26 MARCH 2019 - UNECE

HGV Direct Vision Standard: London Update

Vicky Sims
Transport for London

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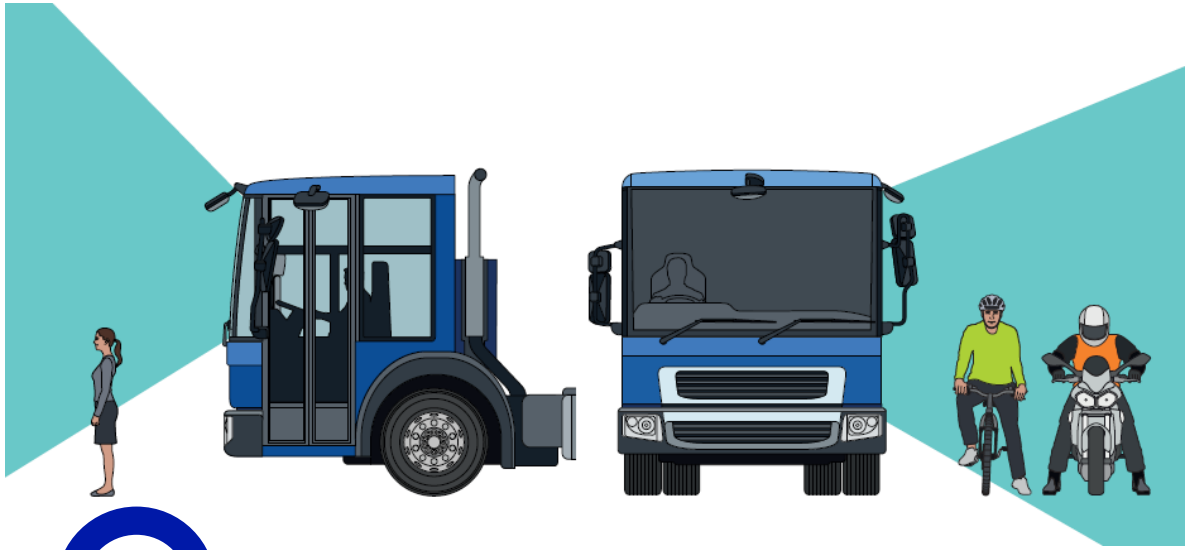
The Direct Vision Standard (DVS)

The technical standard - Loughborough

- World's first Direct Vision Standard for HGVs
- Objective measurement of the 'volume of space' weighted by risk to other road users
- This measurement is converted to a "star rating' from zero (worst) to five (best)



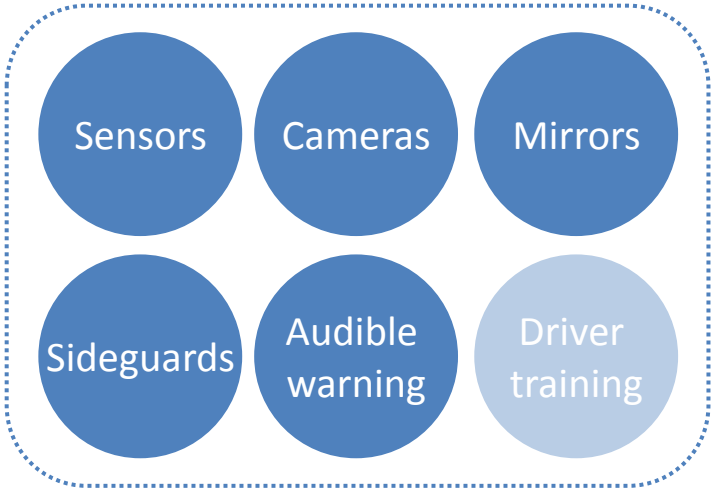
Application of the Standard

- Inform operator purchasing decisions - most suitable vehicle for the city environment
- Manufacturers can use it to improve future designs
- Future European regulations governing HGV designs – an International DVS
- Accelerated adoption of safer HGVs in London
    - DVS and HGV Safety Permit Scheme
    - GLA/TfL contracts

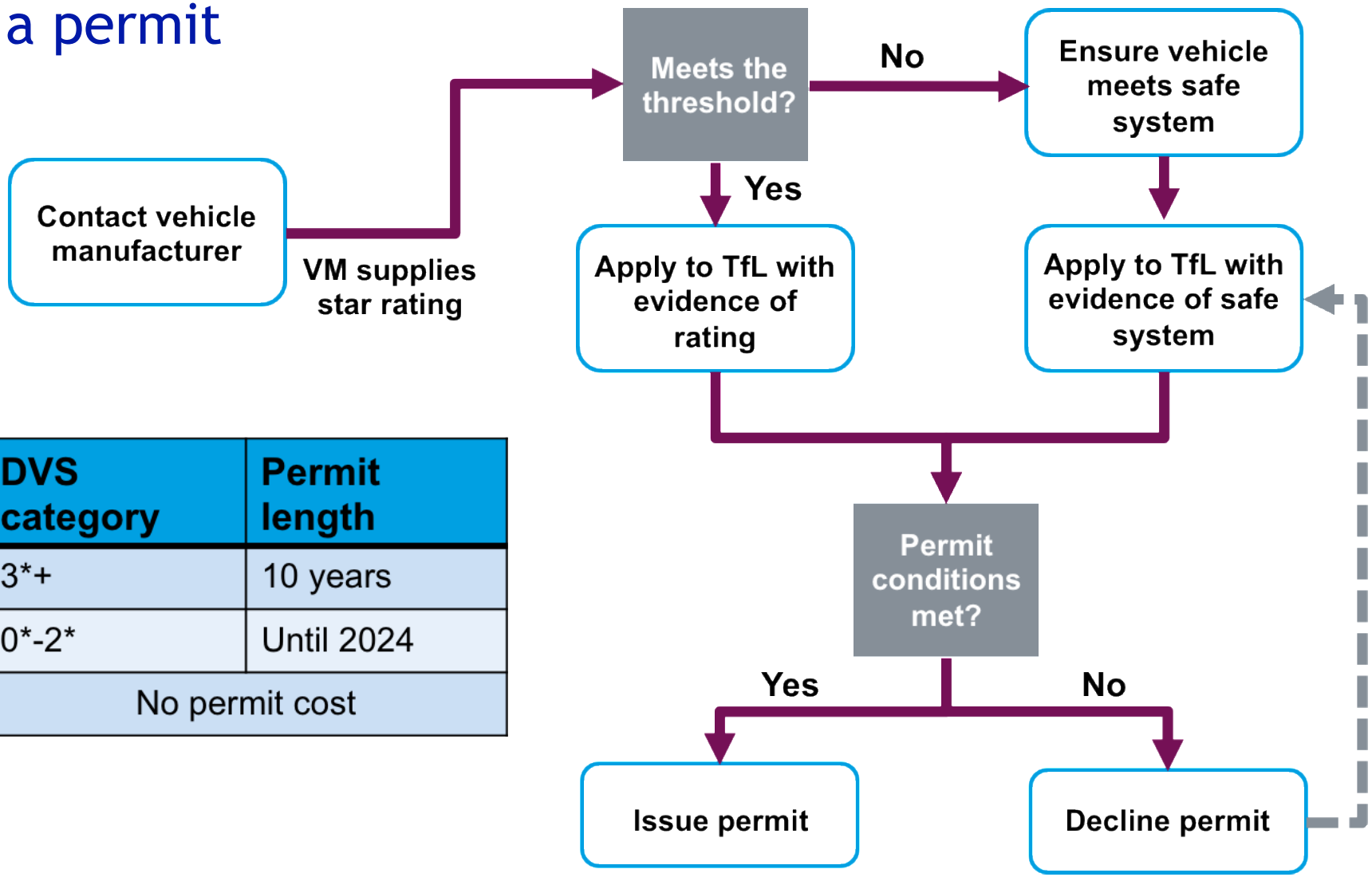
The London Policy

HGV safety permit scheme – London wide, operating 24/7

- All HGVs over 12 tonnes will require a permit to enter Greater London
- Permits will be granted to those that:
  - Meet the minimum DVS star rating to be granted a permit (1 star and above from 2020, 3 star and above from 2024)
  - Don’t meet the minimum star rating BUT do meet mitigating “**Safe System**” requirements



Obtaining a permit



DVS category	Permit length
3*+	10 years
0*-2*	Until 2024
No permit cost	

Consultation

Phase 1 consultation
Jan - Apr 2017
Call for more than direct vision alone

Phase 2a consultation
Nov 2017 –Jan 2018
Strong support for safe system
Call to align with ULEZ timings

Phase 2b public consultation (Jan 2019 – Feb 2019)
Final proposals

Phase 2c statutory consultation (Spring 2019)
Legal implementation, Traffic Regulation Order etc

Next steps

Implementation

- Pre-populating permit database of DVS star ratings against vehicle registrations
- Building online permit application portal
- Permit applications launch October 2019
- DVS validation process – Loughborough Design School

Communications

- Awareness raising marketing and advertising – UK and Europe
- Ongoing Stakeholder engagement
- Ongoing engagement with vehicle manufacturers
- Other cities – advice and guidance

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Thank you

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tfl.gov.uk/direct-vision-HGVs

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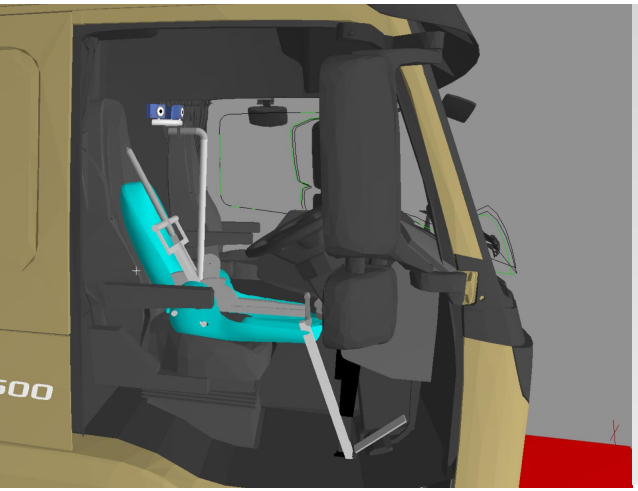
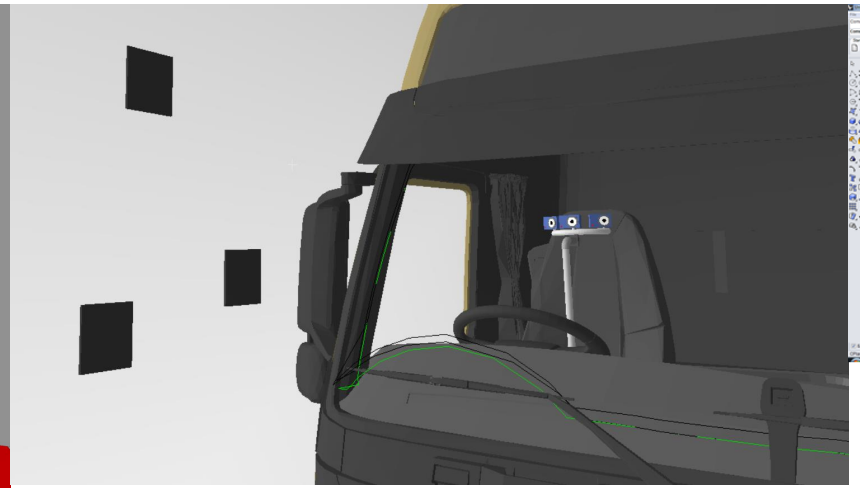
Definition and testing of a Direct Vision Standard for Trucks – A physical test to supplement the virtual DVS method

