Institution: Loughborough University

Unit of Assessment: D32 Art and Design: History, Practice and Theory

Title of case study: The definition of new regulations to reduce accidents between Heavy Goods Vehicles (HGVs) and vulnerable road users

Period when the underpinning research was undertaken: 2011-2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Steve Summerskill	Senior Lecturer	2001 – present
Dr Russell Marshall	Reader in Design Ergonomics	1999 – present
Ms Sharon Cook	Senior Lecturer	1992 – present
Dr Abby Paterson	Lecturer	2014 – present
Dr James Lenard	Research Fellow	1997 – 2017
Mr Anthony Eland	University Teacher	2015 – present

Period when the claimed impact occurred: 2015 - 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Over 4000 pedestrians and cyclists are killed or seriously injured every year in Europe due to collisions with Heavy Goods Vehicles (HGVs). Loughborough University research identified features in the design of HGVs, which limit what a driver can directly see close to the cab, and digitally modelled a large sample of HGVs leading to the following impacts: 1) The United Nations Economic Commission for Europe (UNECE) regulations were changed to remove an HGV driver blind spot; 2) A New Direct Vision Standard was adopted for all HGVs in London; and 3) EU and UNECE policy was shaped to include direct vision requirements in the European General Safety Regulation.

2. Underpinning research (indicative maximum 500 words)

Over 4000 cyclists and pedestrians, referred to as Vulnerable Road Users (VRUs), are killed through collisions with HGVs every year in Europe **[S4]**. Our analysis of accident data highlighted that HGVs are disproportionately involved in accidents with VRUs and that the proportion of killed or seriously injured (KSI) is much higher for HGVs when compared to other vehicle types **[R4]**.

Our research investigated this issue and provided solutions. This research was conducted within six projects funded by Transport for London (TfL) and the UK Department for Transport (DfT). The research was conducted by Loughborough's Dr Steve Summerskill, Dr Russell Marshall, Sharon Cook, Dr Abby Paterson, Dr James Lenard, and Mr Anthony Eland.

The DfT suspected that there was a potential for blind spots to be a contributing factor in accidents and commissioned the research team to investigate the issue (Project P1, 2010-2011, DfT). This involved the development of new software tools to allow the 3D visualisation of what a driver can see using direct vision through windows, and indirect vision through mirrors. This novel approach led to the identification of a blind spot that had not previously been recognised (see *Figure 1 below*) **[R1, R2, R3, R4]**.

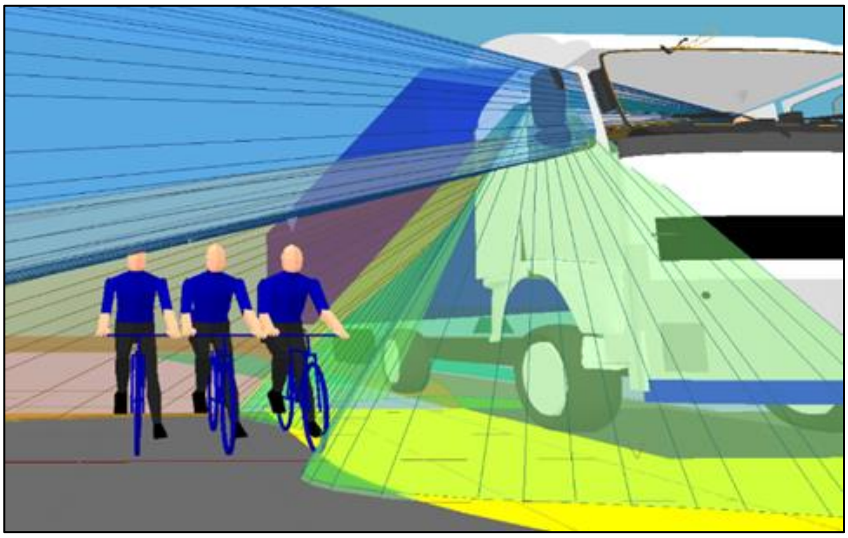

Figure 1. *Cyclists in the blind spot of an HGV which required a change to UNECE Regulation 46. (Project P1).*

