TRL Limited

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Investigation into 'A' pillar obscuration – a study to quantify the problem using real world data

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Executive summary

The scope of this study was to assess if there is a problem caused by car ‘A’ pillar obscuration in the real world and, if so, to start to quantify the size of that problem. This was achieved by using real world crash data to construct 3-D visualisations that would provide a graphical illustration of the obscuration caused by the car ‘A’ pillar. The real world crash data used in the study was obtained from the On The Spot (OTS) crash study.

To enable 3-D visualisations of the real world crashes to be reconstructed it was necessary to conduct some background work to obtain additional data. The report details the methods undertaken to produce the visualisations and outlines the necessary measurements that were required to validate the findings.

Ten reconstructions were undertaken and 3-D simulations produced. Interrogation of these ten crashes showed that six of them potentially involved ‘A’ pillar obscuration as a contributory factor. Further evaluation of the accidents resulted in the research team defining four of the cases as being caused, at least in part, by ‘A’ pillar obscuration. The cases are discussed within the report and visually highlight that ‘A’ pillar obscuration could be a crash causation mechanism.

The OTS Phase 1 database contains 1,513 collisions and these were analysed to investigate the incidence of car driver ‘A’ pillar obscuration. Collisions selected as potentially being associated with ‘A’ pillar obscuration were significantly more likely to occur at T-junctions and are more likely to involve car drivers failing to see vulnerable road users (motorcyclists, pedal cyclists and pedestrians). It was not possible from the information contained within the OTS Phase 1 database, to routinely identify if the selected “Looked but Did Not See” accidents are specifically caused by the ‘A’ pillar rather than observational failures on the part of a driver, or other external environmental factors.

The work to date highlights that car ‘A’ pillar obscuration could be a contributory factor in some road traffic crashes. However, there is rarely only one factor that contributes to an accident, and ‘A’ pillar obscuration is no exception to this.

The report found there is not enough evidence at this stage to suggest changes to the current legislation. However, the EC legislation currently assesses cars based on a 50^{th} percentile male and the visualisations have suggested consideration could be given to smaller and larger drivers.

The study recommends that further work could elaborate on the findings of this report via analysis of the OTS Phase 2 data, an enhanced ‘A’ pillar data collection phase and through driver simulator trials to test the findings and recreate accident scenarios with volunteers running the simulation.

Glossary of Terms

OTS	-	On-the-Spot project, sponsored by the Department of Transport and the Highways Agency.
Nasion	-	The apex of the bridge of the nose.
3-D visualisations	-	A method of presenting different views of an accident by modelling the scene and vehicle dynamics by using different software packages.
HVE	-	A vehicle dynamics software package.
FARO Arm	-	A digital measuring arm.
Laser Scanning	-	A tool used to survey scenes in great detail.
Scan/Scanning	-	Use of the laser scanner.
CAD		Computer Aided Design
Rhino	-	A 3-D CAD software package.
3D Studio Max	-	A visual editing software tool.
PNCAP	-	Primary New Car Assessment Program
TRL	-	Transport Research Laboratory
VSRC	-	Vehicle Safety Research Centre, Loughborough University

1 Introduction

For some time it has been thought that one of the best descriptions of accidents which include an element of visual obscuration is 'looked but did not see'. This description suggests the driver did look for any traffic opposing his / her intended manoeuvre but failed to notice the vehicle or vehicles they subsequently struck. It has been suggested that the increasing thickness of 'A' pillars may be a part of this problem. Road user groups have expressed concerns at the insufficient investigation of this phenomenon. Consequently, the Department for Transport has funded a study using real-world crash data in an effort to establish if there is a problem and, if so, to quantify the size of this problem.

Real-world crash data was collected by the OTS teams based at TRL and the Vehicle Safety Research Centre (VSRC) at Loughborough University. Both OTS teams were asked to look for road traffic accidents which may have been caused by one or more parties suffering 'A' pillar obscuration. The aim was to assess the nature and extent of any possible 'A' pillar obscuration by reconstructing suitable incidents as 3-D visualisations to illustrate a possible contribution to the cause of the collision.

In addition to the 3-D modelling work, a detailed literature review of current legislation and research regarding 'A' pillar obscuration was carried out. The OTS project database, detailing all the data collected in phase 1, was analysed as part of the study to identify accidents where 'A' pillar obscuration may have been a factor. The final area of work centred on an initial Regulatory Impact Assessment (RIA) which was completed according to government guidelines. The OTS phase 1 data analysis is included within the report.

The methods regarding the collection of the additional data required for this study are detailed in chapter 2 of this document. Chapter 3 describes the methods employed for collecting the 3-D scene and vehicle data necessary to construct the 3-D visualisations. The project team designed and performed a validation procedure that allowed the assessment of the accuracy and applicability of accidents selected for representation as 3-D visualisations. This procedure is outlined in chapter 4. The 3-D visualisations and their implications are discussed in chapter 5. Chapter 6 details the OTS Phase 1 Analysis. Chapter 7 consists of a discussion of all the work detailed in the previous chapters. Chapter 8 presents the findings from this study; and finally, chapter 9 suggests future work to further quantify and understand the extent of 'A' pillar obscuration.

Appendices to this document include further information regarding the additional data collection undertaken by the OTS teams.

2 Real-World Data Collection Methodology

TRL has access to a wealth of real-world crash data as part of the On-The-Spot (OTS) project. This project, currently nearing the end of phase 2, requires two response teams to visit the scenes of accidents soon after they have occurred to gather and analyse data pertinent to the accident. The TRL team is based in the Thames Valley Region, whilst the VSRC team have a more rural area based around Nottingham. Both teams were asked to pay particular attention to any accident which they considered may have involved 'A' Pillar obscuration. In these instances, they were asked to collect some additional data which would help if the accident was selected to be modelled as a 3-D reconstruction and visualisation, illustrating the potential effects of 'A' pillar obscuration.

2.1 'A' Pillar Incidents

To enable effective data collection by the OTS teams it was decided that the description of what constitutes a potential 'A' pillar incident should be left quite open. This would encourage the OTS teams to consider all incidents before deciding if 'A' pillar obscuration may have contributed to their cause. This approach allowed the project team to select accidents for reconstruction which best reflected the potential for 'A'-pillar obscuration as a causal factor for the incident.

For some time it has been thought that one of the best descriptions of accidents which include an element of visual obscuration is 'looked but did not see'. This description suggests the driver did look for any traffic opposing his/her intended manoeuvre, but failed to notice the vehicle or vehicles they subsequently struck. It has been suggested that the increasing thickness of 'A' pillars may be a part of this problem and for this reason the OTS teams were asked to look out for accidents where one of the causation codes could be "looked but did not see". Therefore, the basic criteria for selecting an OTS investigated accident as including potential 'A' pillar involvement was as follows:

- More than one vehicle;
- Driver of vehicle suspected of suffering from 'A' pillar obscuration was attempting a manoeuvre which required them to rely on peripheral vision e.g. turning out of a junction;
- Driver of the vehicle suspected of suffering from 'A' pillar obscuration looked but did not see the struck vehicle(s).

2.2 Additional Data

To enable the construction of a 3-D visualisation of an accident a certain amount of data regarding the seating position of the driver in the relevant vehicle was required. A new data collection sheet was designed, with guidelines, allowing the OTS team to collect as much 'A' pillar data as possible for any accident where they considered 'A' pillar obscuration may have been a causal factor. The data sheet is listed in Appendix 1.

Due to the nature of this study, the project team were careful not to label the front page of this data collection sheet with anything which may have suggested 'A' pillar obscuration. The OTS teams were asked not to mention 'A' pillar obscuration so as not to bias the results and the data collection for any accident.

The OTS teams are under pressure to collect as much data as possible prior to the clearance of an accident scene. It was thought inappropriate to require OTS team members to attempt to collect additional data where a driver of a vehicle involved in an accident would need to be seated in the crashed vehicle longer than necessary. Due to the time limitations associated with investigating accidents at the scene, acquiring monocular data for use in the 3-D modelling was considered to be the best compromise for this phase of work.

The additional measurements the OTS teams were asked to collect centred on providing a 3-D eye position; essential for developing the 3-D visualisations. The OTS teams were required to measure the position of the nasion (the apex of the bridge of the nose that reflects a central position between the subject’s eyes) of each driver suspected of suffering from ‘A’ pillar obscuration This allows the 3-D visualisation to be displayed from the driver’s perspective and simulates monocular vision. This method did mean that head rotation could not be accounted for in the real-world data.

In addition to the details of a driver’s seating position, the OTS teams also ensured the path and collision data, and particularly the point of collision, were as accurate as possible. This allowed a detailed reconstruction to be carried out by the project team prior to a 3-D visualisation being constructed. It is believed that certain road layouts may contribute to instances where ‘A’ pillar obscuration has been cited as a possible causal factor.

3 3-D Scene and Vehicle Data Methodologies

The 3-D visualisations required 3-D data from the scene and the vehicle in which the subject suspected of ‘A’ pillar obscuration was driving. It was originally intended that all the necessary 3-D data would be collected by using the laser scanner. However, it became apparent in the early stages of the project that this was technically unfeasible. The technical problems encountered and the devised solutions are detailed in the following sections of this chapter.

3.1 Using the Laser Scanner for 3-D Vehicle Data

The work began by investigating the best way to record the data required from the scene and the vehicle. Initially the results suggested that it would be best to use the laser scanner for everything but further analysis identified problems and showed that an alternative method was preferable for the vehicle. To construct a detailed 3-D visualisation of the accident would require accurate vehicle data. However, investigation into this methodology revealed that the laser scanner was not the appropriate item of equipment to collect this data.

The laser scanner currently used by TRL does not acquire data to a high degree of accuracy in a tight, enclosed space, such as the inside of a vehicle. There are ‘blind’ spots directly above and beneath the area where the head of the scanner rotates; this does not cause major problems if the object/scene/area to be scanned is of a sufficiently large size in comparison to the blind spot. However, it was felt that the small size of a car interior would lend itself to a more appropriate method being used: a 3-D digital measuring arm. Using this method allowed the project to acquire the necessary internal and external vehicle data to develop a 3-D model of a vehicle.

3.2 Using the Digitising Arm for 3-D Vehicle Data

TRL has a digitising arm, also known as a FARO arm that manually acquires 3-D points when positioned on an object. The FARO arm looks similar to a robot arm but is not automated and requires a human operator. The arm is articulated and finishes in a fine point which has a small ball-bearing embedded in the tip. The tip is placed on an object (vehicle) and records the coordinates of a point on the object in three dimensions. Before use, the FARO arm and the object require referencing to a base coordinate system.

As this was a manual process, it was decided early in the project that due to time and cost restraints only half of the vehicle would be digitised. The front half of the exterior of the vehicle was digitised, taking particular care to acquire all the necessary point data around the windscreen and ‘A’ pillar areas. The base of the driver’s seat and the profile of the steering wheel and dash board were also digitised to allow the developed 3-D models to look more realistic when viewed from the driver’s perspective.

Figure 1: Exterior of a Vehicle Prepared for Digitising

Figure 2: Interior of a Vehicle for Digitising

Figures 1 and 2 show some of the taped areas of a vehicle digitized for this study. The output from the FARO arm is a set of 3-D coordinates which can be entered into a CAD package and the coordinates displayed as points, as shown in figure 3.

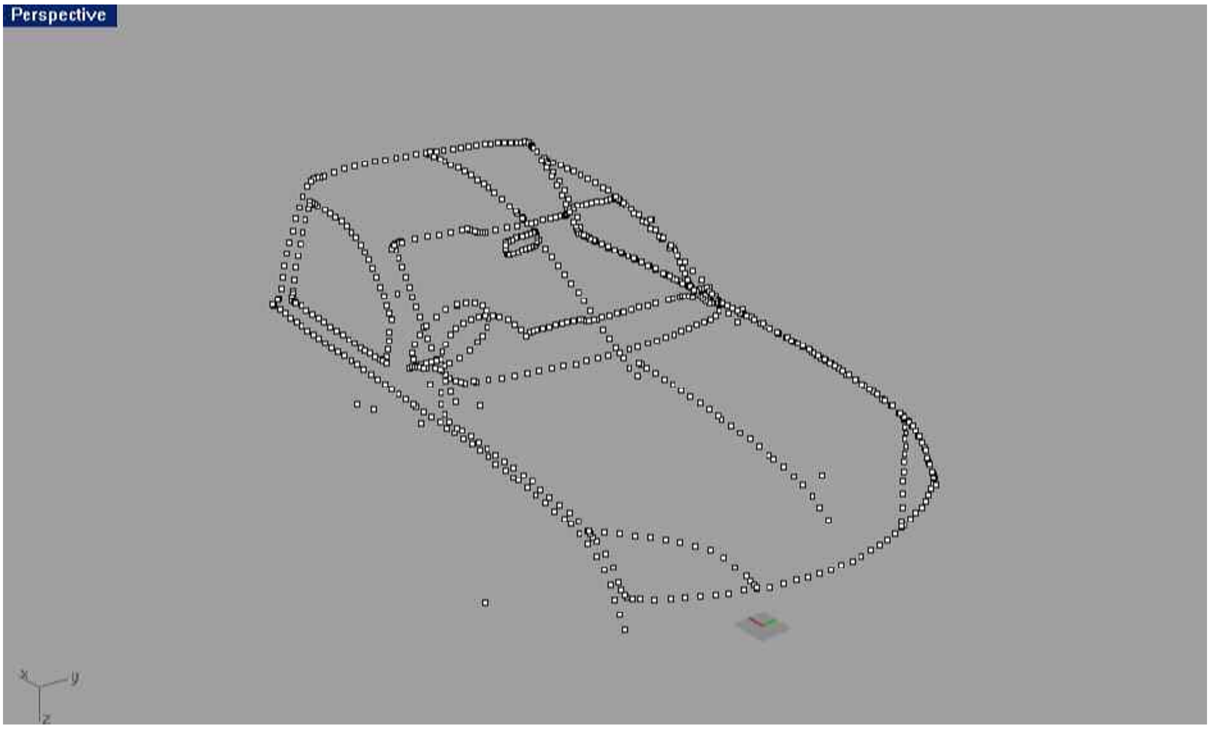


Figure 3: Output from the FARO Arm

This digitized output was used as the basis to draw and surface a 3-D model of the required vehicle (see figure 4).

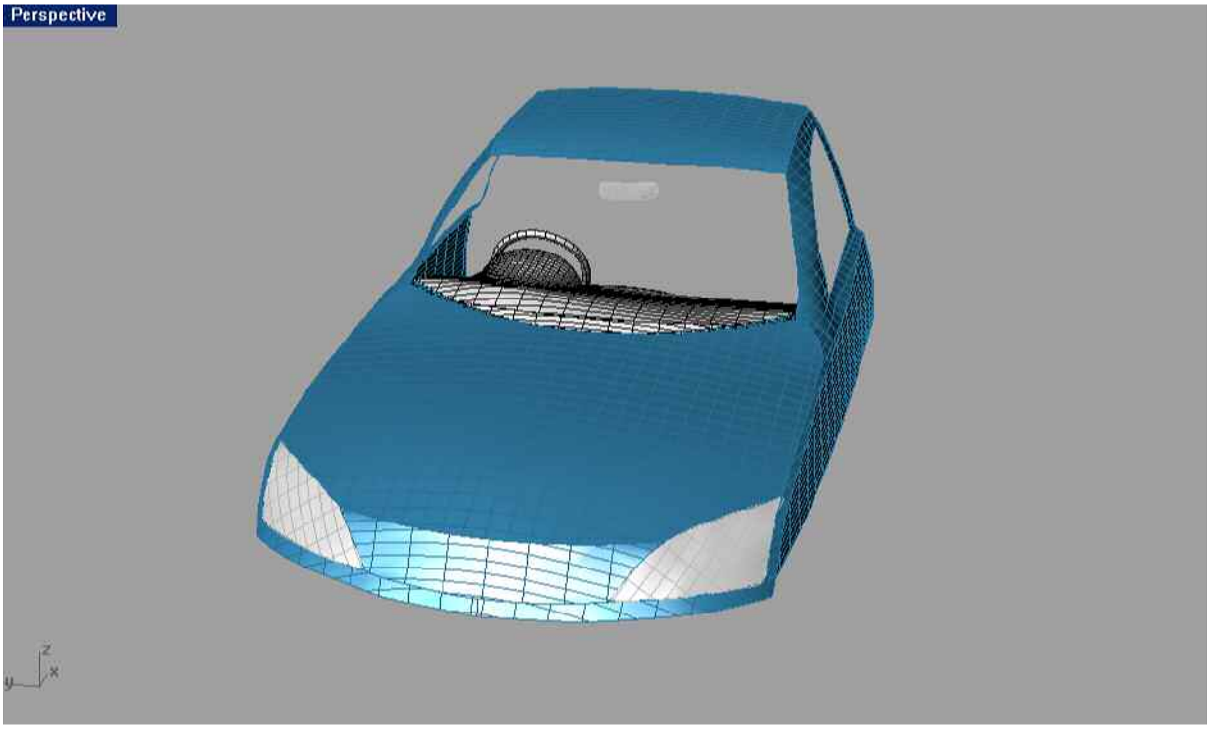


Figure 4: A Rendered 3-D Model of a Vehicle

3.3 Acquisition of 3-D Accident Scene Data Using the Laser Scanner

The laser scanner was an obvious choice to acquire the 3-D scene data for the 3-D visualisations. However, issues arose surrounding the post-processing of the laser scan data. The 3-D data from the scanner is recorded as a point cloud consisting of upwards of a million points. The enormous size of the data file therefore requires a substantial amount of post-processing before it can be used in a vehicle dynamics software package. Innovative methods were employed to crop the scene data without losing the required detail or accuracy. This was achieved for the pilot reconstruction and visualisation and was deemed a success; the laser scanner was chosen as the tool to collect the 3-D scene data for the remainder of the project.

4 Validation Procedure

The data for the 3-D visualisations were constructed from real-world data collected at the scene of the accident. There was a limited amount of data referenced to the driver collected by the OTS teams. The driver data provided the one position in the vehicle (looking straight ahead) from a single point between the driver's eyes, which meant the 3-D visualisations would have to illustrate any 'A' pillar obscuration from a monocular perspective. However, the project team was well aware that people see binocularly and therefore, some method of correlating the monocular with the binocular was explored.

A simple, binocular approach to modelling the area of 'A' pillar obscuration using three volunteers and three test vehicles was undertaken in a controlled environment. In this instance, a controlled environment refers to a situation that is not on a live carriageway and when no urgent time pressures are present. Once the binocular methodology had been affected, the monocular methodology was performed and the results from both were compared. In this way, the project team developed an understanding of the constraints of the monocular area of obscuration that would be developed in the 3-D visualisations.

The following three sections detail the validation setup and the methodologies for the monocular and binocular approaches. These are referred to as the validation procedure.

4.1 Validation Setup Methodology

The validation procedure included a 50^{th} and a 95^{th} percentile male driver and a 5^{th} percentile female driver. Three vehicle categories were specified for the procedure; a small hatch-back car, a family-sized car and a multi-purpose vehicle (MPV). A Ford Ka filled the criteria for the small hatch-back, a Vauxhall Vectra was used as the family-sized car and a Toyota Previa was used to represent the MPV. The FARO arm was used to acquire the necessary 3-D data which allowed a 3-D model of the test vehicles to be created.

These six variables were used for both the monocular and binocular approaches. Both approaches required each test vehicle to be accurately positioned at a set distance to an expanse of flat wall. A simple set up was used, and is shown in figure 5.

