TRANSPORT & ENVIRONMENT

September 2014

Briefing

# Ending lorries' deadly track record: a matter of (direct) vision


## Summary

Lorries are involved in 4,200 fatal accidents in Europe every year. Many of the fatalities are vulnerable road users such as cyclists or pedestrians. Poor driver vision and lorry blind spots are a major cause of accidents. Unlike passenger cars, there are **no direct vision requirements for lorries** and regulators have instead focused on mirrors to reduce blind spots. Unfortunately the, often distorted, indirect vision provided by mirrors is far inferior to direct vision, i.e. seeing something with your own eyes. The European Commission has proposed that lorry tractors could be up to 80-90cm longer, if they are demonstrably more aerodynamic (i.e. more fuel-efficient) and safe. This is a once-in-a-generation opportunity to redesign the EU's typical brick-shaped designs to structurally improve lorry safety and, in particular, direct vision.

Hauliers, trade unions, safety groups, automotive suppliers and cities across Europe endorsed the proposal. The European Parliament overwhelmingly backed the proposal but lorry makers oppose the new design rules fearing it could increase competition if one lorry maker would be allowed to sell new models before the rest. Member States, led by Sweden and France,[i] back lorry makers and want an 8-year ban and postponement of new designs.

This briefing summarises a study by a research team from the Design School at Loughborough University for Transport for London (TfL) and Transport & Environment (T&E) on how lorry direct vision could be improved.[ii] Taking account of the proposed law changes, the Loughborough Design School team analysed and developed an existing 80cm longer cab concept with a curved nose. To increase vision, the 'direct vision concept' has a smaller dashboard, expanded glazed areas in the passenger door and the right corner of the cab, and a slightly lower driver position. **Combined, these small design changes would increase the driver's field of view by 50%, reduce deadly blind spots and potentially save hundreds of lives.**

EU policy makers face a stark choice. In the interest of society as a whole they should:

- **Adopt the Commission proposal without any delay or moratorium** – every year of postponement means preventable loss of lives;
- **Instruct the Commission to develop direct vision requirements for redesigned cabs** – the 'direct vision concept' should serve as guidance;
- **Mandate safety improvements for all new lorries** – after a suitable transition period, all lorries should be obliged, not just allowed, to have improved direct vision.


## 1. Why lorry direct vision matters

4,200 people die in lorry accidents every year in Europe. Many more sustain severe injuries.[iii] Lorries' road safety impact is disproportionate: with just 3% of vehicles, they are involved in 15% of fatal crashes. One of the key reasons for this is lorry design. In Europe lorry drivers sit on top of the engine (cab-over-engine design). This high position makes much of what happens around the cab invisible to the driver. This explains why **"blind spots are a major factor in many accidents involving lorries".**[iv]


**Figure 1**: lorry blind spots are particularly dangerous for cyclists

When such accidents involve cyclists or pedestrians, they are very often fatal. Every year

lorries kill almost **1,000** vulnerable road users (cyclists, pedestrians).[v] In Europe 22% of cycling fatalities involve goods vehicles (N1-3).[vi] In Belgium, it's 43%, in Holland, 38% and in the UK, 33%.[vii] In some cities, like London, lorries cause more than 50% of cyclist deaths.[viii] Given the on-going efforts of many European cities to boost cycling, the issue will only become more urgent.

A UK analysis[ix] of 704 accidents involving goods vehicles (N1-3), where blind spots played a role, shows almost 70% of them involve lorries heavier than 7.5 tonnes (N3 vehicles). Half of these vehicles are articulated, i.e. big lorries (see e.g. Figure 2).[x] 31% of fatal crashes occur right in front of the lorry when a lorry pulls away. Another 19% of fatalities happen in left (rest of EU: right) turning accidents. The findings on where blind spots accidents and fatal crashes are most likely to occur are summarised in the infographic in the Annex.

