THE DESIGN OF THE UNECE HGV DVS FOR TECH NEUTRAL CAB DESIGN

OPTION 3 OR OPTION 4?

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VRU-Proxi-25-03

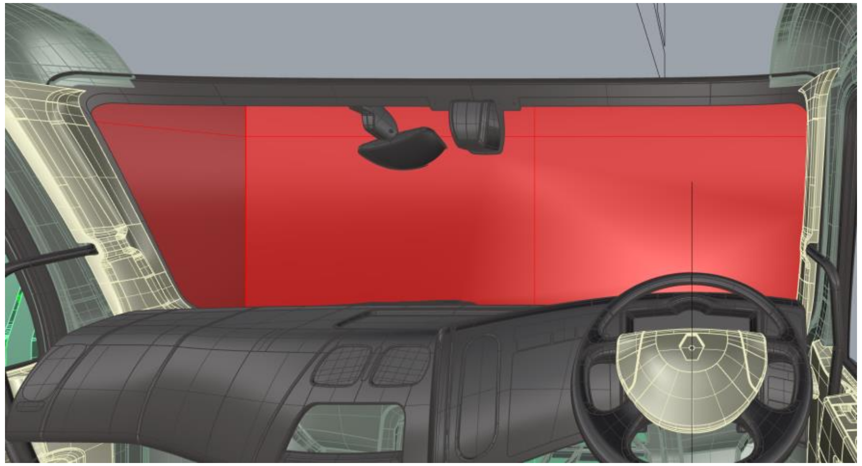
Revised by LDS after VRU-Proxi-25 meeting

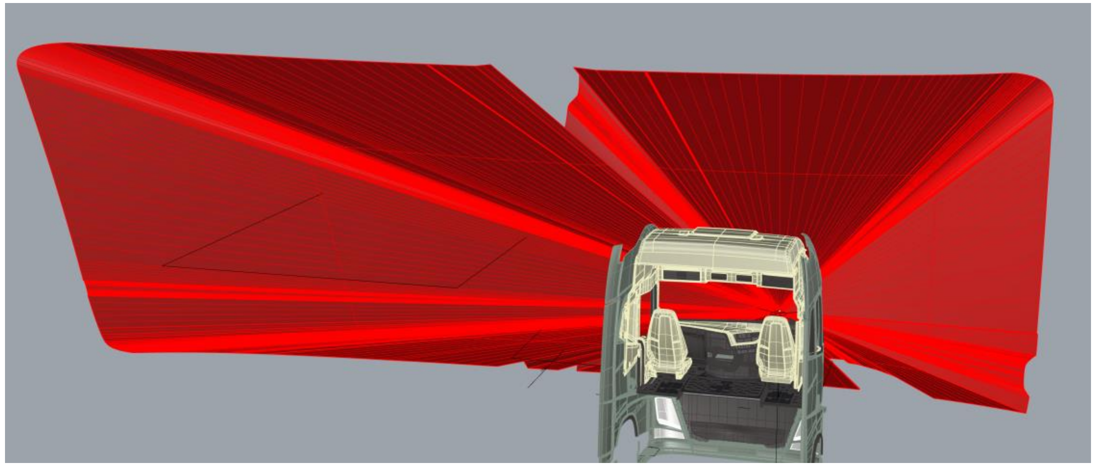
CONTENT

- Results for the sensitivity analysis
- Accident causation data – where do we need to see VRUs?
- Results for VRU distance correlated with each of the 4 options
- Reasons for why we think option 4 is superior to option 3

CONTENT

- What was the aim of the work funded by the Road Safety Trust?
- The method in the current version of the standard measures the front volume by aperture created by the windscreen
- Manufacturers highlighted that measuring frontal volume in a manner that is limited by A-pillar position limits their freedom to propose new designs with different A-pillar configurations
- This led to a new method being explored where instead of defining the volumes to the front and sides of the vehicle using the structure of the vehicle, we would subdivide the assessment volume to provide target areas for front volume





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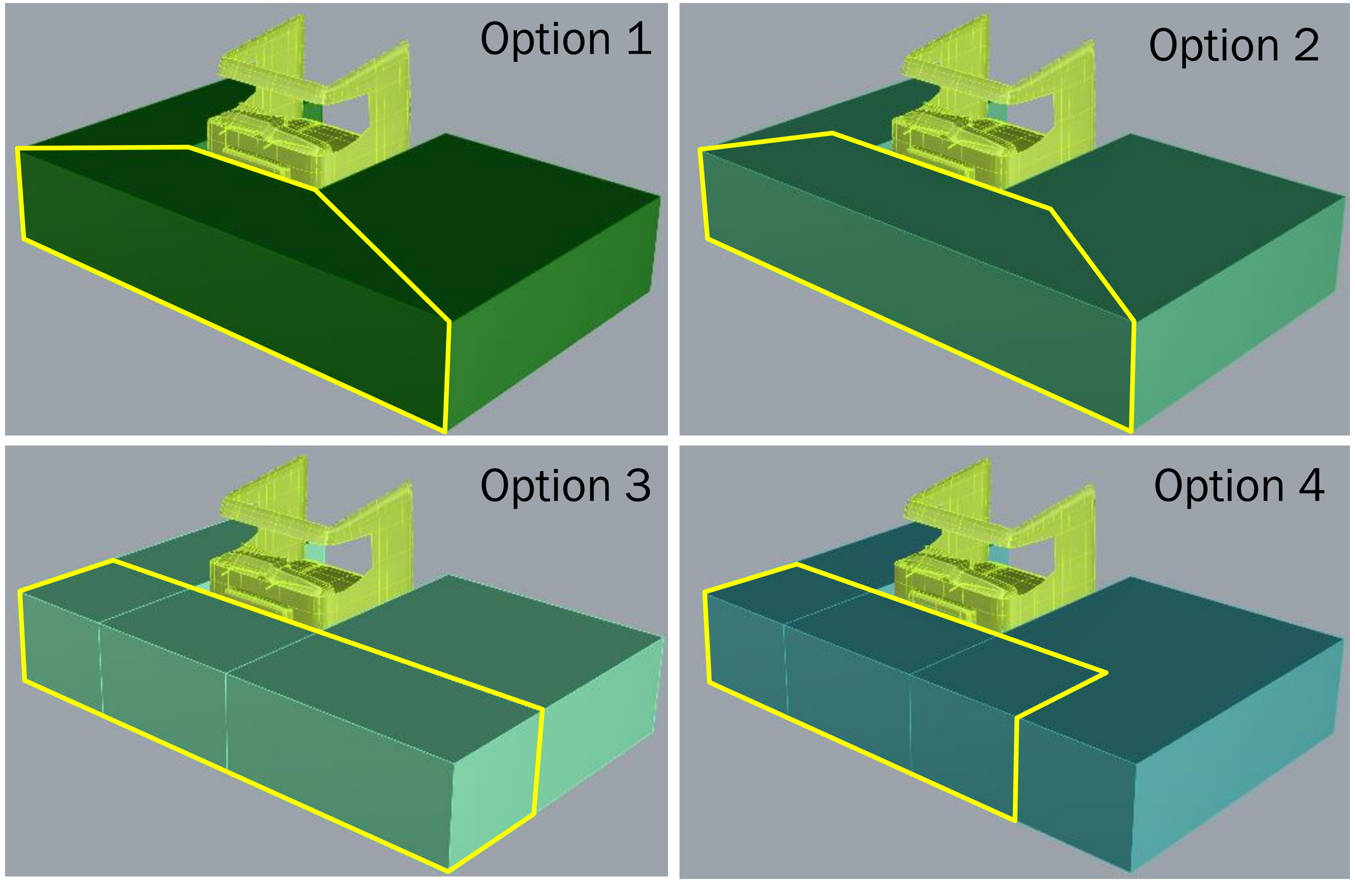
THE FOUR OPTIONS USED



