PRIMER: THE WORK TO DEFINE THE DIRECT VISION STANDARD

DR STEVE SUMMERSKILL, DR RUSSELL MARSHALL, IAIN KNIGHT, JAMES NIX

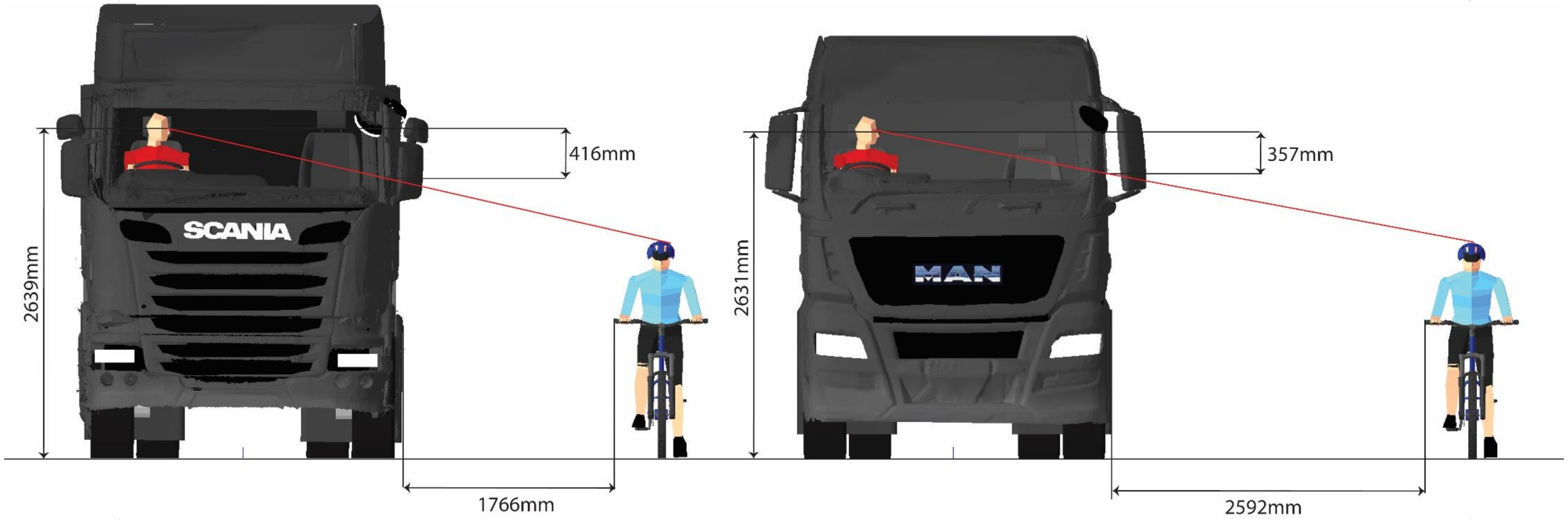
VRU-Proxi-18-03

OBJECTIVES

- The aim of this presentation is to provide a succinct overview of the development of the Direct Vision Standard.
- References are provided to allow access to documents that have a more detailed description.

WHY AND HOW THE DIRECT VISION STANDARD WAS DEFINED

RESULTS TFL PROJECT 2013-2015 – EXAMPLE OF EXPLORING THE IMPORTANT DESIGN VARIABLES

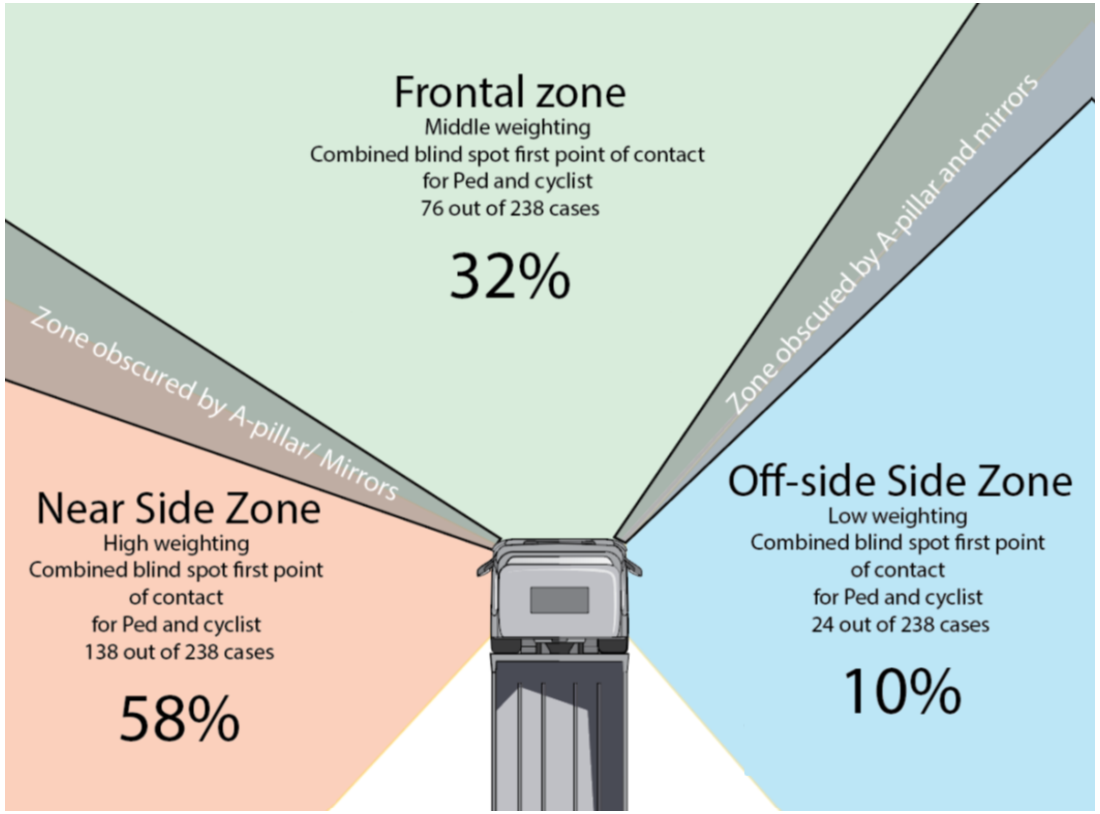


- Analysis of 19 truck designs highlighted large differences in direct vison performance based upon vehicle design

WHY AND HOW THE LONDON DIRECT VISION STANDARD WAS DEFINED

CONCERN ABOUT THE NUMBER OF ACCIDENTS IN LONDON: ACCIDENT DATA ANALYSIS SUPPORTING THE REQUIREMENT FOR A DVS

- An accident data analysis (UK STATS 19 database) was performed in the project that defined the London version of the DVS[1]
- This highlighted that a disproportionate number of accidents were occurring between HGVs and VRUs in London
- This highlighted the key areas in close proximity to the vehicle cab in which different accident scenarios occur
  - Causation data highlighted that the ability to see VRUs was a key issue
- This analysis highlighted the near side zone (58%) was involved in the majority of collisions and collisions to front (38%) also being important to consider. The driver's side involved 10% of collisions
- For more detail on the accident data analysis see section 8 of the DVS project report[1]



UK/Japanese vehicle (Right hand drive). The percentage of collisions that result in a VRU being killed or seriously injured by vehicle side

[1]SUMMERSKILL, S. ... et al., 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

ACCIDENT DATA ANALYSIS SUPPORTING THE REQUIREMENT FOR A DVS - CAUSATION DATA

National causation data for the top 90% of accidents with pedestrians and HGVs above 7.5 tonnes (2010 – 2015)

No. of accidents	Causation category
284	**Failed to look properly**
125	**Vehicle blind spot**
105	Poor turn or manoeuvre
101	Passing too close to cyclist
80	Careless
50	Failed to judge other person’s path or speed
39	Other – Please specify below
31	Overloaded or poorly loaded vehicle or trailer
26	Stationary or parked vehicle(s)
23	Road layout (eg. bend
12	Temporary road layout (eg. contraflow)
12	Vehicle travelling along pavement
11	Disobeyed pedestrian crossing facility
11	Junction restart (moving off at junction)
10	Travelling too fast for conditions

Causation data for the top 95% of accidents with

and HGVs above 7.5 tonnes (2010 – 2015)

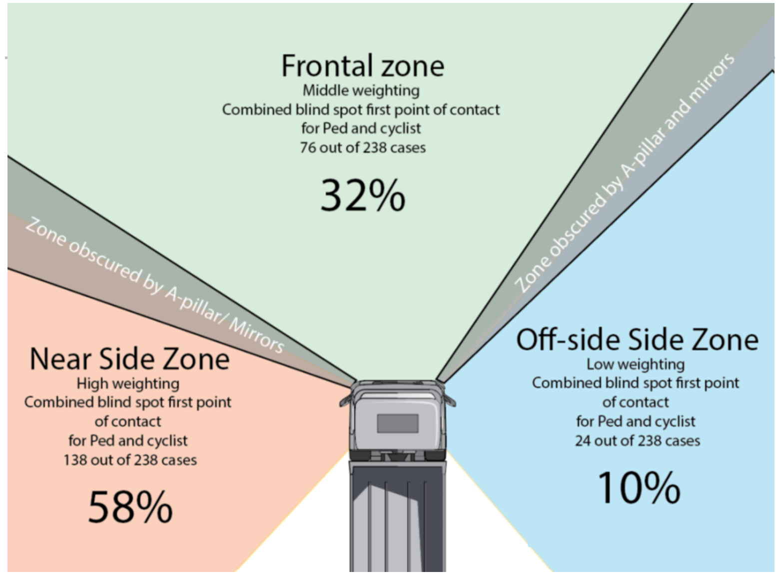
No. of accidents	Causation category
723	**Failed to look properly**
357	Failed to judge other person’s path or speed
321	Passing too close to cyclist horse rider or pedestrian
257	Poor turn or manoeuvre
219	Careless reckless or in a hurry
159	**Vehicle blind spot**
77	Loss of control
58	Cyclist entering road from pavement
39	Cyclist wearing dark clothing at night
36	Following too close
34	Other – Please specify below
33	Swerved
28	Road layout (eg. Bend hill narrow carriageway)
27	Junction restart (moving off at junction)
26	Vehicle door opened or closed negligently
24	Travelling too fast for conditions
23	Not displaying lights at night or in poor visibility
22	Failed to signal or misleading signal
21	Dazzling sun
19	Disobeyed 'Give Way' or 'Stop' sign or markings
18	Impaired by alcohol
17	Sudden braking
16	Stationary or parked vehicle(s)
16	Slippery road (due to weather)
16	Disobeyed automatic traffic signal
15	Nervous uncertain or panic
15	Aggressive driving
12	Rain sleet snowor fog
11	Vehicle travelling along pavement
10	Junction overshoot
10	Learner or inexperienced driver/rider
10	Poor or defective road surface
10	Fatigue