### EU policy to date: mirrors, mirrors and... more mirrors

Contrary to cars[xi], there are no direct vision requirements for lorry direct vision. Lawmakers have traditionally focused on improving indirect vision through mirrors (figure 2). Whilst mirrors are necessary and have helped increasing (indirect) vision, they are an imperfect solution. Relying on a multitude of different mirrors and their often distorted images can be confusing and requires time, which drivers often do not have in complex traffic situations. Mirrors also need to be correctly aligned which often isn't the case.[xii] Indeed, despite the presence of mirrors, blind-spot accidents remain a serious, and in many cities, growing problem.[xiii]

**Figure 2:** lorry blind spot mirrors

### A once-in-a-generation opportunity to make lorries safer

The reason why EU lorry cabs are brick-shaped (cab-over-engine designs) is that lorry makers have maximised cargo space within the existing maximum dimensions. In the US where only maximum trailer lengths are regulated, lorry designs are different.

The European Commission has proposed[xiv] changing the rules to allow the design and construction of slightly longer (ca. 80-90cm) cabs with a curved profile (e.g. Figure 3).[xv] This new design is a golden opportunity to drastically improve lorry safety and could be used to eliminate dangerous blind spots. This is also what the Commission proposes: lorries benefiting from the extra design space need to comply with rules relating to vision, crash performance and aerodynamics. The specific rules and technical requirement are yet to be developed. They are currently under preparation in a European Commission expert group.

**Figure 3**: FKA concept

## 2. Loughborough design school's proposal to improve lorry direct vision

TfL and T&E asked the University of Loughborough to carry out research to identify how lorry designs could be optimised for direct vision, taking into account the Commission's proposal on lorry dimensions. The aim of the research was to develop a realistic concept cab that complies with all existing legislation.

### Objectives and methodology of the study

Loughborough University and its Design School in particular, is an authority in the field of direct vision. Its work underpinned the UK's 2011 amendment to UNECE Regulation 46 regulating lorry mirrors.[xvi] The study for TfL and T&E is based on the same methodology and

aims to scientifically and visually describe how different designs impact direct vision.

The Loughborough University team developed a concept improving direct vision for category N3 lorries (>12 tonnes). As a base vehicle, to compare with its improved concepts, Loughborough chose the DAF XF 105, a typical, big, N3 lorry. It chose to work on N3 vehicles (and not smaller N2 urban lorries) because the Commission's proposal targets big N3 vehicles but also because smaller cabs are usually modelled after big N3 models (Figure 4). This suggests changes in that segment would likely trigger changes in the smaller segments too. Finally, the analysis of UK blind spot accidents shows N3 involvement in blind spot accidents is significant (see above).

**Figure 4**: Renault trucks model line up[xvii]

## The Loughborough Design School's 'direct vision concept'

As a basis for its 'direct vision concept' Loughborough used the University of Aachen's (FKA) aerodynamic lorry concept (Figure 3). The FKA concept also underpins the European Commission impact assessment and proposal to review the lorry dimensions law.[xviii] New designs would need to have better aerodynamics, comfort *and* safety. The FKA concept has integrated these elements but could be further optimised for direct vision.[xix]

The Loughborough University team fitted the interior and dashboard of a DAF XF 105 into the FKA concept using the SAMMIE CAD Digital Human Modelling system that is developed at the Loughborough Design School. To better reflect the FKA design and improve its direct vision, the dashboard was then downsized (Figures 6) drawing on existing smaller dashboards in e.g. buses. The extra space this created was then used to produce glazed areas in the front right corner of the vehicle. These glazed areas were placed in a location below the windscreen line where there are existing apertures in current vehicle designs. [xx] These apertures are used to allow electrical connections to be made inside the cab. In addition extra glazing was added to the passenger doors below the existing windows. Additional glazed areas in doors are being considered by some manufacturers in response to requests from vehicle operators, see Figure 5.