- This led to a new method being explored where instead of defining the volumes to the front and sides of the vehicle using the structure of the vehicle, we would subdivide the assessment volume to provide target areas for front volume
- The images above show the frontal volume definition

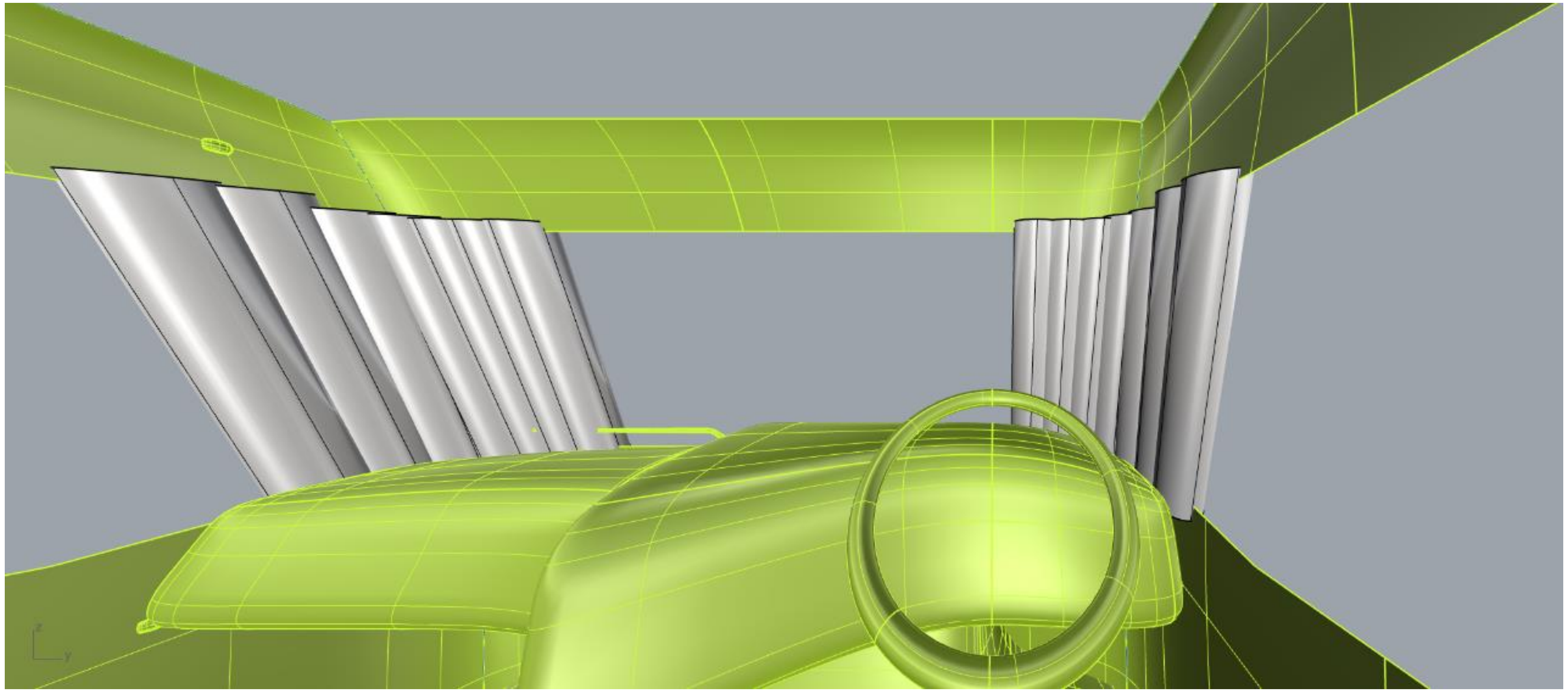
RESULTS FOR SENSITIVITY ANALYSIS OF THE A-PILLAR POSITION

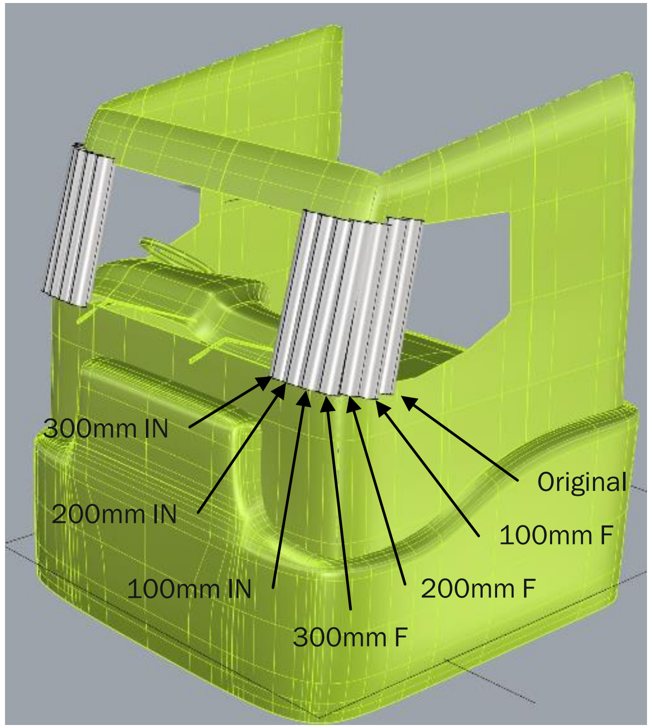
AIMS OF THE TECH NEUTRALITY EXERCISE

- To explore how the DVS score for a vehicle is the affected A-pillar position, to determine which of the 4 defined options for the subdivision of the assessment is the most tech neutral
- We are using the generic truck cab designed for the validation of the DVS method
- We have defined a method that changes the a-pillar position, and tested this for all four of the proposed options
- We have done this with and without mirrors

EXPERIMENTAL DESIGN

- Seven A-pillar positions have been defined
- Each A-pillar has a cylindrical cross section to avoid issues of orientating a traditional A-pillar design for consistency of obscuration as **agreed with ACEA**
- The closest A -pillar position is the same location as the original LDS Generic cab design