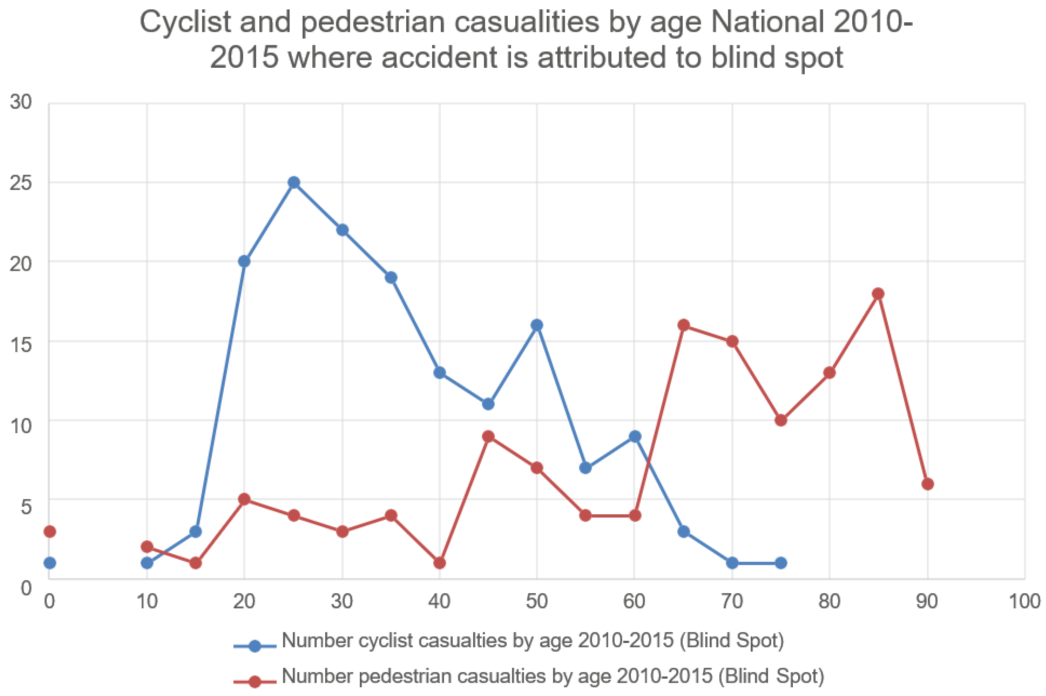
WHY AND HOW THE LONDON DIRECT VISION STANDARD WAS DEFINED

Loughborough University

ACCIDENT DATA ANALYSIS SUPPORTING THE REQUIREMENT FOR A DVS

- Accidents to the passenger side mostly involved cyclists on the passenger side and the truck turning left
- Accidents to the front mostly involved pedestrians being hit when the vehicle pulled away from stand still
- The pedestrians involved are mostly over the age of 65
- The cyclists are younger as one might expect.



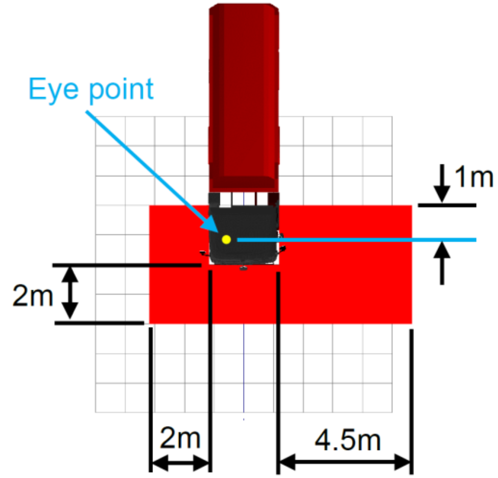


WHY AND HOW THE LONDON DIRECT VISION STANDARD WAS DEFINED

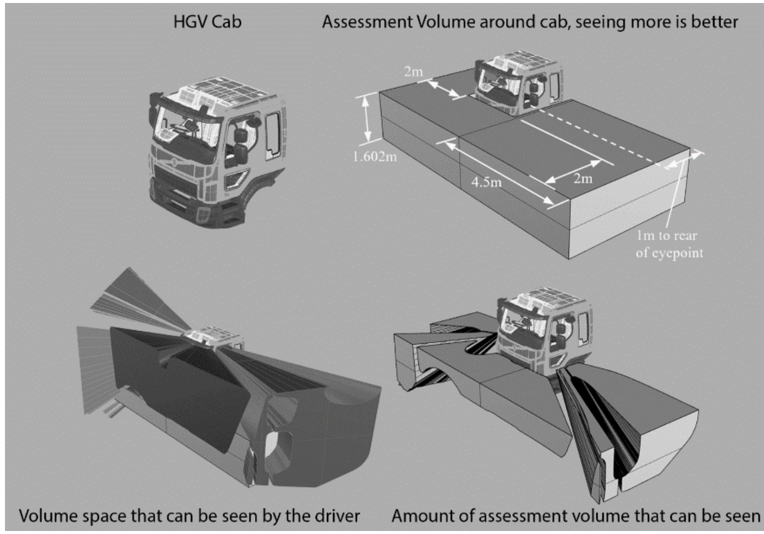
THE VOLUMETRIC METHOD

- The assessment method that has been defined in the London DVS, and adopted in the UNECE version involves the simple premise of constructing a volume of space around the vehicle (assessment volume) which is defined by the area of greatest risk
- The proportion of this volume that can be seen directly from a standardised set of eye points defines a score for the vehicle.
- The more that can be seen, the better the vehicle in terms of direct vision.
- The principle is that **making any volume within this assessment volume visible in direct vision** has a safety benefit and should be encouraged. This based upon issues with using multiple mirrors to gain situational awareness.
- Hence ***Volume is proposed as the sole metric for measuring direct vision performance***. It rewards all innovations that result in more direct vision in a safety critical zone close to the vehicle. It is accurate with high resolution.

- For more detail on the Volumetric method including the definition of the standardised eye point rig please the following
  - 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
  - Section 9.4. Project report. SUMMERSKILL, S. ... et al., 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
  - For more detail on the physical test method see the following presentation. 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



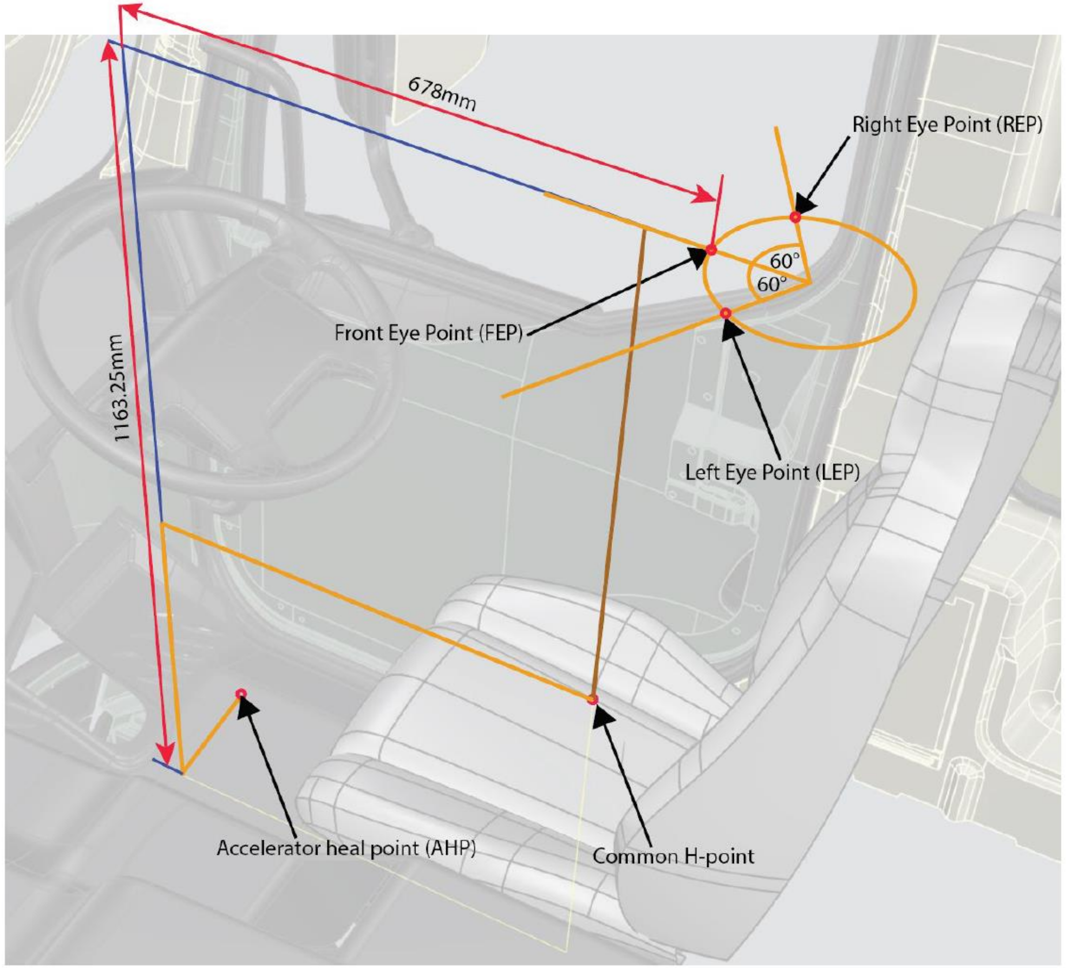
UK/Japanese vehicle (Right hand drive). The plan view of the assessment volume showing the coverage matches the class V & VI mirrors on the passenger side and front. A 2m zone has been added to the driver's side. This is mirrored for left hand drive vehicles