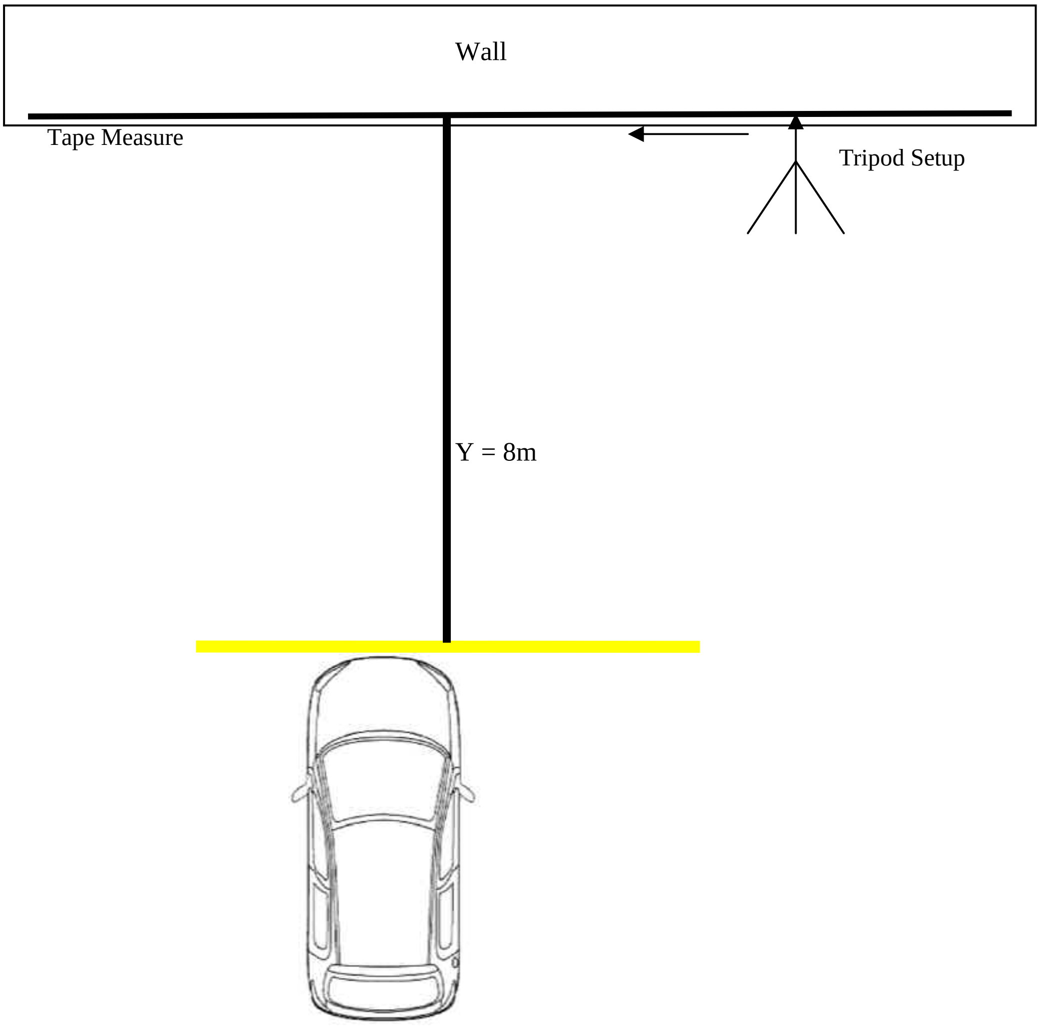


Figure 5: Validation Vehicle Setup

A test vehicle was positioned 8m away from, and perpendicular to, a large expanse of flat wall. The distance of 8m was selected because of the similar triangles methodology which could be applied to manoeuvre the car to ensure it was perpendicular to the wall. Positioning the vehicle perpendicular to the wall was done by applying the following geometry (see figure 6):

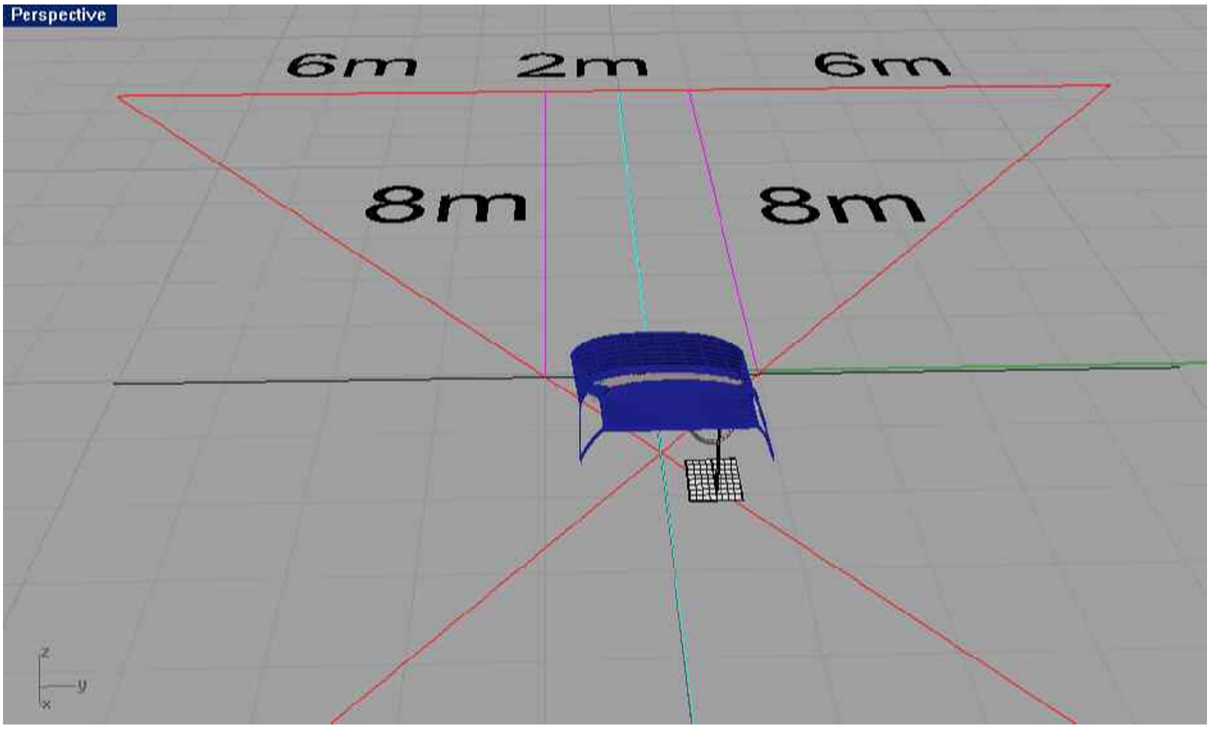


Figure 6: Vehicle Positioning for the Validation Procedure

The geometry in figure 6 was achieved by the following method:

- A good estimate of a perpendicular line was marked out from a central point on the wall;
- Tape measures were placed along the base of the wall from the chosen central point;
- 1m was measured out along the base of the wall from the central point in each direction
- From the 1m marks denoted by the ends of the pink lines in figure 6, a further 6m was measured along the wall in each direction;
- Lines were drawn diagonally from the end of the 6m lines to meet the estimated perpendicular line. These lines were adjusted to ensure they measured 10m;
- A line was marked which joined the ends of the two 8 m lines. The 8m lines were then extended until they intersected, allowing the line perpendicular to the wall to be appropriately adjusted;
- The test vehicle could then be placed as close as possible to the 8m line and perpendicular to the wall.

4.2 Binocular 'A' Pillar Method

The volunteers were seated in the test vehicle one at a time. Each volunteer was asked to adjust the driver's seat to their preferred driving position. A tripod with a reflective marker was positioned on the tape measure along the wall. The reflective marker was set to two heights: 1.15m and 1.50m respectively. These heights were chosen to reflect the heights of real-world objects that could be hidden behind an 'A' pillar.

4.2.1 Binocular Approach

Each volunteer was supplied with an eye patch, and was asked to cover their right eye and look in the vicinity of the offside 'A' pillar. The tripod and reflector, which was initially set to a height of 1.15m, was positioned in the volunteer's field of view to the offside of the vehicle; it was then slowly moved along the tape measure towards the vehicle until it went out of view, and that position was noted. The volunteer was asked to repeat this process twice more in order to achieve an average measurement. The volunteer then positioned the eye patch over their left eye and repeated the process described above. The tripod was reset to a height of 1.50m and the process continued for both eyes.

This whole procedure was repeated for the nearside of the vehicle. The volunteer was asked to turn their head to look in the vicinity of the nearside 'A' pillar, thereby taking into account a suitable amount of head rotation. The tripod was initially positioned in the driver's field of view to the nearside of the vehicle on the tape measure against the wall.

The different heights of 1.15m and 1.50m were defined as the lower and upper heights.

The points where the driver lost sight of the reflector were used to draw the area of obscuration and were denoted as follows:

- LL denotes the point a volunteer lost sight of the reflective marker with their left eye when it was set to a height of 1.15m.
- RL denotes the point a volunteer lost sight of the reflective marker with their right eye when it was set to a height of 1.15m.
- LU denotes the point a volunteer lost sight of the reflective marker with their left eye when it was set to a height of 1.50m.
- RU denotes the point a volunteer lost sight of the reflective marker with their right eye when it was set to a height of 1.50m.

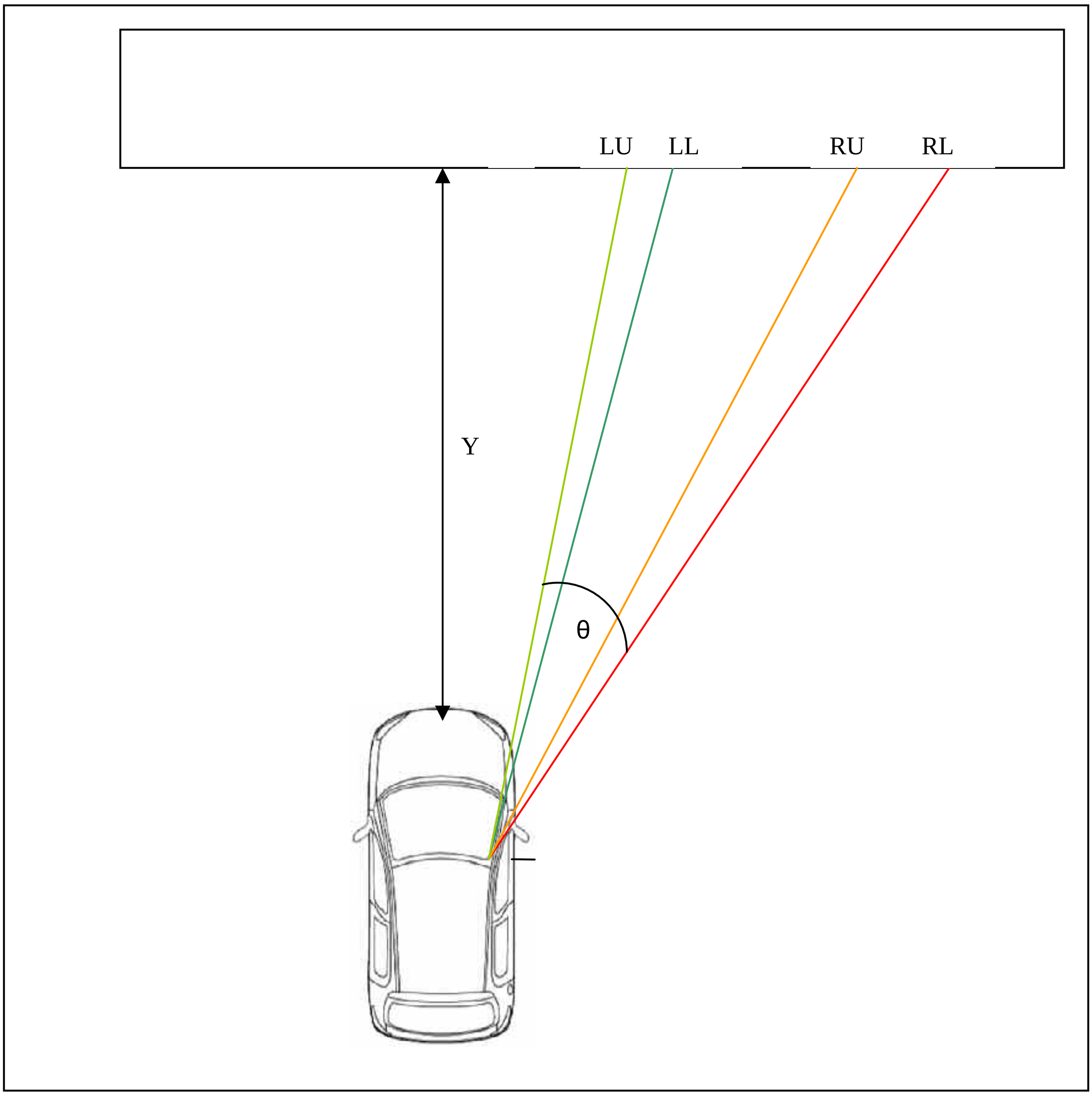


Figure 7: Binocular Angle of 'A' pillar Obscuration

The binocular angle of 'A' pillar obscuration, θ (see figure 7), is the angle which includes all the points measured on a particular side of the test vehicle that mark the point where the reflector first disappeared from the view of a volunteer on both sides of the 'A' pillar. Before leaving the vehicle, two measurements were taken from a volunteer, which positioned the volunteer's nasion with respect to two fixed points in the vehicle. This allowed the binocular angle of 'A' pillar obscuration to be modelled and compared to the monocular angle. For ease of viewing the area of obscuration was drawn at one height in the modelling software.

4.2.2 Monocular Approach

Before each volunteer left a test vehicle, the measurements necessary to model the monocular areas of 'A' pillar obscuration were obtained. Each volunteer was asked to assume their normal driving position and look directly ahead. Two measurements were then taken, one from the nasion of the volunteer to the upper offside corner of the windscreen (measurement p), and the second from the nasion to the apex of the dashboard (measurement q). This allowed a single fixed point, situated at point midway between the eyes of the volunteer, to be modelled and used as the origin for the area of monocular 'A' pillar obscuration in the 3-D models.

The monocular angle of ‘A’ pillar obscuration was an angle modelled by projecting a line either side of the required ‘A’ pillar from the measured nasion point of the volunteer, and in the same plane as the nasion. This method does not account for head rotation, but was the best that could be realistically achieved at the scene of a real-world crash. (see Figure 8) This method was later employed when the 3-D visualisations (see chapter 4) were constructed.

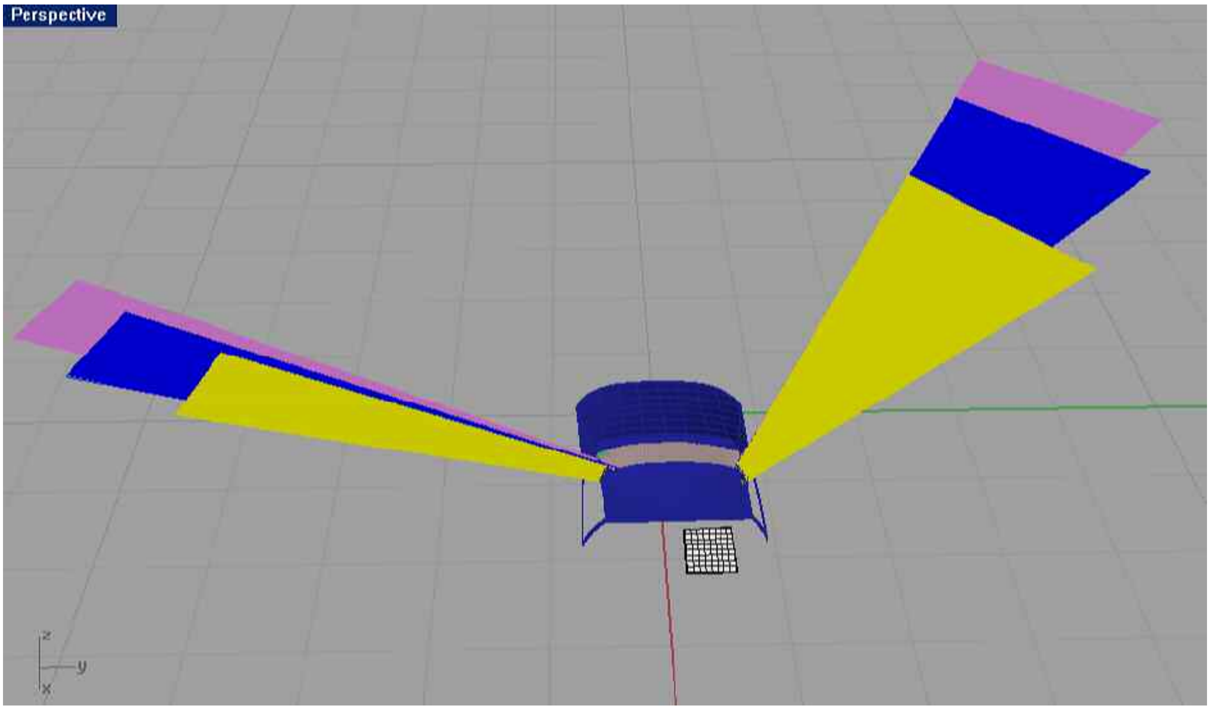


Figure 8: Monocular Model of the Angles of ‘A’ Pillar Obscuration for the Three Volunteers

Figure 8 shows the monocular areas of ‘A’ pillar obscuration for the offside and nearside pillars, for the 95th percentile male (yellow), the 50th percentile male (blue) and the 5th percentile female.

4.3 Validation Results

The results are discussed in terms of vehicle size and include a comparison between the monocular and binocular angles of ‘A’ pillar obscuration. The figures in the results tables 1, 2 and 3, together with the volunteer measurements, constituted the data required for the 3-D models which allowed the areas of obscuration to be drawn. The paler colours represent the monocular areas of obscuration, while the darker colours represent the binocular areas of obscuration.

4.3.1 Ford Ka

The Ford Ka was used in the validation procedure to represent the small hatchback class. The ‘A’ pillars on this vehicle are particularly raked and flare out at the top and bottom of the structure. It was expected that larger areas of obscuration would be found for volunteers who had to look through the wider structures at the extreme ends of the pillar as opposed to those who were able to look through the more central area of the pillars.

The following tables give the validated and predicted angles for each of the three volunteers for the offside and nearside ‘A’ pillars.

Table 1: Angles of Obscuration for the Ford Ka

	Angles of Obscuration /˚			
Test Subject	**Monocular Offside**	**Binocular Offside**	**Monocular Nearside**	**Binocular Offside**
5th Percentile Female	15.17°	5.51°	8.76°	8.67°
50th Percentile Male	21.43°	9.76°	11.12°	6.21°
95th Percentile Male	28.63°	6.92°	15.02°	8.35°

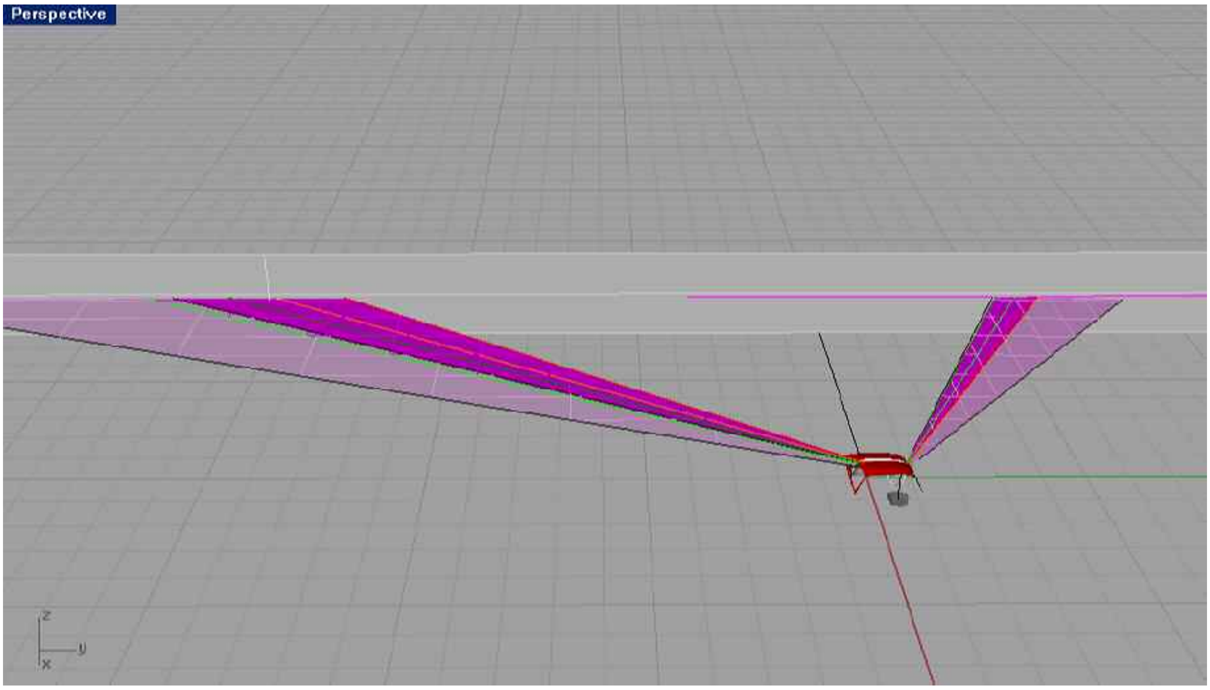


Figure 9: Validated Angle and Predicted Angles of Obscuration for a 5th Percentile Female