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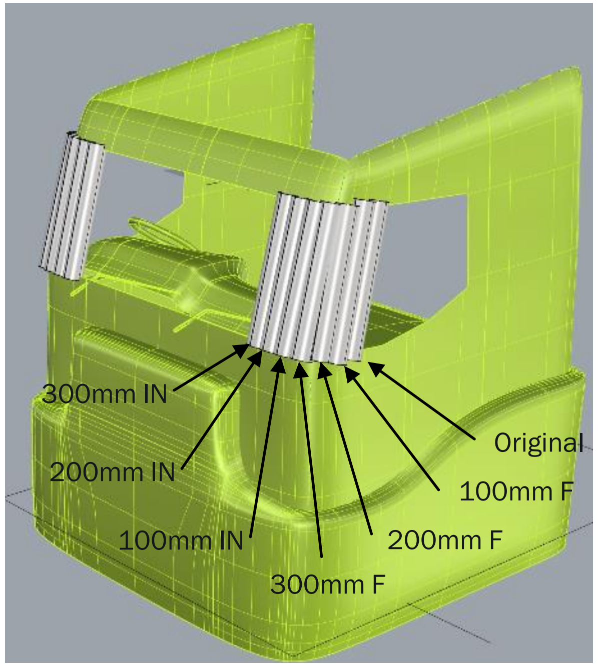
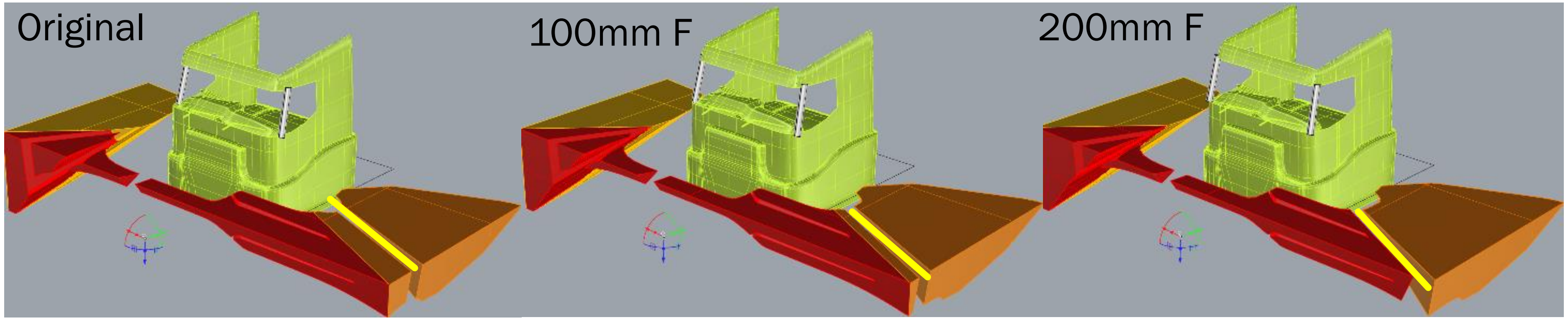
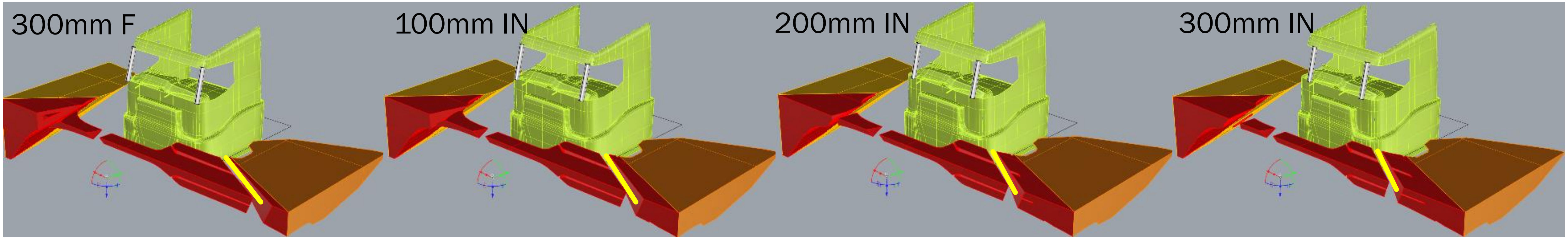
EXAMPLE RESULT FOR OPTION 1







- Note the change in the volume subtracted due to change in A-pillar position obscuration (yellow lines)

RESULTS

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RESULTS

- Variance in the results is seen as the key measure (Highlighted with RED CIRCLES in the table)
- Variance in this case is simply the change in volume seen by the changing a-pillar positions
- More variance across the volume score values for the seven A-pillar positions means that the option is less Tech Neutral
- Less variance means that A-pillar position affects the result less, and is therefore more tech neutral
- The table shows the following
  - The original method (Method 0) produces the most variance, or change in volume, as the a-pillar positions change, because as the a-pillars get closer together the volume that can be seen reduces
  - Option 1 and 4 have the least variance
  - Option 3 has the worst variance (3 x that of option 4)
  - Option 2 has a variance that is close to option 4

METHOD 0

		TOTAL mm	TOTAL M3	FRONT mm	FRONT M3
	MAX	5506357869	5.506358	1.09E+09	1.093681
	MIN	5027316440	5.027316	2.66E+08	0.265902
	RANGE	479041429	0.479041	827778861	0.827779
ROOT MEAN SQUARE	VARIANCE	3.65609E+16		1.007E+17	

METHOD 1

	TOTAL mm	TOTAL M3	FRONT mm	FRONT M3
MAX	5506357790	5.506358	1.32E+09	1.322263
MIN	5028542500	5.028543	1.09E+09	1.087053
RANGE	477815290	0.477815	235210120	0.2352101
VARIANCE	3.63266E+16		9.684E+15	

METHOD 2

	TOTAL mm	TOTAL M3	FRONT mm	FRONT M3
MAX	5506357540	5.506358	1.56E+09	1.564978
MIN	5028542550	5.028543	1.31E+09	1.308683
RANGE	477814990	0.477815	256295120	0.256295
VARIANCE	3.62846E+16		1.331E+16	