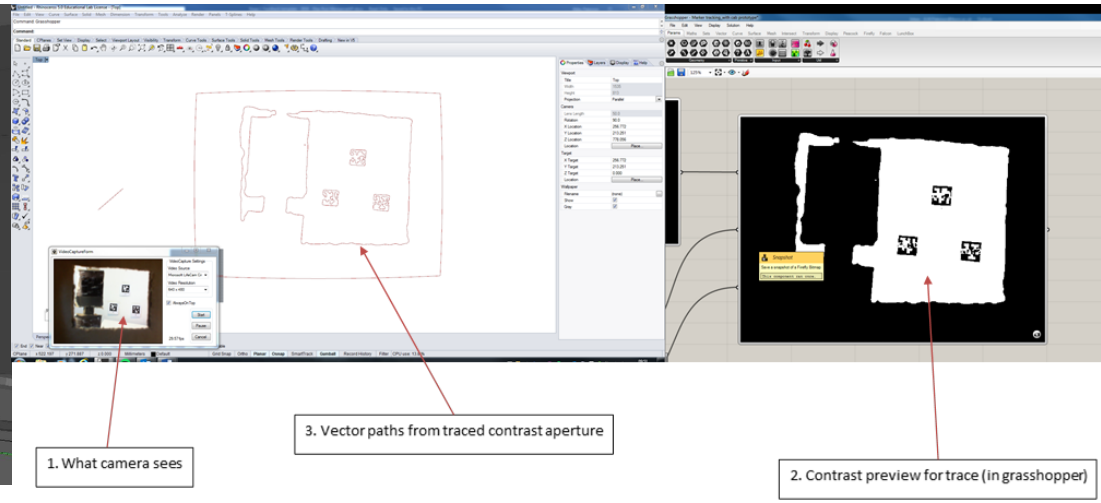
Loughborough University Design School: Design Ergonomics Research Group

Research Sponsored by Transport for London

Dr. Steve Summerskill
Dr. Russell Marshall, Dr Abby Paterson, Antony Eland, James Lenard, Steve Reed



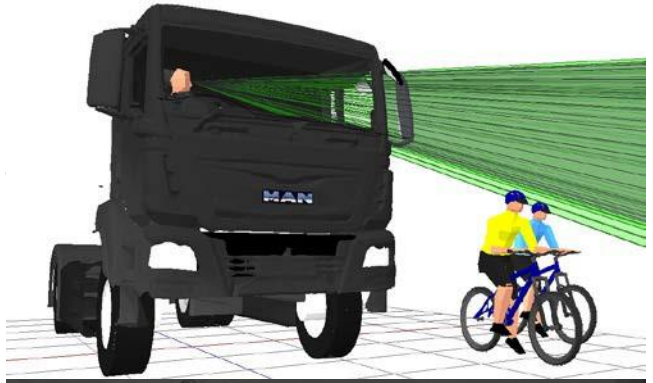


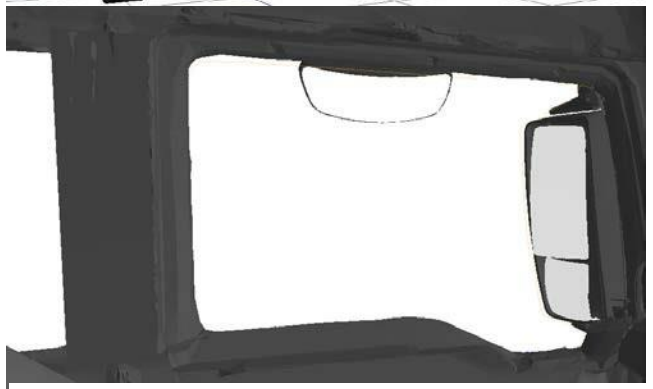


Contents

Detailed review of the work performed so far

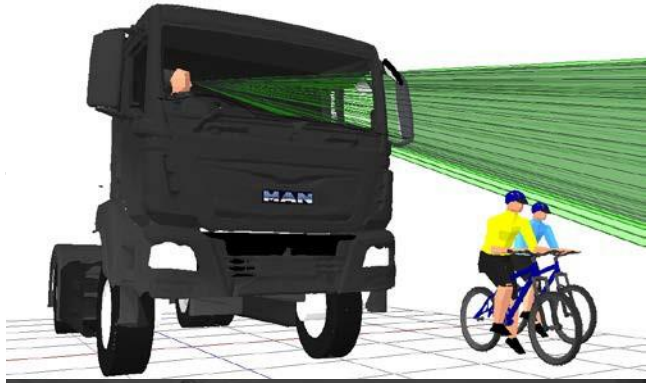
- A reminder of the fundamentals of the TfL DVS process
- The further definition of a physical test that can be used when CAD does not exist

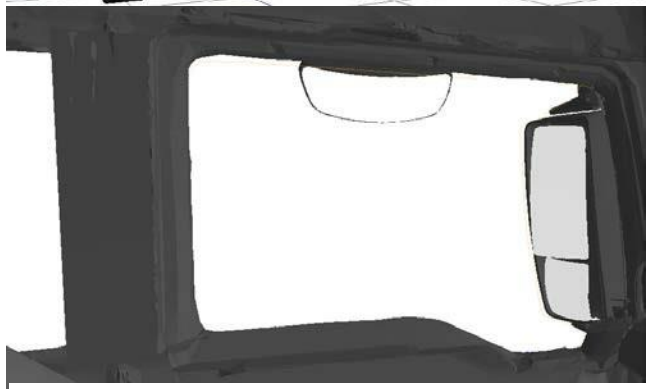


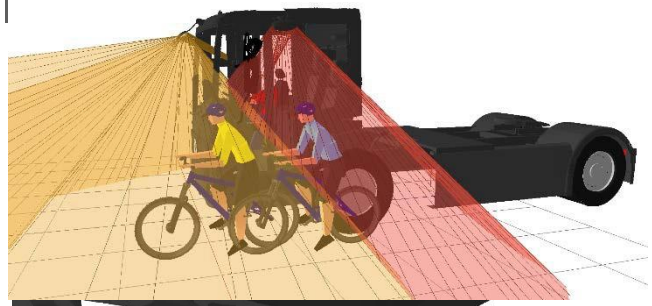


The definition of a ‘real world’ test that can be used for on the spot checks

- At the last VRU Proxy meeting we showed initial ideas for a physical test method
- As discussed at the last meeting the CAD approach should be seen as the gold standard in terms of the accuracy and ability to support the design process for improved direct vision, due to the high resolution nature of the test process
- The following should not be seen as a replacement for the CAD based technique







Engagement with stakeholders

Loughborough University

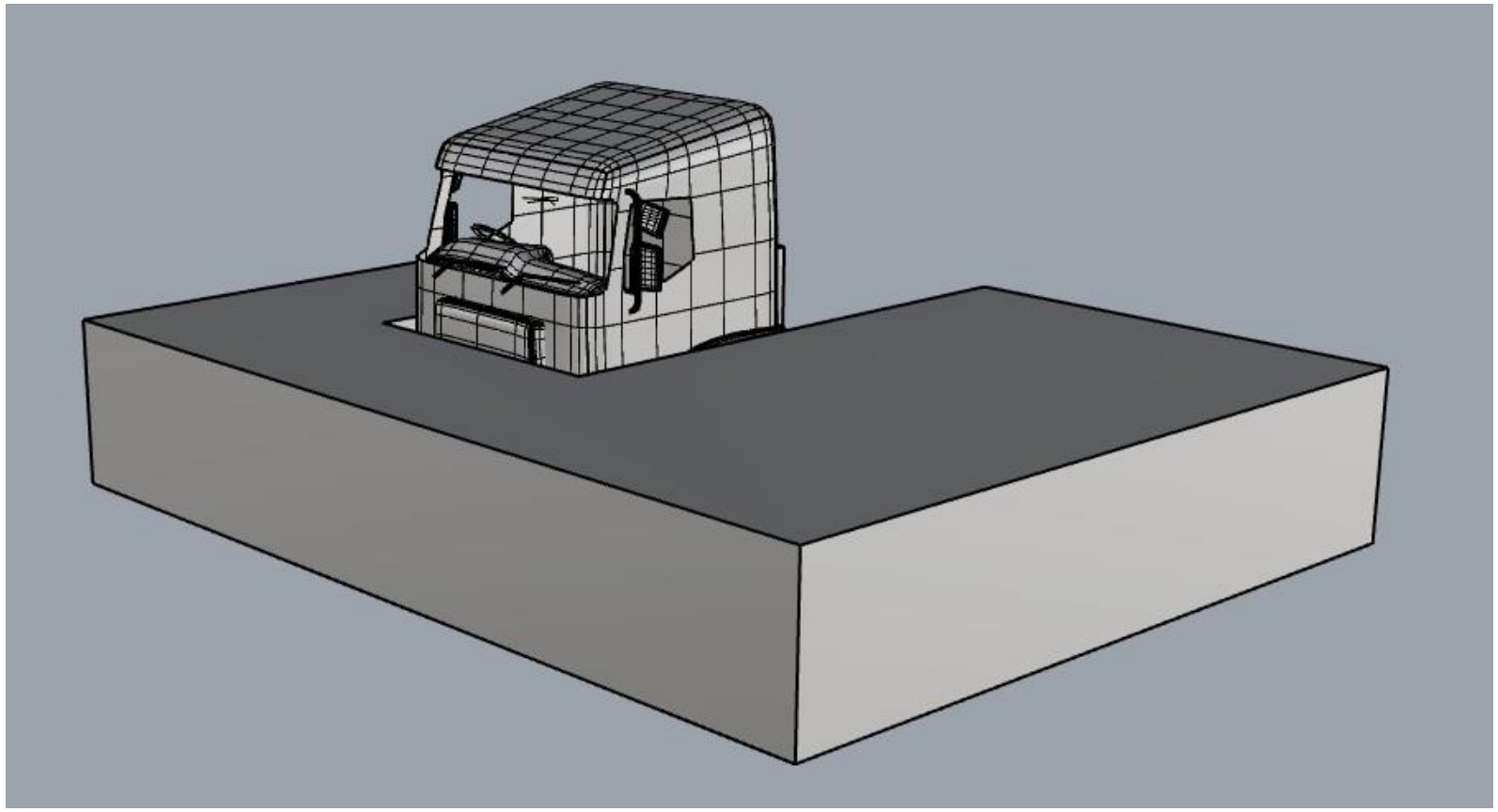
- Visit to Volvo/Renault development team in Gothenburg, Sweden
- Visit to Daimler/Mercedes development team in Stuttgart, Germany
- DAF development team visited the LDS
- LDS visited Dennis Eagle in Warwick
- DAF design team met with LDS and TfL reps in Loughborough
- IVECO meeting with LDS and TfL reps in London
- LDS visit to Scania, Milton Keynes

