Radfahrersicherheit – Was Europa von den Niederlanden lernen kann

Cyclist Safety – What Europe Can Learn from the Dutch

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Abstract

In many EU countries, and especially in major cities like Berlin, Paris, London and Barcelona, the number of cyclists in daily traffic is strongly increasing. The related strong increase in the number of serious injuries and fatalities amongst cyclists is only now starting to gain the attention it deserves. In the Netherlands, where biking is a widely accepted way of transport, cyclist and pedestrian safety is addressed by training, infrastructural solutions and increasing cyclist visibility. Furthermore, international projects related to this are initiated by Dutch organisations. This paper shows two examples of this; the pedestrian & cyclist airbag developments and vulnerable road user path prediction for use in e.g. autonomous braking.

Introduction

The Dutch are world-famous for the 16th century painters, tulips, cheese, walking on wooden shoes, their extended uses of wind mills and of course for biking. Especially in the latter case, many people make the mistake to think that this is purely a Dutch habit.

The first bike, the so-called velocipede, was developed in 1817. No pedals were yet available; one had to make a kind of walking movements. Since then, the development of bikes and bike models has taken an enormous step forward to where we are now. These days, there is a very wide variety of bike types and bike models available. Important types are the granny bike, the city bike, in Germany normally called “Holland Fahrrad” (Dutch bike), the racing bike and the mountain bike. Of course, there are other categories like tandem bikes and carrier tricycles, but these types are so far less represented in daily traffic.

As in most EU countries the bike is mainly used for sporty activities, in the Netherlands the bike is a widely accepted means of daily transport, for distances up to 10-12 km mainly in urban areas.

With the increasing number of both cyclists and passenger cars in a shared environment, the issue of *safety* becomes increasingly important. For the physical safety of the car driver, accidents with cyclists are normally not catastrophic. On the other hand, the cyclist is much more vulnerable. Therefore, passenger car to cyclist accidents often have an injurious or fatal effect to the cyclist.

While a lot of worldwide attention is being paid to the safety of passenger car occupants as well as of motorcyclists in almost any type of accident, pedestrian and pedal cyclist safety has a long time been forgotten. With the increasing number of cyclists, that use the bike as an environment friendly means of transport, in major cities such as Paris, London, Barcelona and Berlin, with unfortunately the related increase of the number of serious injuries and fatalities, cyclist safety starts to gain the attention it deserves.

Fig. 1 clearly shows that safety of cyclists is at stake in many major European cities.