METHOD 3

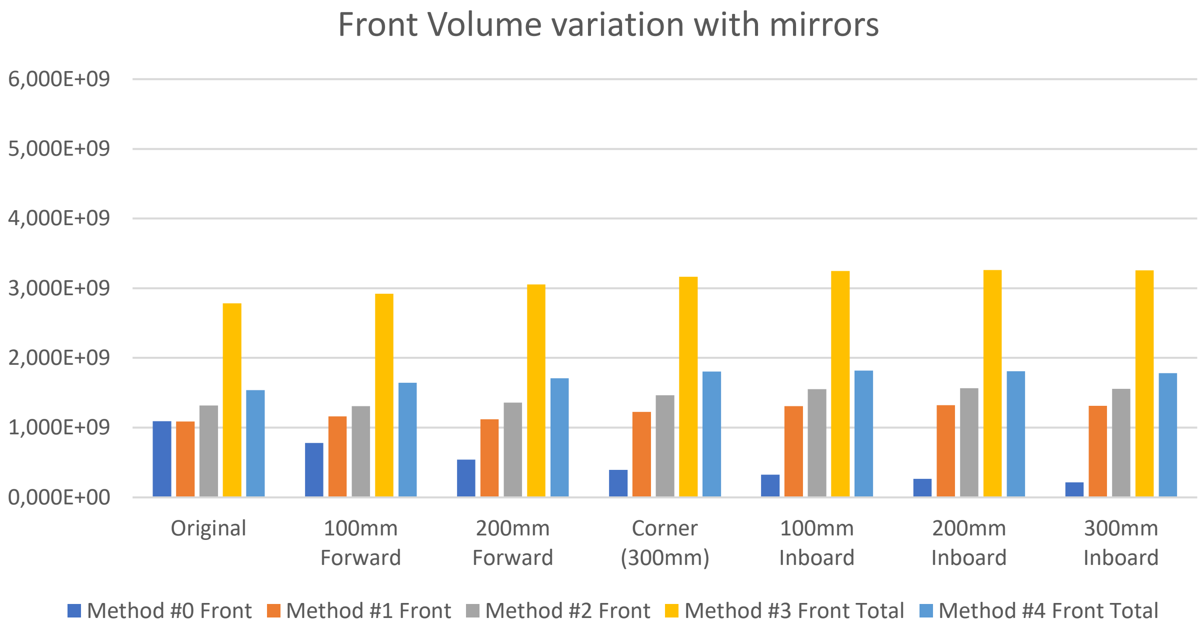
	TOTAL mm	TOTAL M3	FRONT mm	FRONT M3
MAX	5.51E+09	5.505162	3.26E+09	3.261773
MIN	5.03E+09	5.027919	2.78E+09	2.78453
RANGE	477242972.3	0.477243	477242952	0.477243
VARIANCE	3.61579E+16		3.617E+16	

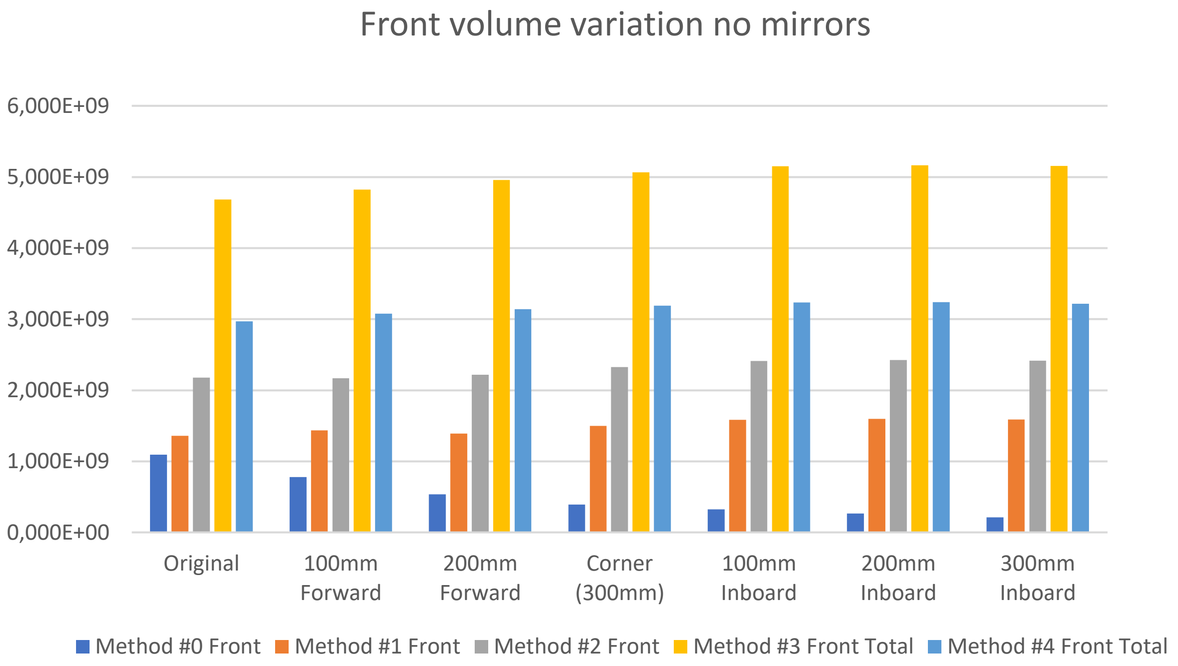
METHOD 4

	TOTAL mm	TOTAL M3	FRONT mm	FRONT M3
MAX	5.51E+09	5.50631	1.82E+09	1.817139
MIN	5.03E+09	5.029118	1.54E+09	1.538326
RANGE	477192142.3	0.477192	278812368	0.278812
VARIANCE	3.62166E+16		1.263E+16	

RESULTS

- Similar pattern for the front volume with and without mirrors
- The volumes seen to the front





- Method zero, the amount of volume seen reduces as the a-pillars get closer together
- Option 3 provides more volume to be seen and varies more by a-pillar position than any other method