**Figure 5**: Scania Laing O'Rourke cab

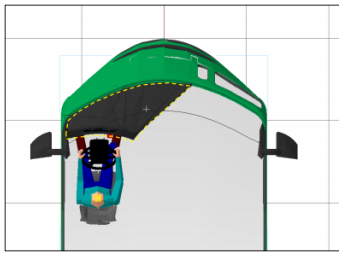

**Figure 6:** Interior of the Loughborough concept

A further and final improvement was made: the cab - and with it the driver eye height - was lowered 230mm. This is a reduction that had been found to be realistic and achievable in another, on-going Loughborough study.[xxi] The lower ground clearance would mean this concept would have more limited off-road capabilities.

The combination of improvements constitute Loughborough Design School's 'direct vision concept', as shown in Figure 7.

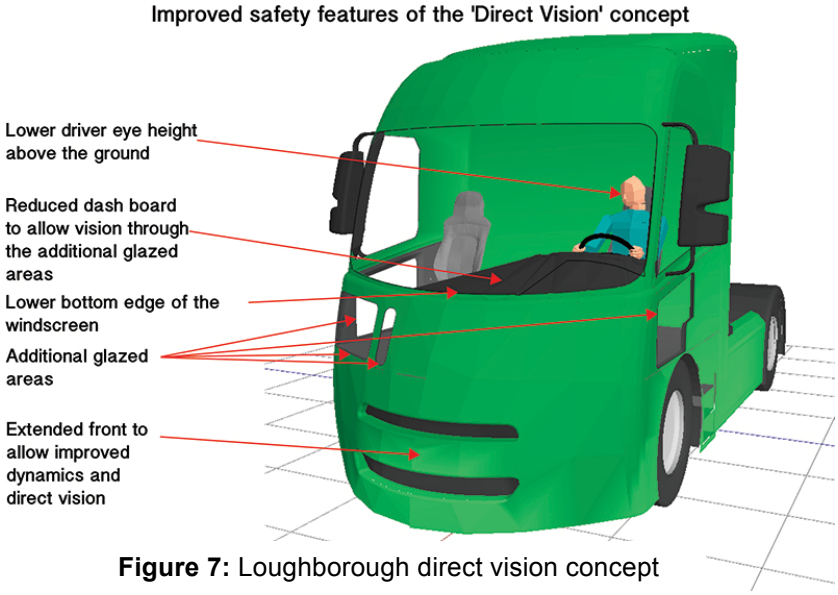


**Figure 7:** Loughborough direct vision concept

## 3. Benefits of the direct vision concept

Loughborough compared the 'direct vision concept' and the base vehicle in different traffic situations based on the UK analysis of blind-spot accidents (see Annex). In all of these, the direct vision concept performed significantly better than the baseline vehicle, leading to conclusion that it provides **"excellent direct vision in close proximity to the cab"**.[xxii]

### Passenger side visibility – right-turn accidents involving cyclists

19% of all fatal blind-spot crashes are right turn (UK left) accidents where a lorry, e.g. at a crossing, turns to the right and hits the cyclist on the passenger side. Vulnerable road users are 70% of the casualties in this type of accident. A cyclist of average height (1.75m) is invisible to the eye of the driver up to 1.9m from the base cab. In the 'direct vision concept' however, that same cyclist would be visible when standing/cycling directly next to the cab which means a key blind spot would be eliminated.

While a passenger seat was not included on all the graphics, it was accounted for. Loughborough recommends the use of a foldable seat. Such foldable seats are already on sale today[xxiii] and would ensure the passenger seat doesn't obscure the driver's sight.