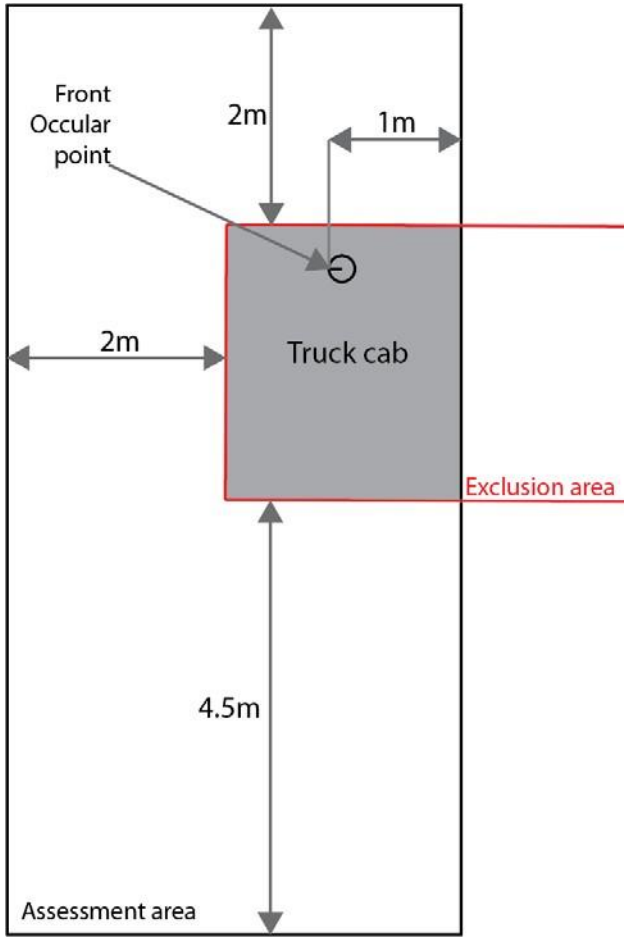
- **Expert working group (6 Meetings)** including all major manufacturers has met frequently to discuss progress and review methodology

- Numerous points of contact with UK reps for manufacturers to access CAD data and arrange legal agreements to allow the use of the data by Loughborough University
- **We have developed an excellent relationship with the manufacturers** which has supported our understanding of the technical issues and the provided valuable data for use in the project

Reminder – the digital DVS methodology

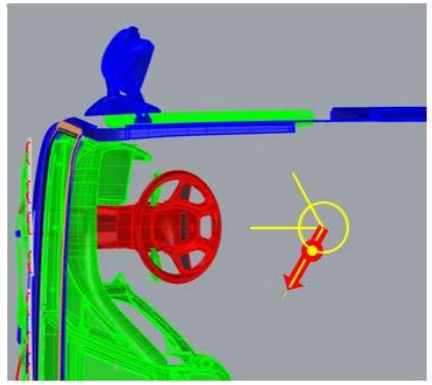
– The assessment volume is aligned to the truck sides and front

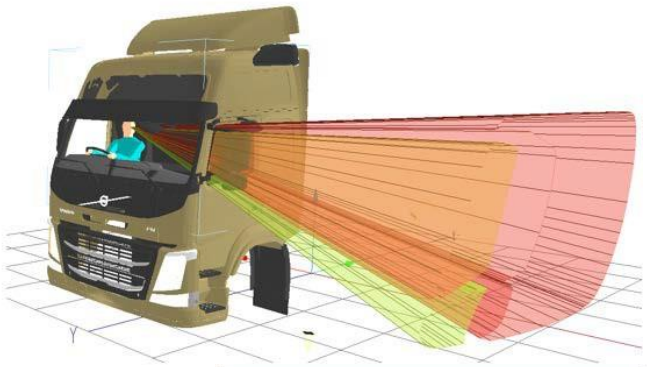


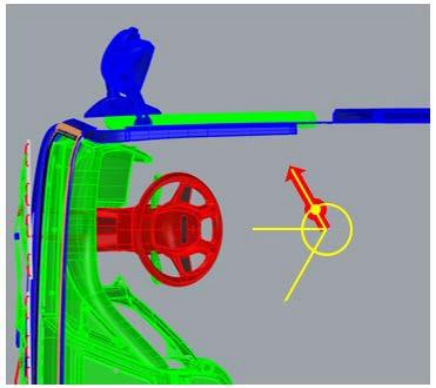


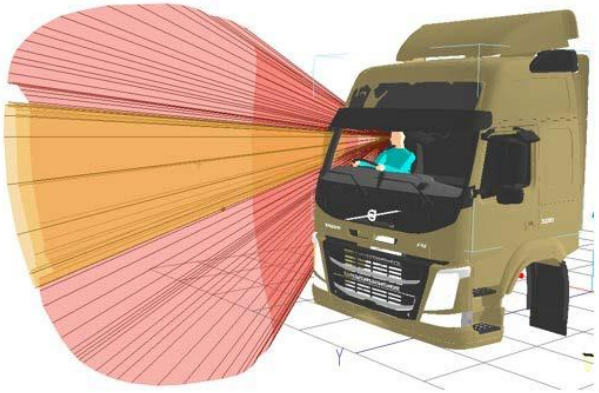
Reminder – the core DVS methodology

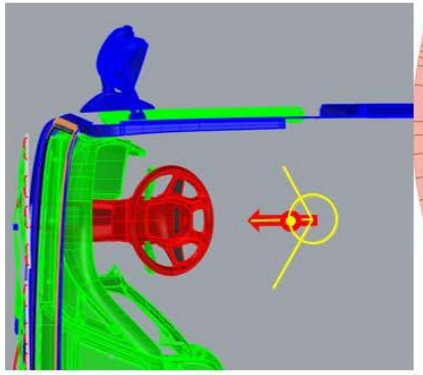
- The volume of space visible from the three defined eye points is projected through predefined window apetures