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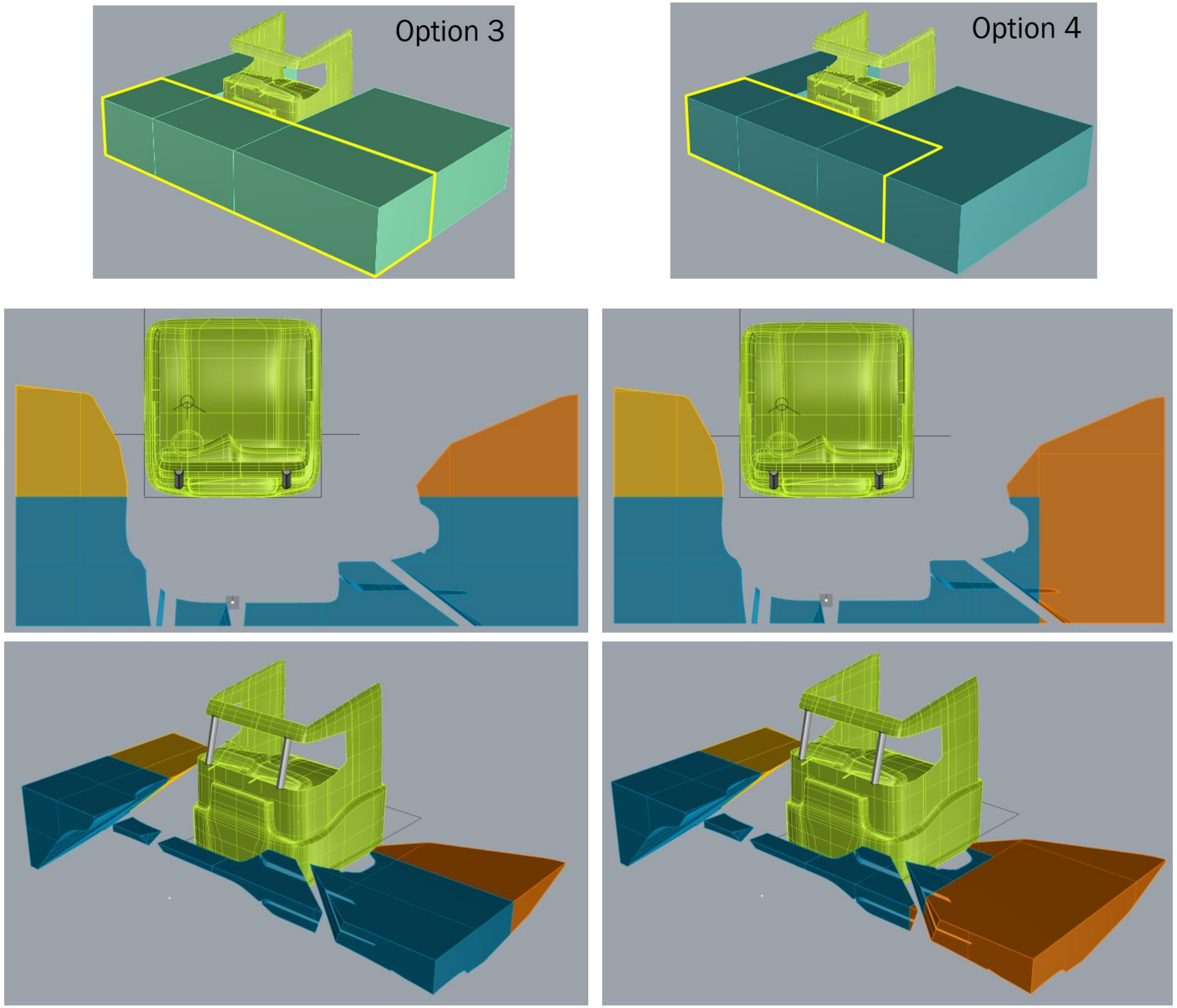
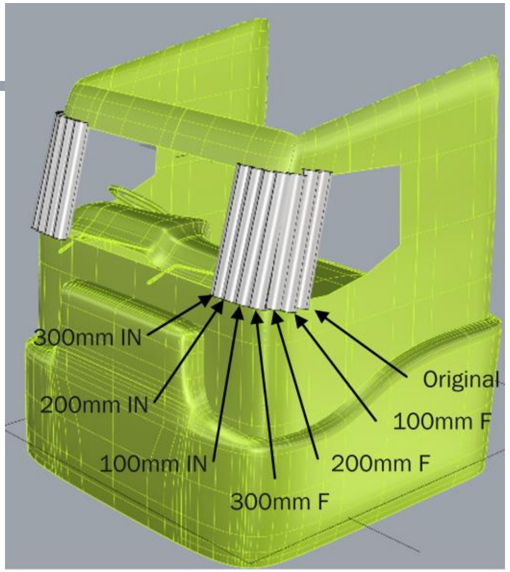
UNDERSTANDING ILLUSTRATIONS OF THE VOLUMES

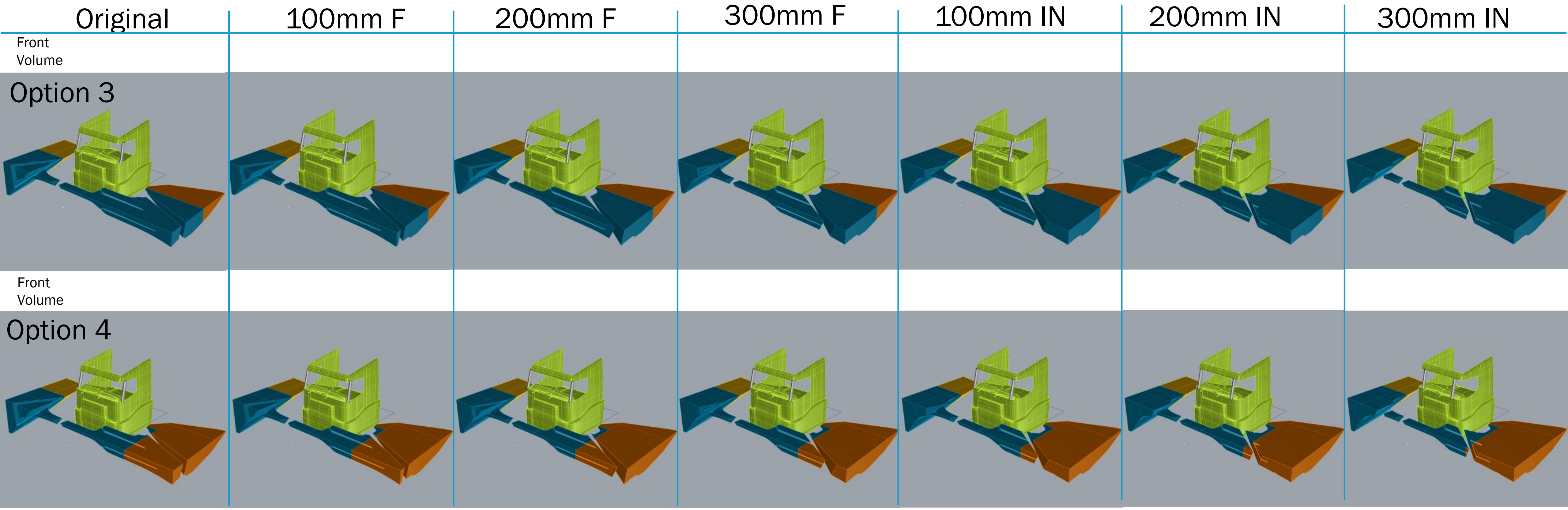
- The following slides include comparisons between the results for option 3 and 4 using illustrations of the visible volumes for each method
- In order to support the correct interpretation of the images used in the following slides, the images on the right have been provided
- In both cases the blue volume shows the volume counted towards to the front score.