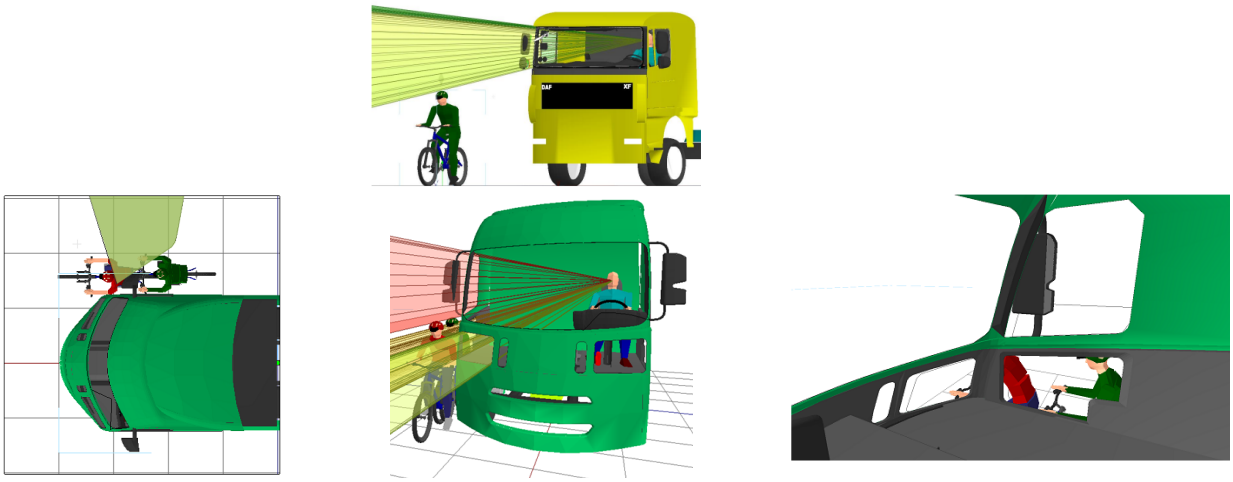

**Figure 8:** Passenger side visibility. Base vehicle (top); 'direct vision concept' (bottom)

### Passenger side visibility – right turn accidents involving cars

18% of blind-spot accidents are from lorries changing lane to the right (UK left). While these accidents did not cause fatalities in the UK dataset that was analysed, they do cause (severe) injury.

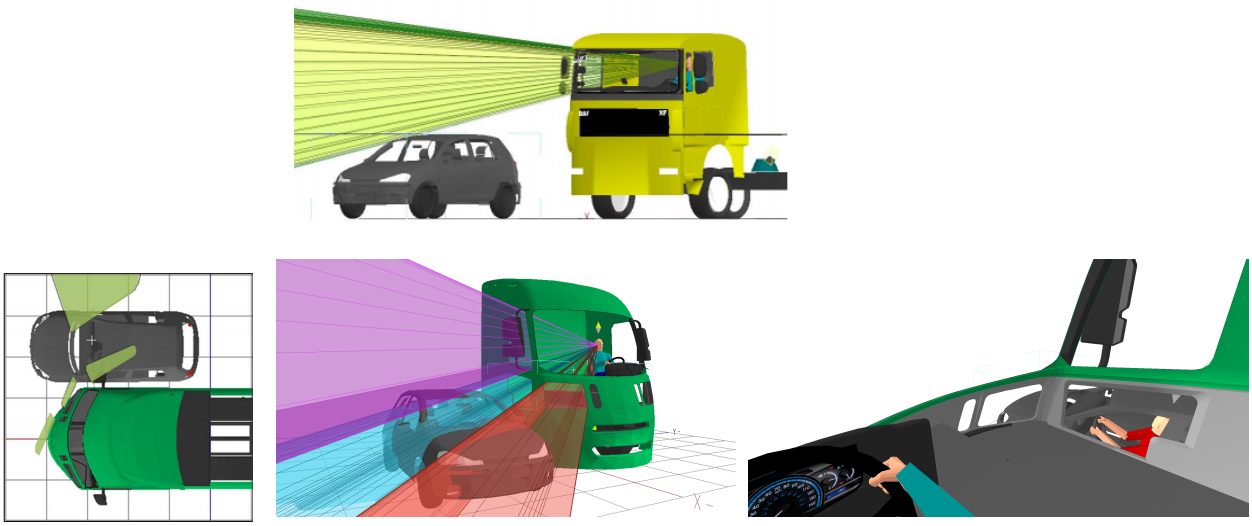

**Figure 9:** Passenger side visibility. Base vehicle (top); 'direct vision concept' (bottom)

In the base concept a car (VW Golf) can be 2.6m away from the lorry and be invisible. In the 'direct vision concept' that same car would be visible to a lorry driver, even when driving very close to the lorry.