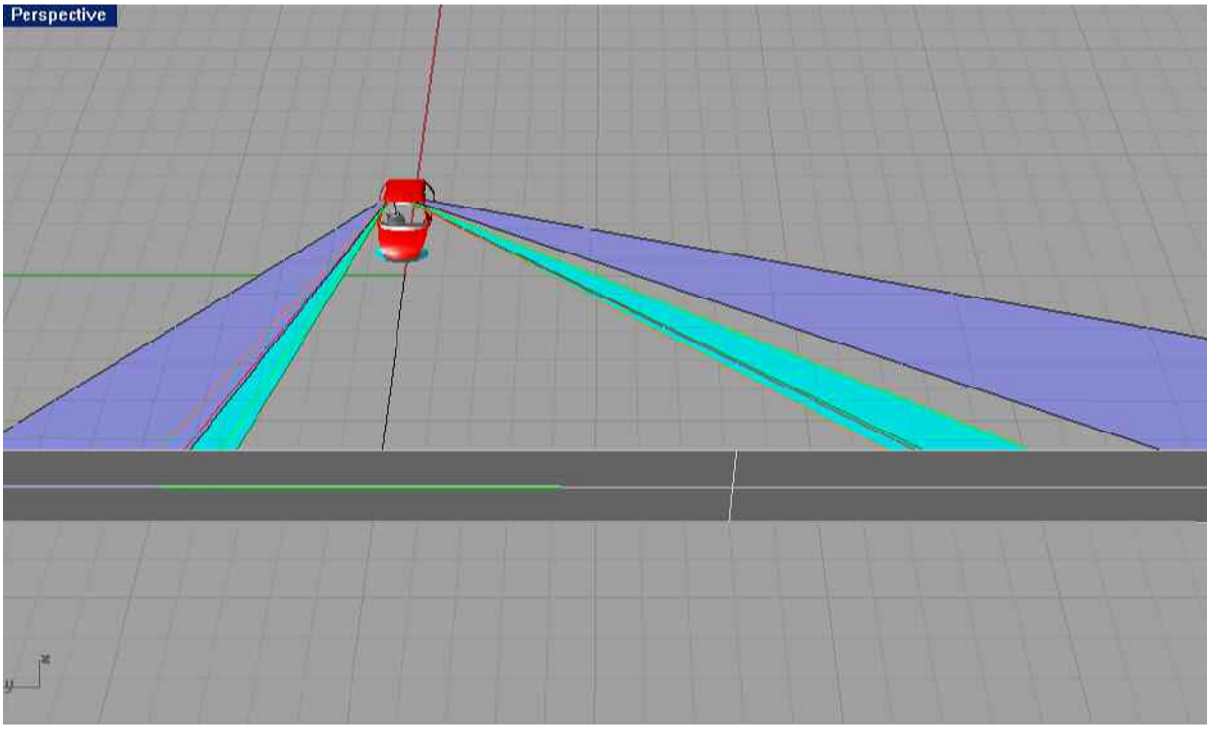


Figure 10: Validated Angle and Predicted Angles of Obscuration for a 50th Percentile Male

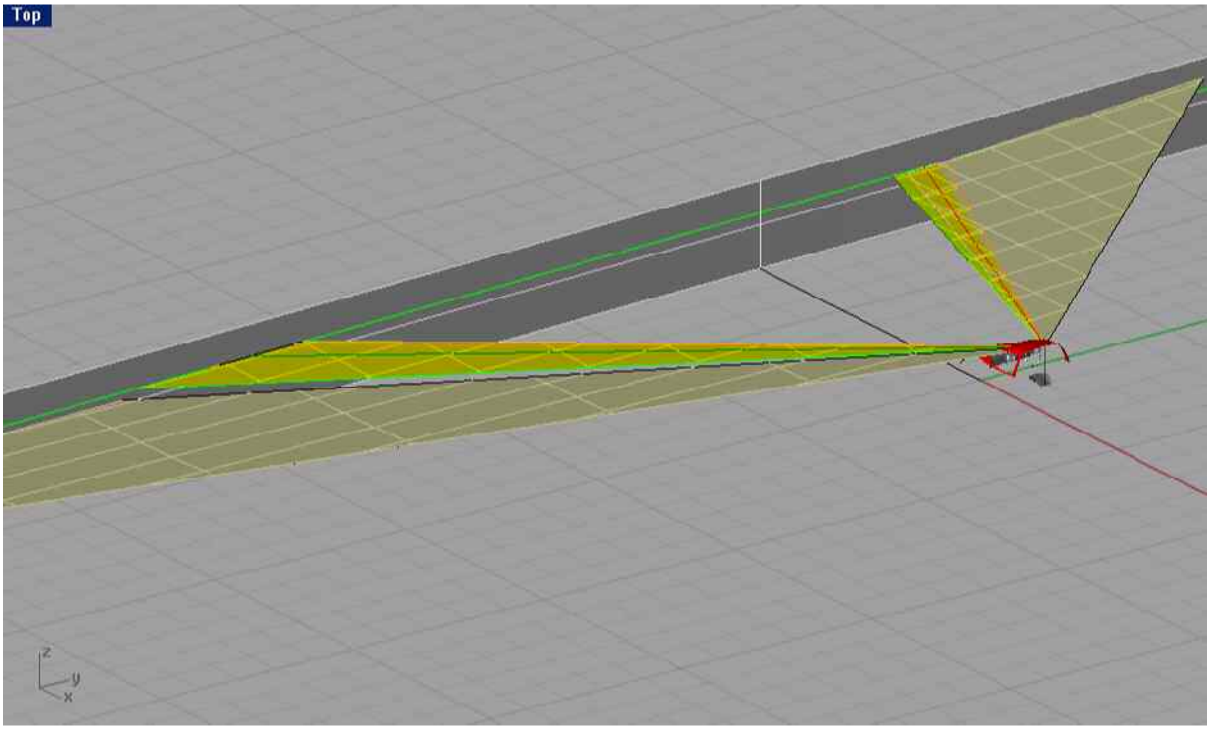


Figure 11: Validated Angle and Predicted Angles of Obscuration for a 95th Percentile Male

All three test subjects have differing amounts of overlap between the monocular and binocular areas of obscuration for the offside ‘A’ pillar. The binocular areas of obscuration are between approximately 25% and 50% of the monocular areas of obscuration. The models also demonstrate the validated areas to fall within the section of the predicted angle closest to the ‘A’ pillar. This suggests the monocular angles of ‘A’ pillar obscuration are: a) a predicted maximum, and b) of a larger angle in comparison to the monocular ‘A’ pillar obscuration angles.

There was very little overlap between the monocular and binocular areas of ‘A’ pillar obscuration for any of the volunteers. It is thought that this was due to an inadequate amount of head rotation applied to the test subjects. When the nearside validated areas are examined in figures 8, 9 and 10 – the cones pass to the right of the ‘A’ pillar rather than through it, and this is particularly apparent for the 50th percentile male test subject. The test subjects were asked to rotate their heads to look through the relevant ‘A’ pillar, but particularly for measurements concerning the nearside ‘A’ pillar, the rotation does not appear to have been sufficient. In conjunction with the issue of head rotation, it is thought the distances at which the volunteers were asked to spot the reflector moving in and out of their vision was probably at the extent of their peripheral vision and may have added a margin of error.

Table 1 highlighted a trend; the larger the test subject, the greater the value of the validated and predicted nearside obscuration angles. It was generally expected that the 5th percentile female would experience greater obscuration from both ‘A’ pillars because her eye position would be closer to them, giving them more prominence in her field of view. However, the Ford Ka design which has particularly raked A-pillars, led to the conclusion that larger test subjects sat further back in the vehicle but were still closer to the flared top of the ‘A’ pillars than the smaller driver was to the flared bottom of the pillar.

4.3.2 Vauxhall Vectra

A Vauxhall Vectra was used to represent a typical family-sized car. The following table gives the binocular and monocular angles of obscuration for each of the three volunteers for the offside and nearside ‘A’ pillars.

Table 2: Angles of Obscuration for the Vauxhall Vectra

	Angles of Obscuration /˚			
Test Subject	**Monocular Offside**	**Binocular Offside**	**Monocular Nearside**	**Binocular Nearside**
5th Percentile Female	15.71°	9.30°	8.56°	8.67°
50th Percentile Male	18.99°	11.53°	9.80°	10.56°
95th Percentile Male	24.98°	11.56°	10.96°	9.37°

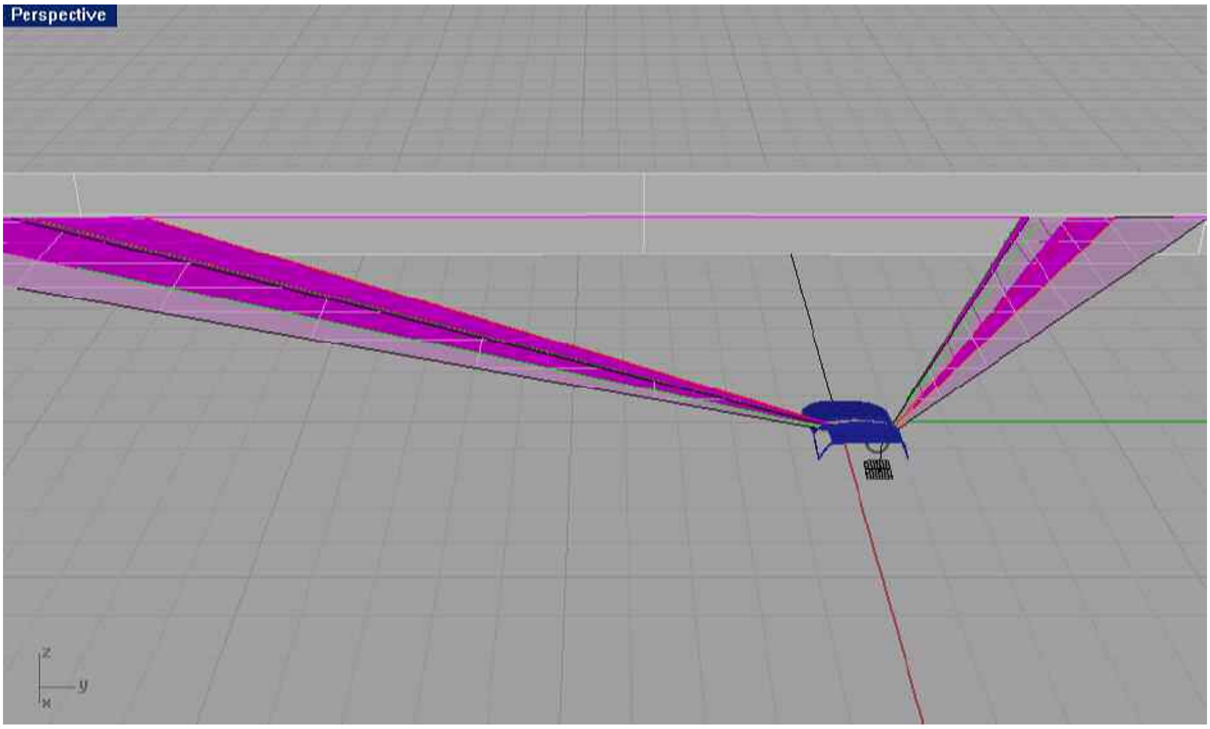


Figure 12: Validated and Predicted Angles of 'A' Pillar Obscuration for a 5th Percentile Female

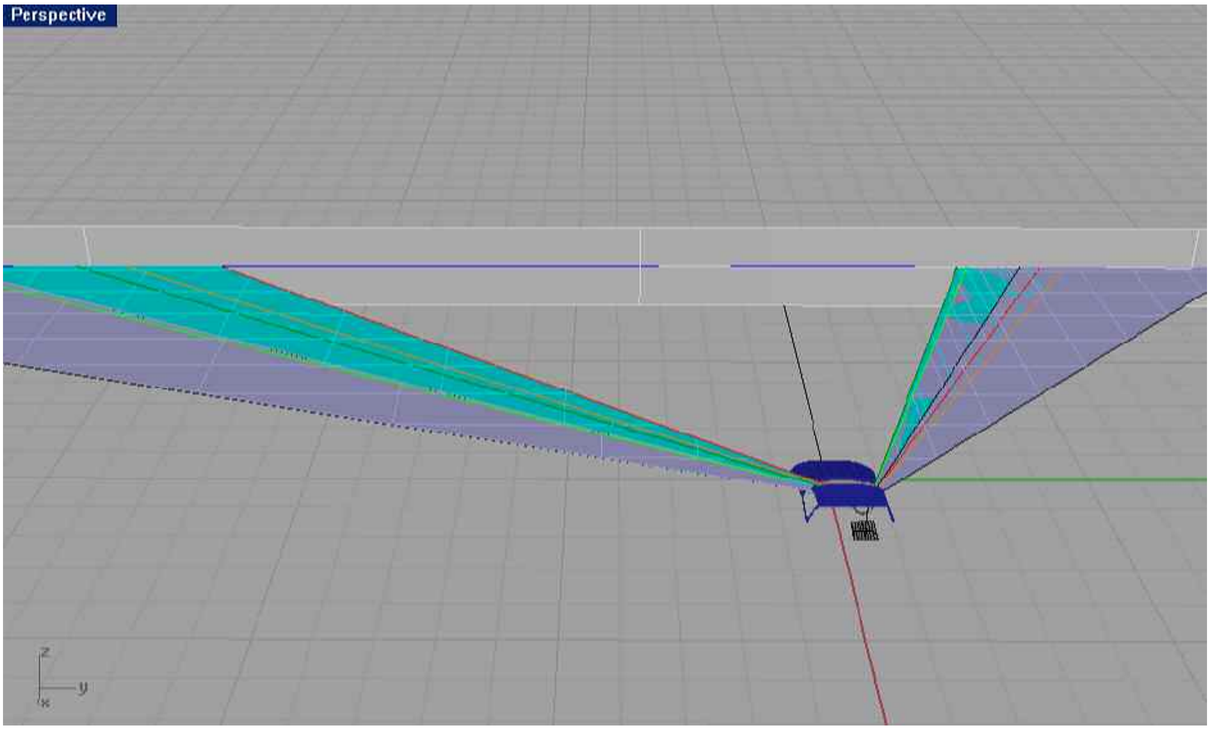


Figure 13: Validated and Predicted Angles of 'A' Pillar Obscuration for a 50th Percentile Male

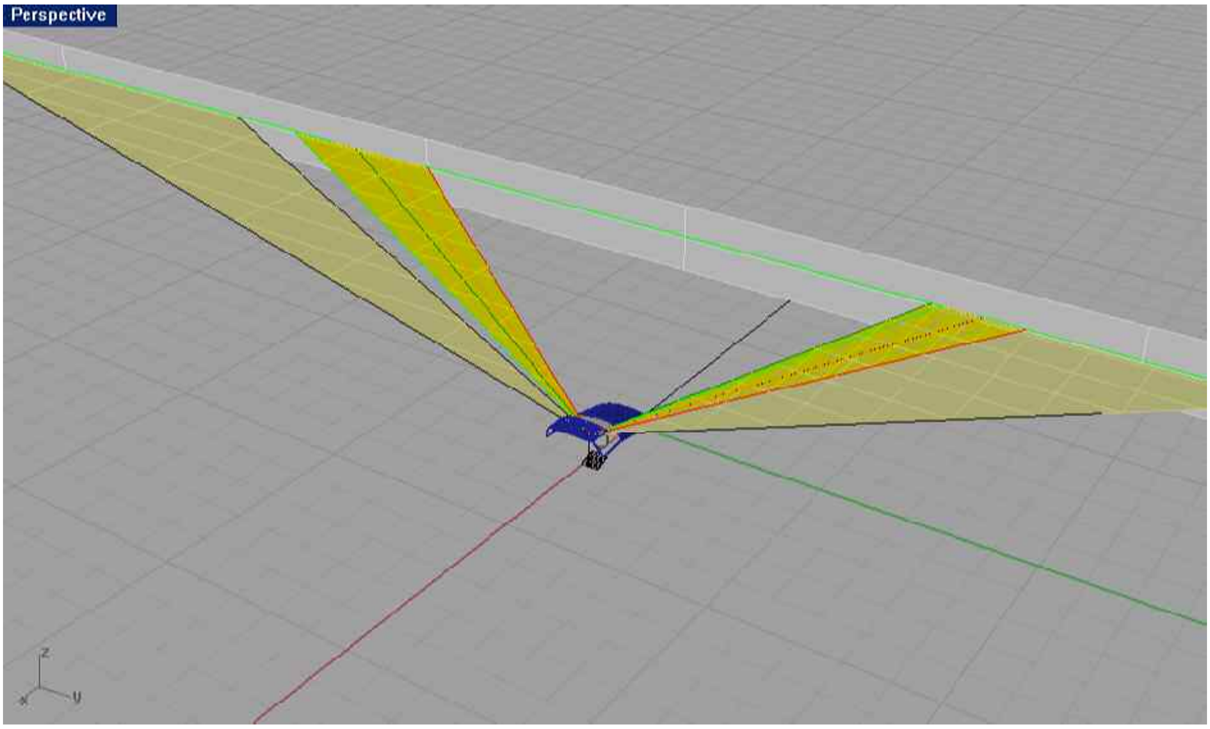


Figure 14: Validated and Predicted Angles of 'A' Pillar Obscuration for a 95th Percentile Male

The general trend appears to show that the larger the test subject the greater the increase in both the binocular and monocular angles of 'A' pillar obscuration. This is somewhat atypical, and in this instance is linked to the raked 'A' pillar of the Vauxhall Vectra and the flared top of that structure. It would normally be expected that a 5th percentile subject would experience a greater degree of 'A' pillar obscuration because their seating position brings them closer to the 'A' pillar. The offside monocular and binocular angles are larger than the nearside angles, which was expected as the volunteers sit closer to the offside 'A' pillar, thus giving it more prominence in their field of vision.

The binocular nearside angles for the 50th and 95th percentile male volunteers did not pass through the nearside 'A' pillar. The reason for this is the same as suggested for the inaccuracy of the binocular nearside angles of obscuration for the Ford Ka mentioned in section 4.4.1 i.e. lack of head rotation.. There was considerable overlap between the monocular and binocular obscuration areas for the 5th percentile female, with both areas passing through the nearside 'A' pillar. Generally, the models based on the Vauxhall Vectra indicate that there is far more overlap in location and size between the monocular and binocular angles for the offside and nearside 'A' pillar (approximately 60% for the 5th percentile female) compared to the other test vehicles. The exception to this is the offside value for the 95th percentile male; the project team theorise the reason for this is the top of the offside 'A' pillar may have been highly prominent in the view of the 95th percentile male due to the raked, flared structure of the Vauxhall Vectra 'A' pillars.

4.3.3 Toyota Previa

A Toyota Previa was used to represent the MPV class of vehicle for the validation procedure. The design of the front side windows is considered to contribute to a driver's poorer field of view. The style of 'A' pillar is long and raked. The bottom half of the 'A' pillar splits where a vertical support forms the opposite side of a small triangular window, which is intended to aid a driver's field of view.

The validation procedure incorporated the vertical structure for the small triangular window as part of the 'A' pillar.

Figure 15: 50th Percentile Male Volunteer in the Toyota Previa

Figure 15 shows the additional front side window toward the base of the 'A' pillar. The vertical structure for this small window can have the unfortunate effect of acting as an additional 'A' pillar which may further obscure the view of the driver.

Table 3: Angles of 'A' Pillar Obscuration for the Toyota Previa

	Angles of Obscuration /°			
Test Subject	**Monocular Offside**	**Binocular Offside**	**Monocular Nearside**	**Binocular Nearside**
5th Percentile Female	10.58°	10.47°	7.47°	12.84°
50th Percentile Male	12.45°	10.06°	7.79°	10.64°
95th Percentile Male	13.04°	6.77°	8.21°	12.37°

The figures in table 3 suggest the 5th percentile female was subject to a larger angle of binocular 'A' pillar obscuration for both sides of the vehicle compared to the 50th and 95th percentile males. The reason for this quickly became apparent; the nasion of the 5th percentile female was in line with the area of the secondary 'A' pillar. The trend in the binocular obscuration figures for the offside of the vehicle indicate that the larger the volunteer the greater decrease in the area of obscuration. The nearside is less clear-cut; the 50th percentile male seems to have been subject to less obscuration than the 5th and 95th percentile volunteers. The reason for the larger than expected angle of obscuration for the 95th percentile male, was thought to be that his line of sight coincided with the thicker, flared section at the top of the nearside 'A' pillar.

There is a correlation of almost 100% between the size of the offside angles of 'A' pillar obscuration for the monocular and binocular approaches for the 5th percentile female; this drops to around 58% for the nearside 'A' pillar. The results for the 50th percentile male also show a higher degree of correlation for the monocular and binocular approaches for the offside 'A' pillar as apposed to the nearside 'A' pillar. The results for the 95th percentile male show the least correlation in terms of the size of angles.