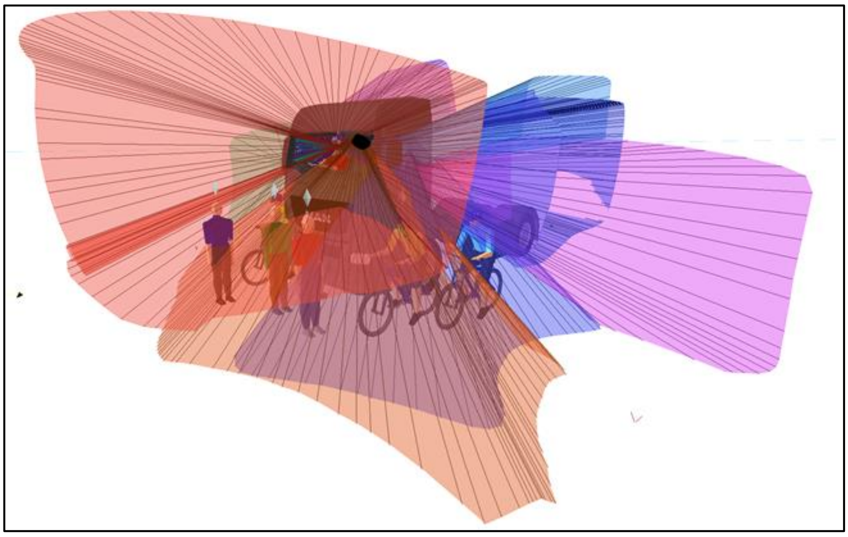

Figure 2. *Visualising the volume of space visible to a driver through windows and mirrors, and the distance at which VRU simulations can be hidden from the driver's view in vehicle blind spots. (Project P2)*

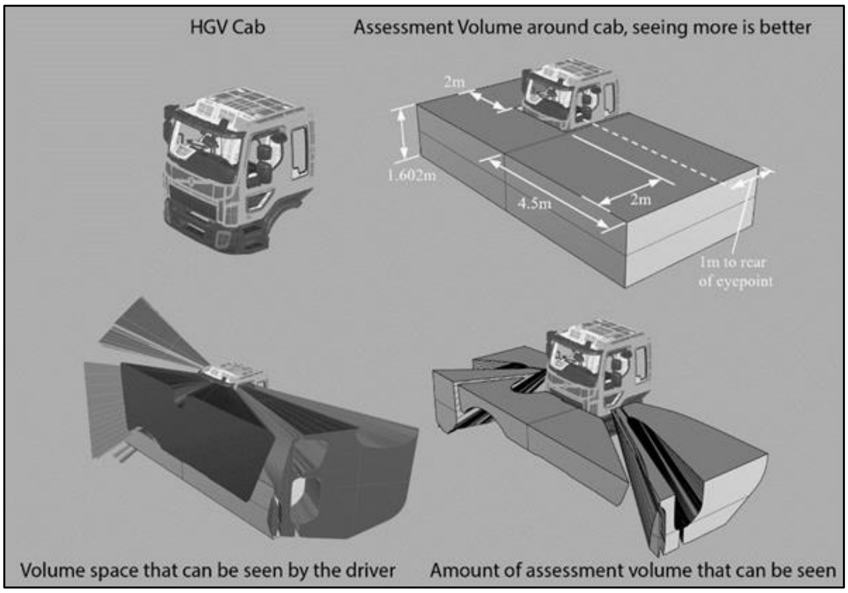

Figure 3. *Showing that the DVS is based upon the ability of a truck cab to allow a certain proportion of an 'assessment volume' around the cab to be visible to a driver (Project P3).*

Due to the large number of collisions between cyclists/pedestrians and HGVs in London, TfL commissioned the research team to analyse accident data and use the techniques established in Project P1 to test a large sample of HGV designs that was representative of the UK HGV fleet (19 cab designs). This analysis involved modelling the volume of space that is visible to a driver through the combination of direct vision through windows and indirect vision through mirrors (see *Figure 2*). This highlighted that the design of certain HGV cab features had an unnecessarily negative impact on the ability of the driver to view VRUs directly in close proximity to the vehicle cab. Key vehicle design features which affect direct vision were identified [R6]. At this point in time there was no regulation of what an HGV driver should be able to see directly through the windows of a vehicle cab. Therefore, as part of the project summary, the research team recommended the definition of a direct vision standard (DVS) which would involve a method to measure direct vision and define minimum safety requirements.

The recommendation for a DVS was supported by TfL and the DfT and the research team developed the world's first standard for HGV direct vision (Projects P2-P5, 2014 – present, **[R6]**, TfL, DfT). The new DVS includes the definition of a minimum volume of space that a driver should be able to see in close proximity to the cab (see *Figure 3*). This minimum safety limit for direct vision has been defined in a manner which, if met, means that there are no inherent blind spots between indirect vision and direct vision.