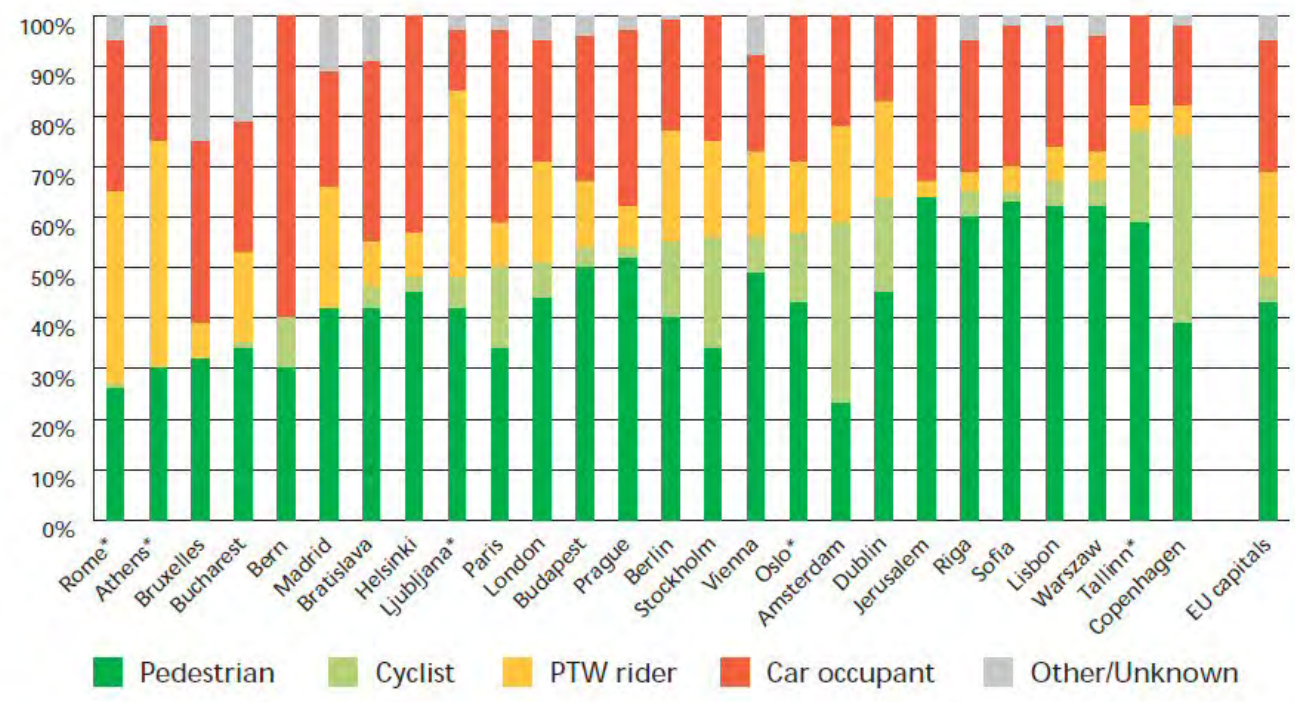

Fig. 1 Distribution of road deaths by road user groups (2004-2006) [2]

1 Increasing cyclist safety

In the Netherlands the number of fatalities in road traffic has been reduced from over 3000 per year in the 1970ties to about 750 in 2008. However the number of fatalities under cyclists has been stable around 200 per year for quite a long period. Concerned by this situation the Dutch national government started some years ago to be more active in increasing cyclist safety. This is supported, stimulated and in some areas initiated by interest organisations such as the Dutch Cyclists' Union. Several other national consumer organisations are supporting this work.

Furthermore, also with international stakeholders such as Euro NCAP one can see an increasing awareness of cyclist safety. For implementation of this issue in any formal test procedure, a lot of formal discussions (and the related time) are needed. Though, one should not ignore the safety boost such regulations can induce.

In increasing cyclist safety, there are a couple of main instruments, such as:

- Training (see section 1.1)
- Infrastructure (see section 1.2)
- Cyclist visibility, especially at dawn and at night (see section 1.3)
- Pedestrian & cyclist –friendliness of the vehicle (see sections 2 and 3).

Focus of this paper will mainly be on this last option.

1.1 Training

Young kids learn cycling from their parents. During their first years in cycling, normally they are accompanied by adults when in traffic situations. Thus, they learn cycling in a stable manner, but also how to behave in traffic.

Dutch kids have “Traffic lessons” at school at the average age of 10 years, which provides them with official rules, guidelines for behaviour in traffic and raises their awareness of dangerous situation and safety. These lessons are finalised by both a theoretical and a practical exam. For this latter part, kids need to practise. The practical exam is by following a described route, meeting a realistic variety of potentially dangerous traffic situations.

When one wants to obtain his/her drivers licence, in the Netherlands again both a theoretical and practical part together form the exams to pass. In the theory to get familiar with, also important parts are related to safety of other road users.

Using this system ensures that a majority of (the Dutch) road users is clearly aware of proper behaviour in traffic, as well as from the risks and dangerous situations.

For special groups like foreigners that start to live in the Netherlands, there are special “Biking schools”, where specialist trainers teach you how to use your bike. These schools are sponsored by the Dutch Ministry of Transport.

1.2 Infrastructure

Regarding infrastructure, one should notice the difference between rural and urban areas. In the Netherlands, an increasing number of cyclist lanes in rural areas are separated from the car lanes, or dominantly indicated. Though clear improvements were made during the past years, there still is enough room for improvement here.