How the Direct Vision Standard defines the volume of the assessment volume that is visible to the driver

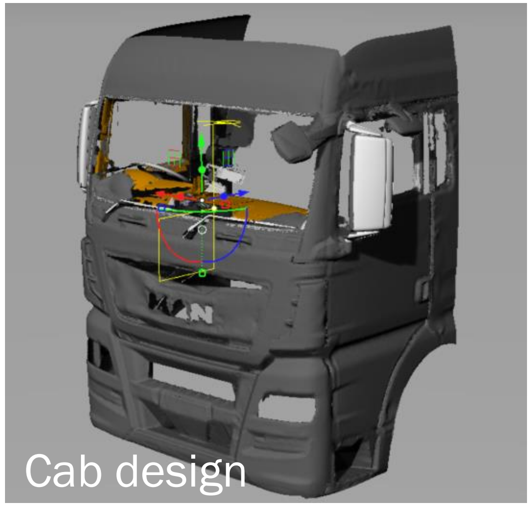
STANDARDISED EYE POINT

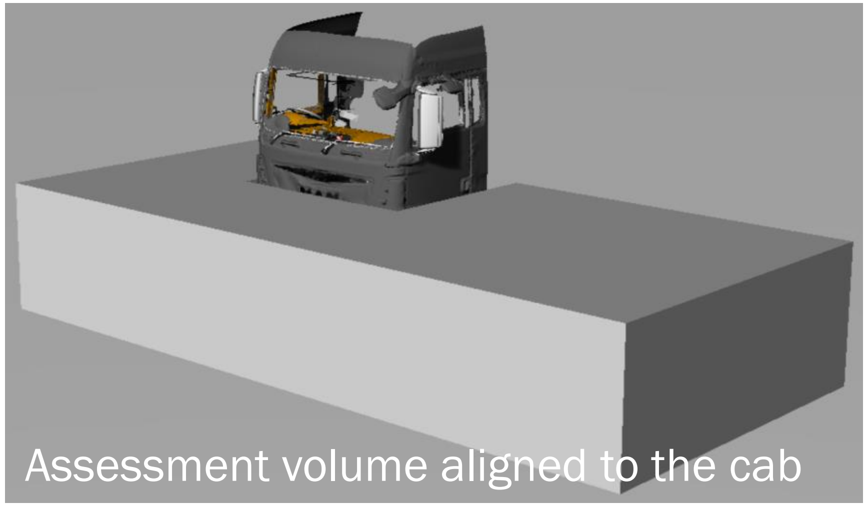
- The DVS method uses a standardised eye point rig. See figure
- This was defined in the TfL DVS project by the stakeholder group including 8 manufacturers
- A standardised eye point was required due to the variability in the use of the seating reference point (SgRP) by manufacturers which had the potential to skew the results

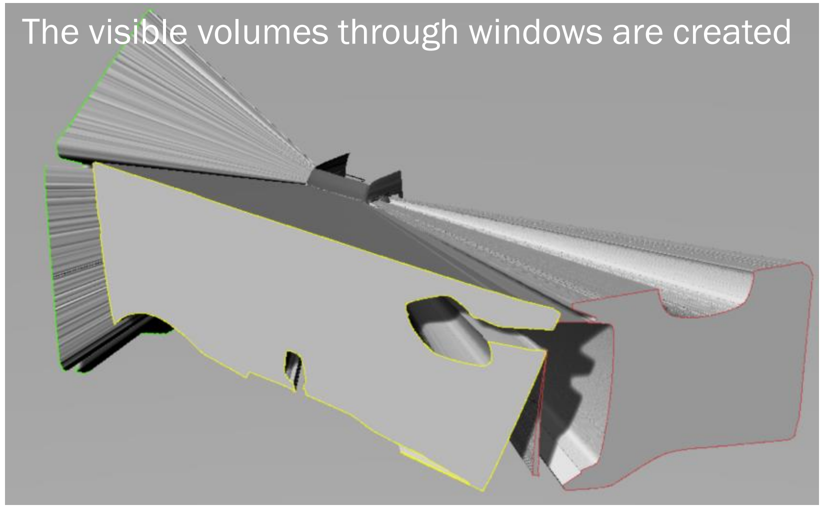


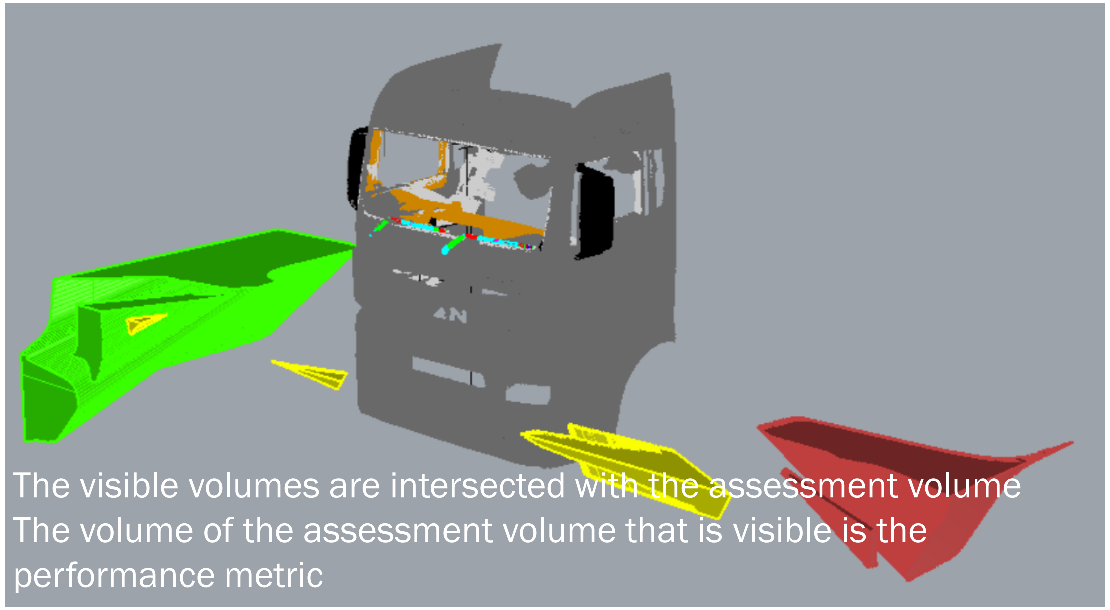
See Section 9.3.1 of the TfL DVS project report for more detail: Report link

THE VOLUMETRIC METHOD – WORKED EXAMPLE RESULTS









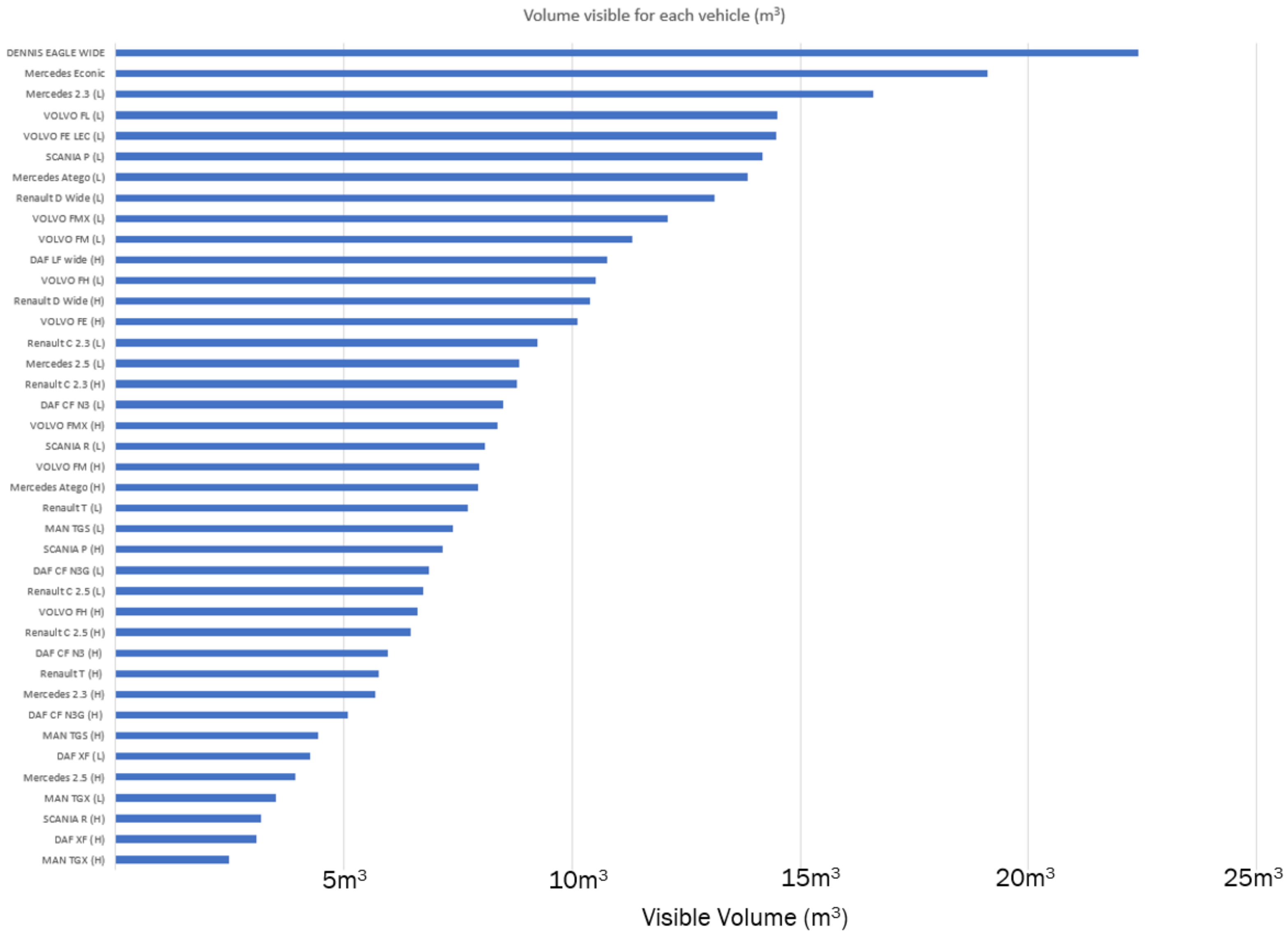
- The simulated driver can see 2.4m^3 or 4.65% of the assessment volume where the majority of this volume is seen to the driver's side which is the area of least risk

