (license registration / driving license / helmet obligation etc.);</td>
</tr>
<tr>
<td>- traffic behaviour (education, educational campaigns, own responsibility of road user).</td>
</tr>
</tbody>
</table>

Spatial quality:
- providing a concrete form for the spatial analysis (identity and classification of a city or area);
- working out the steps to arrive at the preferred structure of urban zoning (including the derivation of speed regimes from a spatial quality) and the realisation of spatial components.

Urban traffic environments, domains:
- the development of design principles at a structural level for walking networks;
- the development of design principles at a structural level for cycling routes within the meshes of the main car network;
- the development of a separate LMV network at a structural level and the drawing up of LMV-attuned design principles;
- the development of general design requirements for a safe and comfortable traffic performance per domain (given the permissible vehicle families and speeds, and the occurring traffic volumes);
- the acknowledgement of walking as a fully-fledged mode of transport. This requires the drawing up of design requirements for the flow function of sidewalks, the defining of walking networks, etc.;
- conduct further research and substantiate speed limits (10, 20, 30, 50);
- research into how each urban traffic environment can attain its own unique nature through design and signage;
- the development of applicable legislation incl. speed-reducing measures for B and C family (analogous to existing measures for D and E family).

Layout and utilisation of the infrastructure:
- research into the possibilities of dynamic arrangement and use of traffic and/or residential space;
- the development of design principles for the organisation of parking for vehicle families B and C, preferably within their respective domain;
- the development of design principles for the various types of intersections (defined by the traffic environments of the intersecting streets);
- research into the possibilities for better utilisation of “concealed qualities” within the existing network (such as the smarter utilisation of existing “grade separations” within the network);
- the development of design principles for the safe intersecting of walking and cycle routes with main car routes;
- research into the influence of car traffic speeds on the traffic performance and the traffic circulation of the urban infrastructure.

Assessment, effects and expansion of the design approach:
- assessment of the design approach for ongoing developments such as fast cycle routes;
- analysis of existing traffic solutions within a developed design approach framework;
- assessing the impact of design approach on functioning of auxiliary services and refuse collection services;
- research into last mile optimisation for city logistics;
- expansion of the design approach to outside of the built-up area.

Organisational programme
We are working on a suitable balance between the various traffic modes and the remaining functions within the (limited) public space in the city. A unified vision and approach is a key prerequisite. The design approach “Urban Mobility” can represent a good national medium in this sense. In order to further imbedding the approach and the methodology, it is preferable that more stakeholders are involved in the subsequent phase. We can distinguish between the following:
- Involving key stakeholders;
- Approaching and generating interest from pilot cities.

Communication programme
The progress of the research and the attained results will be communicated to the public via a range of methods and channels. Key parties in the communication programme include:
- users (e.g. city staff, consultants);
- the professional traffic and spatial sector, including educational institutes;
- governments;
- industry and trade organisations.
Literature


CROW (2012). *ASVV 2012; Aanbevelingen voor verkeersvoorzieningen binnen de bebouwde kom* (Recommendations for traffic provisions within the built-up area). Publication 723. CROW Kenniscentrum voor verkeer, vervoer en infrastructuur (Knowledge Centre for Traffic, Transport and Infrastructure), Ede, Netherlands.


Fietsberaadpublicatie 24 (Centre of Expertise on Bicycle Policy publication 24), Utrecht, May 2013.


SWOV (2005). *Door met duurzaam veilig* (Continuing with Sustainable Safety) SWOV (Institute for Road Safety Research), Leidschendam, Netherlands


SWOV (2014). *Safe Cycling Network, ontwikkeling van een systeem ter beoordeling van de veiligheid van fietsinfrastructuur* (Safe Cycling Network, the Development of a System for the Assessment of the Safety of the Bicycle Infrastructure) SWOV (Institute for Road Safety Research), Leidschendam, Netherlands. 2010


Attachment 1: Overview of background documents

This final report is accompanied by a number of underlying documents, records and presentations. These can be located at www.anwb.nl/verkeerindestad

1. Results of reconnaissance (desk research)
   - Background document 1a: Reconnaissance results per analysis level
   - Background document 1b: the “Mondeman stairs”

2. Records of expert meetings and stakeholder gatherings
   - Background document 2a: Record of experts meeting on January 15, 2015
   - Background document 2b: Record of stakeholder meeting on April 29, 2015
   - Background document 2c: Record of experts meeting September 28, 2015

3. Results of ANWB member consultation
   - Background document 3a: ANWB member consultation – survey
   - Background document 3b: ANWB member consultation – research report
   - Background document 3c: ANWB member consultation – public version
Attachment 2: List of consulted experts and stakeholders

Participants of ANWB experts meeting – 15 January 2015
- Otto van Boggelen (CROW – Fietsberaad)
- Koos Louwerse (CROW – Fietsberaad)
- Wim Bot (Fietsersbond)
- Jeroen Dijk (DSO Amsterdam)
- Michel Heesen (M. Heesen Architecture & Landscape Design)
- Hans Hilbers (PBL)
- Albert Koolma (Municipality of The Hague)
- Frans Botma (Municipality of The Hague)
- Jasper Mallens (Municipality of Rotterdam)
- Tineke Posno (Municipality of Helmond)
- Jan Ploeger (Province of Zuid-Holland)
- Rob Tiemersma (Municipality of Utrecht)
- Marc Verheijen (architect / traffic engineer)
- Ton Hendriks (ANWB)
- Joske van Lith (ANWB)
- Jaap Renkema (ANWB)
- Jan Rijnveld (ANWB)
- Ferry Smith (ANWB)
- Jeanette van ’t Zelfde (ANWB)
- Johan Diepens (Mobycon - study group)
- Bart Egeter (Bart Egeter Advies - study group)
- Ben Immers (Ben Immers Advies - study group)
- Paul Weststrate (Awareness – study group)