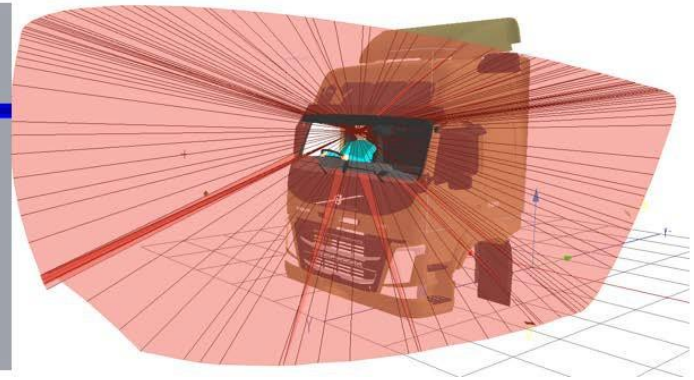






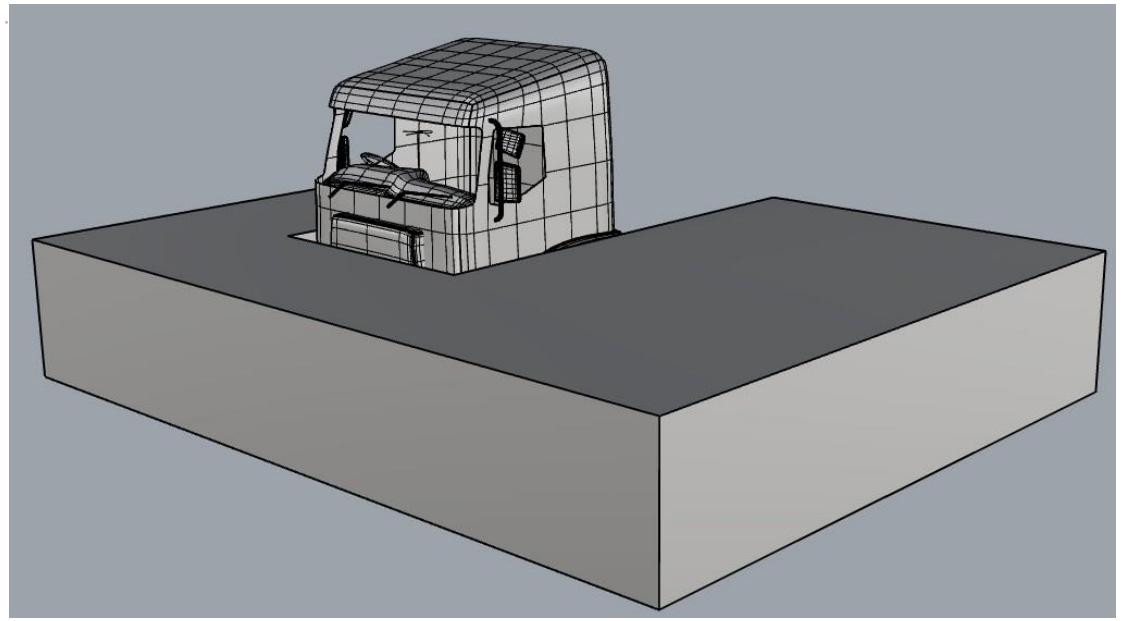


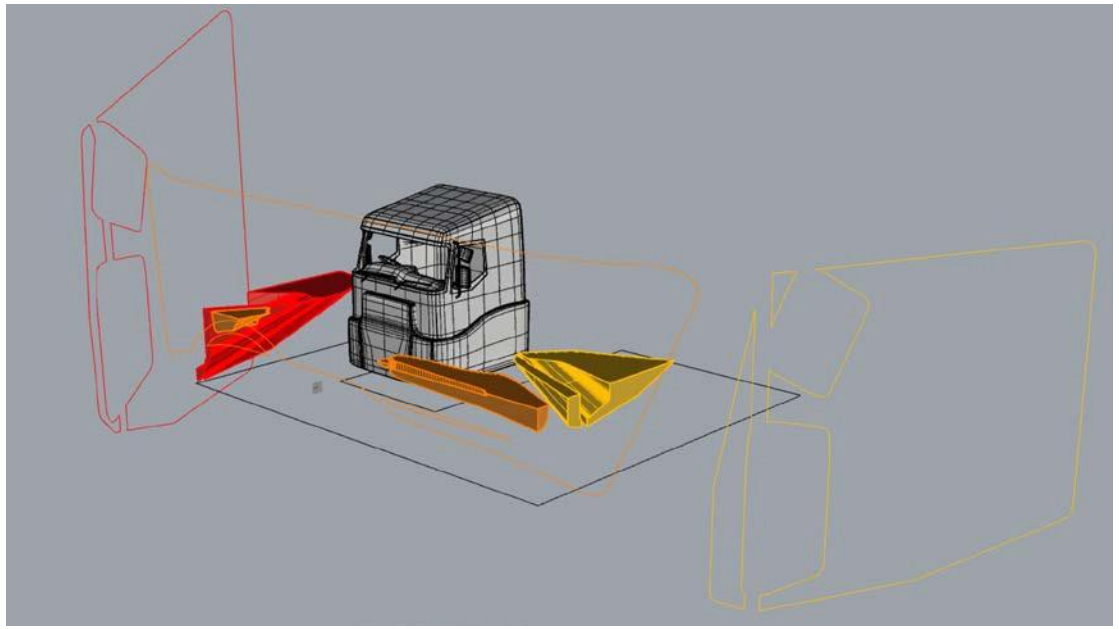




Reminder – the core DVS methodology

- The visible volumes are intersected with the assessment volume to allow the proportion of the assessment volume that is visible to the virtual driver to be calculated





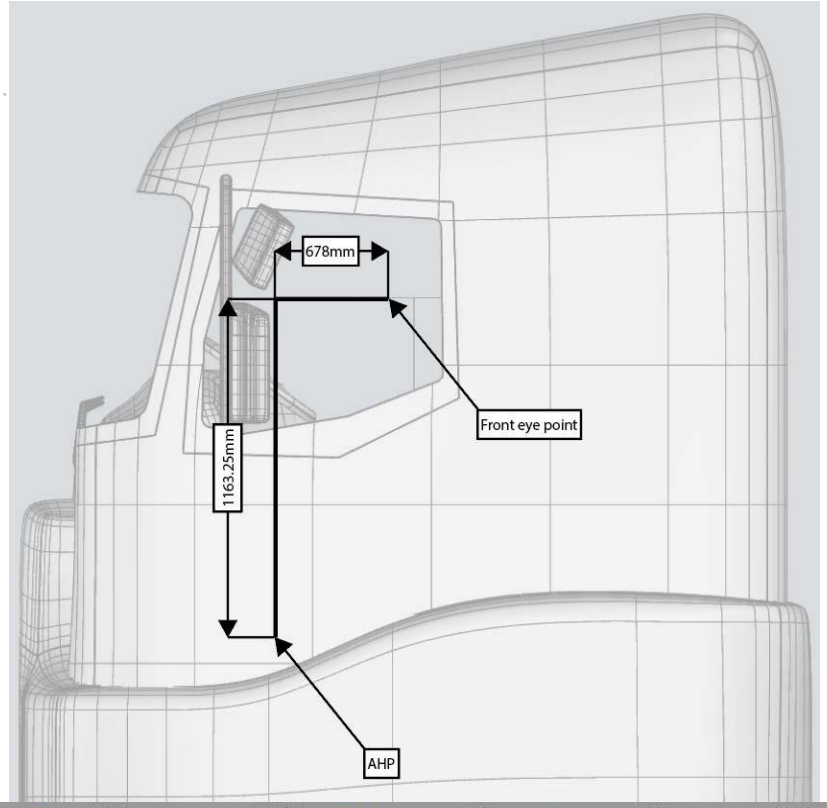
Reminder – the core DVS methodology

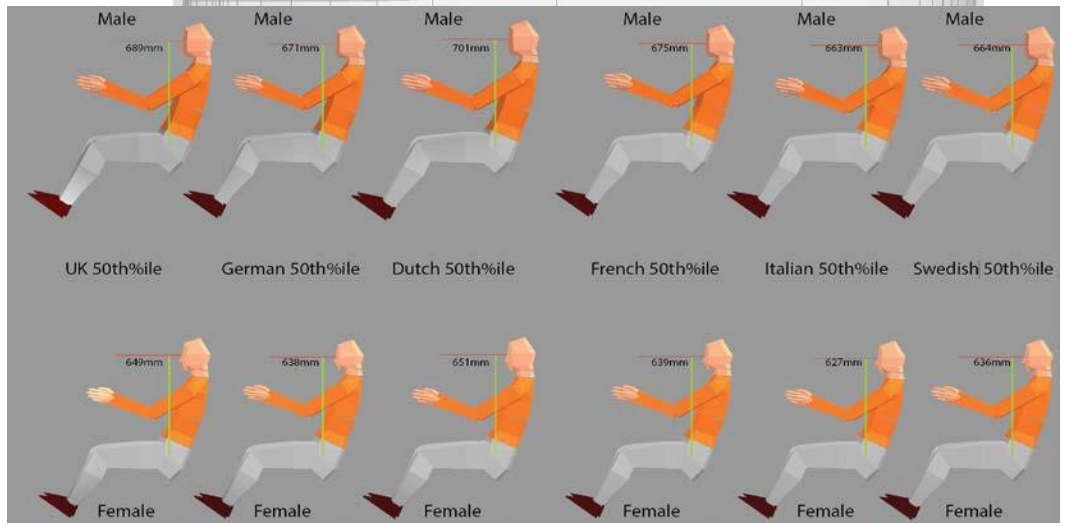
- The forward eye point is defined by an offset from the accelerator heel point (AHP)

- This eye point was defined with the agreement of manufacturers and is a standardised eye point which can be used with any vehicle

  - Multiple other options were considered including using standard hip point (SgRP) definitions and offsets for an eye point as defined in UNECE regulation 46, however these led to some manufacturers gaining an advantage when a full analysis of all trucks was performed due to variability in the use of the SgRP within the H-point envelope

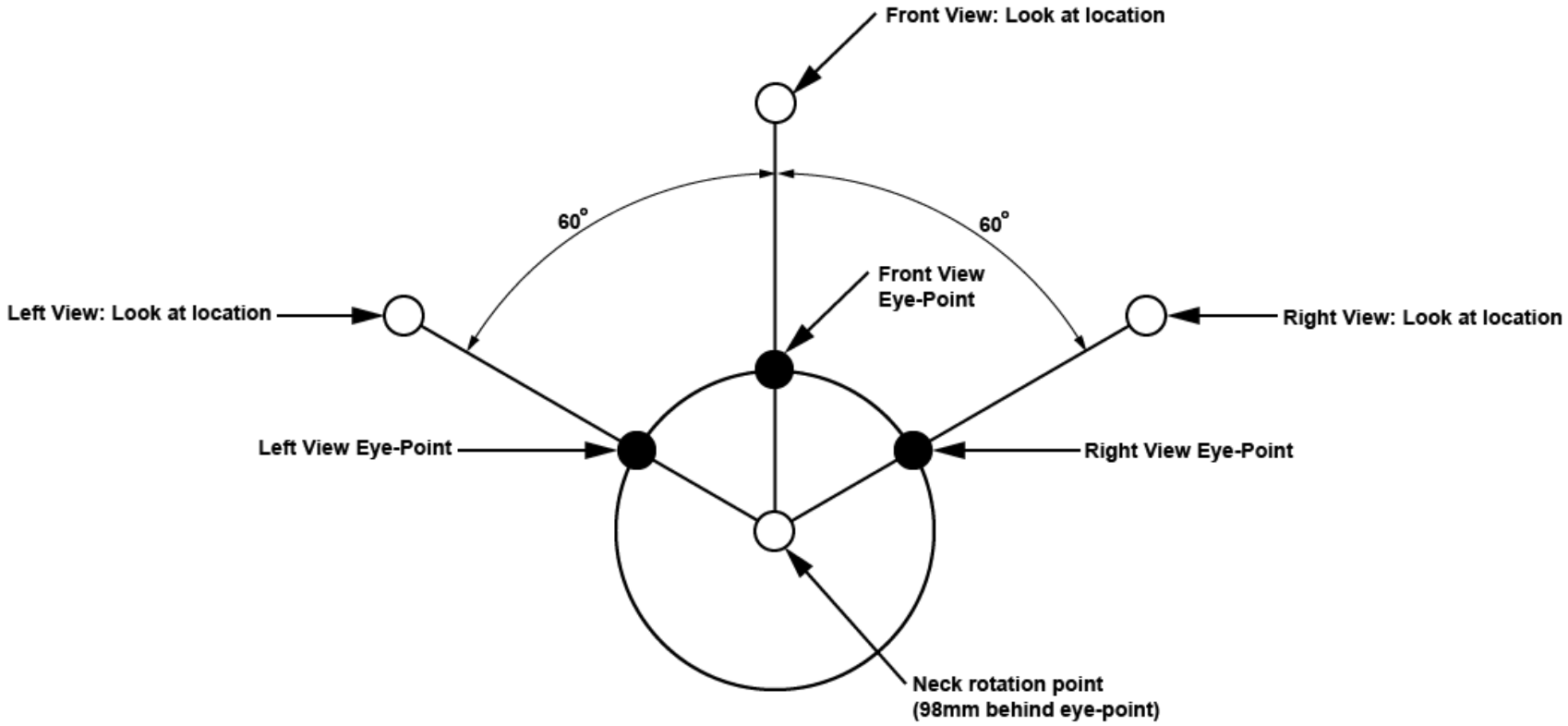
- The eye point has been defined by taking into account the seat positions of all trucks (common h-point location identified), combined with an offset from the seat which replicates average European eye height for a truck driving posture
  - 50th%ile male and female offsets identified for UK, Germany, Holland, France, Italy, Sweden and then this is averaged with a 90:10 male female split.