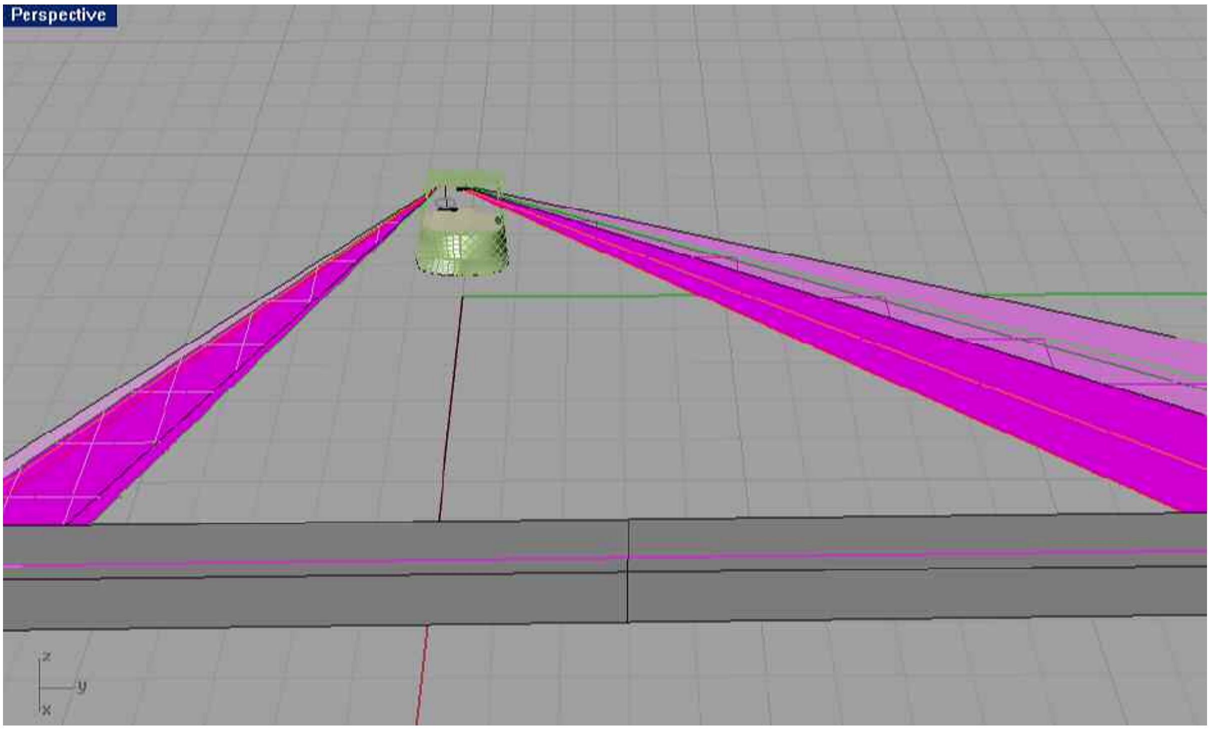


Figure 16: Validated and Predicted Angles of 'A' Pillar Obscuration for a 5th Percentile Female

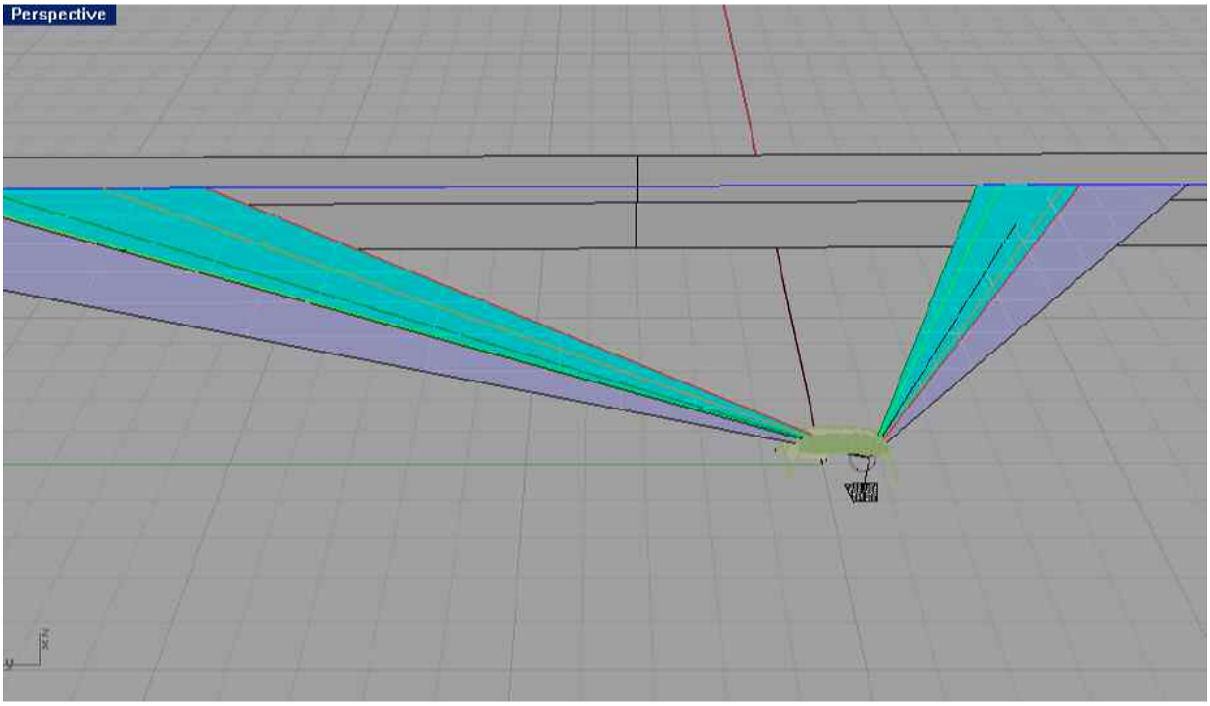


Figure 17: Validated and Predicted Angles of 'A' Pillar Obscuration for a 50th Percentile Male

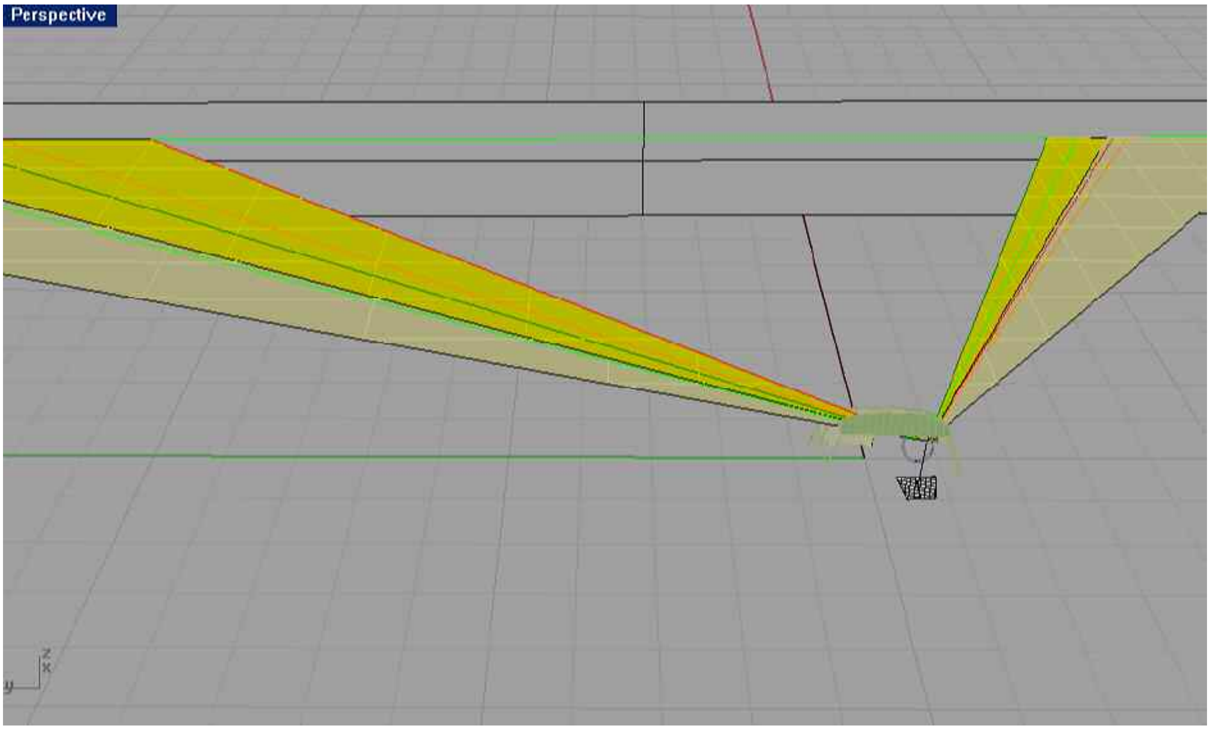


Figure 18: Validated and Predicted Angles of 'A' Pillar Obscuration for a 95th Percentile Male

The binocular offside and nearside 'A' pillar obscuration angles display a trend linking increase to the size of the test subject, which is certainly a reverse of the trend for the offside monocular values.

However, the binocular and monocular angles are closer in value for all volunteers in the MPV, compared to the values obtained for the small hatchback and family-sized vehicles. There is also considerable overlap in the positioning of the monocular and binocular angles for the MPV.

4.4 Summary of the Validation Procedure and Results

The procedure shows the correlation between the binocular and monocular angles of 'A' pillar obscuration for three differently sized vehicles and three volunteers of different stature. The validation results provided the project team with an idea of the limitations for using a monocular approach to constructing the 3-D visualisations from real-world data.

Some problems were identified with the validation procedure. The main one being that the majority of binocular areas of nearside 'A' pillar obscuration, when modelled, did not pass through the nearside 'A' pillar. As previously mentioned, it was considered likely that the distances involved may have been near the extent of the volunteers' peripheral vision, resulting in a certain amount of inaccuracy. A number of interesting conclusions were drawn from the validation work:

Binocular 'A' pillar obscuration tended to increase with occupant size. This was due to the rake of the pillars in these vehicles in that the top of the pillar was closer to the eyes of a large occupant sitting back in the car than the bottom of the pillar was to a small occupant sitting close to the steering wheel. However, there was no obvious relationship between the monocular angle of obscuration and occupant size.

Monocular assessment of 'A' pillar obscuration always over-estimates the size of the obscured area so the areas calculated in the reconstructions must be considered to be a maximum.

The magnitude of the over-estimate resulting from a monocular analysis approximates to being inversely proportional to the size of the car. Monocular assessment introduces greater error when compared to real driver vision when the obstruction is closer to the eyes. Where accidents involving large cars were reconstructed the results can be considered to quite accurately reflect reality but when accidents involving small cars are reconstructed it must be borne in mind that the real angular obstruction may be only 25% to 50% of that estimated.

4.4.1 Suggested Improvements to the Validation Procedure

For future work, some method of accounting for appropriate head rotation should be included. This study asked the volunteers to look towards the nearside or offside 'A' pillar depending on which 'A' pillar angle of obscuration was being measured. However, this did not appear to fully account for a sufficient amount of head rotation. It is unreasonable to expect the OTS teams to gather more detailed data concerning human measurements at the scene of an accident. Therefore, further in-depth validation could lead to a set of rules to be applied allowing a more accurate assessment of the areas of obscuration based on real-world data. The following is a list of suggested improvements:

- A more closely controlled experimental environment;
- A curved surface instead of an expanse of flat wall (this should negate the problems with the range of a volunteers' peripheral vision);
- A wider range of vehicles – more than one vehicle for each of the three classes and a spread of vehicle ages;

- A more detailed approach to quantify the head rotation;
- More points defining when the reflector moves into and out of the field of view of a volunteer from both sides of an ‘A’ pillar.

4.4.2 Relating the Validation Results to the Data Collection

The validation models lead us to believe the areas of monocular obscuration which will be modelled for the 3-D visualisations will represent the worst case for visual obscuration by ‘A’ pillars. This is because the 3-D visualisations are constructed from a nasion point which acts as a monocular view point and at this time it is not possible to accurately account for real-world head rotation.

The OTS teams were asked to collect measurements from the nasion of the driver to two fixed points in the front of the vehicle. The driver was looking straight ahead in a sitting position whilst this was carried out. At the time, it was thought this was the most we could ask the OTS teams to do.

5 3-D Visualisations

This chapter of the report will discuss each collision which was reconstructed and used to make a 3-D visualisation. The data used to create the 3-D visualisations has been previously discussed in chapters 2 and 3. To summarise: a replica vehicle was digitized using the FARO arm, the scene was scanned using the laser scanner and the measurements defining the position of the driver nasion were ascertained by the OTS teams. Used in conjunction with vehicle speeds and dynamics (also from the OTS teams), this data was used to create 3-D visualisations in a plan view and from the driver's perspective.

Initially, the project aimed to reconstruct twenty collisions with the potential to involve 'A' pillar obscuration as a causal factor. However, a shorter time than originally anticipated was allowed for data collection, which resulted in the project team being notified of fewer accidents with suspected 'A' pillar involvement. A total of 16 collisions were reported to the project team, ten of which were deemed suitable for reconstruction. These 10 accidents occurred between mid-April 2005 and mid-September 2005; the OTS teams attended a total of 259 incidents during that time period.

The collisions selected for reconstruction fall into three categories: those that have a good possibility of illustrating 'A' pillar obscuration as a causal factor, those which show 'A' pillar obscuration was involved to a lesser extent and those which show 'A' pillar obscuration did not contribute to the accident. By incorporating accidents from each of these categories it was possible to clarify under what circumstances 'A' pillar obscuration occurs.

In all the cases discussed in the following sections, the vehicles involved in the collision have been allocated speeds just prior to impact. These speeds have been worked from the reconstruction data or have been taken from the HVE visualisation.

5.1 Case 1: The Pilot Reconstruction

Due to the technical issues which became apparent early on in the project, the proposed solutions allowed for two methods of collecting the necessary 3-D data and building the 3-D visualisations. Both these methods were trialled when TRL were notified by the VSRC OTS team of the first suitable data . The preferred method for collecting the 3-D scene data involved using the laser scanner, and the preferred modelling method was using a combination of software packages to post-process the laser scan data. The final model was constructed in a vehicle dynamics package called HVE.

The case 1 collision involved two small vehicles, a Ford Ka and a Peugeot 106. The female driver of the Ford Ka (registered in 2001) was suspected of being subject to 'A' pillar obscuration, thus contributing to the cause of the collision with the Peugeot. The incident occurred on a multi-exit, multi-lane roundabout late in the afternoon. The weather conditions were dry and sunny and visibility was good. The traffic was moderately heavy.

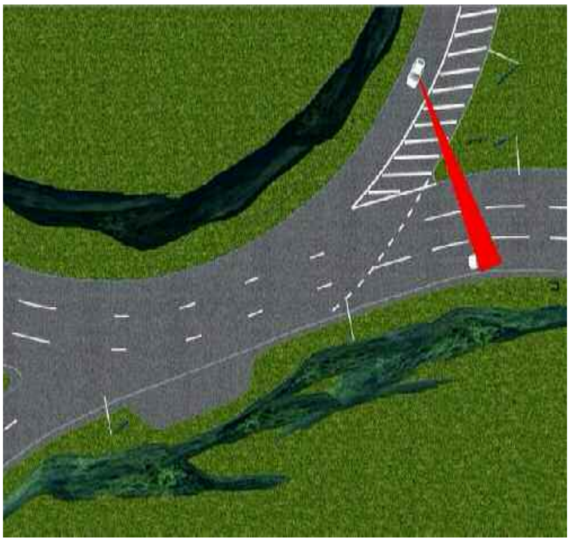
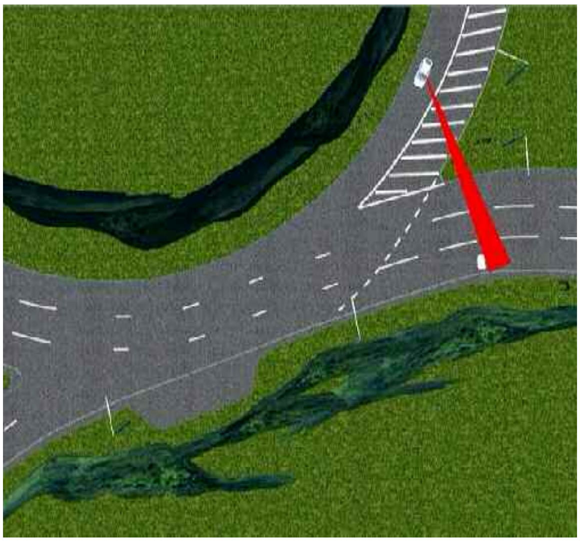
5.1.1 Case 1 Scenario

The Peugeot 106 approached a junction to drive onto the roundabout, decreased its speed and came to a brief stop at the mouth of the junction. Meanwhile, the driver of the Ford Ka was negotiating the roundabout in lane 2 of 2. The Peugeot 106 pulled out in front of the Ford Ka into lane 1 of 2 with the intention of continuing on the roundabout in lane 1 of 2. The driver of the Ford Ka intended to leave the roundabout via the next exit and began to manoeuvre into lane 1 of 2, but appears not to have seen the Peugeot directly to her nearside.

Reconstructing and modelling the incident has shown the Peugeot 106 to have been partially obscured by the nearside ‘A’ pillar of the Ford Ka. Both vehicles collided at the exit of the roundabout (see figure 19) and came to rest just past the exit of the roundabout whilst still in contact with each other. The HVE models allowed approximate speeds of the vehicles to be ascertained, which were 17 mile/h for the Ford Ka and 14 mile/h for the Peugeot 106 at the point of impact.

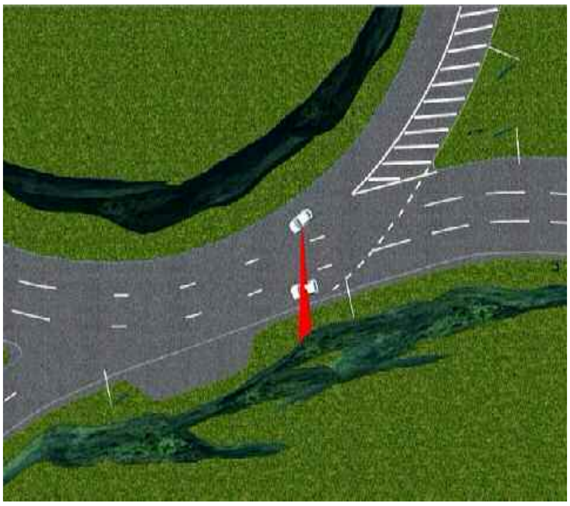
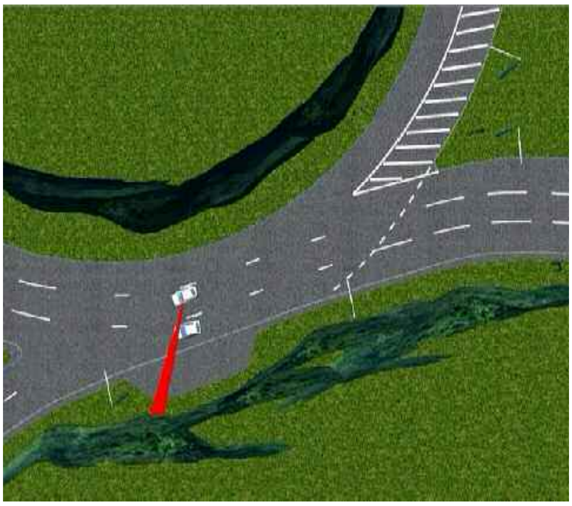
Figure 19: Rest Position of both Vehicles

5.1.2 Analysis of the Case 1 3-D Visualisations

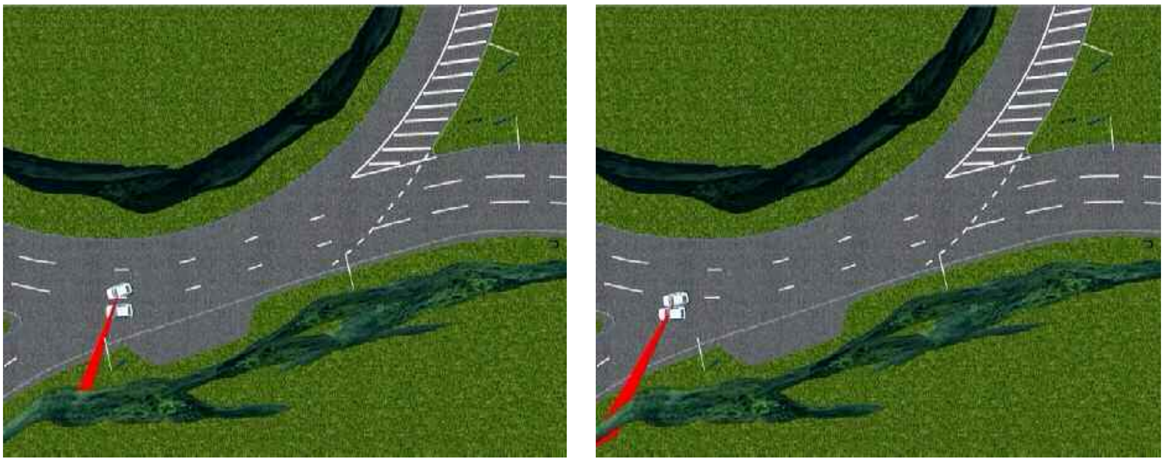



Figures 20 and 21: Plan views of the Accident Scene and the Vehicles Involved

Figures 20 and 21 graphically illustrate the location of both vehicles with respect to each other prior to the collision point. These two figures include the model of the Ford Ka with the area of obscuration that may have been experienced by the female driver of the vehicle. At these points in the approach to the collision, the Peugeot 106 is, to a large extent, completely obscured behind the nearside 'A' pillar of the Ford Ka.

Figures 22 and 23: Plan view



Figures 24 and 25: Plan View

Figures 22, 23, 24 and 25 are more relevant in terms of vehicle movement closer to the point of collision. Although the Peugeot is not completely obscured at this stage, the positioning of the Peugeot with respect to the Ford Ka would have required the driver of the Ford Ka to be looking through her nearside side window to see and react to the Peugeot's position. If the driver of the Ford Ka had relied on her peripheral vision only, the Peugeot 106 could have been hidden behind the nearside 'A' pillar of the Ford Ka for a substantial amount of time.

The 3-D visualisation from the driver's perspective illustrates what the driver may have seen and been aware of. This sequence of stills shows how it was possible for the female driver not to have seen the Peugeot 106 until moments before the impact.

Chapter 4 discussed the results from the validation, concluding that the monocular angle of obscuration, as used in the visualisations above, would always be somewhat exaggerated and would form a worst case assessment. Chapter 4 also showed that the exaggeration caused by a monocular assessment was greater in small cars such as the Ka than it was in larger cars Therefore the area of obscuration predicted in the 3-D visualisations is probably a significant over-estimate and in reality more of the Peugeot would have been visible to the driver of the Ka than is suggested here. The monocular area of obscuration in the visualisations suggests that the Peugeot 106 was obscured by the nearside 'A' pillar of the Ford Ka for approximately 2 seconds.