COMPARING RESULTS FOR OPTION 3 AND 4

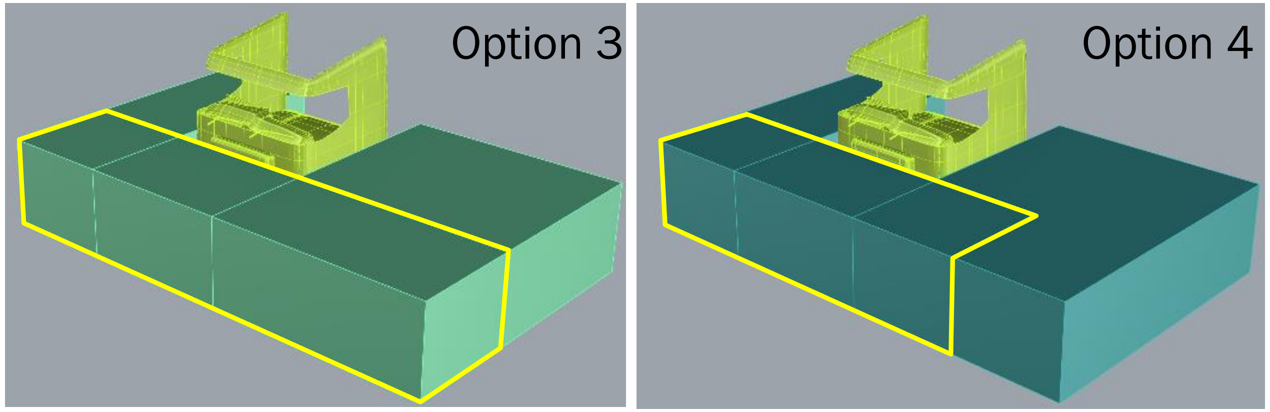


- Comparing the change in A-pillar position and its effect on the change in the frontal volume
- As the A-pillar moves forward and inwards its effect on the volume reduces due to change in thickness of the visible volume. This affects all vehicle types.
- In the images below we are comparing the 'Front' volume scores (Blue area) for options 3 and 4.
- The change from the rearmost A-pillar position to the frontmost is
  - For method 3 = $0.47m^3$ (Variance of 3.62E+16)
  - For method 4 = $0.24m^3$ (Variance of 1.23E+16)
- Therefore in option 3, 'conventional' A-pillar positions effect the volume score more than 'aerodynamic' A-pillar positions
- This makes option 3 less 'tech neutral' than option 4



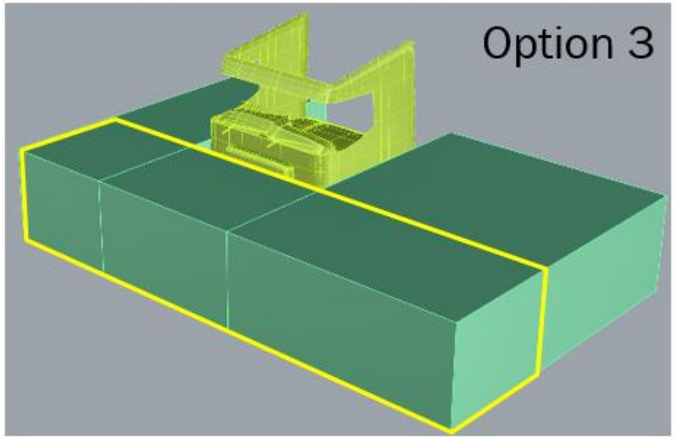
SUMMARY OF THE RESULTS OF THE ANALYSIS AGREED WITH ACEA

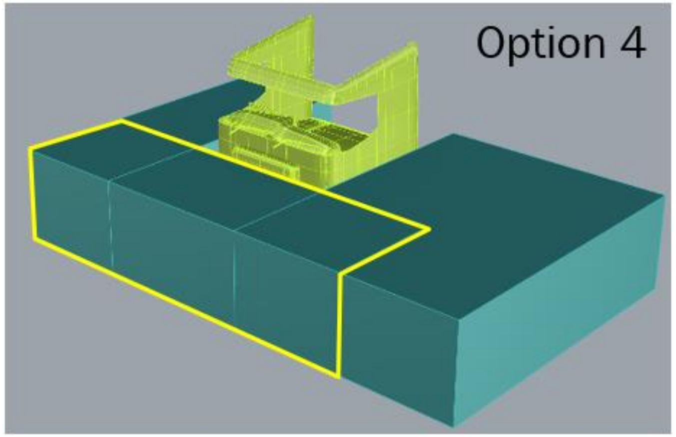
- Options 1 and 2 have been discounted due to their relatively poor correlation between VRU distance and Volumetric score
- Option 3 has the highest variance of all options, and also raises concerns about VRU distance measurement
  - As discussed previously this relates to the benefit of seeing a VRU 4.5m to the passenger side in urban environments
  - The VRU distance measures at this distance are more likely to be zero, skewing the results in comparison to the previous version
- The results of the analysis proposed by ACEA indicate that option 4 is the most tech neutral as the effect of A-pillar position on overall volume is lower than that for option 3.

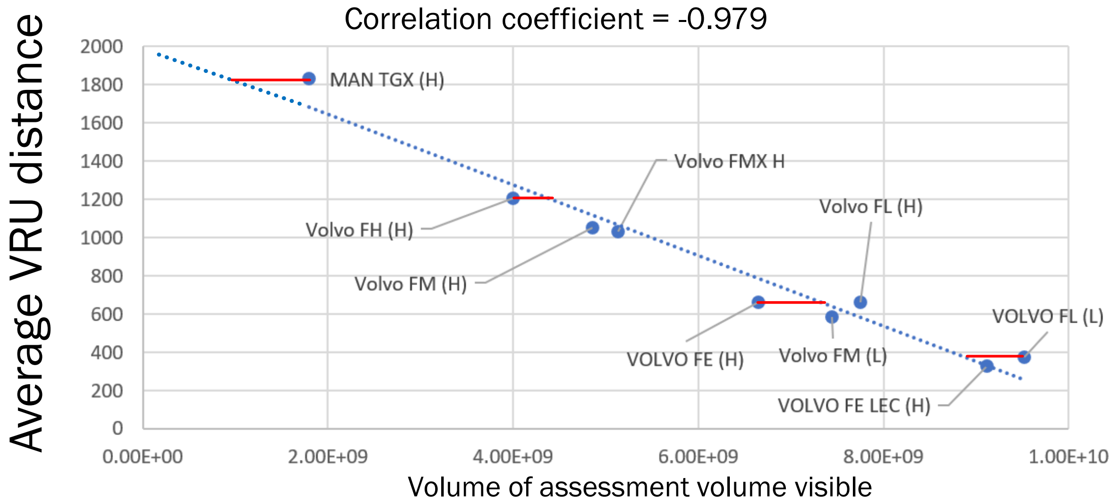


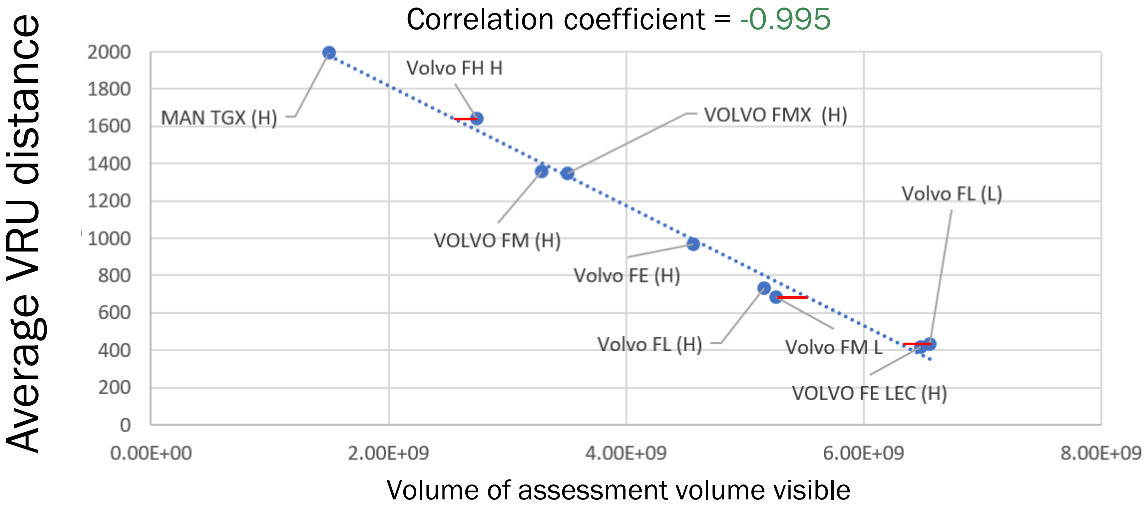
RESULTS FOR CORRELATION OF VRU DISTANCE AND VOLUME FOR EACH OPTION

USING FRONT AS EXAMPLES VRU-VOLUME CORRELATION GRAPHS









- Option 4 has the best correlation between VRU distance and volume with a correlation coefficient of -0.995
  - A correlation coefficient of 1 is perfect.
- The less error at this stage is desirable as we have to achieve equivalence with the original method, note the differences in deviation from the trend line in option 3 compared to option 4 (see red lines)