## Forward vision – pedestrians

Whilst accidents involving a lorry pulling away, e.g. a lorry hitting a pedestrian at a zebra crossing, are rare (5% of blind-spot accidents), they are among the most deadly blind-spot accidents (31% of total).

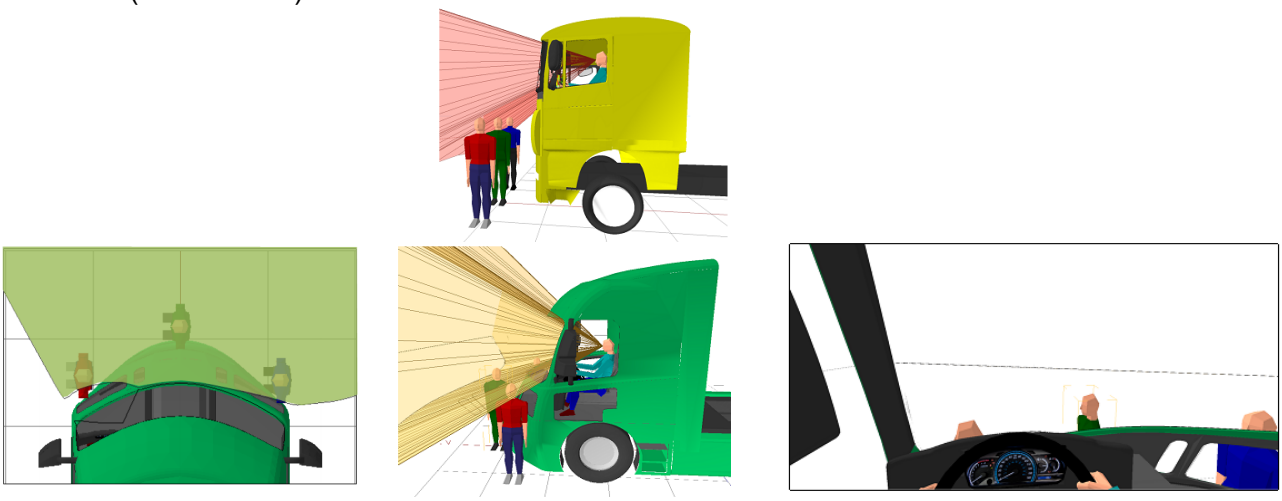

**Figure 10:** Forward vision. Base vehicle (top); 'direct vision concept' (bottom)

As shown in figure 10, above, a pedestrian of average height (1.75m) can easily be invisible up to almost 70cm from the front. A combination of an elongated nose, a lower cab and glazed areas makes the pedestrian perfectly visible from within the 'direct vision concept'.

## 'Direct vision concept': blind spot map

Direct or indirect vision is often schematically presented in 2D, often at the ground plane (i.e. what a driver, from inside his cab, can perceive at ground level). Since this is a simplification of reality, Loughborough has focused on visualising direct vision in 3D.

However, a blind spot map is a useful tool to compare the overall direct vision of the different concepts. As shown below (Figure 11) the comparison of the blind spot map (ground level) of the base vehicle and the 'direct vision concept' clearly illustrates how much better the 'direct vision concept' performs. Direct vision improves on all sides of the vehicle but especially in front of and on the right side of the cab – two of the deadliest blind spots.

A comparison of the glazed area projected onto a sphere 10m away from the driver's eye point shows the DAF XF has just 67% of the visible area of the direct vision concept. This means the driver's field of view is increased by 50%.