Participants of ANWB relations meeting - 29 April 2015
- Goriska van Cooten (Rijkswaterstaat) (Department of Waterways and Public Works)
- Bernell Herder (Urban Cycling Institute – UvA)
- Peter van der Knaap (SWOV)
- Ron van Noortwijk (Metropolitan Area of Rotterdam / The Hague)
- Bastiaan Pigge (VVN - Dutch Agricultural Vehicles Initiative)
- Paul Poppink (TLN) (Dutch Association for Transport and Logistics)
- Rink Jan Slotema (EVO) (Entrepreneurs’ Association for the Transport and Logistics Sector)
- Anneke Smilde (Ministry of Infrastructure and the Environment)
- Peter Veenbrink (SOAB Consultancy Agency)
- Robbert Verweij (Ministry of Infrastructure and the Environment)
- Jaap Vreeswijk (Imtech)
- Christa Grootveld (BOVAG)
- Ko Droogers (ANWB)
- Janique Huijbregts (ANWB)
- Roxy Tacq (ANWB)
- Rob Gremmen (ANWB)
- Marianne Dwarshuis (ANWB)
- Bas Molenaar (ANWB)
- Markus van Tol (ANWB)
- Arjan the Bakker (ANWB)
- Ton Hendriks (ANWB)
- Jaap Renkema (ANWB)
- Bart Egeter (Bart Egeter Advies - study group)
- Johan Diepens (Mobycon - study group)
- Ben Immers (Ben Immers Advies - study group)
- Paul Weststrate (Awareness - study group)

Participants of ANWB experts meeting - 28 September 2015
- Jasper Mallens (Municipality of Rotterdam)
- Hans Nijland (Planbureau for de Leefomgeving)
- Gemma Warmerdam (RAI Association)
- Jan Ploeger (Province of Zuid Holland)
- Fokko Kuik (Municipality of Amsterdam)
- Peter van der Knaap (SWOV) (Institute for Road Safety Research)
- Atze Dijkstra (SWOV)
- Christa Grootveld (BOVAG) (Association of Car Dealers and Garage Holders)
- Jan Bessembinders (BOVAG)
- Jasper Bras (Arcadis)
- Albert Koolma (Municipality of The Hague)
- Frans Botma (Municipality of The Hague)
- Marcel Nieuweboer (Municipality of The Hague)
- Koos Louwerse (Ligtermoet & Partners)
- Wim Bot (Cyclists’ Association)
- Kate de Jager (Ministry of Infrastructure and the Environment)
- Jaap Renkema (ANWB)
- Ton Hendriks (ANWB)
- Jeanette van t Zelfde (ANWB)
- Roxy Tacq (ANWB)
- Bart Egeter (Bart Egeter Advies - study group)
- Johan Diepens (Mobycon - study group)
- Ben Immers (Ben Immers Advies - study group)
- Paul Weststrate (Awareness - study group)
- Eva Keizer (Awareness - study group)
Attachment 3: Pilot city workshop participants

Helmond
- Tineke Posno
- Henk van Lieshout
- Judith van Dijk
- Willem van Hal
- Marieke Martens
- Pieter Klumpers

Rotterdam
- Warner Beumer
- Martin Looiije
- Jasper Mallens
- Dennis Scherpenberg

Utrecht
- Robert Hoenselaar
- Ronald Tamse
- Ruud Ditewig
- Rianne Boot
- Jan Willem van Zeijl
- Han Schraders

Study team
- Bart Egeter
- Ben Immers
- Johan Diepens
- Paul Weststrate
- Dick van Veen
- Peter Volken Smidt
- Ton Hendriks
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Attachment 4: Summary of ANWB member consultation results

Summary of research report for the ANWB Urban Mobility Survey
The ANWB researches how the available space in cities can be utilised by all of the city’s traffic in a smarter and safer way. Part of the research is a survey conducted among ANWB members, held to find out to which extent people can relate to the traffic issues in the cities and what their opinions are in that regard. The survey among the Denk and Doe Mee (Think and Take Part) panel members (10,000 members) of the ANWB commenced on June 10, 2015. On June 24, 2015, the survey closed for panel members. At that point in time, a total of 3708 panel members had completed the survey.

Defined below are the problems as described by the respondents that they experience when travelling within the city. Many of the hindrances that members have spotted in the city traffic lie within the realm of traffic behaviour (by other road users), while a smaller section is either directly or indirectly related to the design of the public space and traffic space.

In this summary, we look at the results that are relevant for the design approach, and are therefore related to the arrangement of the public space, including the traffic space within the city.

The heart of the problem when travelling within the city, according to the ANWB panel members is that:
1. road users do not adhere to the rules;
2. there are too many different types of road users criss crossing one another;
3. there are too many road users for the available space.

The first item is a behavioural problem, but the second and third item (partly) stem from the congestion in relation to the design of the road and the division of the space over the various modes of transport.

In particular, those drivers of vehicles who share the same traffic space, but have differences in speed, are hindered by each other. The drivers of passenger cars, ordinary cyclists and riders of electric bicycles all indicate that their primary hindrance consists of other road users who place them in a dangerous situation. Pedestrians especially are hindered by the fact that other road users obstruct or impede them.

Of the ANWB panel members, close to 75% state that not every street needs to be available to every type of road user, if this increases the flow and/or safety; even if it means that a section of road users (a particular vehicle family) needs to take a detour. This is an initial indication of the large amount of support for the design approach, which sometimes separates traffic flows and diverts routes if it proves necessary to optimise traffic function with residential quality on the street.

For the entire study report and the public version of the research results, go to: www.anwb.nl/verkeerindestad