THE VOLUMETRIC METHOD

- The graph shows the range of volumetric performance in 52 examples of highest or lowest mounting positions across a range of make models

- The size of the assessment volume varies by cab width, a 2.5m wide cab will have assessment volume of approx. 50m^3

- Note: In the London DVS cab designs were assessed at the maximum possible height (H) and minimum possible height (L) for that model. See graph. This was not weighted by sales or freight sector. So, 7 of 52 (13%) specifications assessed had volumes of less than 5m^3 but this does not mean 13% of vehicles on the road have this level of visibility

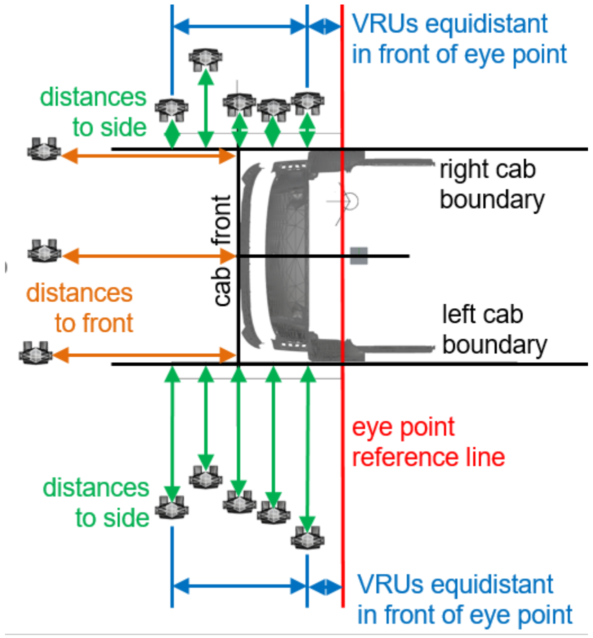


HOW DO WE GIVE CONTEXT FOR THE ABSTRACT VOLUMETRIC SCORE?

Using simulations of VRU distance, i.e. the distance away from the cab that a number of VRU simulations are located at whilst just allowing the head and neck to be visible.

WHY DO WE USE VRU DISTANCE?

- Considered in isolation, volumetric scores are abstract
- A need was perceived for a simplified measure to help illustrate what the visible volumes related to in terms of something more visibly related to safety
- Following a methodology originally applied in projects from 2011[2] and 2015[3] a set of VRU simulations were created which allows VRU visibility to be assessed at 13 points around the vehicle.
- The figure shows the arrangement of the VRUs around the cab.

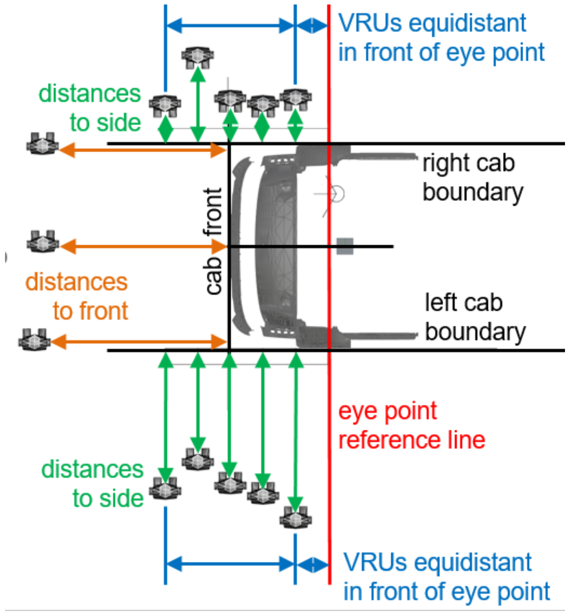


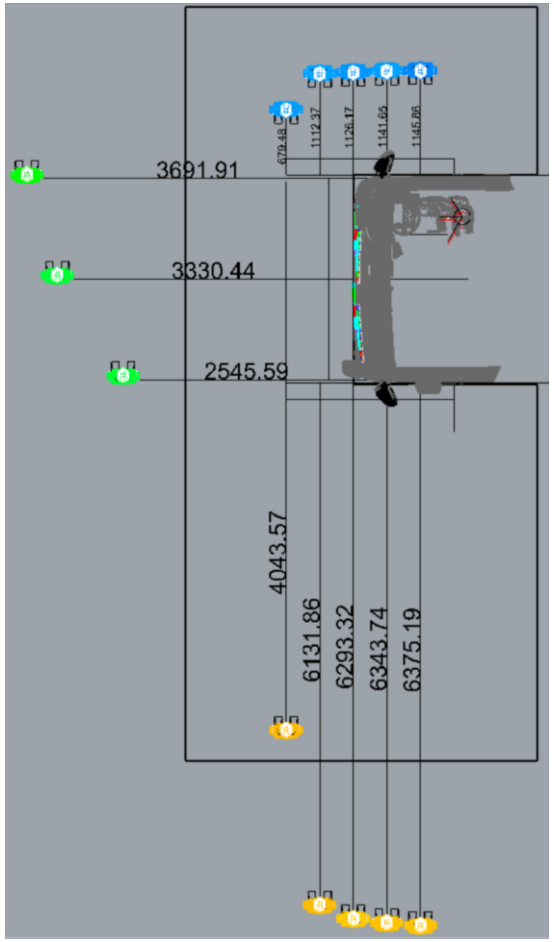
[2] COOK, S., SUMMERSKILL, S., MARSHALL. R., ... et al., 2011. The development of improvements to drivers' direct and indirect vision from vehicles - phase 2. Report for Department for Transport DfT TTS Project Ref: S0906 / V8. Loughborough: Loughborough University and MIRA Ltd. **See section 2.5** https://hdl.handle.net/2134/8873

[3]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

HOW ARE THE VRU SIMULATIONS DEFINED AND USED

- As per the diagram, an array of VRU simulations is arranged around the vehicle using a consistent method. Each VRU is then moved away from the side of the truck in one axis only
- The portion of the VRU that must be visible was originally proposed as head and shoulders but head and neck is now agreed
- This is followed by example results for the VRU distances





[2]COOK, S., SUMMERSKILL, S., MARSHALL. R., ... et al., 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. **See section 2.5** https://hdl.handle.net/2134/8873