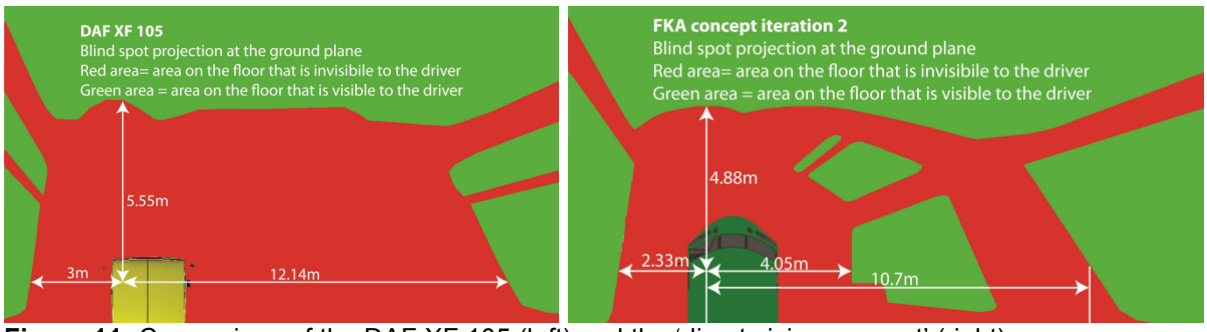


**Figure 11:** Comparison of the DAF XF 105 (left) and the 'direct vision concept' (right)

## 4. Could direct vision be improved further?

The 'direct vision concept' remains conceptually close to current cab-over-engine designs. This means the driver sits on top of the engine and the cab isn't lowered very significantly. This is because the Commission proposal deals mainly with big N3 vehicles for which a design other than the cab-over-engine design is not currently deemed realistic. Lowering the cab more than 23cm may however be perfectly feasible and should be studied further.


**Figure 12**: Mercedes Econic and Dennis Eagle waste collection vehicle

This is certainly true for urban lorries. Some manufacturers already supply low-entry cabs (e.g. waste collection vehicles) where the driver sits (partially) in front, rather than on top of the engine. This is possible because urban lorries (almost always rigid vehicles) don't have the same length constraints as long-haul lorries. Indeed, they are often much shorter than the allowed 12m. Given their high exposure to pedestrians and cyclists, the EU should set specific, much more stringent direct vision requirements for urban lorries (category N2: 3.5 ton – 7.5 ton) as well as light-goods vehicles (N1 <3.5 ton).

## 5. Conclusions and policy demands

Lorries are involved in 4,200 deadly traffic accidents annually. Poor driver vision and blind spots are a major cause of this fatal performance. To reduce blind spots, lawmakers focused on fitting in more mirrors, which, while useful, are inferior to improved direct vision. The Loughborough study and its resulting 'direct vision concept' demonstrate how direct vision could be drastically improved, especially now that the Commission has opened the door for new, redesigned lorry cabs.

The 'direct vision concept' would have a slightly curved and elongated nose, a smaller dashboard, expanded glazed areas in the passenger door and the right corner of the cab as well as a lower driver position. Combined, these relatively small design changes would drastically increase direct vision in critical areas, potentially savings hundreds of lives and avoiding many more severe injuries.

### Recommendations for policymakers

The Commission proposes that new lorry designs could be around a third (80-90cm) longer but only if that space is used to also improve safety. It did not clearly define what specific improvements were needed and how these would be implemented. Hauliers, trade unions, safety groups and cities across Europe have already endorsed this proposal.[xxiv] The European Parliament overwhelmingly backed it too.[xxv] Lorry makers though oppose extra design freedom fearing it could increase competition[xxvi]. Member States, led by Sweden and France, support lorry makers and seeks to ban and postpone lifesaving design changes by at least another 8 years.[xxvii]

EU policymakers face a stark choice. For the betterment of society and safety of vulnerable road users they should:

- Adopt the Commission proposal without any delay or moratorium;
- Clarify the Commission proposal and instruct the EU executive to draw up implementing rules governing *direct* vision for elongated, redesigned cabs no later than 2 years after the adoption of the law as requested by the Parliament;
- Improve the Commission proposal by:

- Mandating all the safety improvements for all new lorries 7 years after the adoption of the law as requested by the Parliament
- Instructing the Commission to propose rules governing the direct vision of urban goods vehicles (N1-N2) no later than 2016.