In urban areas, it is not always possible to have truly separate lanes for cyclists and motorised traffic. In these cases, mostly a white (dotted) line separates the lanes, though in major cities there are also many cyclists' lanes in red asphalt instead of the regular black variant. Decreasing average vehicle speed by introducing roundabouts and speed ramps increases road safety for vulnerable road users. In some urban traffic light situations, cyclist stand in front of cars; this enhances their visibility.

Some of the well intended infrastructural safety measures make cycling much harder by introducing sharp corners and double crossings. This might seems quite safe on the drawing table, in practise it often results in cyclists bending the rules. Especially in those situations, when other road users no longer know what they can expect (one can call it the path unpredictability of cyclists), cyclist safety is in a scrape.

Although the situation is the Netherlands can still be improved to increase cyclist's safety; the Dutch infrastructure for cyclists can be an example for many EU-cities and rural areas, where cyclists are forced to use the same roads as cars and heavy trucks, with the related safety risks.

1.3 Cyclist visibility, especially at dawn and at night

As in many other countries, Dutch cyclists have to ensure that they are visible for other road users. Many years, it was obliged to have a standard and working light device on the bike. Since 2008, it officially is allowed to have cycle lights attached to the human body or clothing, though it should be a constant light, non-flashing.

Especially in the autumn, with less and less daylight, police performs regular checks to ensure that a large majority of cyclist are indeed using their lights. Sadly, this turns out to be still necessary.

In many cases, bikes also have reflecting areas, which increase especially visibility from the side. This is specifically important in junctions and crossings. Furthermore, a lot of attention is being paid to blind spot accidents, where VRU's are hit by a heavy vehicle (truck or buss). Blind spot monitoring technology, especially for use in urban areas, is becoming a more and more general feature in the Dutch heavy vehicle fleet.

2 Pedestrian & cyclist –friendliness of the vehicle

Unfortunately in the Netherlands, despite a good infrastructure and training, the above mentioned items are not enough to increase vulnerable road user (VRU) safety to an acceptable level.

In the Netherlands about 50% of the cyclist fatalities are caused by impacts with passenger cars. In vehicle against VRU accidents, the vehicle speed and the vehicle front design play major roles. In this view, several items should be mentioned to make vehicles safer:

- “Soft” front structure design
- Avoidance of head contact with hard vehicle parts like the windscreen and the A-pillars
- Decrease of the impact speed

Within the European project APROSYS, a lot of work has been done on “softening” the vehicle front, by decreasing bonnet stiffness by taking away parts of the underlying structure. Also, good results were obtained here regarding increasing the energy absorbing capacity of the bonnet, by using special materials and energy absorbing design solutions. In APROSYS, also concepts were made for a deployable bumper and a special construction for covering the A-pillars by the windscreen. From an early stage on, also important work was performed on pedestrian airbags. Parallel to the work within APROSYS, this airbag work was taken further by TNO and the Dutch Cyclists’ Union, focussing on the benefits for cyclists, as countermeasures for pedestrians are not automatically beneficial for cyclists too. After a limited and a following extended simulation study, it was concluded that an airbag covering the windshield offers good benefits for both pedestrians and cyclists. Though, the basic concepts seen so far, being a pedestrian airbags, need to be changed both in geometry, gas flow and sensor system to protect all vulnerable road users

3 Pedestrian & cyclist airbag

3.1 Need

In 2008, 750 people were killed in road accidents (see *Fig. 2*). The Dutch authorities aim for a further reduction towards a maximum number of fatalities of 500 per year in 2020. This ambitious target can only be met by serious efforts. Amongst the fatalities, car occupants and cyclists are a clear majority. While the number of fatalities amongst car occupants shows a clear decreasing trend, the number of fatal injuries amongst cyclists has shown no decrease since 2004, as also shown in *Fig. 2*. Therefore, the Dutch Ministry of Transport wants to increase cyclist safety.

As depicted earlier, the work on this airbag was started in cooperation between TNO and the Dutch Cyclists’ Union, supported by the Dutch Ministry of Transport. Now, it is being taken further by a larger group of international stakeholders.