SUMMARY OF THE RESULTS OF THE ANALYSIS AGREED WITH ACEA

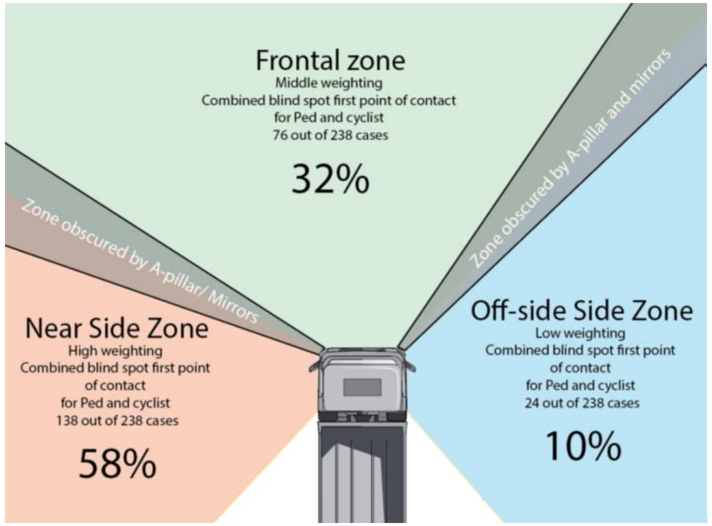
- Despite the evidence gathered, ACEA still prefer option 3
- Option 3 has the worst variance, which simply means that changing the A-pillar for Option 3 has a larger effect on the volume score when compared to option 4
- It is clear that Option 3 is less tech neutral.
- There are a number of other reasons why we think that option 4 is the best option

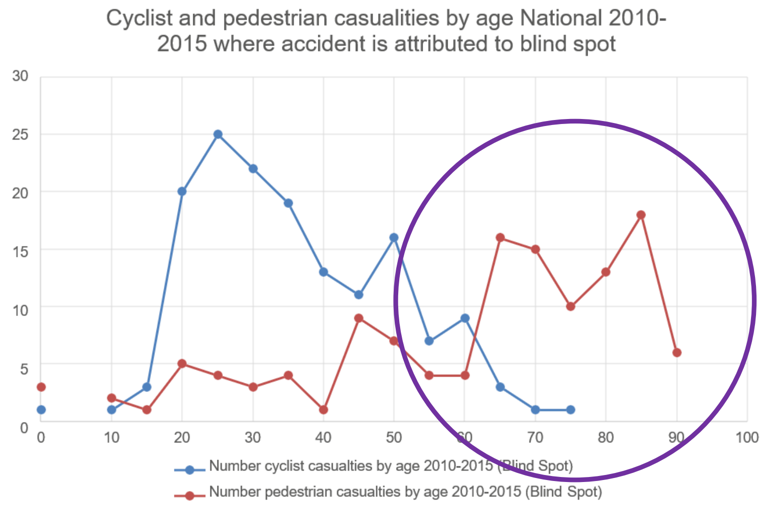
ACCIDENT DATA ANALYSIS FOR THE COLLISIONS TO THE FRONT OF THE VEHICLE

- In the project that defined the direct vision standard in London we performed an accident data analysis of collisions between HGVs and VRUs (Cyclists and pedestrians) using the UK STATS 19 database and the extra causation data provided by the UK Department for Transport

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





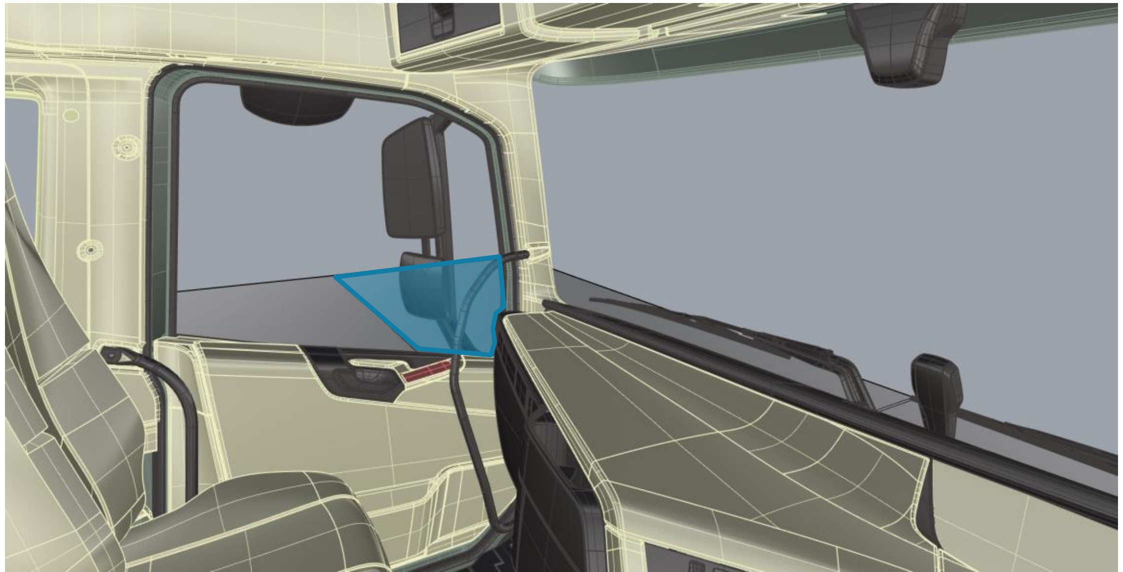
- The majority of accidents to the front of the vehicle involved pedestrians over the age of 65
- It is our analysis that older people were unable to get out of the way of the vehicle as it started to pull away from standstill at a junction, having not seen the pedestrian
- Slow moving pedestrian

