Looking out for vulnerable road users

www.clocs.org.uk
Modelling HGV blind spots

Loughborough University Design School: Design Ergonomics Research Group

Research Sponsored by Transport for London

Dr. Steve Summerskill & Dr. Russell Marshall
Contents

• Background – Blind spots in Heavy Goods and construction vehicles
• Aims and objectives of the project
• Methodology
• Results for all vehicles
• Discussion of results
Why was this project funded by Transport for London?

• The research has been informed by concerns for the safety of vulnerable road users (VRUs) in London and elsewhere in the UK and EU.

• Recent research conducted by Loughborough highlighted that there has been a general improvement in road safety in the UK with casualties falling 49% between 2000 and 2012.

• Cyclist casualties have not followed the national trend. Data shows that over the same period the numbers of cyclists killed or seriously injured have increased by 21% nationally and in Greater London by 59%.

• A common factor in accidents involving cyclists and other VRUs is the overrepresentation of Heavy Goods Vehicles (HGVs) as the collision vehicle.
Why do HGVs have blind spots?
Background

Blind spots in Heavy Goods and construction vehicles

- Blind spots in existing vehicles are caused by a number of factors

- The height of the driver position above the ground, which is a result of EC regulation 96/53/EC that limits the overall length of a tractor and trailer combination to 16.5m

This has led to a vehicle design process where the driver cab is placed above the engine bay to allow the length constraints to be met, with flat fronted vehicles.
Background

Blind spots in Heavy Goods and construction vehicles

• Blind spots in existing vehicles are caused by a number of factors

• The structure of the vehicle, including mirror mounts, A-pillars and the vehicle body, can obstruct vision of vulnerable road users and other vehicles

Drivers view of the passenger window
TfL Project aims

Using Digital Human Software to simulate and quantify blind spots

• The aims of the current project being performed by the LDS team include;
  • To objectively model the extent of areas around different HGVs by make and model which are:
    – Directly visible by the driver through the cab windshield and windows
    – Indirectly visible by the driver through the mandatory mirror set
    – Neither directly, nor indirectly visible by the driver (i.e. the blind spots)
Background

Using Digital Human Software to simulate and quantify blind spots

• The Loughborough Design School (LDS) team used a method to visualise and quantify blind spots in a previous project for the UK Department for Transport (DfT)

• This technique uses Digital Human Modelling software to visualise the volume of space that can be seen by a driver in the combination of direct vision (through windows) and in-direct vision (through mirrors)
The use of Digital Human modelling software in the identification and quantification of blind spots
Using Digital Human Software to simulate and quantify blind spots

• This technique was successfully used to identify a key blind spot next to the drivers cab
• The LDS team then supported the UK DfT in the definition of a revision of the United Nations Economic Commission for Europe Regulation 46 which specifies mirror coverage
• We acted as the UK experts at the 100th UNECE GRSG meeting which led to a revision of UNECE Regulation 46 to increase the required area of mirror coverage

This change was applied to all vehicles in July of 2015
TfL Project

Methodology

• In order to allow an understanding of the blind spot issue 19 vehicle configurations have been modelled;

• The top selling vehicles in the UK based upon SMMT vehicle registration data including: DAF, SCANIA, Mercedes, Volvo and MAN

• In addition, four low entry cab vehicles have been selected from, Dennis, Mercedes, Scania and Volvo
Methodology – Vehicle data capture

• We have 3D scanned the vehicles and processed those scans to create CAD models
Looking out for vulnerable road users

Vehicles in the sample that were analysed

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Construction</th>
<th>Long Haul</th>
<th>Low entry cabs</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAF CF</td>
<td>DAF CF N3G</td>
<td>DAF XF</td>
<td>Dennis Eagle Elite 6</td>
</tr>
<tr>
<td>MAN TGS</td>
<td>MAN TGS N3G</td>
<td>MAN TGX</td>
<td>Volvo FE LEC</td>
</tr>
<tr>
<td>Mercedes Antos N3</td>
<td>Mercedes Arocs N3G</td>
<td>Mercedes Actros N3</td>
<td>Mercedes Econic</td>
</tr>
<tr>
<td>Volvo FM</td>
<td>Volvo FMX</td>
<td>VCLVO FH</td>
<td>Scania LEC</td>
</tr>
<tr>
<td>Scania P N3</td>
<td>Scania P N3G</td>
<td>Scania R N3</td>
<td></td>
</tr>
</tbody>
</table>
Vehicles models

Methodology – How to define **Vehicle height**

- The range of vehicle specifications for variables such as tyre size, axle configuration, suspension type and engine size result in a large range of potential cab heights for each vehicle model.

- Consultation with manufacturers defined an approach in which the cab height of the ‘most sold’ configurations for each vehicle model were created.

- This has benefits in terms of simulating the most common vehicles on the road, but does not explore the vehicles with the maximum mounting heights for the cab.

- This pragmatic approach was deemed the most fair by all stakeholders.
The main analysis method used to compare the truck designs
Methodology for the simulation of Vulnerable Road Users

- A number of tests have been designed which simulate pedestrians and cyclists at key locations around the vehicle cab.

- The first test deals with direct vision of pedestrians in front of the vehicle.