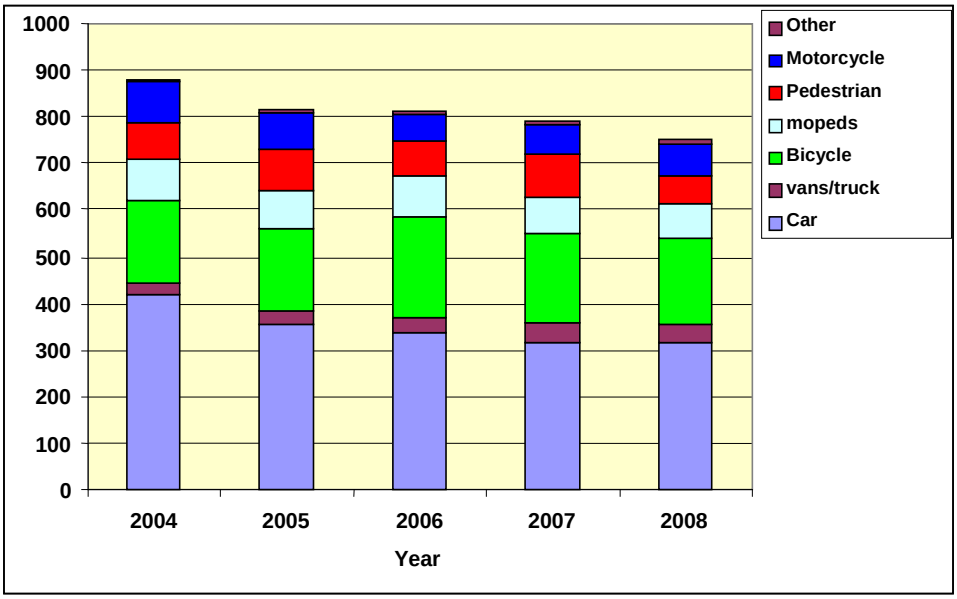

Fig. 2 Dutch fatality numbers for different categories of road users, 2004-2008

3.2 Vision towards cyclist safety

In 2008, the Dutch Ministry of Transport has published its Strategic Plan on road safety. One of the goals set out in this strategic plan is to reduce the number of fatalities and serious injured casualties amongst vulnerable road users (VRU's). As follow up on the TNO/Cyclists' Union cooperation, a new project was defined. This project focuses on reducing accidents whereby VRU's are impacted by passenger vehicles. The idea in this project is to support the development of valuable solutions that protect all VRU's, pedestrians and cyclists, which will get an award similar to the Beyond NCAP protocol. Furthermore, a boost towards the implementation and acceptation of these safety systems is very beneficial to increase VRU safety.

The potential solutions as mentioned in previous TNO studies are [3]:
- Reduce the impact speed (brake assist / autonomous braking)
- Exterior airbags, in particular a windshield airbag to prevent harsh head impacts

Both solutions need a reliable sensor system to detect and classify pedestrians and cyclists prior to impact. The sensor output can be used:
- To trigger braking actions
  - in this case a pre-crash decision is required.
- To deploy an exterior airbag
  - this decision can be made at the moment of impact using an in-crash sensor.

Various manufacturers have developed prototype airbags dedicated to protect pedestrians; however these airbags and especially the sensor systems are not yet ready for introduction in the vehicle fleet. The Dutch Ministry wants to encourage the further development of these airbags with a focus on pedestrian and cyclist safety.

The foreseen draft time path, depending on the outcome of this project and the introduction of this type of airbags by OEM's is shown in *Fig. 3.*

Fig. 3 Time path for development, testing and introduction in the fleet

3.3 Towards a Proof of Concept of the pedestrian & cyclist airbag

In short, the actions defined in the current project are [4]:

1. A study to the potential effectiveness of a windshield airbag to protect all Vulnerable road users, in comparison to other solution such as “Brake Assist” or “Pedestrian-only” airbags
2. Specification of the airbag system including the sensing part, specification of the sensor field test and the final system evaluation
3. System pre-development, by suppliers and car manufacturers involved, for a prototype demonstrator to proof the feasibility and reliability of airbag and sensor system
4. Performing a sensor field test in a crowded urban area
5. System evaluation, using Beyond NCAP protocol
6. Dissemination of results enabling a wide spread implementation of this new airbag

Very important for the success of the project is the cooperation between the participants: the Dutch Ministry of Transport, the Dutch Cyclists’ Union, TNO, insurance companies and main 1st Tier suppliers, with OEMs on the background.