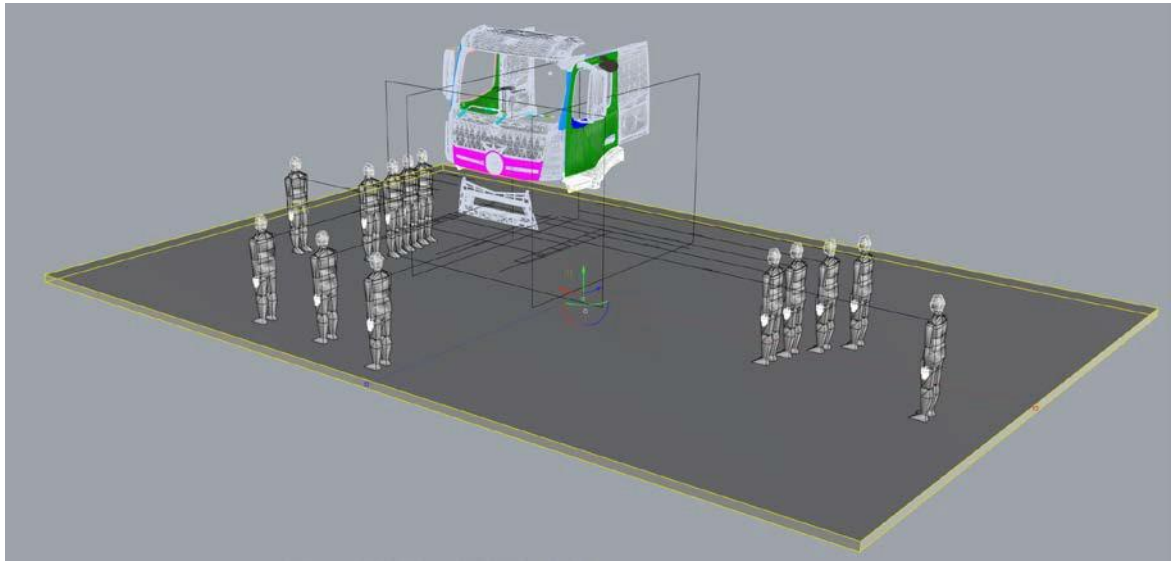


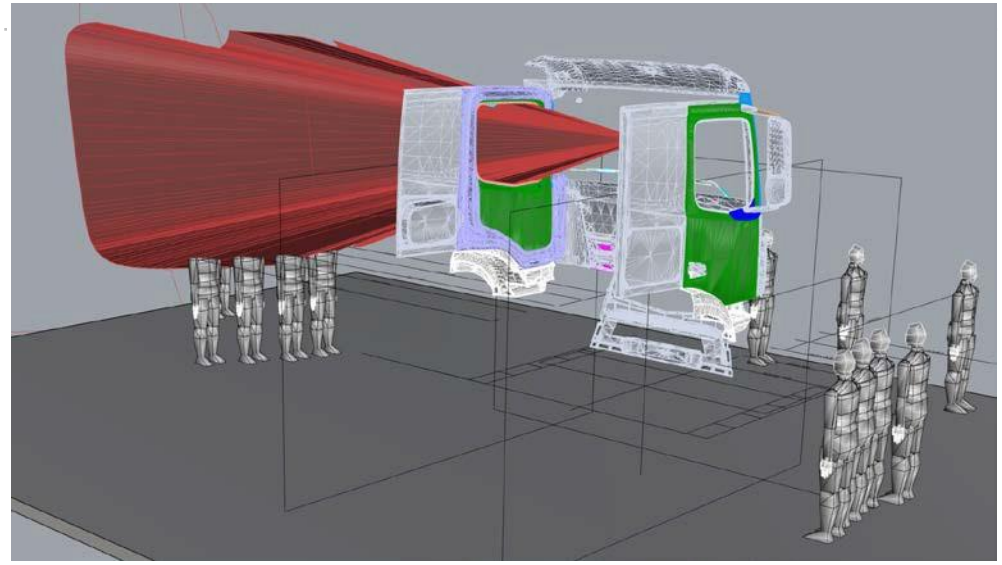
Reminder – the core DVS methodology

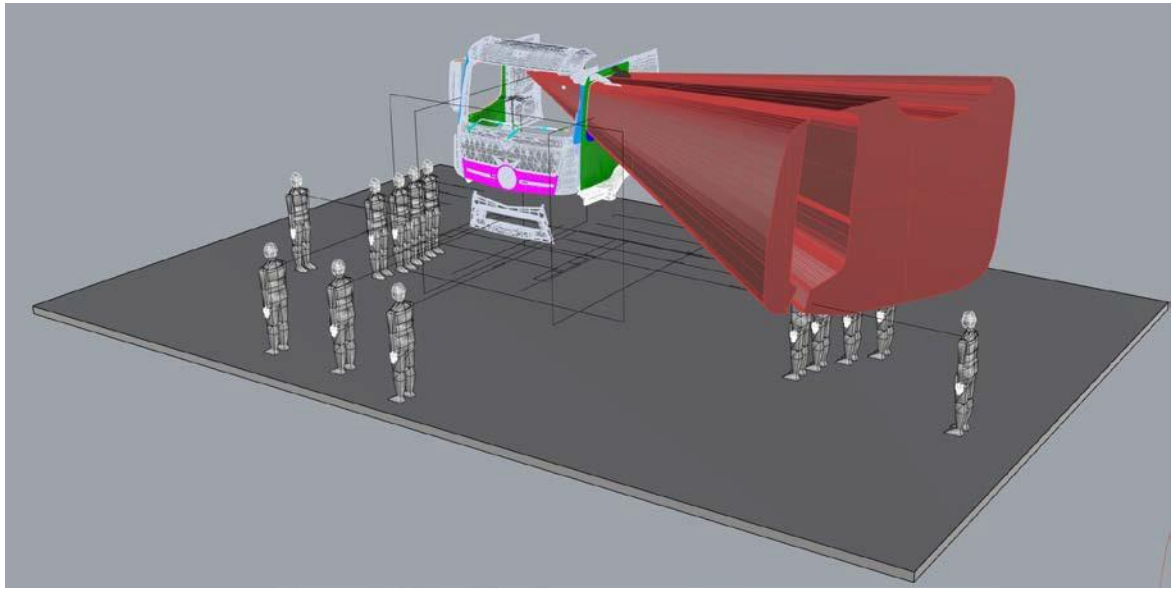
– The ‘eye rig’ is generated to simulate the view of virtual driver to the front, left and right of the cab using the premise defined by reg 125.



The use of VRU simulations to validate the volumetric results







- Top Left – The VRUs are shown around the truck
- Bottom left- the visible volume through the left window is shown
- Top right – The head and shoulders of the VRU intersect with the visible volume at the locations shown and the distances of all VRUs from the side of the truck are measured

The results: Volume plotted against VRU distance

0.97 correlation between volume scores and VRU scores : 0.5 is strong, 1 is perfect

Real world test that is proposed for prototyping

Part 1 – using the seat to support an eye rig that can support three small wireless cameras

Part 2 – The use of computer algorithms to process the camera images to generate a DVS score

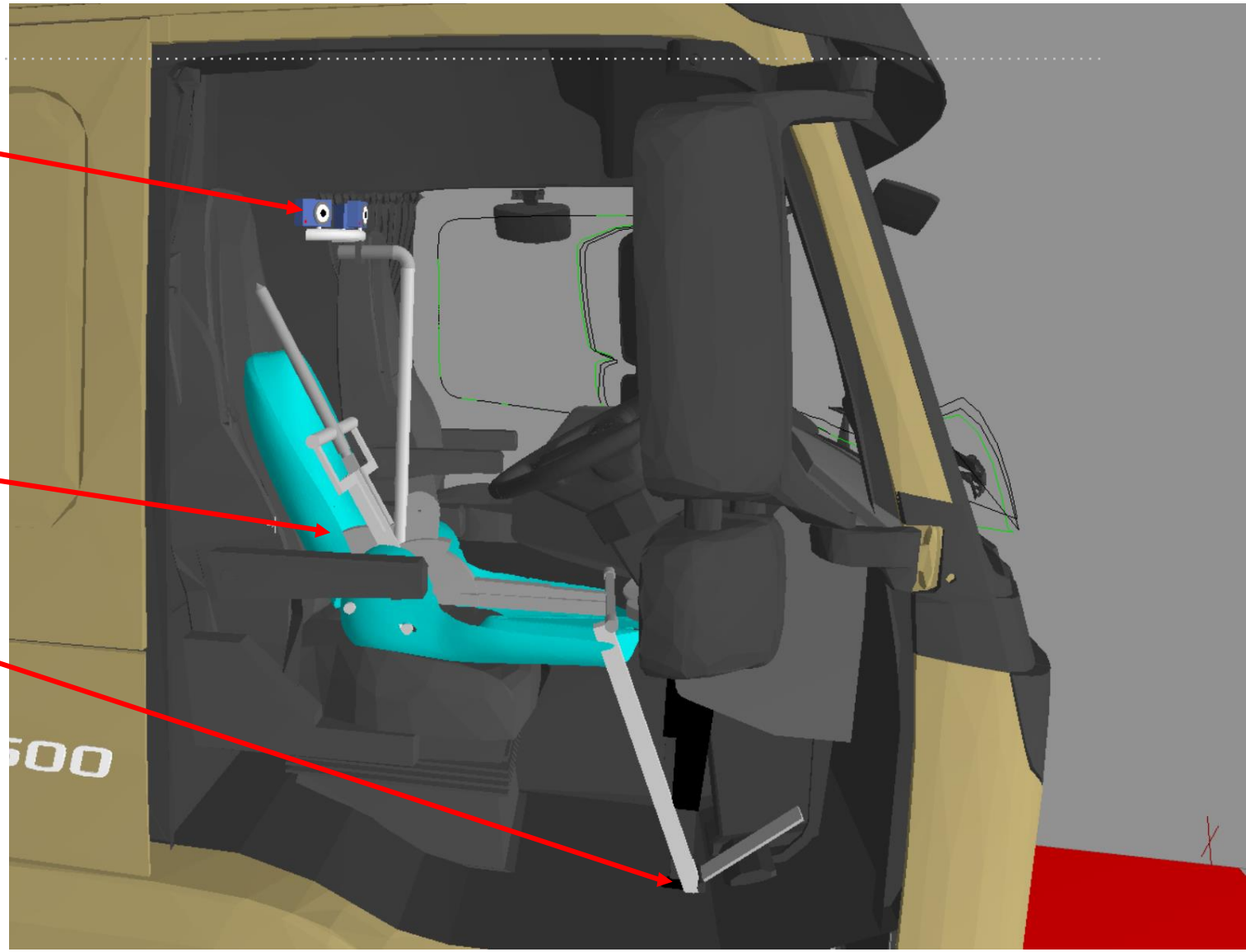
Loughborough University

Real world tests that are proposed for prototyping

Part 1 – using the seat to support an eye rig that can support three small wireless cameras

Rig proposal – adapting the SAE MANIKIN

- Uses three wireless cameras to allow views to be remotely captured outside of the cab
- Uses a weighted form that is supported by the seat to correctly locate the front camera location
- Uses the AHP calculations in SAE 1516
  - The SGRP height defines the foot angle for interaction with the A pedal
- Eye points match those used in the virtual version.