## Further information

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[i] Financial Times, *France and Sweden close to victory over EU lorry designs*, 14 May 2014. http://www.ft.com/intl/cms/s/0/602a0b1c-db5b-11e3-94ad-00144feabdc0.html#axzz3DUrA6LJM
[ii] Loughborough design School (Steve Summerskil, Russel Marshall), *The design of category N3 vehicles for improved driver direct vision*, 2014. http://www.transportenvironment.org/publications/ending-lorries-deadly-track-record-matter-direct-vision
[iii] ETSC http://etsc.eu/towards-safer-transport-of-goods-and-passengers-in-europe-pin-flash-24/
[iv] European Commission, http://ec.europa.eu/transport/road_safety/topics/vehicles/blind_spot_mirrors/index_en.htm
[v] FKA, *Design of a Tractor for Optimised Safety and Fuel Consumption 2011*, p68.
[vi] European Cyclists' Federation, http://www.ecf.com/news/hgv-cab-design-cycling-collisions/#_ftn1
[vii] Including light goods vehicles: ETSC, *Pedalling towards Safety*, 2012. http://www.etsc.eu/documents/BIKE_PAL_Safety_Ranking.pdf
[viii] http://www.britishcycling.org.uk/campaigning/article/20140130-campaigning-news-Unsafe-lorries-ban-is-a-significant-step--says-British-Cycling-0
[ix] Loughborough 2014, p5-11.
[x] Loughborough 2014, table 2, p7.
[xi] UNECE Regulation 125
[xii] See for example: http://www.swov.nl/rapport/Factsheets/UK/FS_Blind_spot_crashes.pdf or http://www.ecf.com/news/hgv-cab-design-cycling-collisions/#_ftn4
[xiii] UK road deaths at record low but cyclist casualties rise http://www.theguardian.com/world/2013/jun/27/uk-road-deaths Same happens in Belgium: http://www.fietsersbond.be/nieuws/fietsongevallen
[xiv] http://ec.europa.eu/commission_2010-2014/kallas/headlines/news/2013/04/doc/com(2013)195_en.pdf
[xv] http://www.transportenvironment.org/publications/saving-lives-saving-fuel-changing-face-european-lorries
[xvi] Steve Summerskil, Presentation to Working Party on General Safety Provisions – 100th session ECE/TRANS/WP.29/GRSG/2011-01
[xvii] Retrieved from: http://motortransport.co.uk/blog/2013/06/14/volvo-boss-full-of-confidence-in-new-renault-line-up/
[xviii] http://ec.europa.eu/commission_2010-2014/kallas/headlines/news/2013/04/doc/com(2013)195-impact-assessment.pdf
[xix] http://www.transportenvironment.org/sites/te/files/publications/Cleaner,%20safer%20lorries%20-%20briefing%20April%202013_final.pdf
[xx] See FKA p87.
[xxi] Loughborough 2014, p115.
[xxii] Loughborough 2014, p112.
[xxiii] http://www.scania.com/_system/img/highres/353070_highres_11664-008_11664-009.jpg
[xxiv] https://www.iru.org/cms-filesystem-action/mix-publications/Saferdeclaration.pdf
[xxv] EP position adopted 15/04/2014, http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P7-TA-2014-0353+0+DOC+XML+V0//EN
[xxvi] Financial Times, France and Sweden close to victory over EU lorry designs, 14 May 2014.
[xxvii] Council position, http://register.consilium.europa.eu/doc/srv?l=EN&f=ST%2010761%202014%20INIT

## Annex: Infographic lorry blind spots