5.2 Case 2

This incident fulfilled the basic criteria for an 'A' pillar related incident, as outlined in section 2.1, even though the motorist suspected of being subject to 'A' pillar obscuration was attempting a U-turn at the time of the collision. The manoeuvre would have required the driver to rely to some extent on her peripheral vision.

When the incident occurred it was dark with street lighting that would have negated the effects of light diffusion from the headlights of the vehicles involved. When dark, the diffusion of light from headlights is generally thought to be a good indication to other road users of approaching vehicles. In this instance, there was good street lighting which would have mitigated the effects of light diffusion.

Subsequent analysis of the vehicle movement highlighted the possibility that the driver of the green Renault Clio (hereafter referred to as p1v1) may have had her vision disrupted by the nearside 'A' pillar allowing her to lose sight of the blue Renault Clio (hereafter referred to as p2v1) whilst in the process of negotiating her U-turn manoeuvre. This case highlights the occurrence of the 'A' pillar disrupting a driver's forward field of view, rather than completely obscuring another road user. A motorist may acquire the struck vehicle some distance away from the point of collision and may then lose the vehicle from sight once a change in their road position has occurred.

In this instance, the driver of p1v1 probably saw p2v1 before she started her U-turn manoeuvre, but in the dark she may have thought p2v1 was further away than it actually was. As she started her manoeuvre she would have been looking in the direction she intended to go, but when she looked for oncoming traffic there is a distinct possibility that p2v1 would have been obscured by the nearside 'A' pillar of p1v1.

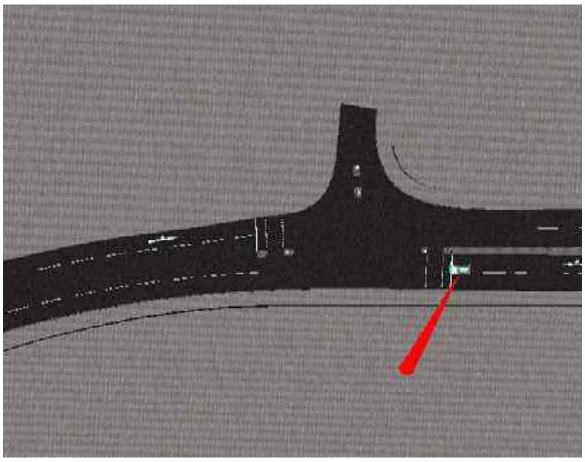
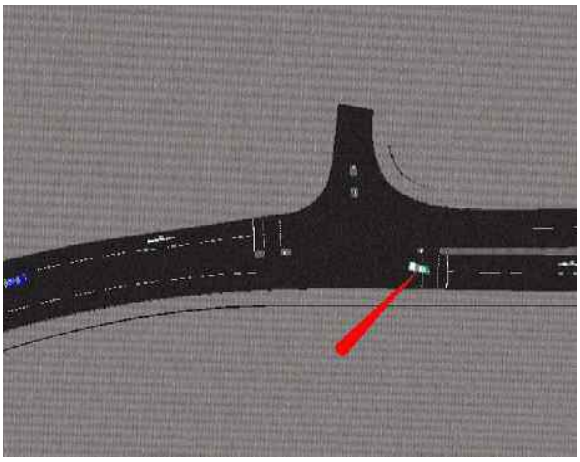
5.2.1 Case 2 Scenario

P2v1 was travelling in lane 2 of 2 towards an intersection when the driver of p1v1 decided to attempt a U-turn. This manoeuvre was intended to move the vehicle to the opposite side of the carriageway into lane 1 of 2. As she was about to start her U-turn manoeuvre, p2v1 was travelling towards the same intersection from the opposite direction. P2v1 braked hard in an attempt to avoid colliding with p1v1, but struck the rear of p1v1. P2v1 came to rest in lane 2 of 2, whilst the impact forced p1v1 to rotate anticlockwise before coming to rest on the footway of the same carriageway.

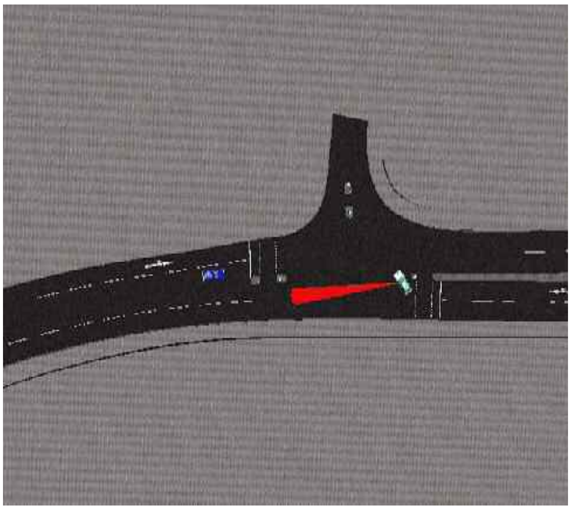
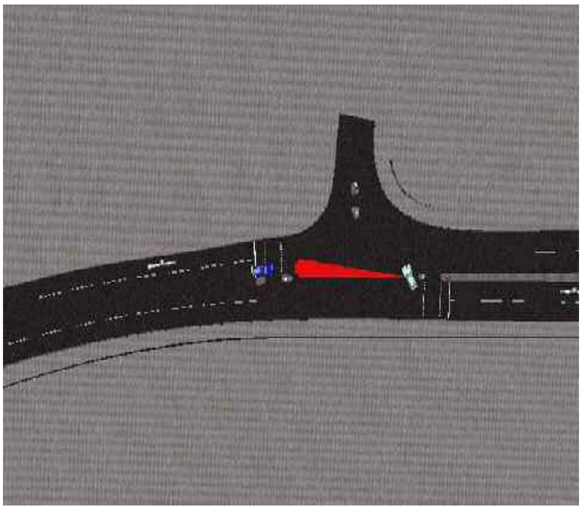
Figures 26 and 27: Rest Positions of p1v1 and p2v1

Prior to the collision, it is estimated that p1v1 was attempting the U-turn whilst travelling at no more than 10 mile/h. P2v1 was travelling at 40 mile/h, and then slowed to 15 mile/h under heavy braking just before the impact.

5.2.2 Analysis of Case 2 3-D Visualisations

Figures 28 and 29: Plan View of the Vehicle Paths

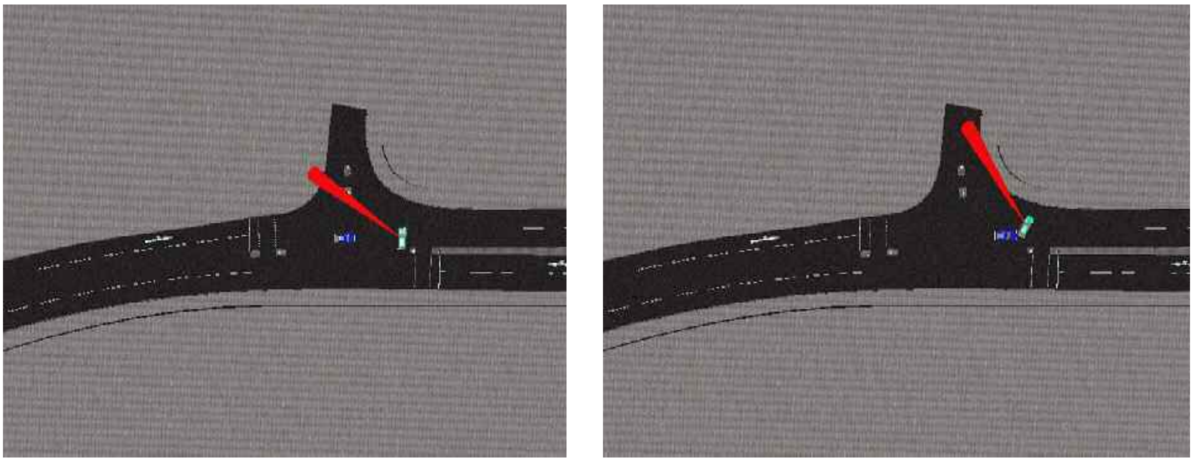



Figures 30 and 31: Plan View of Vehicle Paths

Figure 31 illustrates the potential for the nearside ‘A’ pillar obscuring the view of p2v1 for the driver of p1v1 before she had completed 50% of her manoeuvre. This situation would have been exacerbated by the difference in speeds for the vehicles. P1v1 had reduced speed in order to attempt the U-turn and was travelling at around 10 mile/h, whilst p2v1 was travelling on the opposing carriageway at approximately 40 mile/h.

The primary cause of this accident was considered to be a distinct lack of judgement by the driver of p1v1, but the obscuration from nearside ‘A’ pillar may have been a contributory factor. This would indicate that the first time the driver of p1v1 acquired the movement of p2v1 in her sight, her manoeuvre would have meant that, at the speed p2v1 was travelling at, it could have become obscured behind the nearside ‘A’ pillar of p1v1.

This is a situation where the ‘A’ pillar may have affected the driver’s decision to abort a manoeuvre or to take evasive action to avoid a collision. The visualisations suggest that p2v1 was obscured by the nearside ‘A’ pillar of p1v1 for approximately 2 seconds.



Figures 32 and 33: Plan View of the Vehicles Prior to Impact

From the validation procedure for the small hatchback vehicle, the closest fit for the Renault Clio, we know the monocular areas of obscuration are positioned to a wider extent than the binocular areas. However in this instance, assuming a more ‘binocular’ area of obscuration would have provided an earlier opportunity during the U-turn manoeuvre for the driver of p1v1 to lose sight of p2v1; this is explained better by viewing the figure 34.

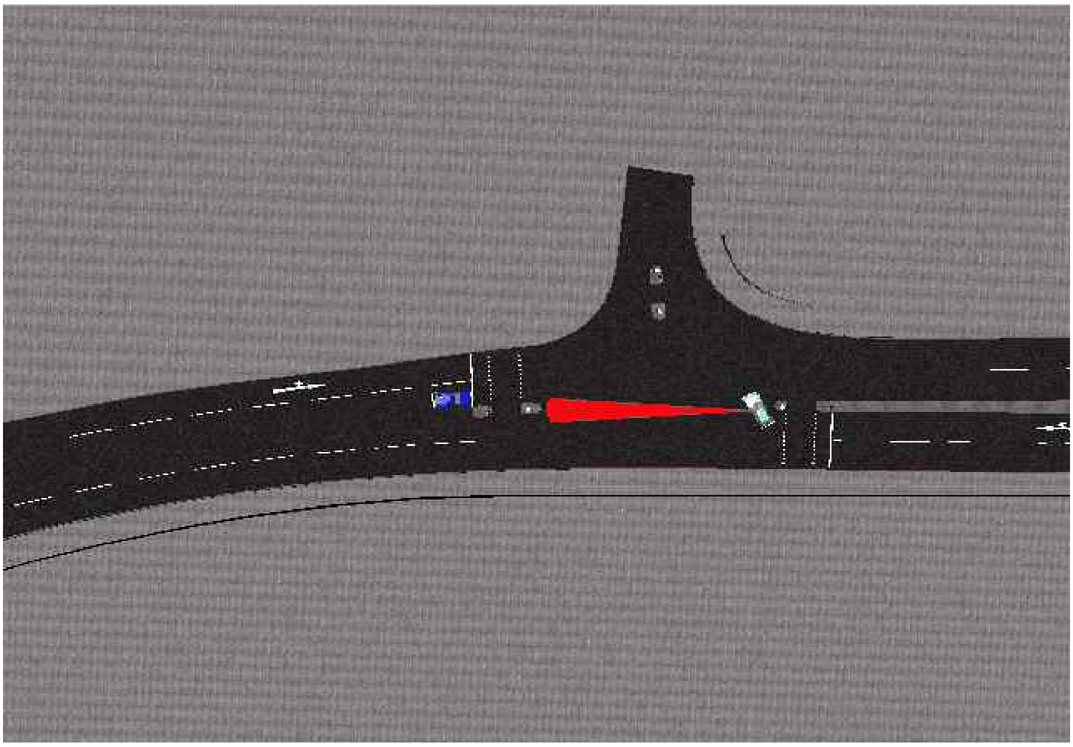


Figure 34: Plan View of the Vehicles – if the red cone was moved towards the front of p1v1 it would completely obscure p2v1

5.3 Case 3

The collision happened on a rural road, with no street lighting, at night and in bad weather. Both vehicles involved had their head lights switched to full beam, so the diffusion from the headlights should have allowed the drivers to know the approximate location of the other motorist. Due to the potential issue of light diffusion this incident was initially discounted as an 'A' pillar case. However, reconstructions of the collision did show an element of 'A' pillar involvement.

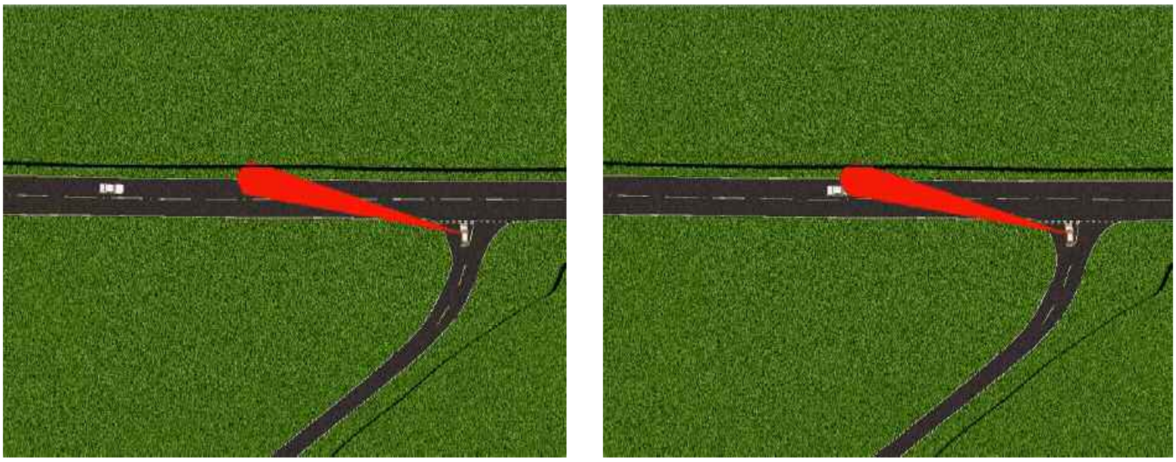
5.3.1 Case 3 Scenario

This incident occurred late in the evening in wet, inclement weather. The driver of the vehicle initially suspected of suffering from 'A' pillar obscuration, approached a junction from a road that was little more than a farm track, which adjoined a wider, de-restricted country road. She was driving a Vauxhall Corsa, registered in 1994. The other vehicle involved in the collision was a Nissan Sunny, also registered in 1994. The driver of the Nissan was travelling in an easterly direction on the country road when he was confronted by the Vauxhall Corsa pulling out and across his path with the intention of turning right. The driver of the Nissan veered to the nearside in an unsuccessful attempt to avoid a collision with the Vauxhall Corsa and subsequently lost control of the vehicle as it left the carriageway to the nearside. The front nearside of the Vauxhall Corsa struck the front offside of the Nissan Sunny. The driver of the Vauxhall Corsa attempted to correct her steering, but in doing so lost control of the vehicle and spun off the road to the offside.

The reconstruction of the accident places the speed of the Vauxhall Corsa at approximately 12 mile/h just prior to impact and the speed of the Nissan Sunny as 40 mile/h decreasing to 33 mile/h at impact.

5.3.2 Analysis of Case 3 3-D Visualisations

Figures 35 and 36: Driver's View from the Vauxhall Corsa



Figures 37 and 38: Plan View of the Vehicles

The plan views shown in figures 37 and 38 depict the Vauxhall Corsa stationary at the junction. The driver of the Vauxhall Corsa may have registered the approaching Nissan Sunny; however, if she glanced to the left again a few seconds later it is possible that the Nissan Sunny could have been obscured by the offside 'A' pillar of the Vauxhall Corsa. Although this is a possible scenario, the headlights of the approaching Nissan Sunny should have given the necessary visual clues to the driver of the Vauxhall Corsa.

There is a possibility that 'A' pillar obscuration played a part in this collision, and if so, this would suggest the diffusion from headlights does not give as great a visual clue to motorists as was previously thought. However, this may have been due to the weather conditions which could have lessened the effects of light diffusion. The visualisations show the approaching vehicle was obscured by the nearside 'A' pillar of the Vauxhall Corsa for up to three seconds.

If the incident had occurred in daylight 'A' pillar obscuration may well have been a contributory factor that caused this accident; but the validation results for the small hatchback vehicle suggest the monocular area of 'A' pillar obscuration is a maximum and the real binocular blind spot is likely to be smaller. If a 'binocular' area is considered there is the possibility the approaching vehicle would have been obscured for less time.

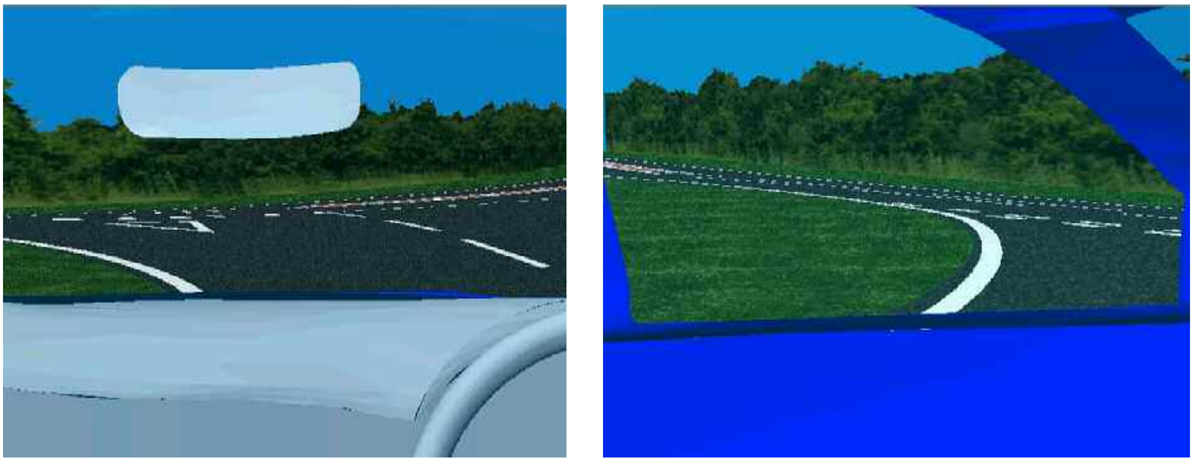
5.4 Case 4

This incident involved a 3 year old Ford Mondeo, driven by a 5 ft 8'' female, and a motorcyclist. The elements of this case met all the criteria as an incident that may have involved 'A' pillar obscuration. In addition, the recent model of the Ford Mondeo has thick, raked 'A' pillars, adding to the possibility of 'A' pillar obscuration. When the collision was reconstructed, and the plan view 3-D visualisation built, the model of the motorcycle was completely obscured by the Ford Mondeo's offside 'A' pillar for the majority of the run time.

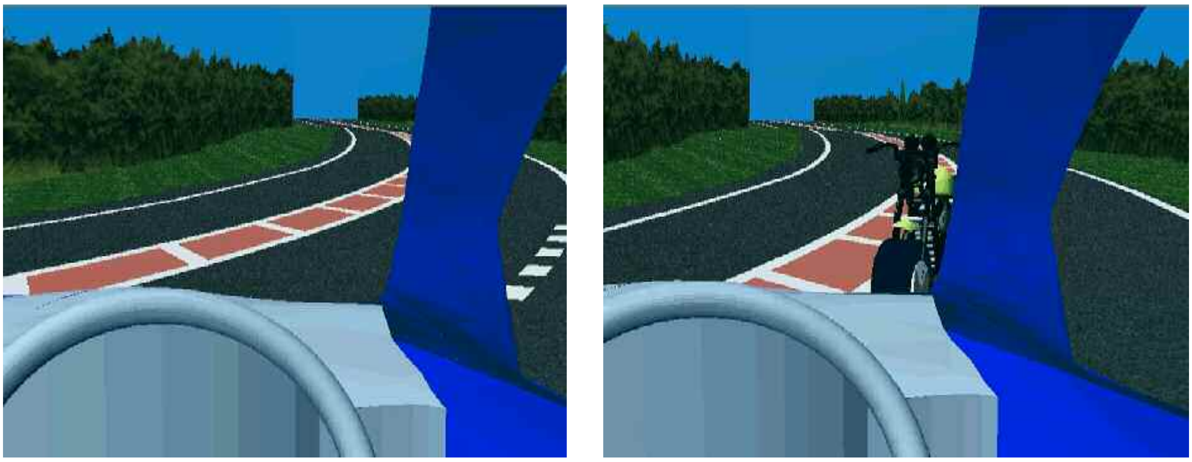
5.4.1 Case 4 Scenario

The female driver of the Ford Mondeo was on her way to work, taking a familiar route. As she approached a junction that bent to the right, she slowed her speed, looked left and right and then started to turn right out from the junction. Before she had completed her manoeuvre she struck a motorcyclist who had been travelling on the main road adjoining the junction, from the offside of her vehicle. The motorcyclist had attempted to steer to the right in an effort to avoid the collision, but was unsuccessful. The motorcyclist was seriously injured and was taken to hospital by paramedics at the scene. The OTS team were unable to interview the female driver of the Ford Mondeo at the scene of the accident due to her distress. However, during a later telephone conversation with the Ford Mondeo driver, she made it very clear that she did not see the motorcyclist before she started her manoeuvre, but had definitely looked to see if any traffic was present on the adjoining road before pulling out.