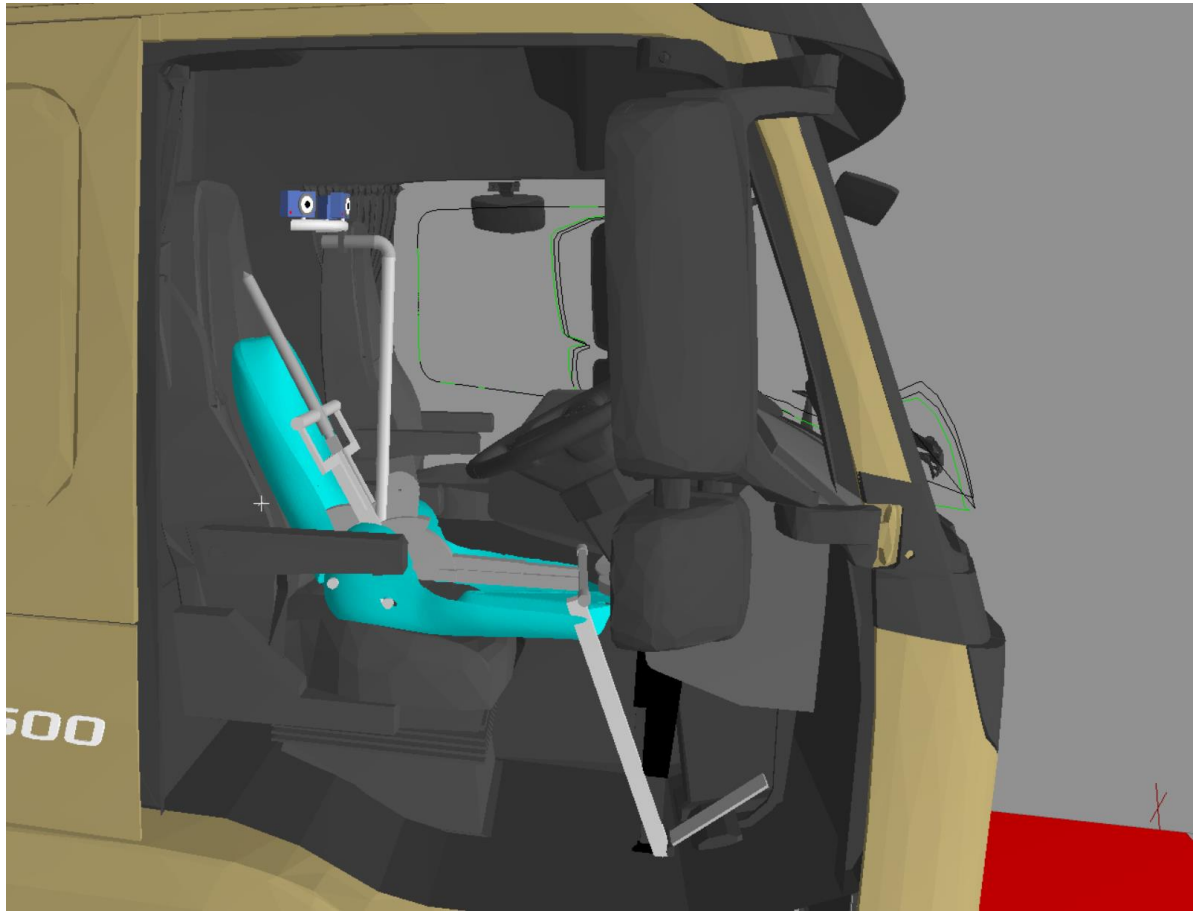
Real world test that is proposed for prototyping

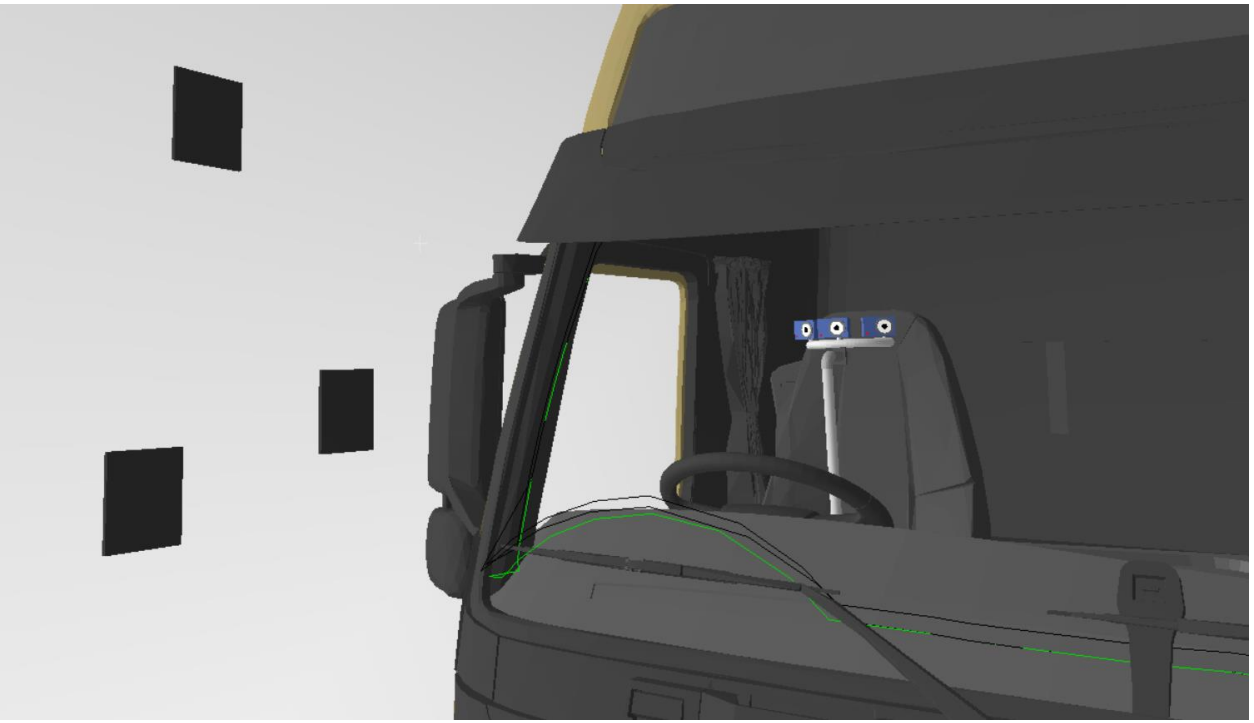
Part 2 – The use of computer algorithms to process the camera images to generate a DVS score

This has been the main effort since the last meeting

Example test method – Stage 1: Investigator sets up the physical rig

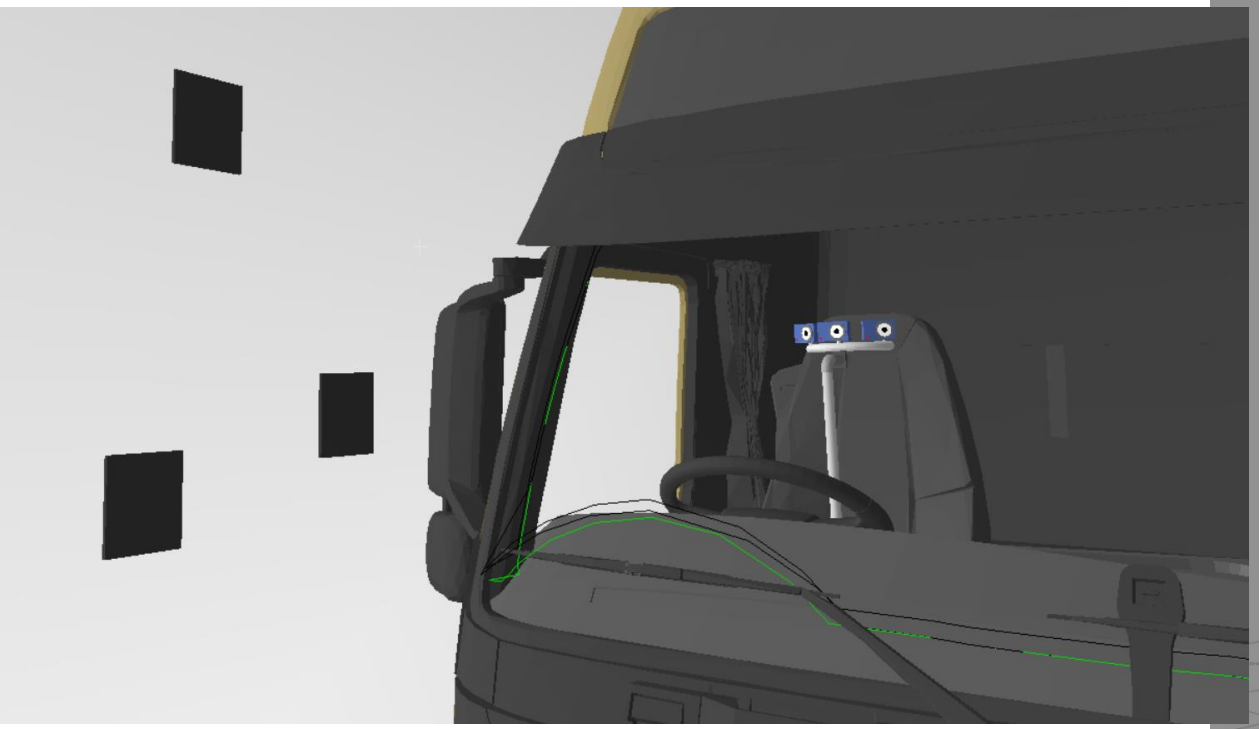
1. The investigators set up the eye rig inside the cab, representing the eyepoint in left, forward and side positions. Cameras will be positioned to represent these three eyepoints, and will capture still images of what can be seen (both in terms of cab interior and features external to the cab)