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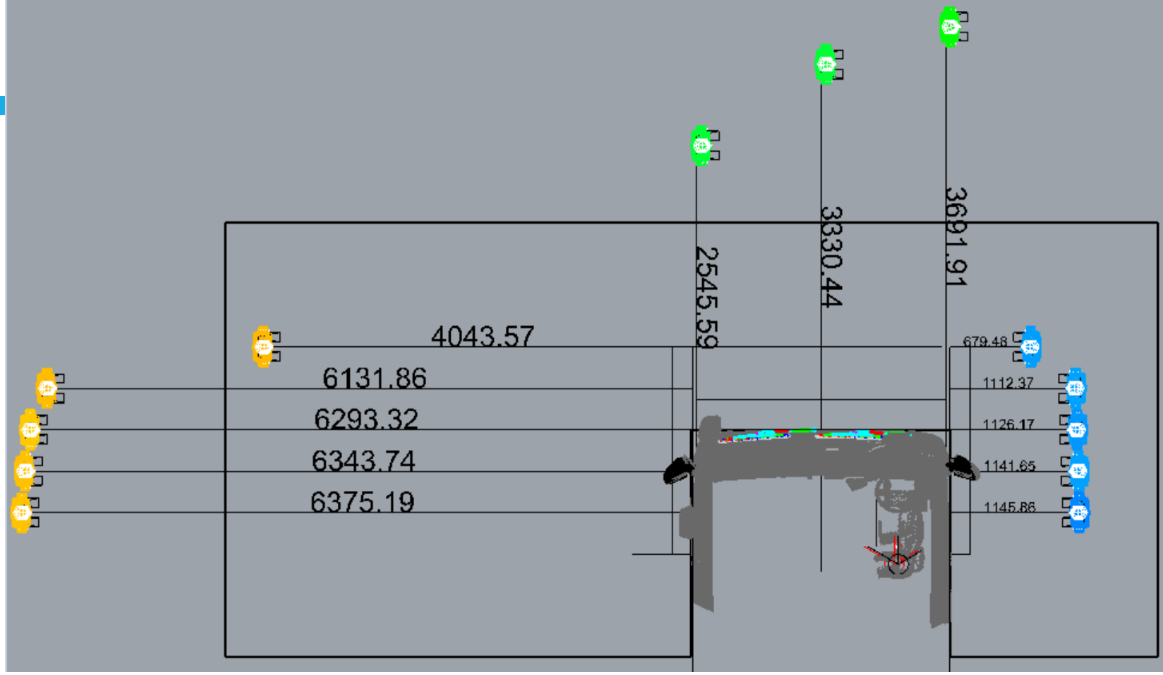
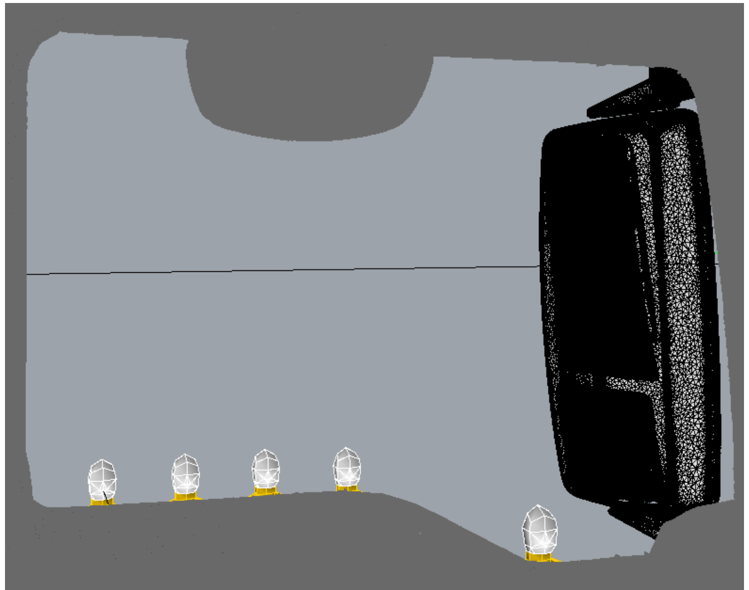
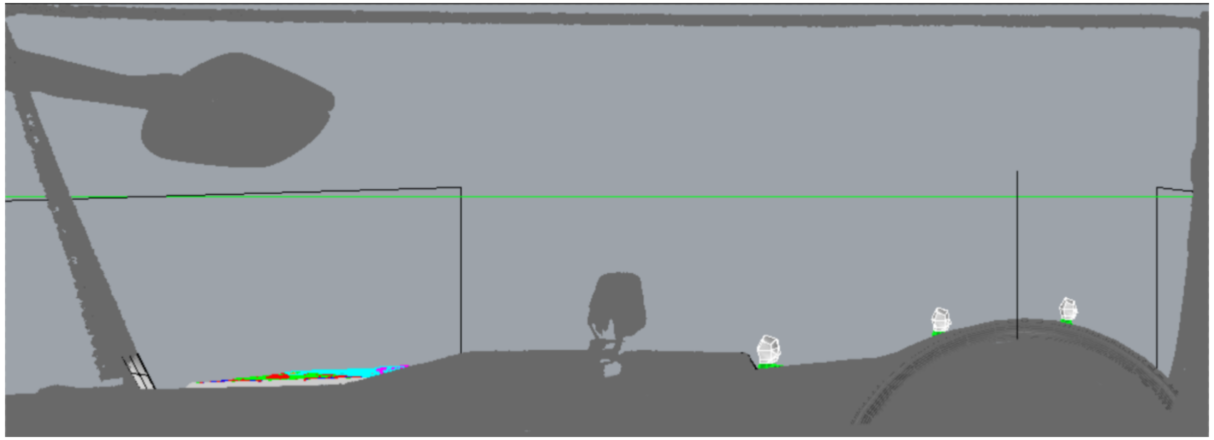
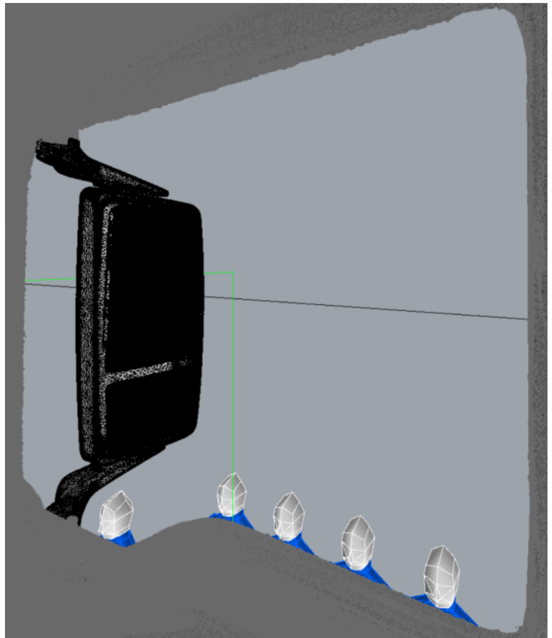
EXAMPLE VRU DISTANCE RESULT

- The bottom images shows the placement of the VRU simulations to the front and sides of the vehicle for **head and neck visibility from the simulated eyepoint.**
- Top right shows a plan view of VRU positions