The speed of the Ford Mondeo when approaching the junction is estimated at 15 mile/h; at the point of impact the vehicle had slowed to approximately 10 mile/h. The motorcyclist was thought to be travelling at 43 mile/h just prior to braking hard.



Figures 39 and 40: The View from the Perspective of the Driver of the Ford Mondeo as she Approaches the Junction



Figures 41 and 42: The View from the Perspective of the Driver of the Ford Mondeo as she Manoeuvres From the Junction

5.4.2 Analysis of Case 4 3-D Visualisations

The subsequent reconstruction and 3-D visualisation of the accident does tend to confirm the Mondeo driver's view of the accident. The combination of the junction and the small size of the oncoming vehicle strongly suggest the motorcycle was obscured by the offside 'A' pillar of the Mondeo. The shape of the minor road bends to the left as it joins the major road. Figures 41 and 42 show what the driver of the Mondeo may have seen when she turned her head to look left; her field of view would incorporate the nearside side window. However, by turning her head a similar amount to the right (see figures 43 and 44), her view would have been obscured by the offside 'A' pillar. To clearly see her intended path and the approaching motorcyclist, she would have needed to lean forwards or backwards to make a conscious effort to look around the 'A' pillar.

The stature of the female driver would place her in the 95th percentile; roughly equating to the 50th percentile for the male population. The validation model of the Vauxhall Vectra with the simulated nasion height of a 50th percentile male is therefore the most relevant for comparison for this case as it has large overlap between the monocular and binocular areas of obscuration. For this vehicle, the validation areas displayed in the plan views of the 3-D visualisation give a good idea of the blind spot created by the 'A' pillars of the Ford, although the real binocular blind spot is likely to be smaller than is represented here. The visualisations suggest the motorcycle was obscured by the offside 'A' pillar of the Ford Mondeo for at least 4 seconds.

Due to the positioning of the Ford Mondeo at the mouth of the junction, it is conceivable a larger vehicle, such as another car, could have been obscured in a similar manner. However, other factors which must be considered in this case are the way in which the Mondeo driver cut the corner when turning right and the positioning of the road side furniture (signs), which may have also contributed to the obscuration of other road users.

5.5 Case 5

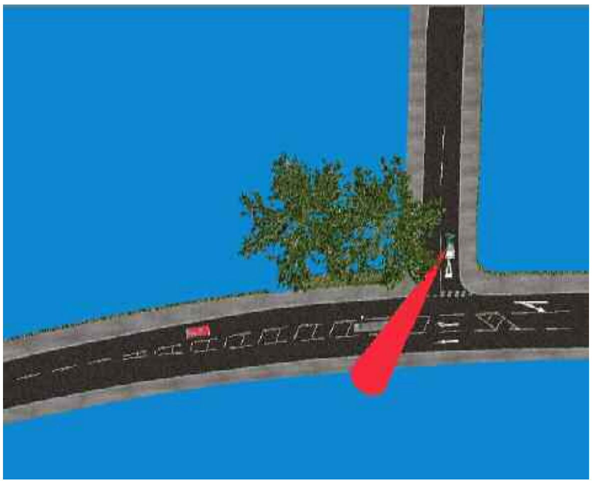
This collision involved two relatively new Fiat cars; a four year old Fiat Punto and one year old Fiat Stilo. The road layout was a T-junction, which when it was laser scanned, appeared to afford particularly good views from a car to the left and right. The vehicle at fault, the Fiat Punto, was driven by an inexperienced female driver, who was 5ft 4'' in height. The accident causation for this incident, on balance, was not due to 'A' pillar obscuration; rather the lack of judgement of the driver. Initially the project team were led to think this was an incident that may have involved 'A' pillar obscuration and this was not disproved until after the full reconstruction was carried out.

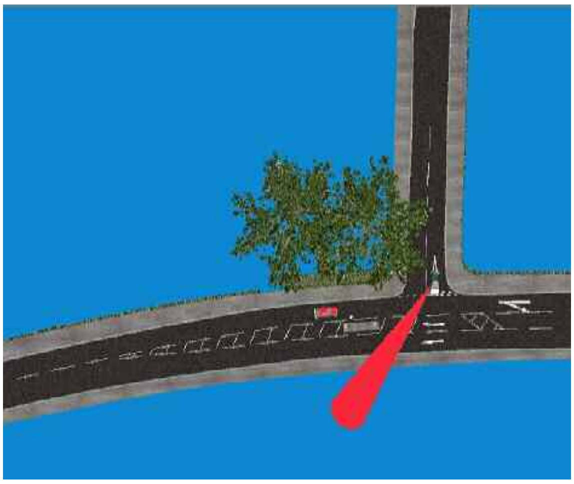
5.5.1 Case 5 Scenario

The Fiat Stilo was travelling along the adjoining road to the junction in a southerly direction, at an estimated speed of 30 mile/h. The Fiat Punto approached the junction mouth and did not come to a complete stop before pulling out and turning right. This manoeuvre brought the Fiat Punto directly into the path of the oncoming Fiat Stilo. The front nearside of the Fiat Stilo struck the front offside of the Fiat Punto, rotating the Fiat Punto in an anticlockwise direction before coming to rest. The Fiat Punto was travelling at approximately 9 mile/h when the collision occurred.

5.5.2 Analysis of Case 5 3-D Visualisations

When this incident was reconstructed and the 3-D data was collected, it became clear that this accident could not be attributed to 'A' pillar obscuration.





Figures 43 and 44: Plan View of the Vehicles

Figures 43 and 44 show the positions of the vehicles as both approached the junction, the Fiat Punto from the side road and the Fiat Stilo along the main road. The possible area of offside 'A' pillar obscuration, shown by the projected red cone, does not 'cover' the approaching Fiat Stilo. We know from the validation procedure that the predicted areas of obscuration are approaching a maximum in terms of the actual area obscured by an 'A' pillar; it is unlikely therefore that the oncoming vehicle would have been occluded by the offside 'A' pillar at any point in this scenario.

5.6 Case 6

Case 6 occurred on a busy stretch of road accessed by a T-junction on a country road leading from a more rural district. This incident was another collision which fitted the selection criteria, but after the reconstruction and 3-D visualisations were complete, it became apparent the junction and the positioning of the vehicle allowed a good field of view for the drivers involved and was not hampered by vehicle 'A' pillars.

The driver suspected of being subject to 'A' pillar obscuration was an elderly female driver of a four year old Toyota Yaris.

5.6.1 Case 6 Scenario

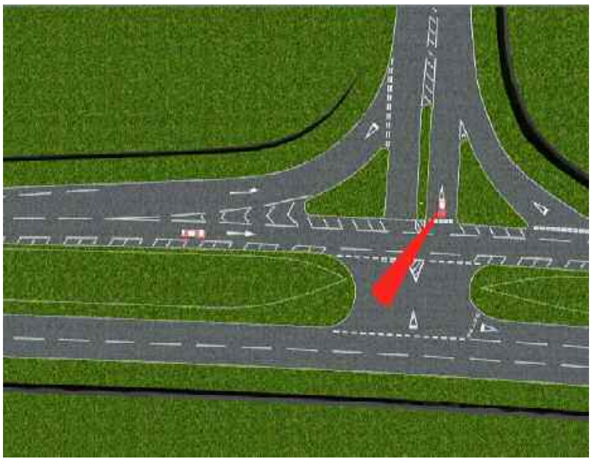
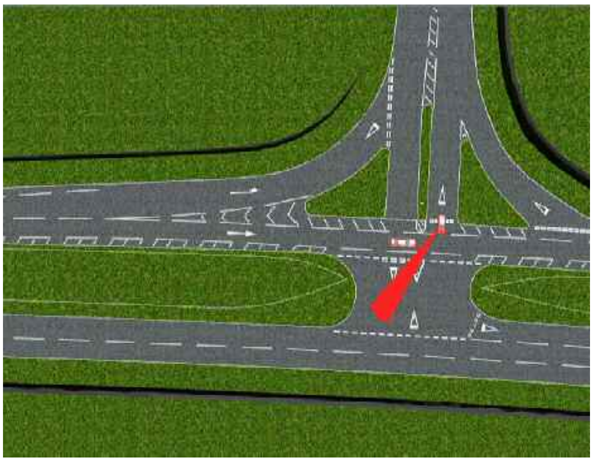
The Toyota Yaris driven by the elderly, small female approached the junction and came to a halt. The junction allows for an unobstructed view of the oncoming traffic for a driver. Evidence suggests the driver of the Toyota Yaris thought she had looked and found the adjoining carriageway was clear before she attempted to drive across the carriageway to a central crossover point. A Rover 416, travelling on the adjoining carriageway, was confronted by the Toyota Yaris crossing its path. The driver of the Rover 416 steered to the right in an effort to avoid the Toyota Yaris. The front of the Rover 416 struck the front offside of the Toyota Yaris, causing it to rotate 90˚ before coming to rest at a point just beyond the junction.

The Toyota Yaris was stationary before it was driven away from the junction and probably reached a speed of around 8 mile/h before impact. The Rover 416 was travelling at approximately 45 mile/h before braking, and slowed to 23 mile/h at the point of impact.

5.6.2 Analysis of Case 6 3-D Visualisations

It is highly unlikely that the offside 'A' pillar would have obscured the view of the female driver.

This is illustrated by the following figures:

Figures 45 and 46: Plan View of the Vehicles as they Approach the Junction

Figures 45 and 46 show the positions of the vehicles as they progress along their intended paths prior to their collision. At no point was the Rover 416 obscured by the offside 'A' pillar of the Toyota Yaris. To obscure the Rover 416, the Toyota Yaris would have had to have assumed a more rotated, angular position which would have been inappropriate for the road layout and the manoeuvre the driver wished to execute.

The cause of this accident appears to have been a lack of judgement by the driver of the Toyota Yaris. There is a possibility that her advanced years may have meant her upper neck and torso movements were somewhat impaired and this could have contributed to her lack of judgement.

5.7 Case 7

This accident took place at a junction between a narrow, residential side street and a busy road. The vehicles involved in this collision were an 11 year old Vauxhall Corsa and an old moped. Under normal circumstances Case 7 would not have been deemed an accident where 'A' pillar obscuration was a contributory factor because of a parked car at the mouth of the junction which possibly blocked the driver's view. However, as the car was parked on double yellow lines, the moped, which was travelling along the adjoining main road, was forced to take a wider path than would normally be expected. This could have resulted in placing the moped and rider in the blind spot created by the offside 'A' pillar of the Vauxhall Corsa.

5.7.1 Case 7 Scenario

This incident occurred on a bright, sunny day, with good visibility. The driver of the Vauxhall Corsa approached the junction, slowed and rolled across the junction mouth at approximately 10 mile/h in order to be able to see around the stationary car parked a few metres to the right of the junction. The Vauxhall Corsa was angled to the right so the driver could complete his right turn manoeuvre.

The moped and rider were travelling along the main road in an easterly direction and it is assumed that the rider had to take a wider path than anticipated to go around the parked car. At this point, the moped was travelling at 25 mile/h. The picture in figure 47 shows a police car, which attended the scene, positioned in the same place as the parked car at the time of the accident. As the driver of the Vauxhall Corsa crept forward, he began his right turn manoeuvre, but failed to see the approaching moped rider who struck the front offside of the car. The moped rider had applied the brakes before the impact and was travelling at an estimated 15 mile/h at the point of collision.

Figure 47: A Stationary Police Car Demonstrates the position of the Illegally Parked Car

5.7.2 Analysis of Case 7 3-D Visualisations

The causation for this incident is interdependent on the position of the parked car and the subsequent path of the moped rider. Had the stationary vehicle not parked on the double yellow lines at the mouth of the junction, the driver of the Vauxhall Corsa would have been afforded a good view of approaching traffic through the side windows of his vehicle.

Figures 48 and 49 illustrate how the driver's view would have been obscured by the parked car when attempting to see the approaching moped, and then by the offside 'A' pillar of the Vauxhall Corsa as he pulled out from the junction. This may have prevented him from making an earlier decision to halt the manoeuvre which could also have allowed the moped rider time to veer to the right and miss the Vauxhall Corsa. The male driver of the Vauxhall Corsa was 5ft 4'', and so would be grouped in the 5th percentile male population. Due to his small stature there is a real possibility his eye height would have brought his field of view into conflict with the thicker base of the 'A' pillar. However, it must be considered that the Vauxhall Corsa and driver are most akin to the small hatchback and 5th percentile female validation model, the validation results for which vehicle suggest the monocular area of ‘A’ pillar obscuration presents a maximum. In reality, the binocular blind spot was likely to have been smaller than represented here.

The visualisations suggest the moped was obscured by the offside ‘A’ pillar of the Vauxhall Corsa for 3 seconds.

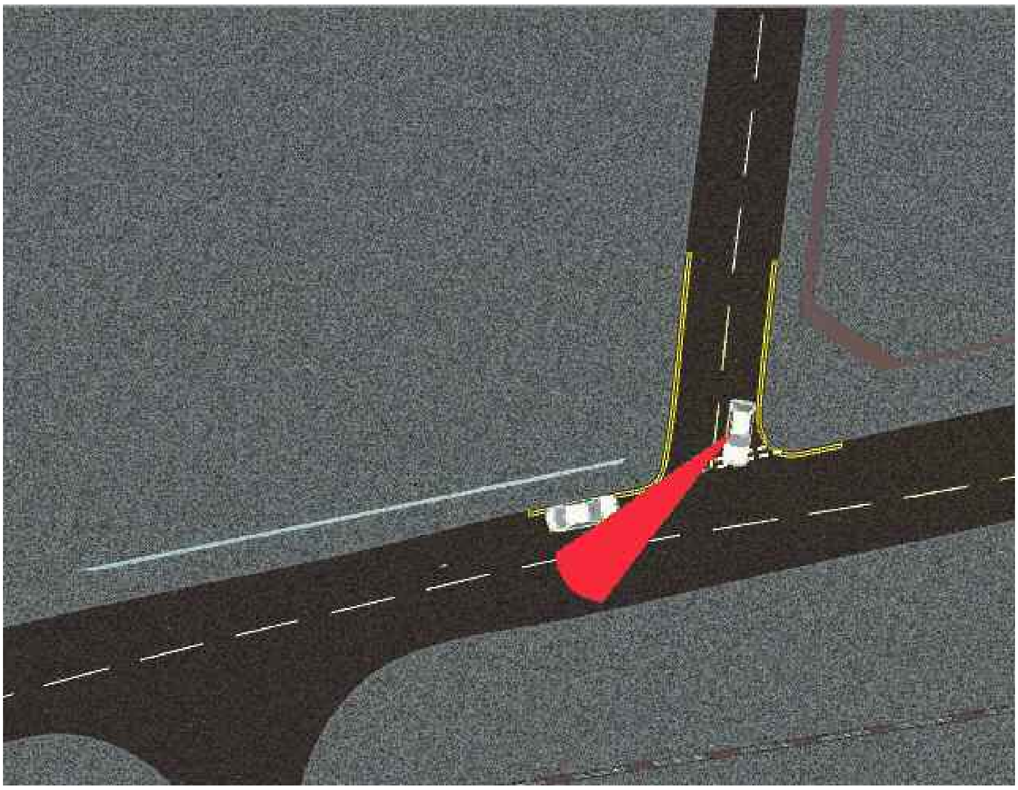


Figure 48: Plan view of Vehicles Approaching Junction

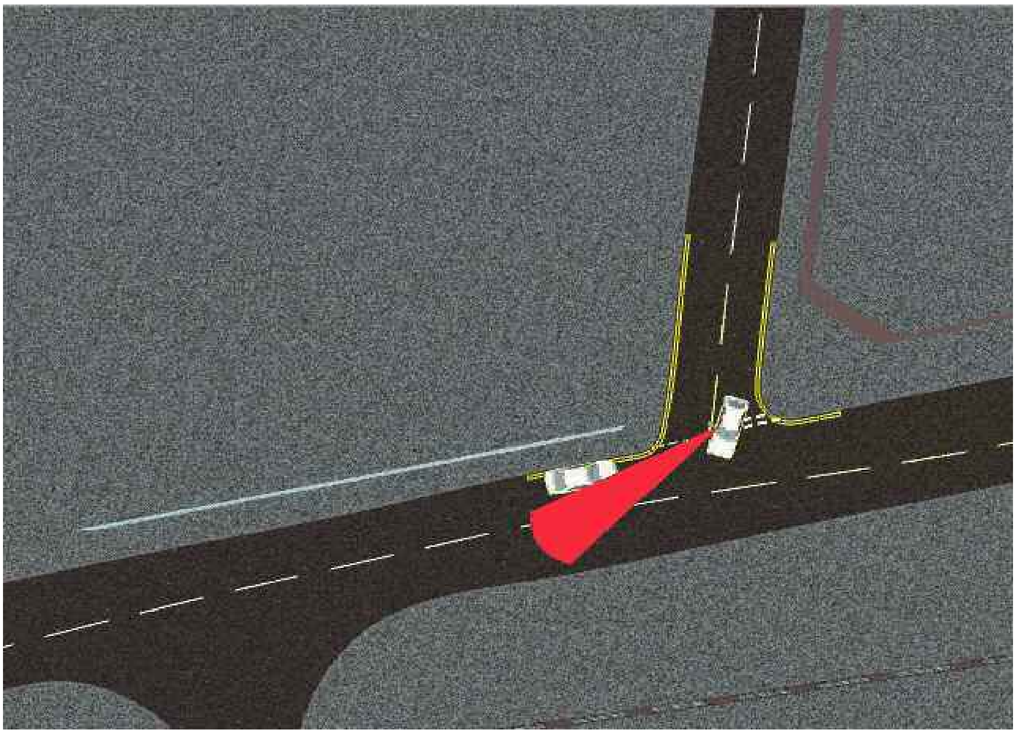


Figure 49: Plan View showing the Moped as Hidden by the Offside 'A' pillar of the Vauxhall Corsa

5.8 Case 8

Case 8 involved a nine year old Mercedes C200, the driver of which may have been subject to some 'A' pillar obscuration, and a Honda Civic. This incident was initially considered as 'A' pillar-related because of the path the white Mercedes C200 took when approaching the junction. The male driver of the Mercedes appears to have driven in rather an aggressive manner. His approach to negotiating the junction was to cut the corner when attempting to turn right out of the junction. Due to the extent the driver in the Mercedes cut the corner, it would have had the affect of partially positioning the struck vehicle in the blind spot created by the offside 'A' pillar of the Mercedes.

5.8.1 Case 8 Scenario

The Mercedes C200 was driven aggressively towards a T-junction with a wide, busy. The driver of the Mercedes 'cut the corner' and started his right turn on the right hand side of the road. Meanwhile, a Honda Civic was approaching the junction in slow-moving traffic. Witness evidence suggests that the driver of the Mercedes performed a cursory look left and right when he reached the junction, but failed to notice the Honda Civic approaching from the offside. The front offside of the Mercedes struck the front of the Honda Civic and the force of the impact rotated the Mercedes anticlockwise whilst the Honda Civic veered to the right before coming to rest.

The Mercedes was travelling at an approximate speed of 7 mile/h just prior to the impact. The Honda Civic was travelling at an estimated 15 mile/h in heavy traffic and had just started to brake when the collision occurred.

5.8.2 Analysis of Case 8 3-D Visualisations

Figures 50 and 51: Plan View of the Mercedes and Honda Approaching the Junction

Figures 50 and 51 show the Honda Civic was not obscured by the offside 'A' pillar of the Mercedes as it approached the junction even though the area of 'A' pillar obscuration is more towards the Honda than it would have been if the Mercedes had not cut the corner. The Mercedes driver had already committed to the right turn by the point where the Honda is obscured by the Mercedes offside 'A' pillar. However, had the 'A' pillar not obscured the view of the Mercedes driver, he may have been able to brake sooner in an effort to avoid the collision.

Figures 52 and 53 show how the Honda Civic is obscured by the offside 'A' pillar of the Mercedes as it pulls out from the junction.

Figures 52 and 53: Plan Views of Mercedes Starting a Right Turn from the Junction

The driver of the Mercedes was a 5 ft 3'' male and his seat position suggests his eye height would have been close to the bottom of the offside 'A' pillar of the vehicle. The validation results showed that for large cars, such as the Mercedes, the monocular assessment used in the visualisations only slightly over estimated the actual size of the real binocular blind spot. The visualisations showed the

Honda Civic was only obscured from the view of the driver of the Mercedes for around 1 second. This case is another incident where the ‘A’ pillar may have inhibited the driver’s chance of making an earlier decision about a manoeuvre which resulted in a collision.

5.9 Case 9

Case 9 occurred at a T- junction in a village. There were two vehicles involved: a 2 year old BMW 320 and a Suzuki R600 motorcycle. The BMW was driven by a female, 5 ft 4’’ The BMW has a particularly thick ‘A’ pillar, flared at the bottom, which would have been in the region the driver of the BMW may have been looking.