Interest in the DVS method was shown in Europe (see Section 4), and the research team supported the development of the UNECE (United Nations Economic Commission for Europe) version of the DVS. This research project, funded by TfL and the DfT, (Project P6) involved two main activities: (1) to refine the London DVS to make it suitable for use in all UNECE member states, and (2) to design and test a physical method that can be used to measure the performance of a real-world vehicle, which can complement the digital version of the test that was developed for London.

3. References to the research (indicative maximum of six references)

R1: SUMMERSKILL, S. (2011). Presentation to the UNECE GRSG to highlight the causes of a specific HGV blind spot and how UNECE Regulation 46 should be changed to solve this. https://www.unece.org/fileadmin/DAM/trans/doc/2011/wp29grsg/GRSG-100-26e.pdf

R2: COOK, S., SUMMERSKILL, S., MARSHALL. R., RICHARDSON, J.H., LAWTON, C., GRANT, R., BAYER, S.H., LENARD, J. AND CLEMO, K., 2011. The development of improvements to drivers' direct and indirect vision from vehicles - phase 2. Report for Department for Transport DfT TTS Project Ref: S0906 / V8. Loughborough: Loughborough University and MIRA Ltd. https://hdl.handle.net/2134/8873

R3: MARSHALL, R., SUMMERSKILL, S. and COOK, S., 2013. Development of a volumetric projection technique for the digital evaluation of field of view. Ergonomics, 56 (9), pp.1437-1450. https://doi.org/10.1080/00140139.2013.815805

R4: SUMMERSKILL, S., MARSHALL, R., COOK, S., LENARD, J. AND RICHARDSON, J., 2015. The use of volumetric projections in Digital Human Modelling software for the identification of large goods vehicle blind spots. Applied Ergonomics, 53, pt. A, pp.267-280. https://doi.org/10.1016/j.apergo.2015.10.013

R5: SUMMERSKILL, S. Marshall, R; Paterson, A; Reed, S (2015): Understanding direct and indirect driver vision in heavy goods vehicles. Report. https://hdl.handle.net/2134/21028

R6: SUMMERSKILL, S., MARHSALL, R., PATERSON, A., ELAND, A. AND LENARD, J., 2019. The definition, production and validation of the direct vision standard (DVS) for HGVS. Final Report for TfL review. Version 1.1. London: Transport for London. Report https://hdl.handle.net/2134/36622

The references above include reports to the DfT and TfL (R2, R5, R6), which have been reviewed for accuracy by a stakeholder group including representatives from eight vehicle manufacturers. Items R3 and R4 are published papers in high quality peer reviewed journals. The total research funding from TfL and DfT was over £800,000. All funding was gained through a competitive tender process.

4. Details of the impact (indicative maximum 750 words)

The impact that has been generated by the research team was enabled by the development of relationships with the DfT, TfL, the European Union, the UNECE and eight vehicle manufacturers. It is through this network that the team has modified existing and created new vehicle design regulations through the application of our innovative analysis techniques. The impact achieved was a culmination of multiple pathways over a 10-year period. This research effort has led to the following impacts.

Impact 1: The UNECE regulations were changed to remove an HGV driver blind spot.

All HGVs sold in Europe from the 15th of July 2015 must meet UNECE Regulation 46 revisions defined by P1, which increases the coverage of standardised mirrors to fill in the blind spot identified in the project **[R3, R4]**. The pathway to this impact involved research performed in 2010/11 **[R2]**, the presentation of the results and suggested change to regulation to the UNECE in 2011 **[R1]**, the acceptance of the suggested change to regulation in 2012 by the UNECE **[S9]** and the final change to the regulation which came into force for all new vehicles in 2015. The vehicle standards defined by the UNECE are applicable in 56 nations, including the EU, Japan, and Australia. This change to the regulation removed the blind spot that is in a location around the vehicle which is the 'area of greatest risk' for VRUs in close proximity to the HGV cab in an urban environment **[R5]**.

Impact 2: A New Direct Vision Standard was adopted for all HGVs in London.

All HGVs which enter London must meet the minimum safety requirements of the TfL Direct Vision Standard, which has been defined by the research team in projects P2-P5 **[S1, S2, S3]**, **[R6]**. This involved the manufacturers applying the Direct Vision Standard method by following our protocol for every vehicle design. The results were then presented to TfL by the manufacturers, which in turn allowed a permit to be produced for each vehicle. If the performance that is stated in the permit was below the minimum requirement defined by the research team, the vehicle operator was required to fit 6 extra safety features to the vehicle. This compromise was implemented by TfL due to over half of the vehicle designs which were assessed being unable to meet the DVS minimum requirement. Therefore, over half of the existing designs allowed blinds spots between indirect vision through mirrors and direct vision through windows, highlighting the significant scale of the problem.