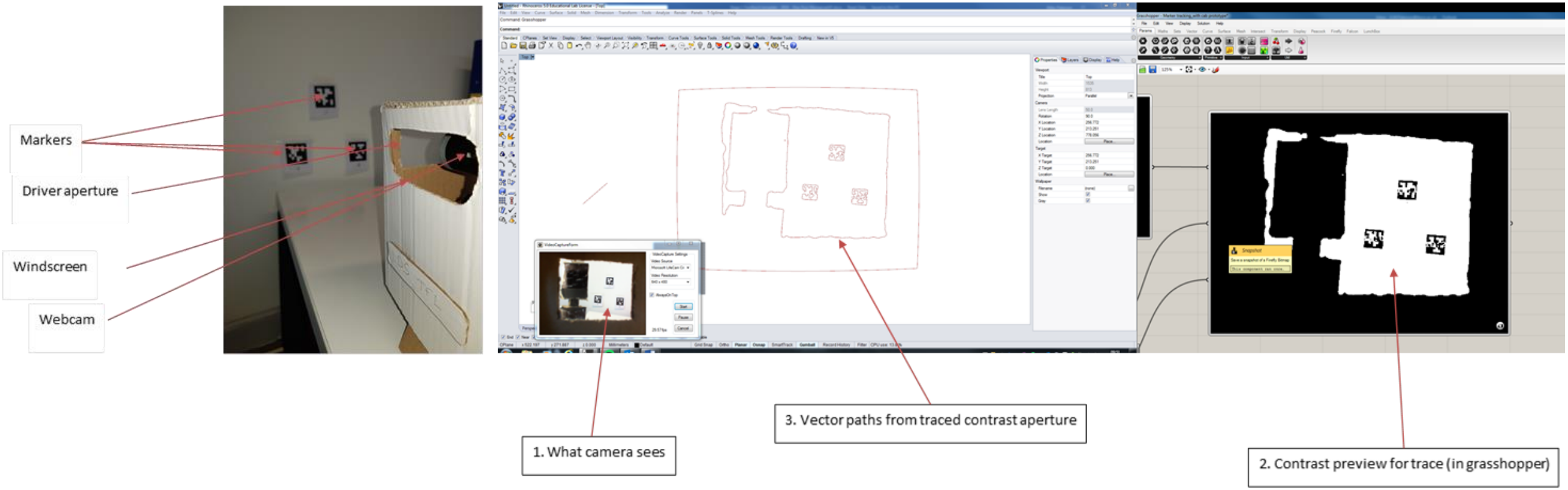
Example test method – Stage 2: A wall is orientated next to the vehicle

2. A moveable assessment wall will be used. On each of these walls, a number of markers (similar to QR codes) will be positioned in a triangular arrangement; two will be positioned with a set distance from the floor, and a third higher up (although the exact location/distance of this third marker relative to the two lower markers is less important). All markers must be visible in each eye point camera.



Example test method – Stage 3: Visual markers show distance to wall and height above floor

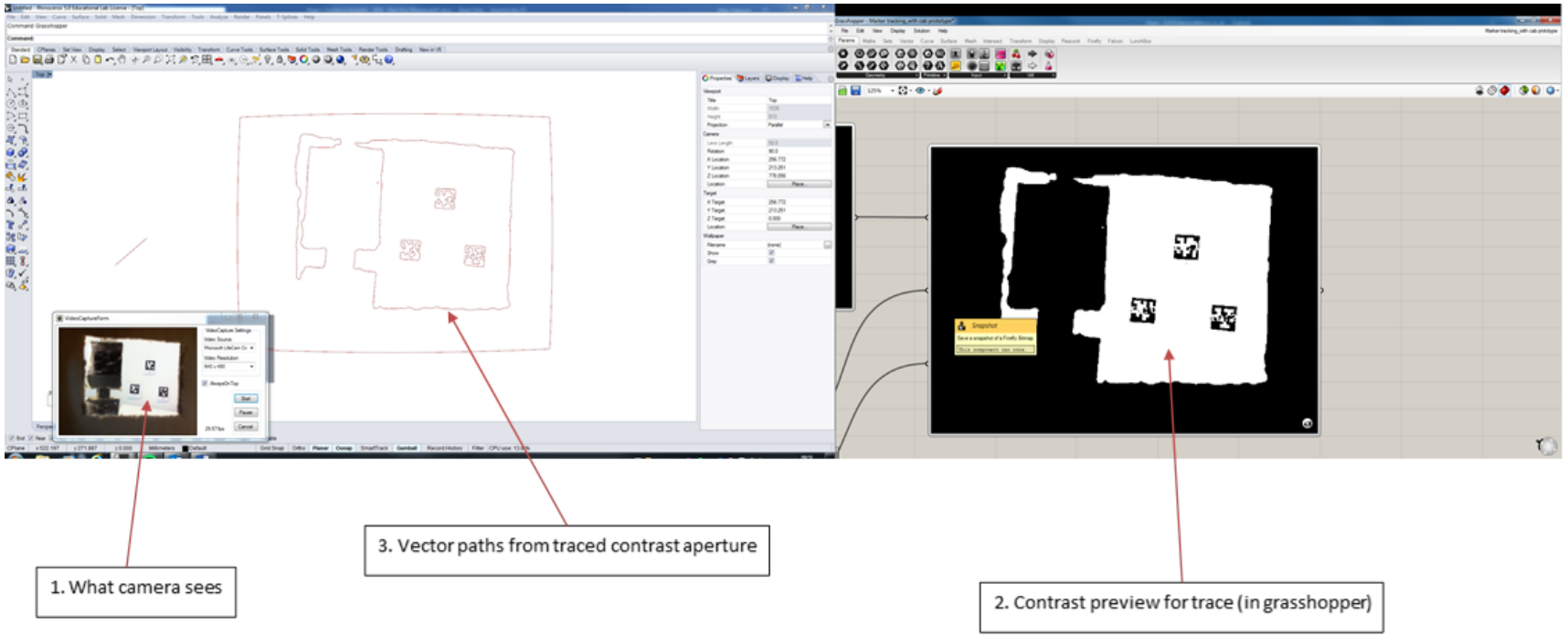
3. The automated script recognises the position of these markers. The physical size of the marker is detected, and this in turn then determines their distance from the camera. Using triangulation, the algorithm seeks to fit a ‘plane’ through these three markers which can then determine the distance but also angle of the wall relative to the camera. The two lower markers can also be used to identify/determine the assessment volume height which will then be used later in the algorithm for volume assessment definition. A separate wall must then be used to identify the edges of the vehicle for assessment volume building



Example test method – Stage 4: Contrast in the image used to derive a window path

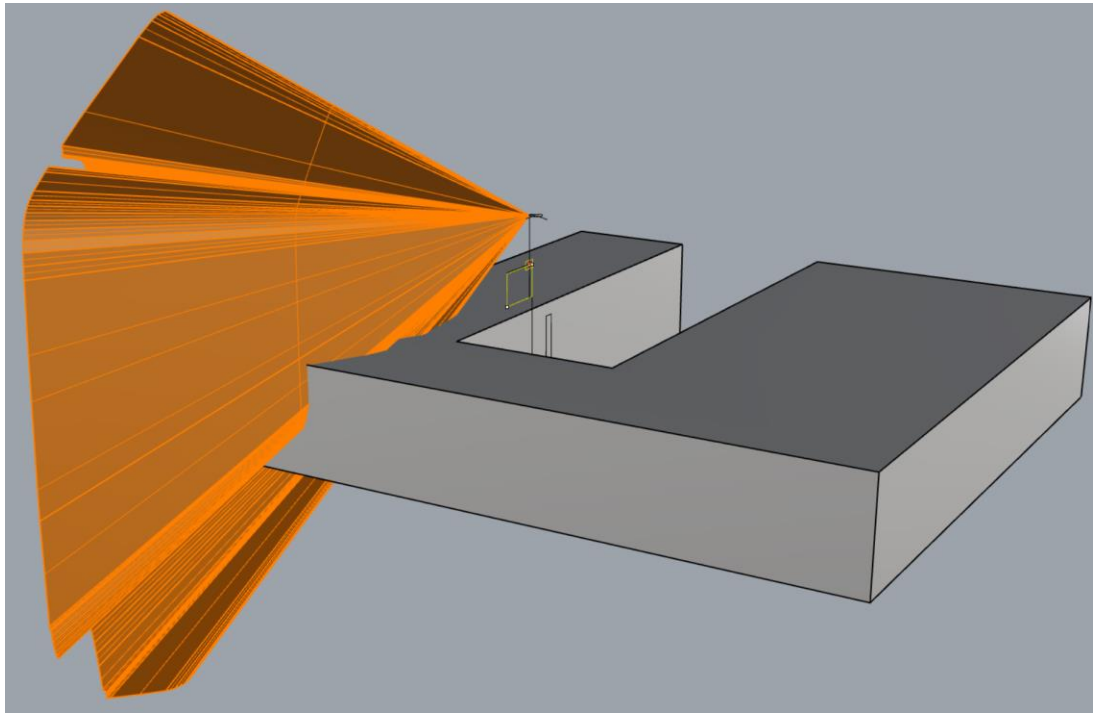
4. With the positions of the walls now set up, the creation of apertures can now be determined. By illuminating the walls, and keeping all other aspects of the setup dark (especially important inside the cab), there should be sufficient contrast between the inside of the cab and the wall (with the internal cab appearing dark, and the wall appearing light – ideally a black and white image will be captured). Using contrast threshold adjustment techniques, it will be possible to determine a clear boundary between light and dark regions of the camera. The script will fit a spline around the areas with highest levels of contrast.

A similar method is used for Computed Tomography (CT) imaging, to determine high density materials compared to low density, so is a well established method of data/image processing in a range of disciplines from medicine to mechanical engineering for diagnosis and inspection. Whilst the application is different, the technique is the same but may require some minor adjustments to threshold levels to get the best contrast and clearest boundary



Example test method – Stage 5: The path and other info gathered generate a visible volume

5. With the splines created to determine the apertures (determined by high/low contrast represented by light and dark regions in a black/white capture of the camera), a digital projection from the eyepoint can be set up. This is achieved as the camera position is represented in the script with a point thaty is known in relation the walls and the sides and front of the cab



6. The existing Grasshopper algorithm developed by Loughborough University for the Digital DVS can then be used; the projections can be trimmed with the assessment volume, and if necessary, a range of height iterations could then be made with the existing script, but based on physical geometry.

An important benefit of this technique

- The digital DVS technique can quickly calculate the DVS score for hundreds of potential cab heights

- For example, the cab height range for one model of a Daimler truck that we have tested is over 800 millimetres between lowest possible height and maximum possible height, and 800 results can be produced in three hours.