The female motorist would have found it hard to abort her right turn unless she had specifically looked around the ‘A’ pillar and had seen the approaching motorcycle; this is particularly true considering her small stature.

Figure 54: View of the Offside ‘A’ Pillar taken from the Drivers Seat

Figure 54 is a photograph of the offside ‘A’ pillar taken from the driver’s seat. Although this is a rather distorted view of the ‘A’ pillar, as the photographer was looking directly through it when the photograph was taken, it does illustrate the amount of obscuration by the offside ‘A’ pillar; the nearside carriageway is almost completely hidden.

5.9.1 Case 9 Scenario

The motorcyclist approached a sweeping left-hand bend on a slight downhill stretch of road travelling at an estimated 30 mile/h. Meanwhile, the BMW approached the junction with a small, adjoining road with the intention of turning right. The driver of the BMW came to a halt at the junction, where upon she looked to see if the road was clear. As she pulled away from the junction and began her right turn she failed to see the approaching motorcyclist. The motorcyclist started to take avoiding action by moving towards the centre of the carriageway, braking hard when he saw the BMW crossing his path. The front of the BMW was positioned in the nearside carriageway to its direction of travel having completed approximately half of the right turn and was travelling at an estimated 6 mile/h. The motorcyclist struck the front of the BMW although at the point of impact it was estimated the motorcyclist had slowed to approximately 11 mile/h.

5.9.2 Analysis of Case 9 3-D Visualisations

The head movements of the female driver prior to and during her manoeuvre from the junction cannot be known with certainty. It is conceivable that the adjoining carriageway was clear when she first checked, but if she happened to be looking to the left as she started to pull out, it would have given the motorcyclist enough time to become obscured by the offside 'A' pillar of the BMW. This would have been particularly true when the motorcyclist, in an attempt to avoid the collision, moved to the centre of carriageway, inadvertently taking himself deeper into the obscured area.

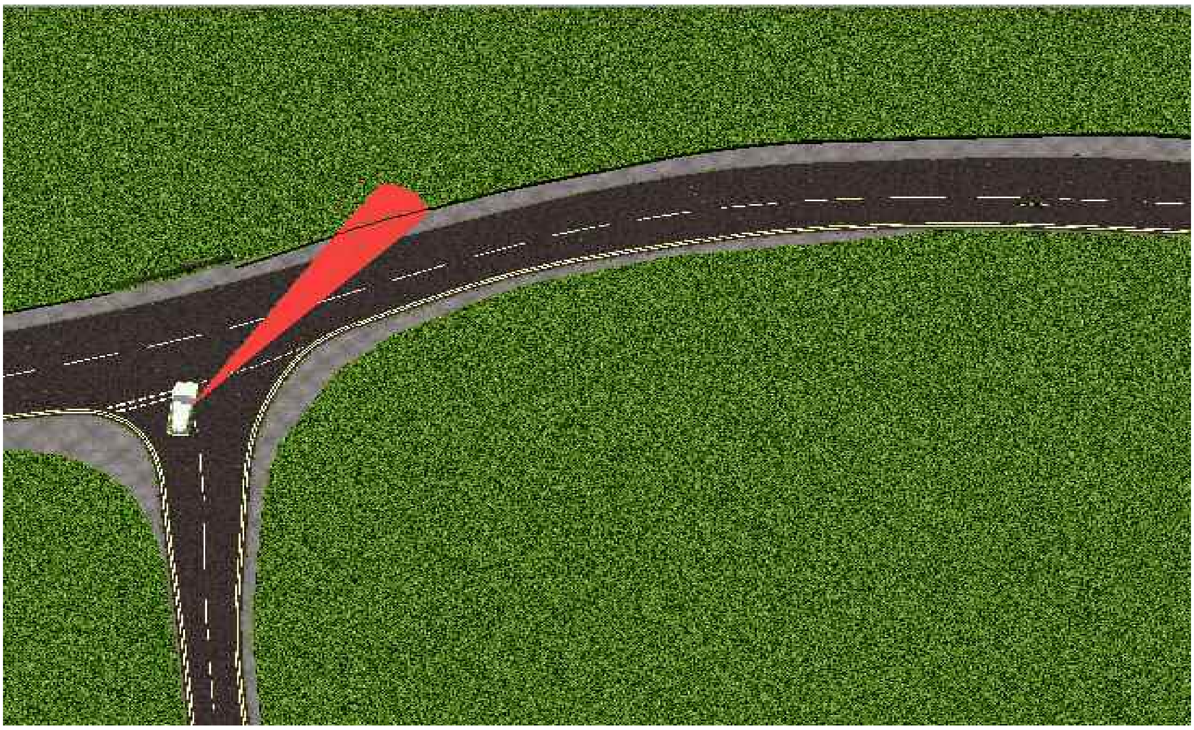


Figure 55: Plan View of BMW as it Starts to Pull Out of the Junction and Approaching Motorcycle

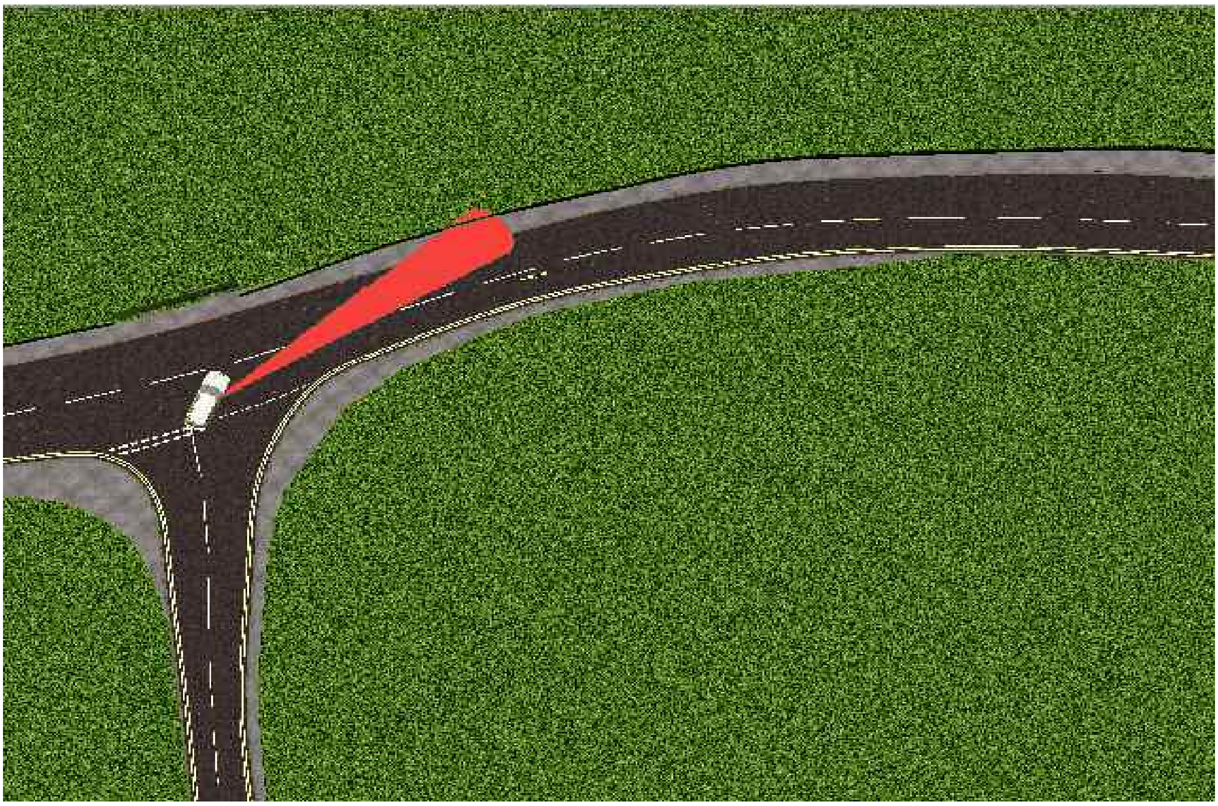


Figure 56: The BMW has turned across the Path of the Motorcycle

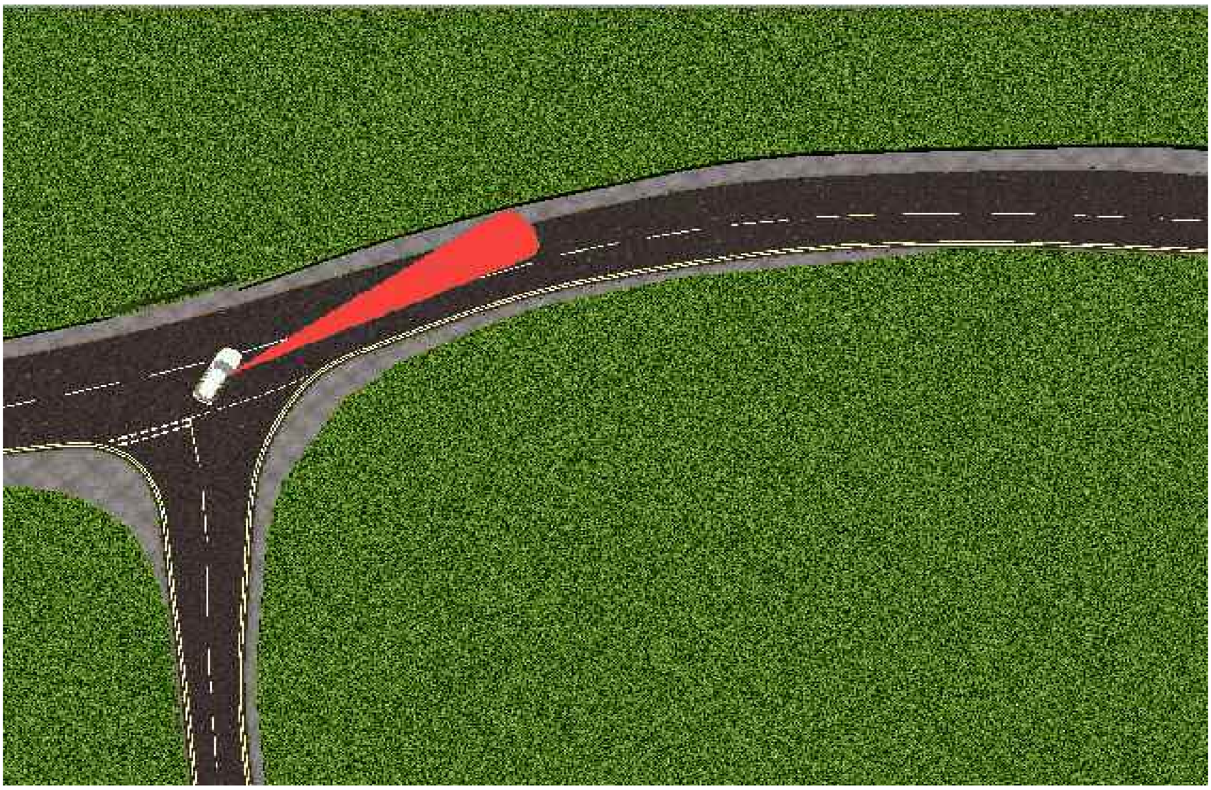


Figure 57: The BMW just prior to Impact the Motorcycle is now Obscured by the Offside 'A' Pillar

Figures 57 and 58 show the movement of the BMW as it starts to pull away from the junction. The motorcycle is not yet in the area of obscuration caused by the offside ‘A’ pillar of the BMW. However, in figure 59, the motorcycle is now completely hidden by the offside ‘A’ pillar. Unless the driver had seen him before her right turn manoeuvre he would have been entirely obscured until just before the impact. The visualisation indicates the motorcycle would have been obscured for around 2 seconds by the offside ‘A’ pillar of the BMW.

The validation model which maps to this incident is the family-sized vehicle with the 5th percentile female. There is a particularly good correlation between the monocular and binocular angles of ‘A’ pillar obscuration from the validation models; so the area of monocular offside obscuration in the 3-D visualisation for this case has a good degree of accuracy.

5.10 Case 10

This is another case involving a motorcycle as the struck road user and fulfilled all the necessary criteria to be classed as an ‘A’ pillar incident. Laser scanning the scene, caused the project team to reconsider the extent of ‘A’ pillar obscuration in the causation of this incident. This collision involved a 9 year old Volvo 850, driven by a 50th percentile male, and a motorcyclist. The road layout is a T-junction, but the adjoining road is a wide, busy road with a 60 mile/h speed limit.

5.10.1 Case 10 Scenario

The driver of the Volvo 850 approached the junction and remained there stationary for some time, waiting for a gap in the traffic to allow him to turn right. Eventually, the driver saw a chance to pull out from the junction and turn right. At this point the motorcyclist was travelling on the main road that adjoined the country road the Volvo was turning from. As the Volvo pulled out of the junction, the motorcyclist tried to steer to the right in an attempt to avoid the car. Both vehicles collided; the front offside of the Volvo struck a glancing blow to the motorcyclist.

Figure 58 and 59: Views of the Junction and the Intended Direction of the Volvo 850

5.10.2 Analysis of Case 10 3-D Visualisations

Laser scanning the scene allowed the project team to have a good look at the junction and it was decided that this was probably not an ‘A’ pillar related incident. The width of the junction mouth would afford a good field of view for the driver of the Volvo 850 when looking out of the side windows of the vehicle. This was supported by the 3-D visualisations in a plan view.

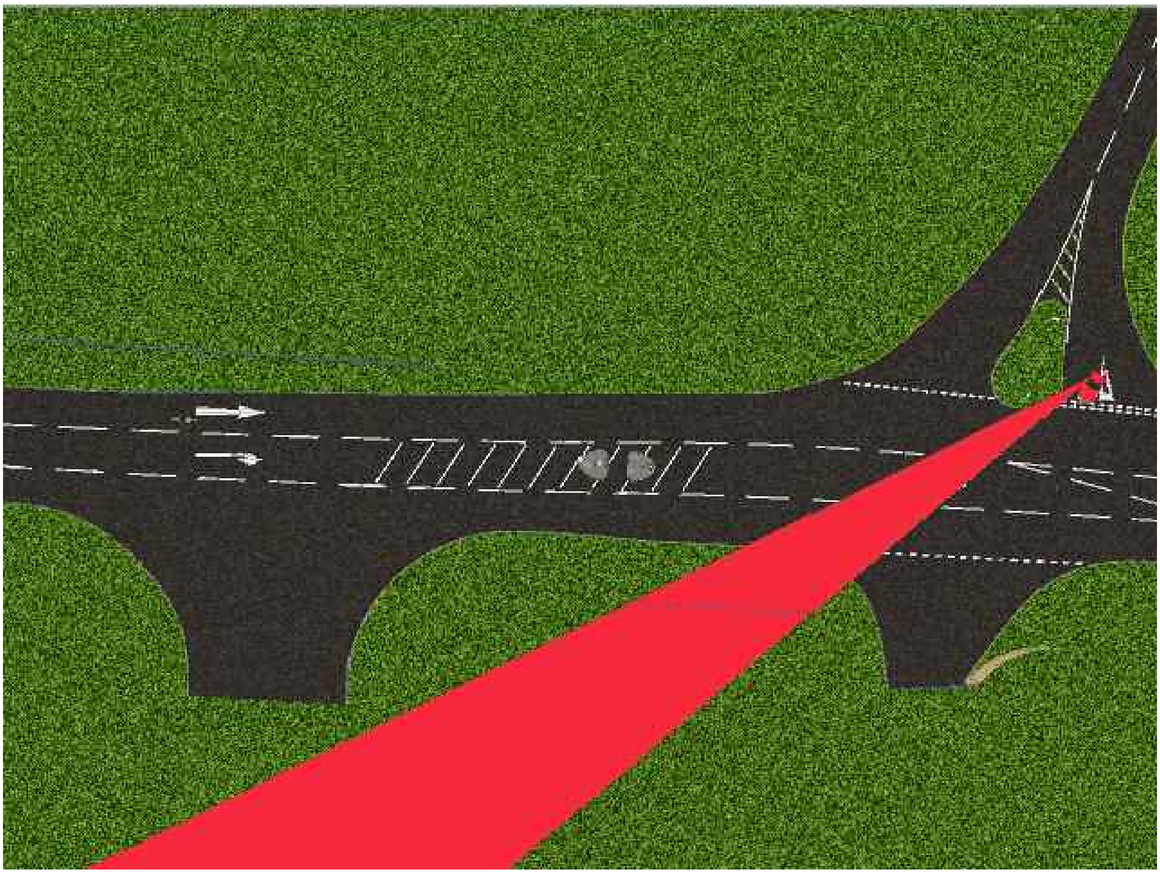
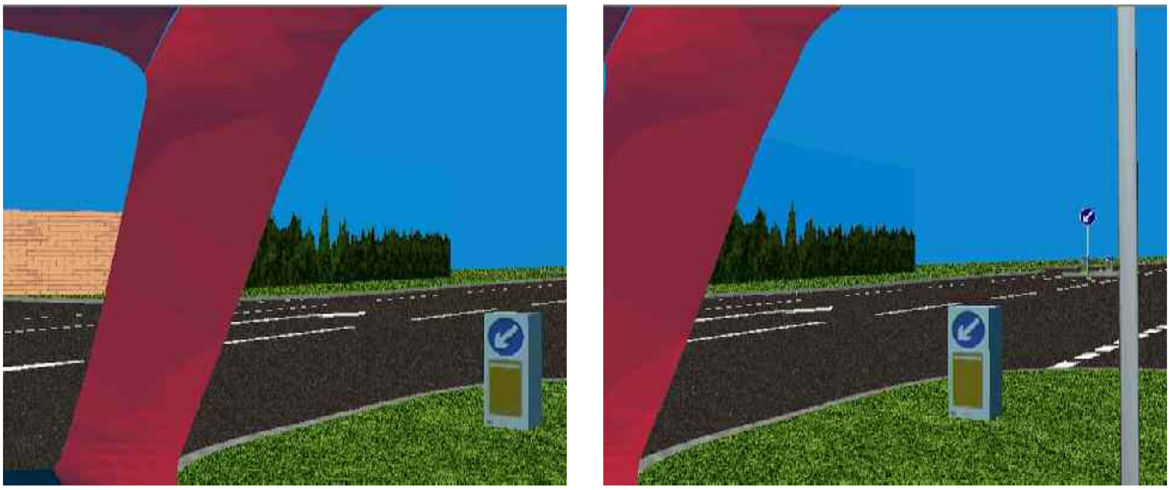


Figure 60: Plan View of the Vehicles Prior to the Collision



Figures 61 and 62: The Junction as seen from the Volvo Driver's Perspective

The Figures 60, 61 and 62 show the Volvo 850 waiting at the mouth of the junction. The Plan view shows the projected cone, representing the maximum area of 'A' pillar obscuration, being some distance from the position of the motorcycle and thereby making it unlikely that the offside 'A' pillar obscured the driver's view. Figures 61 and 62 of the driver's view tend to support this hypothesis; they illustrate the extent of the field of view for the Volvo driver.

This cause of this accident was more likely to have been a lack of judgement on the part of the Volvo driver. The oncoming speed of the motorcyclist, which could have been up to 60 mile/h, may have resulted in the Volvo driver looking to his left and seeing a clear carriageway, then looking to his right and by the time he started his manoeuvre the motorcyclist could have been closer than previously expected. The visualisations of this incident show the motorcyclist to be obscured for slightly less than 2 seconds.

6 OTS Phase 1 Data Analysis

6.1 Introduction

The OTS Accident Data Collection Study has been developed to overcome a number of limitations encountered in early and current research. Most accident studies are entirely retrospective in that investigations take place a matter of days after the accident and are therefore limited in scope to factors which are relatively permanent such as vehicle deformation and occupant injuries. They do not, in general, record information relating to evidence existing at the crash site, such as, post-impact location of vehicles, weather and road surface conditions; nor do they consider events leading up to the accident such as the driving conditions encountered as the protagonist approached the crash site or their behaviour. It is these factors which give an insight into why the accident happened. The police, who do attend the scenes of accidents whilst such "volatile" data is still available to be collected, tend to have other priorities, such as ensuring the injured receive help, clearing the scene to restore the flow of traffic and looking for indications that any of the parties involved have broken the law.

The philosophy of the OTS project was to put experienced accident researchers at the crash scene at the same time as the police and the emergency services. The timing is such that it should be possible to gather information on the environmental and behavioural conditions prevailing just before the crash. This provides valuable in-depth data on the causes as well as the consequences of crashes and allows counter measures to be developed in the fields of human behaviour and highways engineering as well as vehicle crash worthiness.

The study involves two teams, from the Transport Research Laboratory (TRL) and the Vehicle Safety Research Centre (VSRC) at Loughborough University, working in close cooperation to produce a joint data set. Phase 1 of the project ran from September 2000 to September 2003, and collected information relating to 1513 accidents (Department for Transport Road Safety Report No.59). Phase 2 of the project commenced in September 2003 and is due to complete in September 2006.

6.2 OTS Terminology and Accident Data Representation

The data recorded for each OTS case both at the scene and subsequently through the follow-up activities and reconstruction work, is organised by the appropriate hierarchy within a 'crash tree structure'. Figures 1a and 1b detail this 'crash tree structure' showing the associated different statistical levels that are used to organise and group the data.