- Three average sized UK male human models represent a pedestrian walking in front of a stationary vehicle (stature = 1755mm).

- They are initially located at the right corner, centre and left corner of the cab front.

- They are then moved forwards to determine the maximum distance at which they can be hidden from the direct vision of the driver.
Methodology for the simulation of Vulnerable Road Users

- The second test simulates the projection of the Class VI mirror for pedestrians to the front.

- With the simulated pedestrians at the maximum distance from the front of the cab at which they can be still be obscured from the driver, the class VI mirror is projected.

- Any intersection between the pedestrians and the volume of space contained within the projection indicate that the pedestrians will be visible in the Class VI mirror.

- This highlights that pedestrians should be visible to the driver through the Class VI mirror.
Methodology for the simulation of Vulnerable Road Users

- The third test simulates two cyclists located to the near side of the vehicle
  - The cyclists are modelled as average sized UK males on full sized road bicycles
  - The rearmost cyclist is aligned with the top of the head in line with the driver’s eye point
  - The foremost cyclist is placed one meter forwards of the rearmost cyclist in a manner which simulates two positions of a cyclist passing the cab
  - The cyclists are then moved laterally to determine the maximum distance at which they can be hidden from the direct vision of the driver
The fourth test simulates the projection of the Class II, IV, V & VI mirrors to determine if cyclists can be seen through indirect means.

With the simulated cyclists at the maximum distance from the side of the cab at which they can be still be obscured from the driver, the Class VI, V, IV and II mirrors are projected.

Any intersection between the cyclists and the volume of space contained within the projection indicate that the cyclists will be visible.

This highlights that some vehicles allowed locations in which cyclists cannot be seen through either direct or indirect vision.
TfL Project

Methodology for the simulation of Vulnerable Road Users

• The fifth test simulates two cyclists to the off side of the vehicle

• The cyclists are modelled as average sized UK males on full sized road bicycles
• The rearmost cyclist is aligned with the top of the head in line with the driver’s eye point
• The foremost cyclist is placed one meter forwards of the rearmost cyclist in a manner which simulates two positions of a cyclist passing the cab
• The cyclists are then moved laterally to determine the maximum distance at which they can be hidden from the direct vision of the driver
Methodology for the simulation of Vulnerable Road Users

- The sixth test simulates the use of Class II, IV and VI mirrors

- The cyclists are modelled as average sized UK males on full sized road bicycles
- The rearmost cyclist is aligned with the top of the head in line with the driver’s eye point
- The foremost cyclist is placed one meter forwards of the rearmost cyclist in a manner which simulates two positions of a cyclist passing the cab
- The cyclists are then moved laterally to determine the maximum distance at which they can be hidden from the direct vision of the driver
Results – Simulated vulnerable road users

*What was the variability in blind spot size?*
Results – Obscuration of nearside cyclists
Looking out for vulnerable road users

Results – Obscuration of nearside cyclists: distance away from the side of the cab at which cyclists can be fully obscured for direct vision

-1 = visible i.e. visible when directly adjacent to the cab side
Results – Obscuration of front middle pedestrian
Results – Obscuration of middle pedestrian: distance away from the front of the cab at which the pedestrian can be fully obscured

-1 = visible i.e. visible when directly adjacent to the cab side
- Smaller pedestrians could be hidden further away from the vehicle
Unpacking the results

Comparison of driver’s eye height above the ground
Results – Driver’s eye height above the ground

The driver height in the cab varies by approx. 1m across all vehicle tested
Results – Example of exploring the important design variables

- **This means that there is a link between the eye height of the driver above the floor and the maximum distance that a cyclist can be hidden to the near side**
- There were however some anomalies which required further investigation to allow key design features to be identified
• MAN TGX has a lower driver eye height above the ground, but the cyclist is fully hidden further away from the vehicle when compared to the Scania R.
Looking out for vulnerable road users

Results – Example of exploring the important design variables

- MAN TGX has a lower driver eye height above the ground, but the cyclist is fully hidden further away from the vehicle when compared to the Scania R

- This is due to the driver’s eye point being relatively higher above the window sill in the Scania R
Results – Example of exploring the important design variables

- Driver’s eye views of the passenger window
- The higher window sill at the rear edge of the window in the MAN TGX reduces the field of view in this critical area
Key issues identified in the project
Discussion of results for the simulation of VRUs around the vehicle

- The height of the cab above the ground is the key factor that determines the size of the blind spots.

- There are stark defences between the results for Low Entry cabs and Standard cab designs.
Discussion of results for the simulation of VRUs around the vehicle

- A further finding is that for the same cab design, the specifications for distribution (N3) and construction (N3G) variants produce significant differences in the size of blind spots.
Discussion of results for the simulation of VRUs around the vehicle

- Also, the project highlighted that the design of windows and cab structure, in relation to the driving position can also influence the size of blind spots.

- These results led to the LDS team calling for a direct vision standard which allows the performance of vehicles to be compared in terms of the ability of a cab design to allow direct vision of vulnerable road users.
Thank you for your attention, are there any questions?

Dr Steve Summerskill (s.j.summerskill2@lboro.ac.uk)
Dr Russell Marshall (r.marshall@lboro.ac.uk)

Design Ergonomics Group
Loughborough Design School
Loughborough University
United Kingdom