- By using real world data to feed into the same technique that defines the digital DVS, the power of the digital DVS to calculate results for multiple cab heights can be leveraged

- This means that it is does not matter what the cab height is for the real world test vehicle, we can calculate all possible heights from one measured vehicle from height range data provided by manufacturers

		Volumes				
Cab floor height above ground plane	Increment	Right	Front	Left	Total volume	Rating
1900	160	3775121128.800	142731258.380	1033963538.400	4951815925.600	Zero star
1899	161	3777692892.600	143956580.350	1037371798.500	4959021271.500	Zero star
1898	162	3780263390.800	145191507.790	1040784888.700	4966239787.300	Zero star
1897	163	3782832622.700	146436117.550	1044202797.200	4973471537.500	Zero star
1896	164	3785400588.000	147690455.840	1047625537.900	4980716581.700	Zero star
1895	165	3787967286.100	148954555.690	1051053098.800	4987974940.600	Zero star
1894	166	3790532716.600	150228445.380	1054485476.800	4995246638.800	Zero star
1893	167	3793096879.000	151512152.830	1057922668.700	5002531700.500	Zero star
1892	168	3795659772.700	152805701.610	1061364659.100	5009830133.400	Zero star
1891	169	3798221397.300	154109140.010	1064811468.800	5017142006.100	Zero star
1890	170	3800781752.300	155422508.470	1068263082.500	5024467343.300	Zero star
1889	171	3803340837.400	156745873.860	1071719497.100	5031806208.400	Zero star
1888	172	3805898651.800	158079329.560	1075180709.100	5039158690.500	Zero star
1887	173	3808455195.200	159422999.820	1078646715.500	5046524910.500	Zero star
1886	174	3811010466.900	160777020.590	1082117504.300	5053904991.800	Zero star
1885	175	3813564467.200	162141442.180	1085593089.400	5061298998.800	Zero star
1884	176	3816117195.900	163516269.550	1089073458.900	5068706924.400	Zero star
1883	177	3818668652.600	164901537.370	1092558609.800	5076128799.800	Zero star
1882	178	3821218837.600	166297301.180	1096048538.600	5083564677.400	Zero star
1881	179	3823767750.400	167703548.880	1099543242.200	5091014541.500	Zero star
1880	180	3826315391.000	169120321.170	1103042716.300	5098478428.500	Zero star
1879	181	3828861759.900	170547630.550	1106546959.400	5105956349.900	Zero star
1878	182	3831406855.700	171985475.840	1110055967.800	5113448299.300	Zero star
1877	183	3833950678.900	173433914.360	1113569738.300	5120954331.600	Zero star
1876	184	3836493229.300	174892985.970	1117088267.800	5128474483.100	Zero star
1875	185	3839034506.700	176362562.290	1120611545.000	5136008614.000	Zero star
1874	186	3841574511.000	177842498.020	1124139582.400	5143556591.400	Zero star
1873	187	3844113242.300	179332694.770	1127672371.000	5151118308.100	Zero star
1872	188	3846650700.100	180833065.050	1131209906.400	5158693671.600	Zero star
1871	189	3849186884.500	182343549.730	1134752185.700	5166282619.900	Zero star
1870	190	3851721795.300	183864104.850	1138299205.800	5173885106.000	Zero star
1869	191	3854255432.400	185394677.960	1141850963.800	5181501074.200	Zero star
1868	192	3856787795.600	186935198.940	1145407456.500	5189130451.000	Zero star
1867	193	3859318884.800	188485603.250	1148968680.900	5196773169.000	Zero star
1866	194	3861848699.700	190045805.280	1152534634.000	5204429139.000	Zero star
1865	195	3864377240.600	191615702.530	1156105314.900	5212098258.000	Zero star
1864	196	3866904511.700	193195191.600	1159680715.900	5219780419.200	Zero star
1863	197	3869430504.100	194784163.610	1163260835.800	5227475503.500	Zero star

Design to remove variance in the real world testing

- There are two key elements which need to be considered for the accuracy of the test

- 1. The matching of the real world vehicle to the criteria for the digital test
  - There are a number of conditions set in the DVS protocol to ensure consistency of DVS digital system

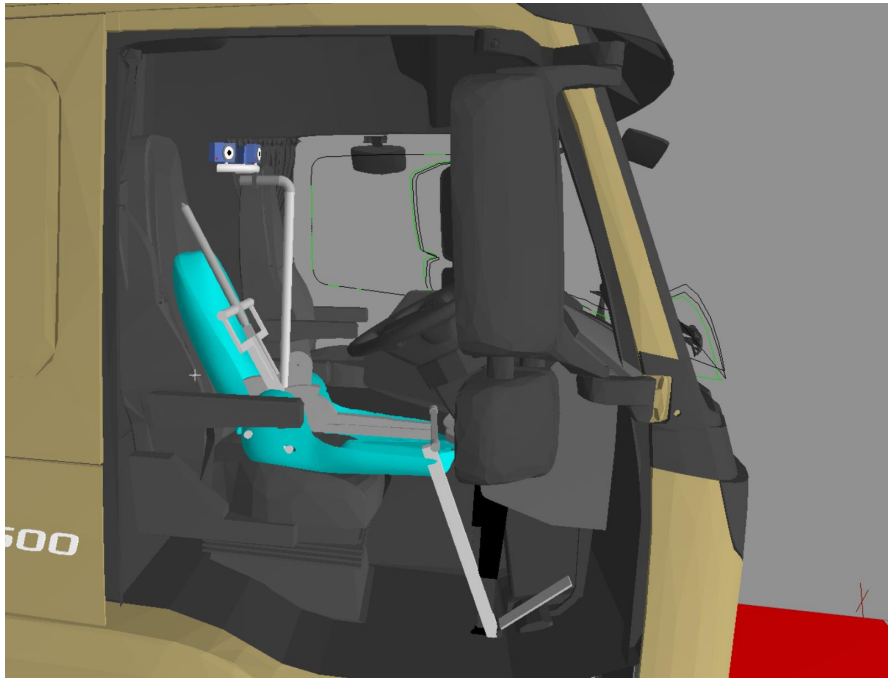
    - The simulated vehicle must have a representation of cab height based upon
      - Predefined fluid levels (fuel etc)
      - The cab must be unladen
      - The chassis should be horizontal (this may not be possible but **can be corrected for in the algorithm**)

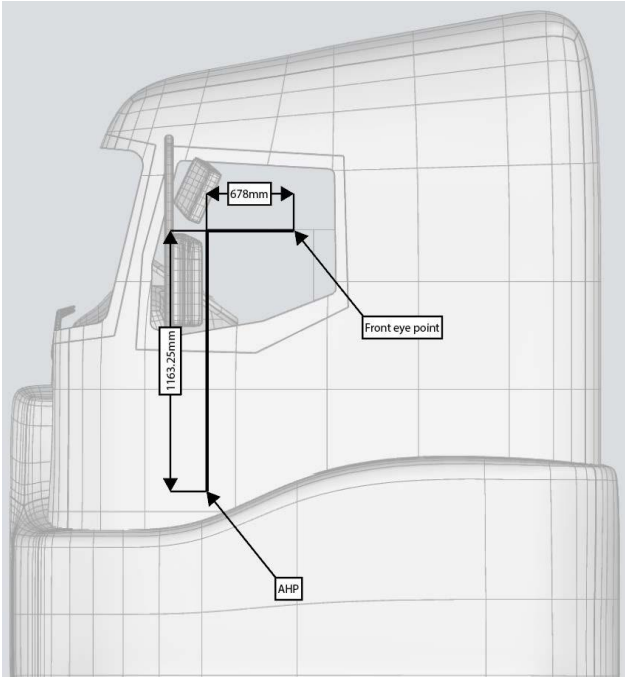
  - These conditions are defined by existing UNECE regs and so testing houses should have methods to ensure they can be met
    - This will be further explored

Design to remove variance in the real world testing

- There are two key elements which need to be considered for the accuracy of the test

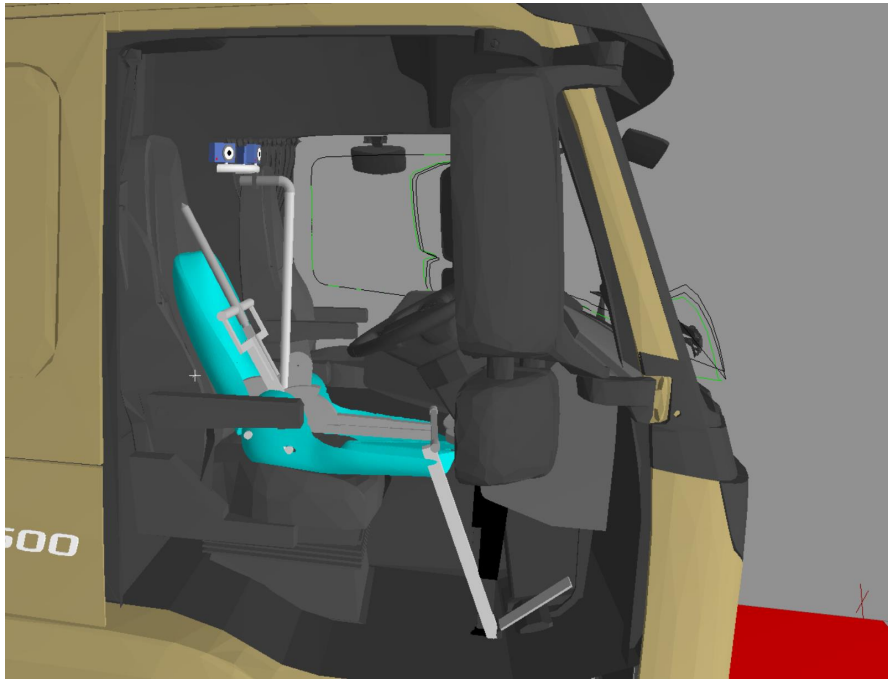
- 2. The repeatability of the positioning of the rig that is used to define the camera locations which simulate the DVS virtual eye points
  - The rig must provide a location that is in the centre of the drivers seat
  - It must provide a load on that seat of 72Kg
  - It must allow the repeatable location of the eye point with specific offsets from the Accelerator Heel point





Design considerations for the physical rig

- The rig will include removable augmentations to the SAE H-point manikin that allow the following
  - The central location of the rig in the seat with no twisting of the rig in the Z axis
    - This will be achieved through the addition of adjustable paddles which will extend from the side of the rig to allow the seat sides to be used as a reference or central alignment
  - The alignment of the camera locations with those defined in the virtual version
    - This will be achieved by adjusting the seat to within close range of correct location. The rig will then allow the fine adjustment of the position through the open window of the cab to avoid the weight of the operator causing a change to the cab position



Next steps

- Real world scale modelling of the test rig to test the algorithm against the Digital DVS system
  - During April a physical rig will be 3d printed to allow a comparison between the real world and virtual versions of this test

- Building of the prototype test rig
  - During April the seating rig, which will be designed as an attachment to the SAE H-Point manikin will be designed and manufactured – A high resolution 3D scan of the SAE H-Point manikin has been performed to support this

- The whole process will then be tested at a manufacturers training centre (Volvo, DAF?)

- The test will be performed multiple times to examine variance and repeatability in the results using two known trucks for which we have CAD data

- This will allow the accuracy of the technique to be determined.

Next steps

- The testing of a vehicle in the real world, when compared to CAD data testing, could result in differences in the volumetric score
- The size of these differences will be determined in part by the manner in which the variables discussed above are controlled in terms of rig placement and fluid levels in the vehicle, for example
- It is highly unlikely that the physical test will provide the exact same results as the virtual test.
- If the 1 star boundary is adopted by the EU as a minimum requirement, it may be that a real word test vehicle must reach a 1.5, or 2 star performance to be allowed to operate
- The size of this tolerance will be determined by testing of the technique with a sample of vehicles

Project information

Thank you for your attention, are there any questions?

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