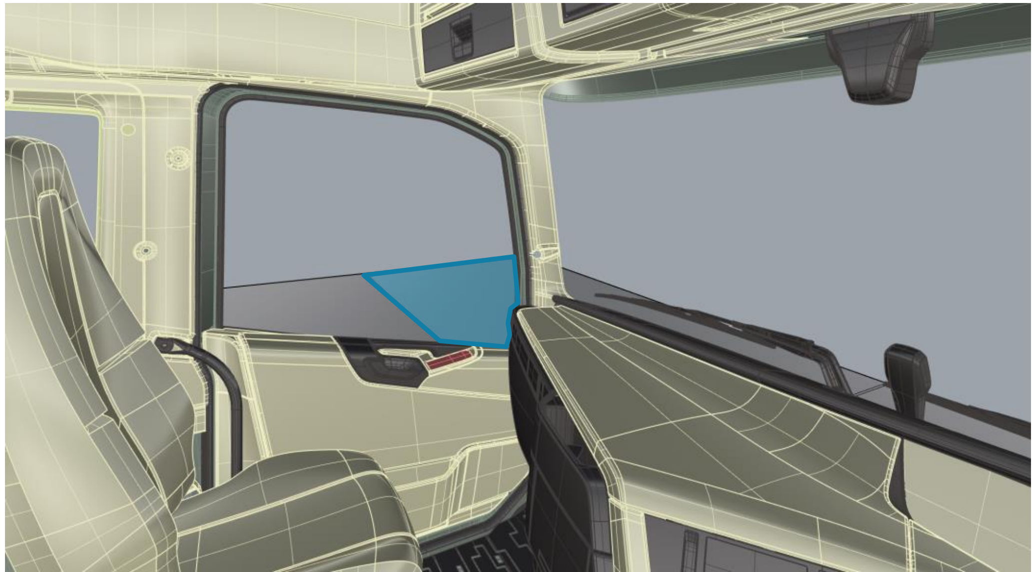
ISSUES WITH OPTION 3 – DISTANCES OF VRUS FROM THE CAB FOR FRONT VOLUME

- Option 3 allows VRUs to be counted in the testing of front volume at a distance of 4.5m
- As you can see in the image below, using a typical street in London with wide pavements this places a VRU inside a building
- Not useful for the driver to able to see.
- Option 3 also has issues with the skewing of the VRU distance results, this will make defining equivalence between the version of the standard that exists and the new version more difficult.

ISSUES WITH OPTION 3 – UNFAIR ADVANTAGE AS IT ALLOWS DESIGN CHANGES TO THE SIDE TO AFFECT FRONT VISION VOLUMES

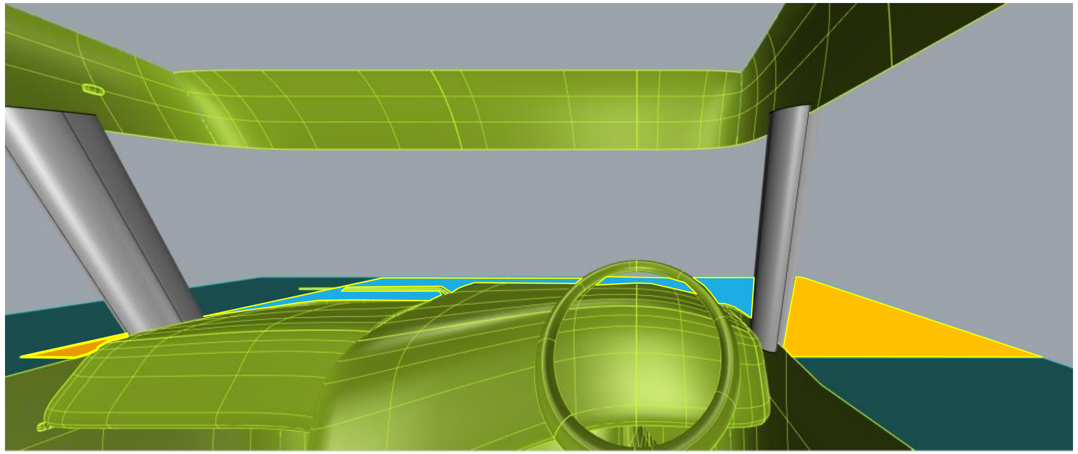
- Option 3 allows manufacturers to make changes to the sides of the vehicle which affect frontal volume
- E.g. removing the mirrors and hand rails to the side allows more volume to the Front to seen
- The same design changes also effect the side volume and are counted in the process of measuring side volume
- We think this provides an unfair advantage
- The method defined in the UNECE VRU proxi group selection a separated performance score to each side to avoid exactly this kind of advantage
- This is not the case for Option 4

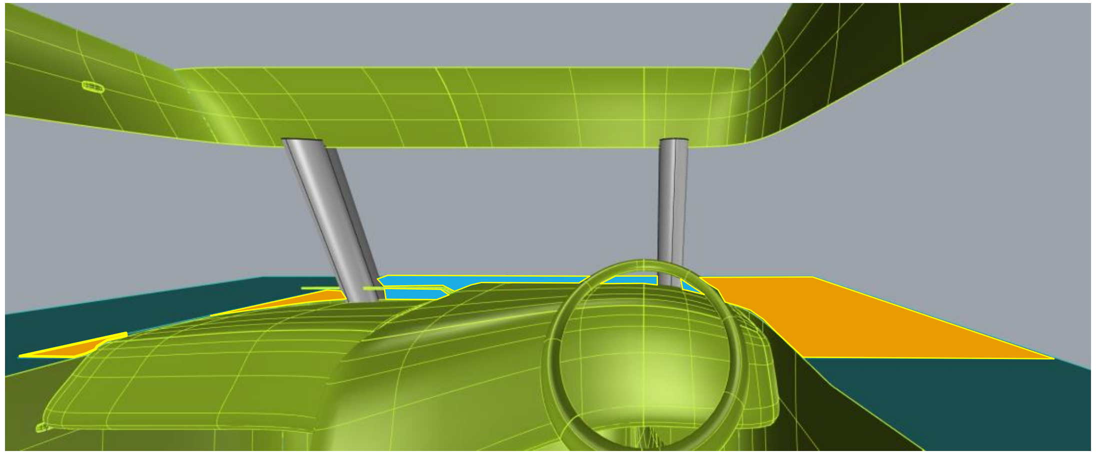




EQUIVALENCE

- It should be noted that whilst option 3 might seem attractive as there is more volume to see, this effect will be nullified by the need to ensure that the results for the new method are equivalent to the old method.
- Option 4 does however provide a strong benefit to vehicle design engineers as it allows volume to the left of the left A-pillar and the right of the right A-pillar to be counted as shown below.
- Orange sections would not have counted in the previous version. This is a great benefit in terms of design freedom





SUMMARY

- Based upon the evidence option 4 is superior to option 3 for the following reasons
- Option 3 has worse tech neutrality for a-pillars, i.e. changes in a-pillar position affect the volume score more for option 3 than option 4
- Option 3 allows VRUs to be seen 4.5m but accidents to the front are predominantly older pedestrians who (in general) would not walk at speed that make seeing them 4.5m useful, indeed we think this is the case for all VRUs
- Option 3 allow VRUs to be seen 4.5m and this skews the VRU distance/volume correlation BUT VRUs at this distance are likely to inside a building next to the road in a Urban environment, not useful to see at this distance
- Option 3 allows manufacturers to gain front volume by making changes to the design of mirrors and windows to the side
- Option 4 is superior