The project start date is September 1st 2009; under special conditions new partners can join the consortium at a later stage.

4 Where is the VRU??

Both in working towards the pedestrian & cyclist airbag and e.g. autonomous braking, there are some important issues for the sensing system and decision logic:

- Is “it” a bicyclist, pedestrian or something else, such as a pole or tree?
- What is the VRU’s path? Will there be an impact?

The first issue currently is widely enough addressed, but the second issue is harder. Therefore, TNO works on path prediction of VRU's, based on profound experience with path prediction for cars. That work followed an approach, extrapolating the current trajectories of the object vehicle and host vehicle, and determining if a collision occurs. When a collision will occur, a lateral and longitudinal acceleration is advised for collision avoidance.

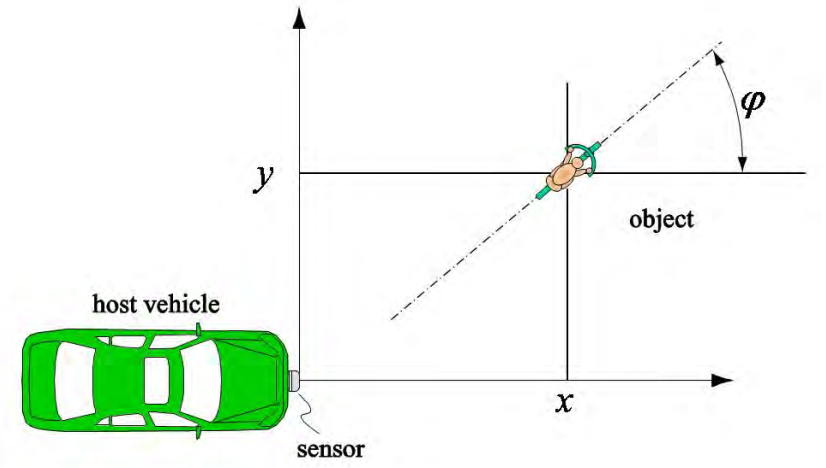

Fig. 4 Host vehicle coordinate frame with incoming cyclist

Now working on active safety systems towards VRUs, a new method has to be developed. This new method should be able to predict the future trajectory of objects (pedestrians and cyclists) and the host vehicle. The method TNO uses is based on probability density functions (PDFs). The host vehicle coordinate system, with an approaching cyclist, is shown in *Fig. 5.* In literature, two drawbacks of probabilistic distributions are indicated [1]: the increase of computation time and a lack of an accurate model of the driver's behaviour in different traffic situations. With the new TNO approach, these potential drawbacks can be overcome. Using simplified Monte Carlo techniques and simplified vehicle models, the computation time is quite limited and thus useful for real time applications. A realistic model of the driver's behaviour is part of further work. Finally the probability density functions are combined with general probabilistic risk estimation (PRE).

5 Discussion

Awareness of safety needs for the combined group of cyclists and pedestrians is growing. Not only in the Netherlands, the need for improved cyclist safety is seen; an increasing number of other European countries starts feeling this need.

Apart from training and infrastructure improvements, which mostly need a very long time for realisation, vehicle technology can truly be very beneficial for these vulnerable road users.

Main issues currently are the pedestrian & cyclist airbag and autonomous braking. For both, very reliable sensing systems are needed to detect and classify the VRU. Furthermore, predicting its path and the risk of an impact are yet unaddressed challenges.

6 Definitions, Acronyms, Abbreviations

VRU = Vulnerable Road User, meaning pedestrian and cyclist

PDF = probability density functions

PRE = probabilistic risk estimation

Pedestrian & cyclist airbag = external car airbag, covering the windscreen and A-pillars. Thus, it protects the VRU head from harsh primary impacts.

7 References

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