Impact 3: New EU and UNECE policy was shaped to include direct vision requirements in vehicle safety regulations that are applied to all HGVs sold in Europe.

The research on understanding blind spot size and location, and the subsequent design of the direct vision standard for London has had an impact beyond the UK. An increasing number of accidents between HGVs and VRUs has been recognised by other European cities including Berlin, Amsterdam and Copenhagen. Driven by the research performed by the Loughborough research team, Transport for London, safety and sustainability related NGOs, and European city representatives have lobbied the European Parliament to improve the design of all HGVs used in urban environments in Europe. The research team have supported these lobbying efforts by presenting the research in a number of European cities with audiences of MEPs and other stakeholders.

In 2019 the lobbying efforts came to fruition when the EU parliament voted to include direct vision requirements in the European General Safety Regulation using the following statement:

> *"Vehicles of categories M2, M3, N2 and N3 shall be designed and constructed to enhance the direct visibility of vulnerable road users from the driver's seat, by reducing to the greatest possible extent the blind spots in front of and to the side of the driver, while taking into account the specificities of different categories of vehicles."* **[S8]**

It was determined that the most effective way to implement this change was through UNECE regulations which would apply to all EU nations. In 2018, the research team was invited to join the UNECE VRU Proxi working group which directly feeds recommendations for change in vehicle standardisation to the UNECE in Geneva **[S6]**. The London DVS became the model to follow by the UNECE VRU Proxi group. The research team, funded by the DfT and TfL, subsequently worked with the UNECE VRU Proxi group over a two-year period to refine the London DVS methodology into a standard for all vehicles sold in the EU. The records of the UNECE VRU Proxi group **[S7]** clearly showed that our research and methods influenced the approach adopted by the UNECE. This was confirmed by the Chair of UNECE VRU Proxi group when discussing our methodology for the measurement of direct vision from HGVs:

> *"It is fully clear that the methodology for the assessment of direct vision is fit for purpose and that it will be the foundation of the method that will, within the foreseeable future, be adopted by the UNECE World Forum for the global harmonization of vehicle regulations, as the new regulatory standard to be implemented by the UNECE Contracting Parties, which will include all European nations."* **[S5]**

The changes to vehicle design that are required by the new UNECE regulation will impose a development burden upon vehicle manufacturers around the world, with redesign of the vehicle cabs and underlying structures being required in many cases. Therefore, the proposed regulation change for the UNECE direct vision standard will come into force in 2026, allowing this development time. The impact claimed here is therefore the use of our research to support the lobbying efforts leading to the EU parliament vote requiring improved direct vision for HGVs in Europe, and the adoption of our methodology for measuring direct vision by the UNECE VRU Proxi group. An EU impact assessment **[S4]** performed in 2015 has indicated that adopting the DVS method will save 553 lives per year in Europe.

5. Sources to corroborate the impact (indicative maximum of 10 references)

S1: Letter from Transport for London.
S2: Press Release from the London Mayor https://www.london.gov.uk/press-releases/mayoral/new-measures-to-rid-london-of-dangerous-lorries
S3: Press Release from the London Mayor https://www.london.gov.uk/press-releases/mayoral/mayor-launches-world-leading-lorry-safety-scheme
S4: EU impact assessment https://op.europa.eu/en/publication-detail/-/publication/47beb77e-b33e-44c8-b5ed-505acd6e76c0/
S5: Letter from the chair of the UNECE VRU Proxi working group.
S6: UNECE WIKI of meeting records from the UNECE VRU Proxy Working Group. See meeting 6, first presentation from LDS https://wiki.unece.org/display/trans/VRU-Proxi+6th+session
S7: UNECE WIKI of meeting records from the UNECE VRU Proxy Working Group. Meeting 15, presentation of testing results for the physical method. https://wiki.unece.org/download/attachments/109347936/VRU-Proxi-15-02%20Rev1%20%28LDS%29%20LDS%20Presentation%20-%20%20UNECE%20VRU%20PROXI%2014th%20meeting_DraftV2.pptx?api=v2
S8: Record of EU parliament and council decision upon the requirement for direct vision from HGVs: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R2144&rid=4 See article 9 section 5.
S9: UNECE GRSG (2012). Evidence of the amendment suggested in R1 being accepted by the UNECE GRSG. https://www.unece.org/fileadmin/DAM/trans/doc/2012/wp29grsg/GRSG-102-29r1e.pdf