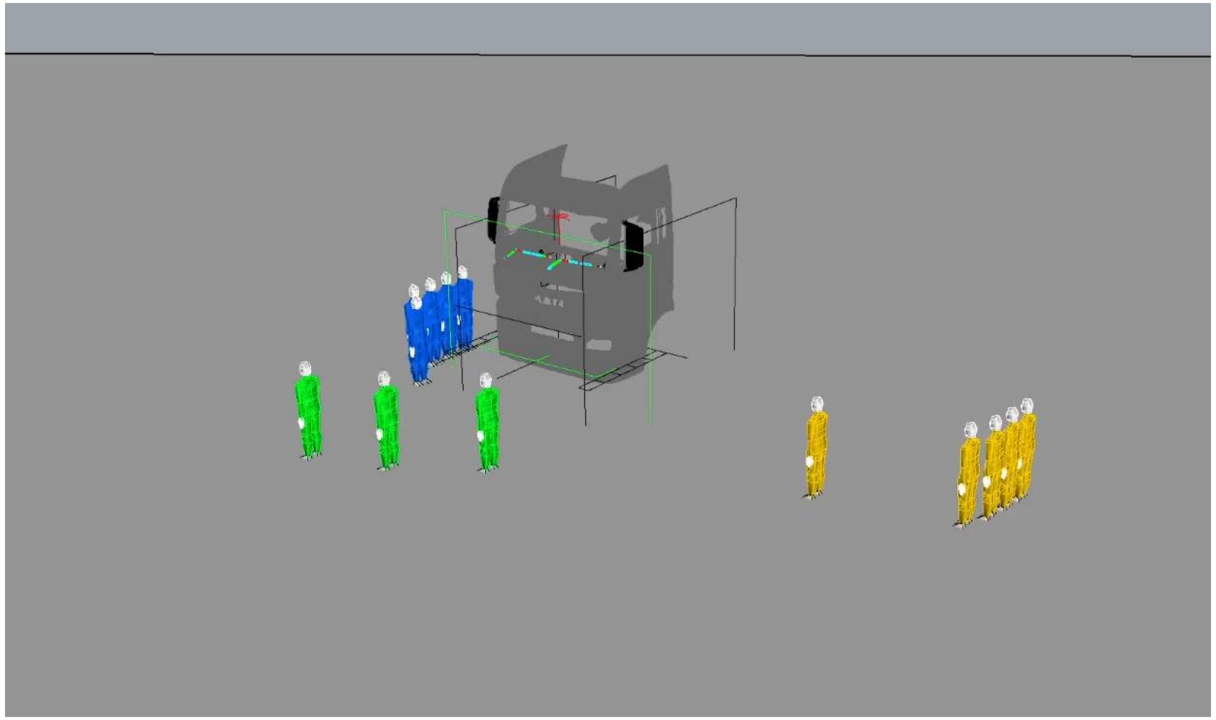


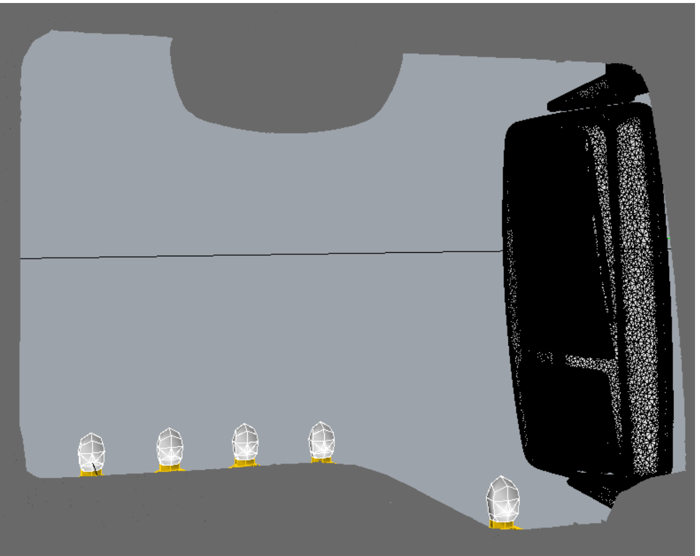


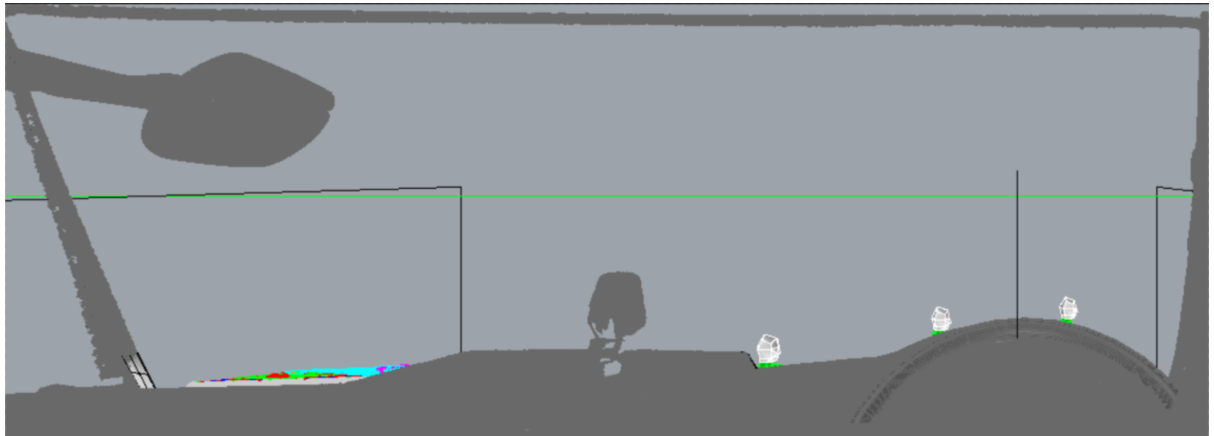


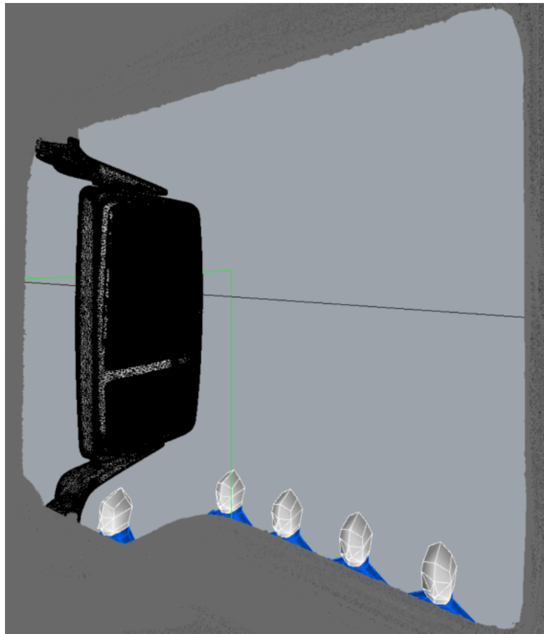


EXAMPLE VRU DISTANCE RESULT



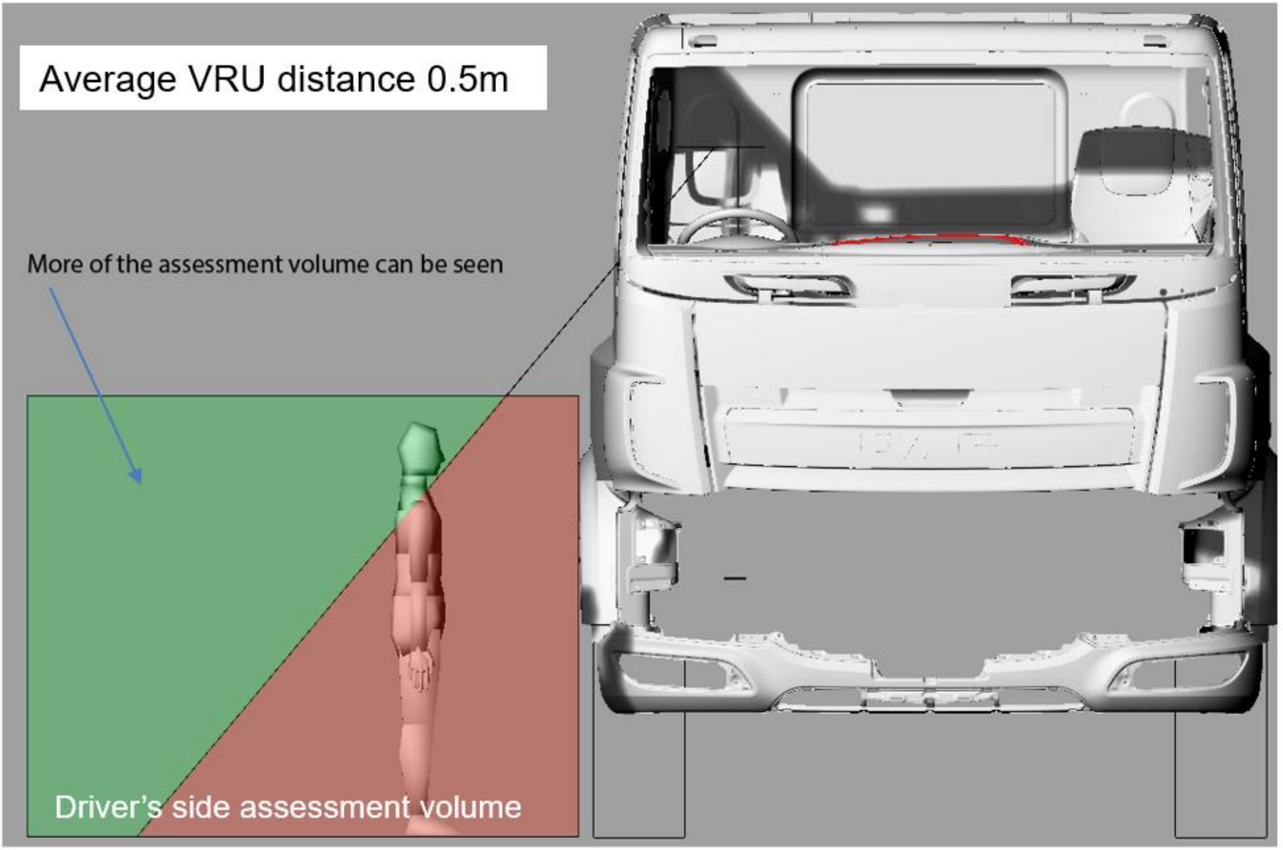


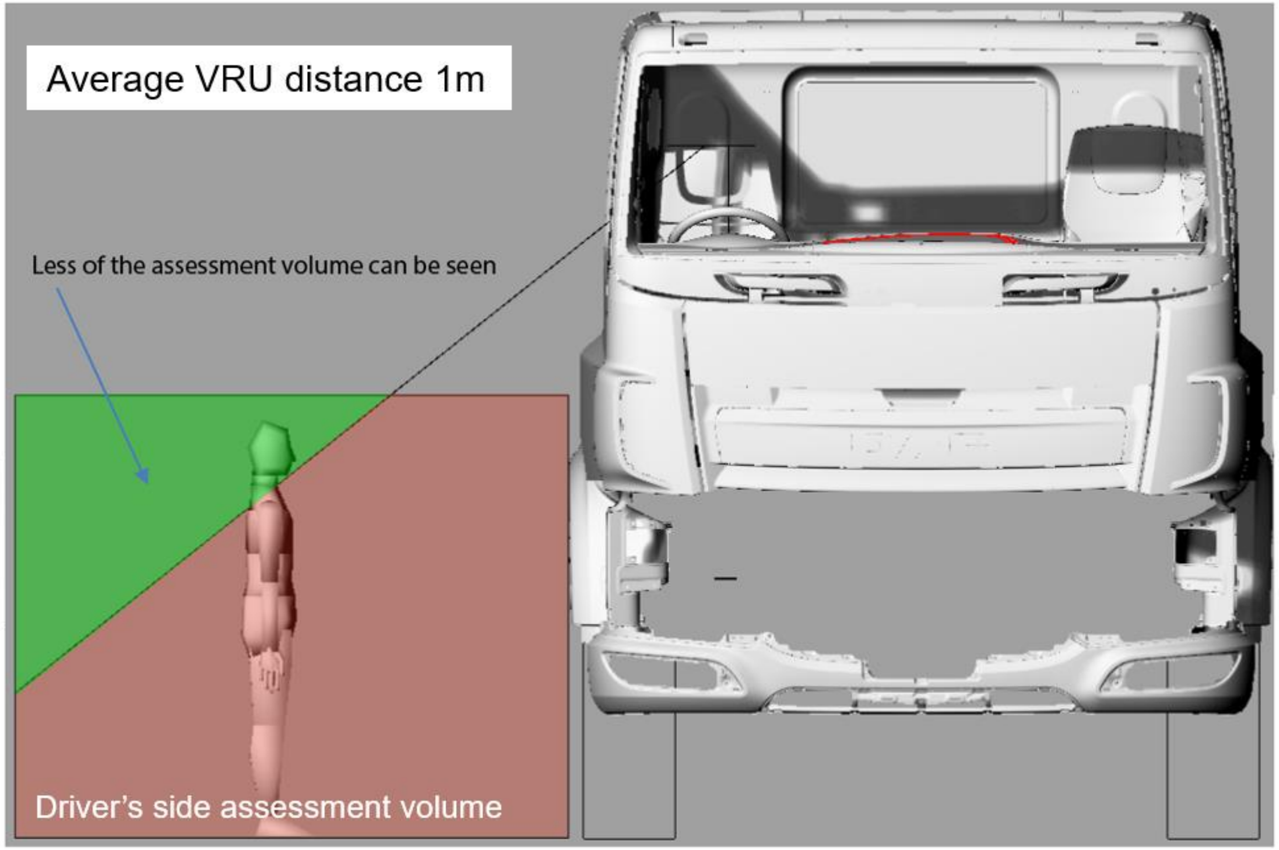




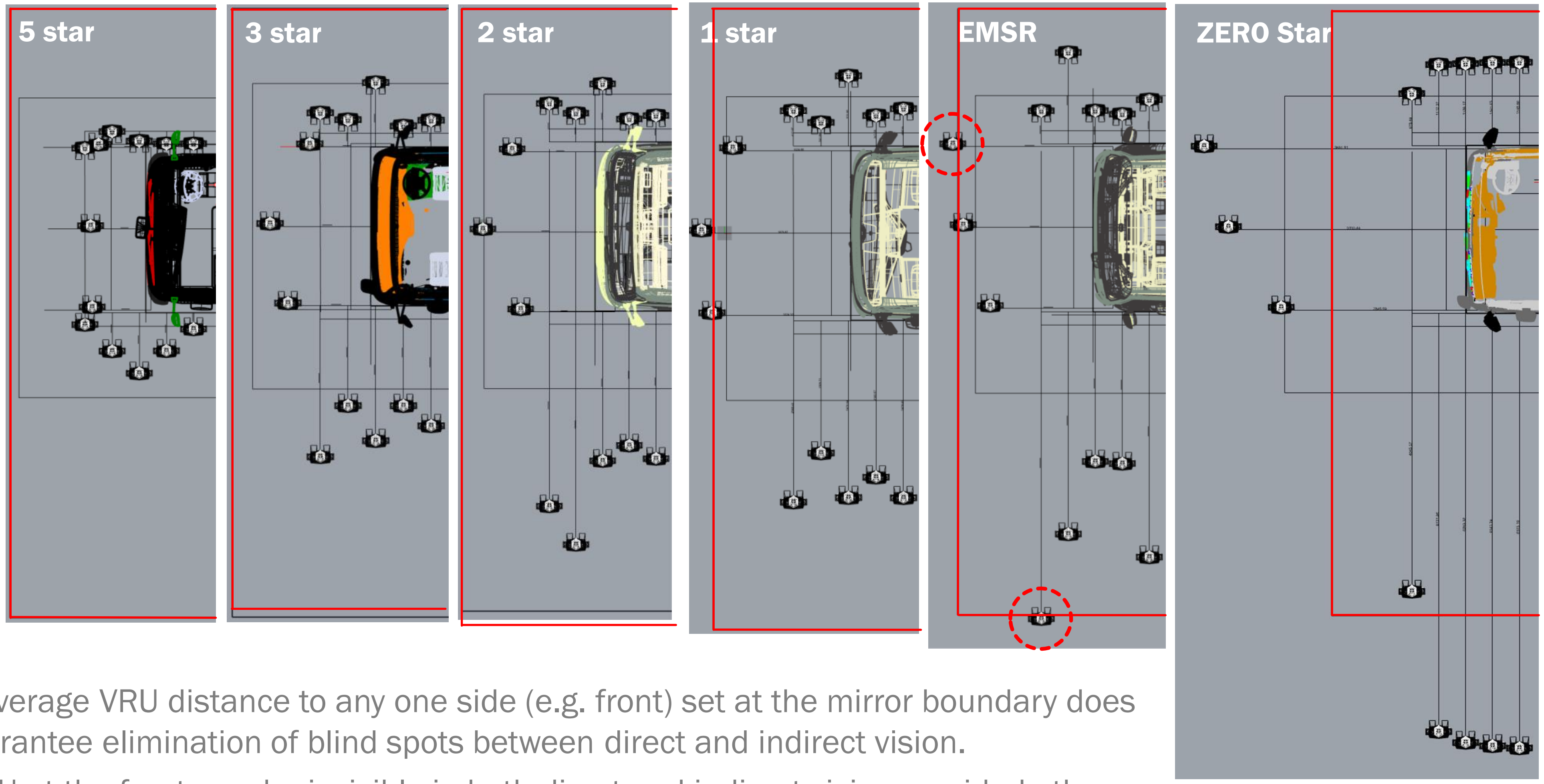
THE USE OF VRU SIMULATIONS (5TH%ILE ITALIAN FEMALE)

- There has been a consistent misunderstanding where it has been assumed that changing the average VRU distances changes the assessment volume
- This is not the case. Changing the average VRU distance changes the amount of the assessment volume that must be seen in the DVS test





EXAMPLE VRU DISTANCES FOR VEHICLES IN THE STAR BOUNDARY CATEGORIES (NEW VERSION, HEAD & NECK ONLY VISIBLE) TFL VERSION

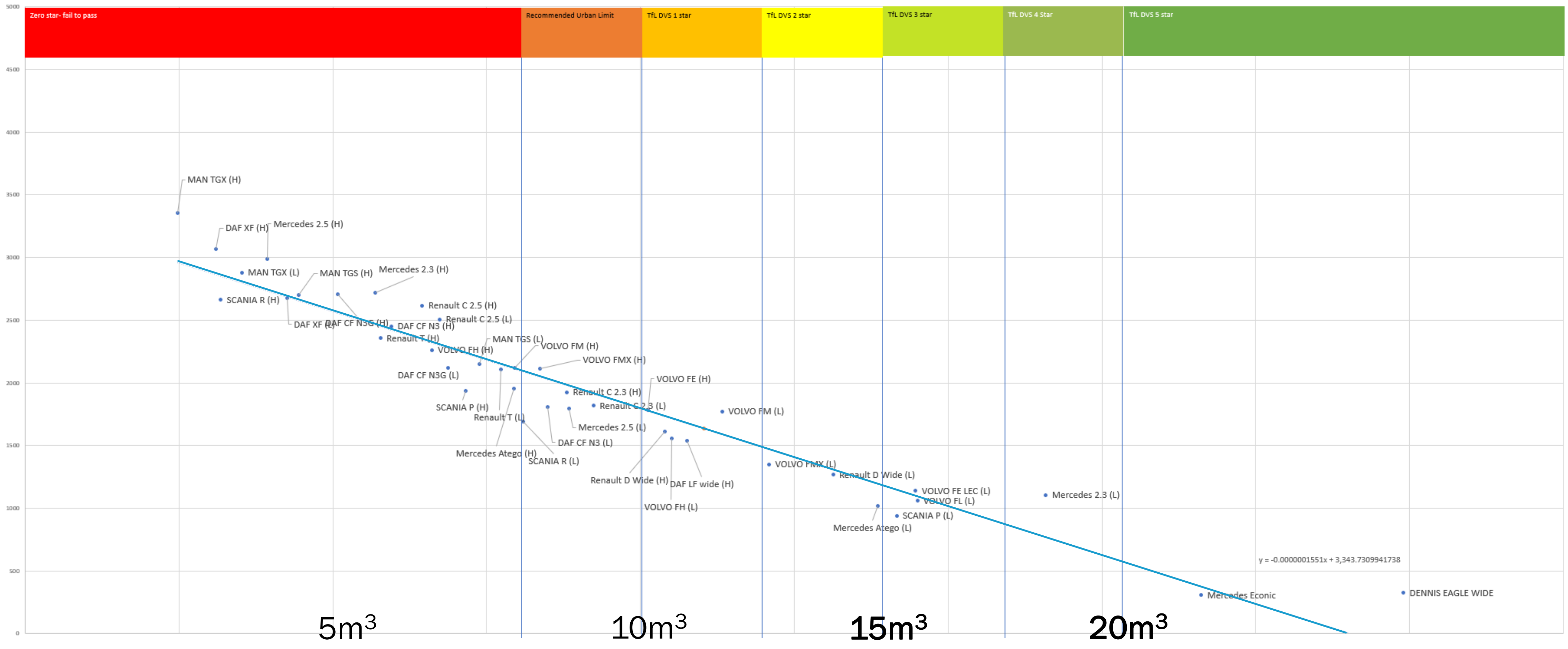


- Note: average VRU distance to any one side (e.g. front) set at the mirror boundary does not guarantee elimination of blind spots between direct and indirect vision.
- One VRU at the front may be invisible in both direct and indirect vision provided others are visible sufficiently far inside the mirror boundary for the average to be equal to 2m or less

PLOTTING THE AVERAGE VRU DISTANCE AGAINST VOLUME

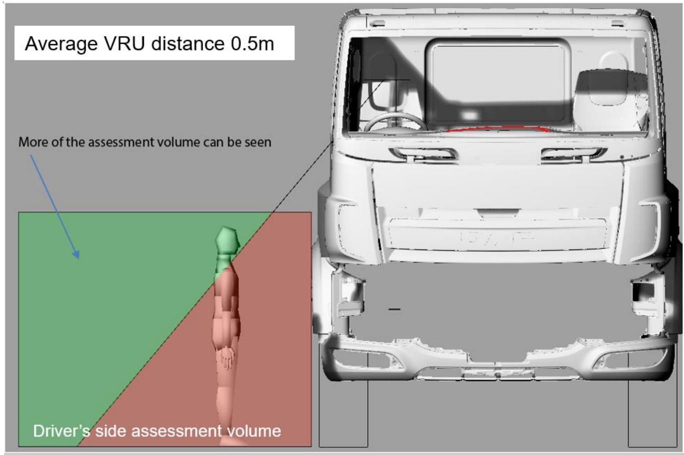
- When we plot the average VRU distance against volume we get a very strong correlation of 0.964 (where 1 is perfect)
- Therefore we can now use the average VRU distance that we want to define the volume that must be seen by using the equation of the graph trendline

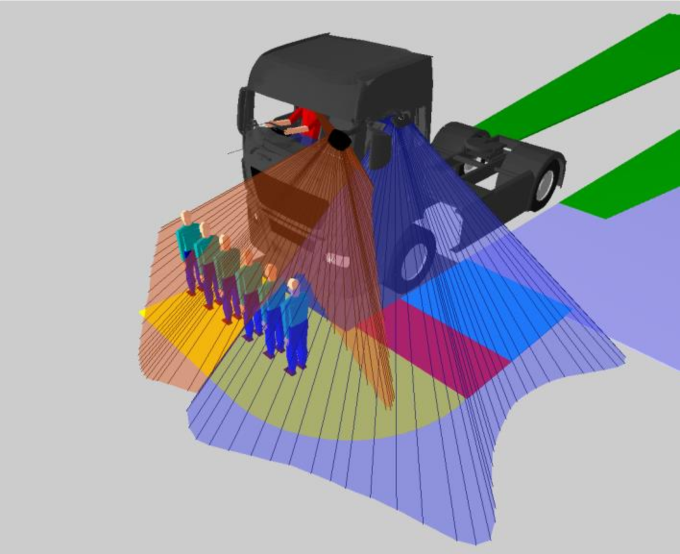
The Average VRU distance (Y axis) plotted against the volumetric score (X Axis).



WHAT IS A BLIND SPOT? OUR VIEW

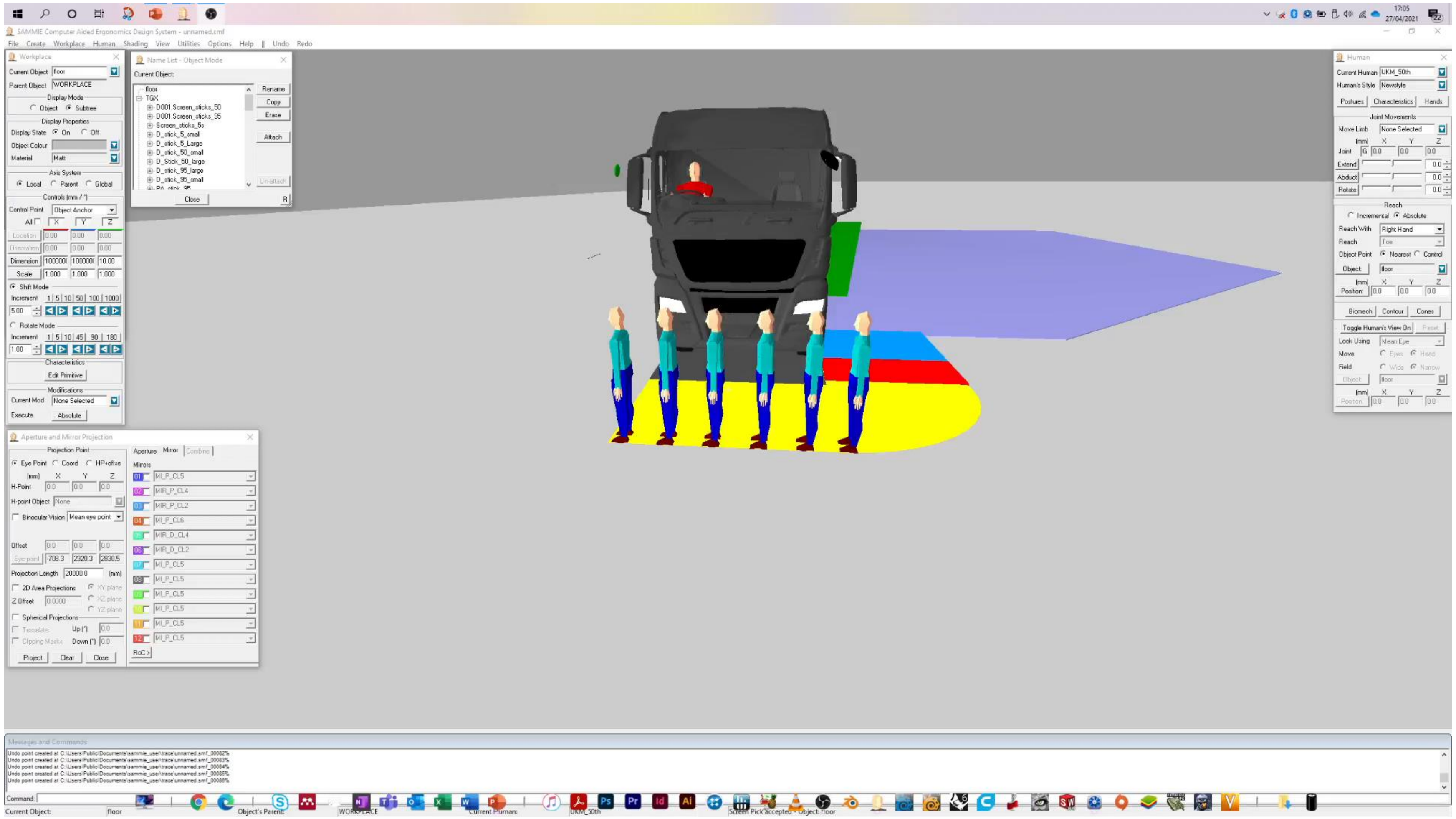
- The accident data highlights that **‘not seeing’** is the main causation factor for accidents
- And yet the mirrors cover the area in close proximity to the vehicle in a comprehensive manner
- A study by the UK DfT highlighted that the mandatory introduction of the Class VI mirror which covered the front of the vehicle **has not reduced accidents** when the vehicle pulls away from a crossing or junction
- A driver must use 6 mirrors **(indirect vision)** and the windows **(direct vision)** to gain situational awareness. In some scenarios we suggest that this is too challenging
- A study by Leeds University highlighted that indirect vision increases reaction time by 0.7 seconds compared to direct vision
- Therefore in our view the **DIRECT VISION** blind spot is any area currently covered by a mirror in close proximity to the vehicle cab
- We therefore want to see minimum volume requirements which allow **as much direct vision of the area of greatest risk**, or the assessment volume as possible which is defined by the VRU distance
- **ACEA present the idea that indirect vision can supplement direct vision – we disagree due to the points above.**
- **Also see the next slide**





WHAT IS A BLIND SPOT?

- A row of VRU simulations
  - 5th%ile Italian female
- VRUs **inside** the class VI mirror zone (yellow area)
- Class VI mirror covers the required zone (UNECE reg 46)
- VRUs can't be seen through direct vision from a standardised seating posture
- Only a small portion of VRUs are **visible at edge** of a mirror with radius of curvature of 300mm (distorted image)
- Therefore we do not find it acceptable to say that VRUs can be at the edge of the mirror coverage zone and can effectively be seen through indirect vision
- The VRU distance should be closer to the cab than 2m in our view



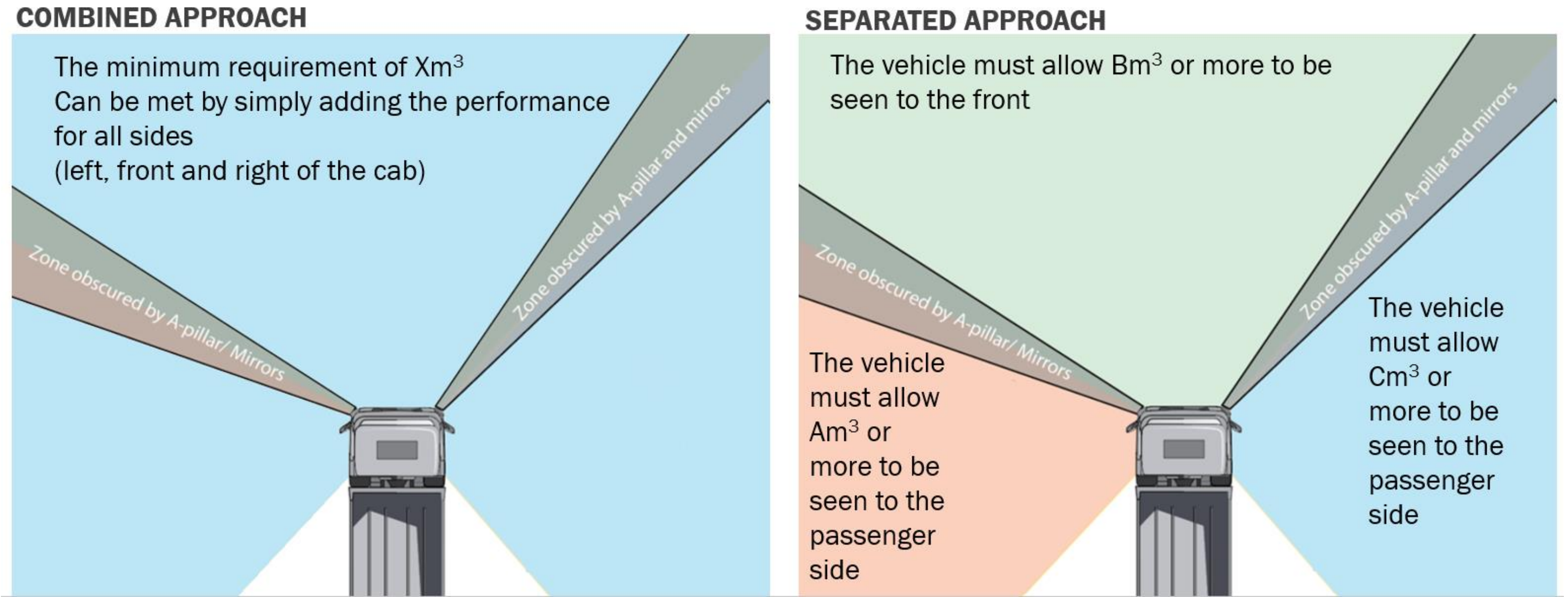
WHAT IS A BLIND SPOT?

- We therefore want to see minimum volume requirements which allow **as much direct vision of the area of greatest risk**, or the assessment volume, as possible.

- This is defined by the VRU distance

COMBINED OR SEPARATED APPROACH?

- The London DVS used a combined approach.
- The combined approach would allow the required visible volume to be gained from any side of the vehicle BUT a manufacturer may improve performance substantially to the driver and passenger sides by replacing mirrors with a camera system, but make no improvements to the front visibility as long as the total volume requirement is met. This may leave an area to the front of the vehicle where VRUs are visible in neither direct or indirect vision. Evidence for this has been shown in a number of VRU Proxi meetings (14 and 16)
- A separated approach has been defined to avoid a situation where vehicles still have blind spots to the front. The separated approach would require a minimum requirement to be met for each side individually, potentially requiring improved vehicle designs to the front. See right hand figure below



HYBRID APPROACH

- A hybrid approach has therefore been suggested which requires a specific amount of visible volume to the front to counter the issue of the combined approach
- ACEA have stated that the current method of defining the volumes to the front, left and right (the A-pillars as separators) is not technology neutral and therefore the separated approach in the current form is not acceptable
  - i.e. a design which uses a tapered front end with closer a-pillars would be penalised as the inter A-pillar distance would be smaller and therefore one would see less of the assessment volume through the front window.
- We agree. Therefore we have offered to look at the definition of the front volume in a new way to avoid this problem
- If this work is not done to redefine how the assessment volume is seen, there are two options available

1. Use the combined approach which we are against
2. Use the separated approach which ACEA are against

- CPs will have the choice
- This is covered in the T&E proposal from the 17th meeting of the VRU Proxi group.

- The End.