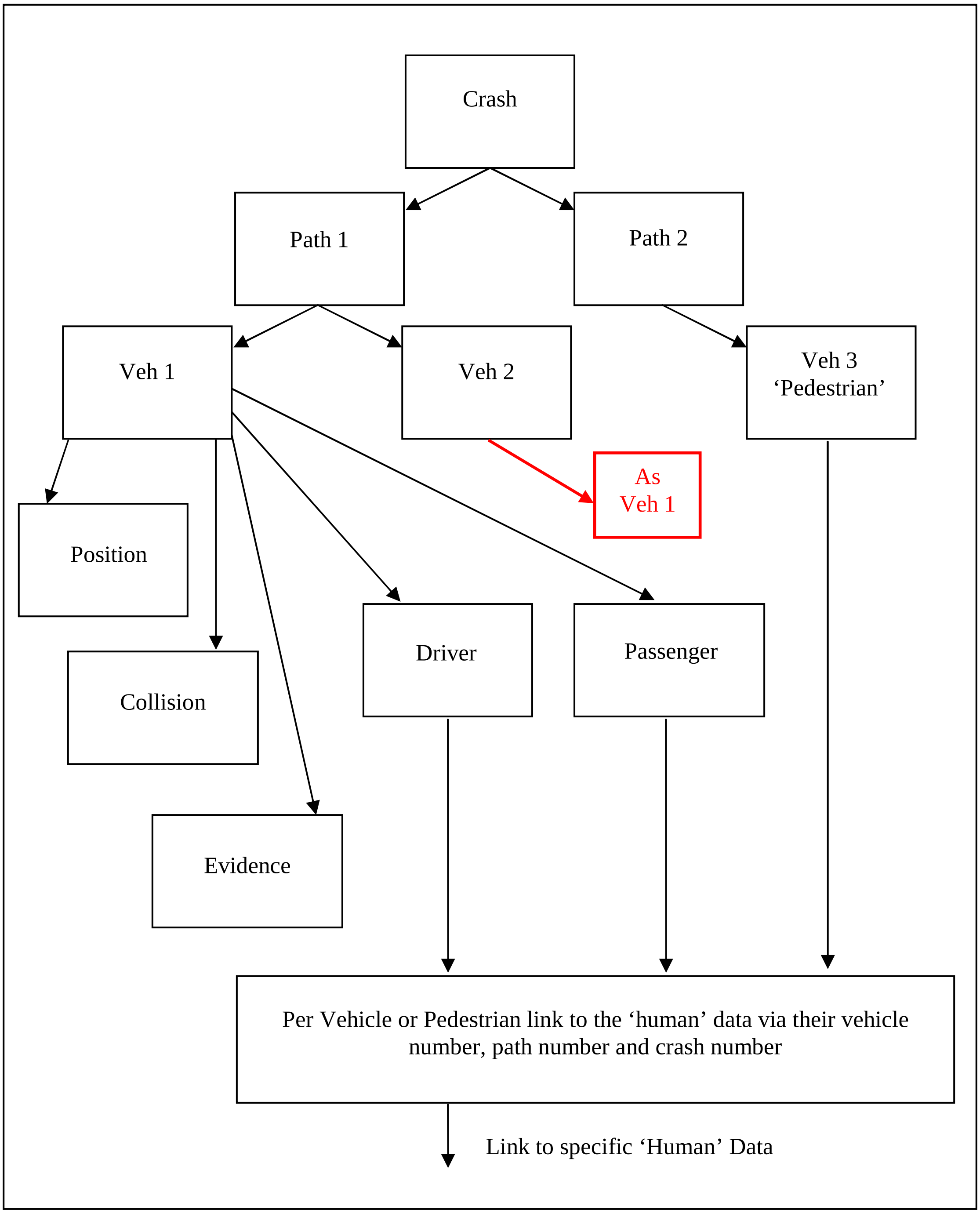


Figure 67: Example of an OTS Case Structure, (crash involved two cars and a pedestrian)

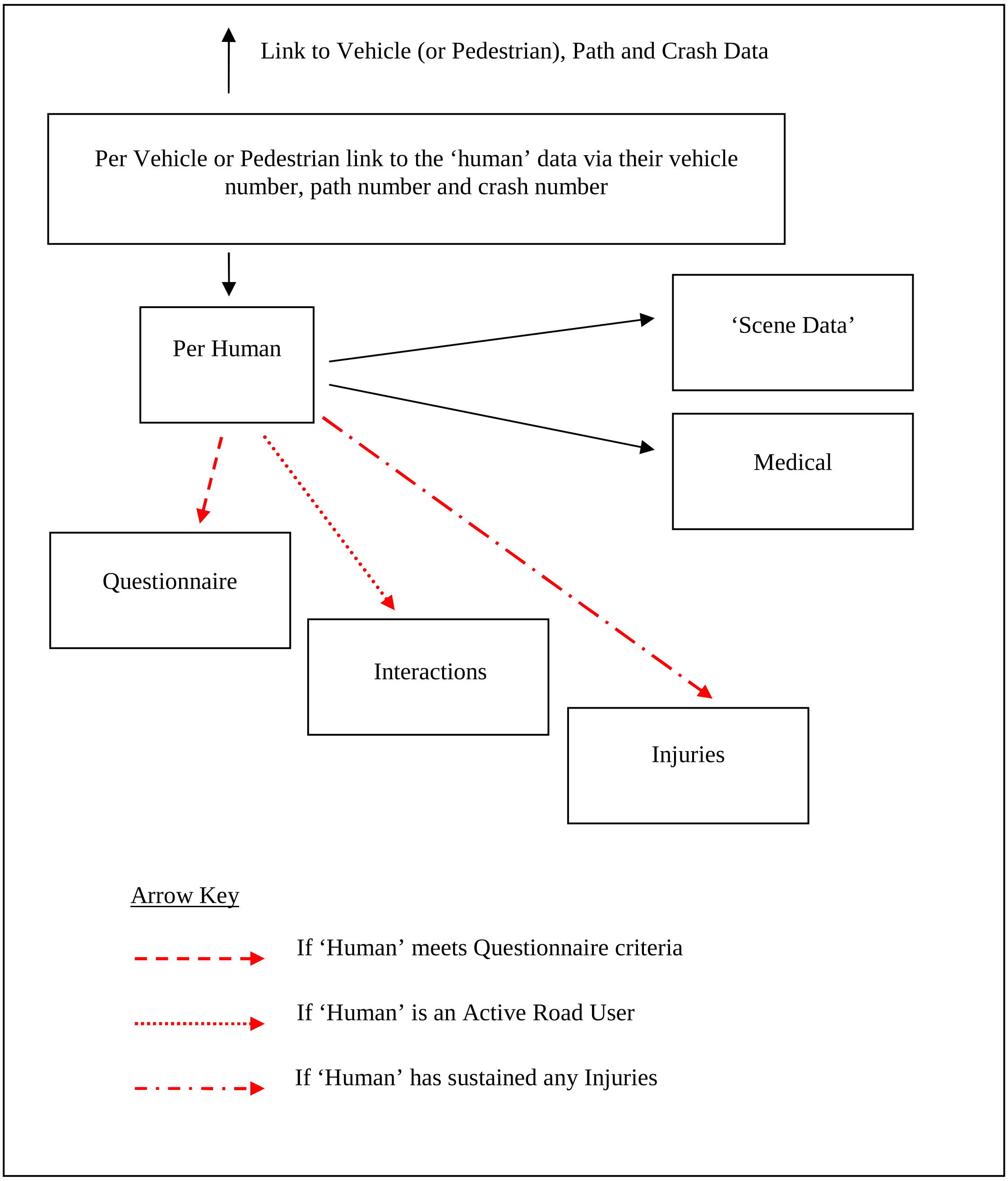


Figure 68: Example of an OTS Case Structure, (crash involved two cars and a pedestrian)

The division and organisation of the case data into a structured format is essential to allow navigation through each case and ensure the different relationships from the multiple items of evidence collected to the actual date, time and type of crash are linked succinctly. The variables recorded are all associated with their pertinent statistical level within the database. A unique key identifier allows each variable investigated to be related to the crash, path, vehicle, human and the other information related to that incident. Thus every accident investigated is documented consistently and it is possible to understand the key events and identify the key features of the incident easily.

6.2.1 Path (Approach) Level Definition

Each road user involved in the accident will have travelled along a particular 'path'. The path refers to the road or footway used by the vehicle or pedestrian. Specific information relating to the path is recorded, such as the presence of street lighting or the nature and type of the road and characteristics such as speed limits. For single vehicle collisions or shunt-type accidents there will only be one path.

The Path level is immediately beneath the Scene level and contains data relating to the various approaches to the actual locus of the accident. This is necessary in order to distinguish environmental factors that are different depending on which path a particular road user took to arrive at the locus. For example, a head-on accident may occur on a bend in the carriageway, but one driver would be negotiating a left bend on his approach while the other negotiates a right bend.

Some of the information relating to the path level is divided into three major components describing the conditions before the crash loci, at the loci and beyond the loci. This system has been named the Terminology for Annotating Roads, or TAR codes.

6.2.2 TAR Code Definition

Highways Description of the Path or Approach to the Accident Loci (TAR Codes)

For this study a new system was developed for recording key descriptive details about the highway environment. This has become known as a Terminology for Annotating Roads (TAR). In keeping with the database structure, this methodology was designed to describe each path to the accident locus rather than simply the whole scene.

The aims of the TAR coding method were to provide an analytically valuable structure for recording data in a concise, high density format that was (wherever possible) generic and thus able to provide comparison of accidents sharing common highway features. The key fields that are included are:

- Feature
    - Shape
    - Control
- Geometry
    - Horizontal
    - Vertical
    - Camber
- Status
    - Class
    - Speed Limit
    - Width

“Feature” records the overall layout of the path – whether there is a junction of a certain shape and what controls are present to control and regulate the flow of traffic through that junction from that particular path.

The “Geometry” section describes the physical characteristics of the highway surface – whether a (horizontal) bend, a gradient and a camber are present; together with a simple assessment of their direction and relative magnitude, such as to differentiate between a steep hill or a gentle ascent.

"Status" quantifies some of the designed-in highway parameters that are frequently used to classify roads and their properties compared with national and local highway network standards.

6.2.3 Interaction Level Definition

One particular branch of the structure or level is a new innovation that was conceived and developed by the OTS teams and was first used in the OTS database. Each human who took an 'active role' in the crash is described as having displayed 'interactions' with the other road users, their own vehicle and their highway environment. The Interaction codes are essentially accident causation factors described from each active road user's perspective.

The On the Spot database has been designed to allow flexibility in the possibilities for analysis. To that end, one of its key elements is that it allows the conclusions that are drawn by the accident investigators to be recorded in a structured way. These conclusions cannot be entirely objective, nor can the evidence gathered at the scene and afterwards be known to be complete and wholly accurate. However, the purpose of the OTS study is to place experienced researchers at accident scenes where they are best placed to understand the issues that conspired to bring about each particular collision.

To document these findings, the researchers are asked to consider the situation as presented to each of the active road users who were involved in the accident. Vehicle passengers are omitted from this exercise unless they become an "active" rather than passive contributor to the accident causation as a result of their actions.

This method of understanding why each accident occurred was developed with the objective of providing fresh insight into accident causation through OTS but without being constrained by existing definitions of groups of "similar" road users. In order to learn about the reasons why accidents occur, it is important to take a holistic view and consider every road user in a generic sense and examine each one in turn.

The TAR codes have provided a highways context in which the events took place, but the new codes provide a mechanism by which we can record how each person:

- Interacted with their own vehicle in order to control it,
- Interacted with the highway infrastructure in understanding what was required,
- Interacted with the other road users who were sharing that highway.

Because of the necessity to examine the interactions between the road users and these highway, vehicle and other user aspects, rather than examining the aspects themselves, this coding scheme is referred to as Interactions Coding.

The concept of blameworthiness has intentionally been almost entirely removed from the Interactions section of the database. Violations of traffic law are still recorded within the system, however this is not the main focus and those aspects of the crashes are well documented elsewhere in the structure of the database (the contributory factors system).

The Interactions fall into seven categories:

1. Legal
2. Perception
3. Judgement
4. Loss of Vehicle-control
5. Conflict
6. Attention
7. Impairment

In a relatively simple approach, one could interrogate the database for accidents in which there was a legal breach by some party. Likewise one could look for the relative prevalence of Judgement and Perception issues simply by looking for accidents in which one of these played some part. The greater value is however obtained by examining the combinations of interactions that were immediate precursors to the crash.

The descriptions for individual interactions are structured into levels of increasing detail. This structure is reflected in the code numbers chosen, with a digit for the category, another for the subsection and a third for the detail. An example of an interaction code, relevant to this work, is "Looked But Did Not See" (lbdns) which is a sub-category of the Perception Interaction Code.

The interactions coding system is designed to allow as many codes as are necessary to describe *why* the crash happened. From descriptions written from each road user's perspective, the salient conclusions may be extracted and coded.

6.3 Selection of Cases for 'A' pillar Obscuration Analysis

In order to understand the potential size of any 'A' pillar obscuration problem it is necessary to identify the type of accidents where 'A' pillars may have had an effect. Accidents where 'A' pillars could have contributed to the cause of the accident can then be placed in context with the total sample in the OTS phase 1 database.

The following list defines the sample criteria which were applied to the OTS phase 1 database to define the group of accidents, known as Group A, where there was a potential that 'A' pillar obscuration may have been a contributory factor. The accident selected must have involved:

- At least one car which was travelling in a forward direction;
- More than one path;
- The road layout may include a junction or a roundabout;
- One or more road users on each path for the accident;
- The accident occurred in daylight or at night with road lighting both present and on.

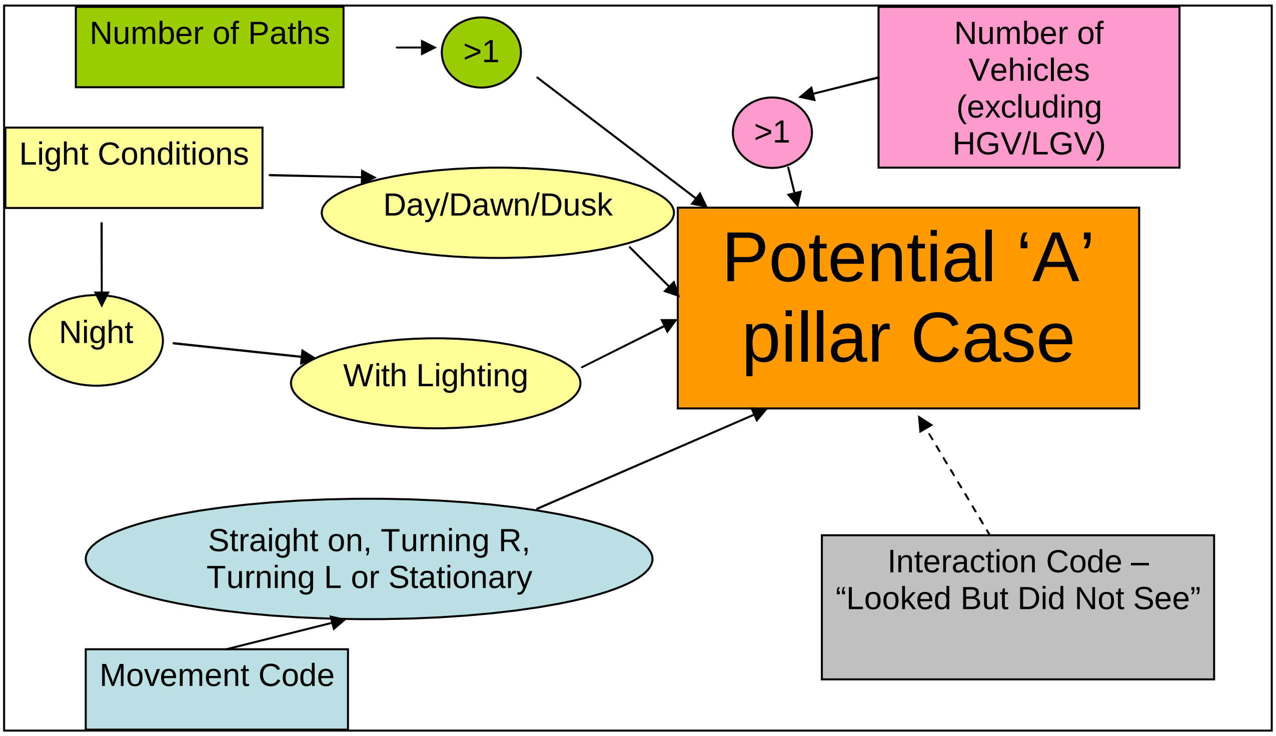


Figure 69: Selection Criteria for Potential 'A' Pillar Incidents

For 'A' pillar obscuration to have occurred, one of the vehicles involved in an accident has to have had another road user obscured by it's 'A' pillar. Figure 69 shows a schematic of the thought process behind the selection criteria. More than one path must be involved; a road user must be obscured to some extent by a vehicle's 'A' pillar which is suggestive of a minimum of two paths. The more prevalent road layouts in 'A' pillar obscuration cases are expected to be junctions and roundabouts.

6.3.1 'A' pillar Accidents

The OTS Phase 1 data collection protocols were not designed to identify 'A' pillar obscuration as a crash causation factor. There are many reasons for this, not least the complex and detailed pre-crash information required, specifically regarding speed and direction of travel. Without a good understanding of the relative time-distance histories of the impact partners, it is very difficult to determine if a cars' 'A' pillar obscured another road user. This situation is even more difficult when, for every car and driver, the likely area of obscuration can vary.

Accidents where the 'A' pillar could have been a contributory factor by obscuring another road user, as detailed in figured 69, are referred to as Group A. Although it is not possible in the OTS phase 1 data to select accidents where the 'A' pillar was definitely causative, a sample of accidents can be identified where it is likely that 'A' pillar obscuration could have contributed to a collision.

Accidents that could have involved 'A' pillar obscuration, known as Group A, may have been coded under the OTS Perception Interaction Code "Looked but Did Not See". This sub-group of accidents, known as Group B, contains car drivers who may not necessarily have had their vision obscured by an 'A' pillar; therefore, the number of accidents which falls into this category may be an over-representation of the true number of cases that involved 'A' pillar obscuration.

Some crashes that met the Group A criteria, were, at least in part, caused by ‘A’ pillar obscuration; but these may not have had drivers ascribed the interaction code “Looked But Did Not See”. Therefore, the rate of accidents that may have involved ‘A’ pillar obscuration is difficult to quantify from the OTS phase 1 data set at this time. For the purpose of this report, the number of accidents coded as “Looked but Did Not See” provides an estimate of the number of incidents involving ‘A’ pillar Obscuration.

An initial search of the OTS phase 1 data base was performed according to the basic search criteria detailed earlier in this section.

6.4 Results of Analysis of OTS Phase 1 Database

There are 1,513 cases in the OTS Phase 1 database. The selection criteria detailed in section 6.3 were applied to the database to find accidents where ‘A’ pillar obscuration could have been a contributory factor. Two approaches were taken to identify crashes that may have involved ‘A’ pillar obscuration. Firstly, all crashes that met the main criteria, shown in figure 69, known as Group A; followed by a selection of a sub-sample of these crashes where the driver was identified by the interaction code to have ‘Looked But Did Not See’, known as Group B.

In total there were 458 and 113 accidents which met the selection criteria of Group A and B respectively.

The following tables detail the crash severity, road type and driver details of the two groups. When comparisons are made of different variables and statistically tested, the Chi-Square test level used is $p \leq 0.05$ for acceptance or rejection of any significance.

Group B is a sub-sample of Group A, and the characteristics of the crashes are summarised in Table 4.

Table 4: Crash Characteristics

Crash Characteristics	**Group A**	**Group B**
Number of Accidents	458	113
Total Number of Road Users	1225	232
Total Number of Cars	914	177
Total Number of Cars that met ‘A’ Pillar Selection Criteria	636	115

6.4.1 Scene Variables

Table 5: Crash Severity

Crash Severity	Group A	Group B
Fatal	17 (3.7%)	2 (1.8%)
Serious	65 (14.2%)	12 (10.6%)
Slight	239 (52.2%)	69 (61.1%)
Uninjured	132 (28.8%)	30 (26.5%)
Not known	5 (1.1%)	-
Total	458 (100%)	113 (100%)

Table 5 illustrates that the proportion of fatal and serious accidents in the “looked but did not see” group (Group B) is less than that in the total sample (Group A), however this is not statistically significant. However, there are significantly more slight accidents ($p<0.05$) in Group B compared to Group A.

Table 6: Roundabout Present

Roundabout Present	Group A	Group B
Yes	49 (10.7%)	10 (8.8%)
No	409 (89.3%)	103 (91.2%)
Total	458 (100%)	113 (100%)

Table 7: Crossroads Present

Crossroads Present	Group A	Group B
Yes	90 (19.7%)	20 (17.7%)
No	368 (80.3%)	93 (82.3%)
Total	458 (100%)	113 (100%)

Tables 6 and 7, compare the presence of key road features thought to be potentially associated with ‘A’ pillar obscuration collisions. No statistical differences were noted. Similarly, Table 8 indicates that the distribution of road types is equivalent between the two groups.

Table 8: Class of Road

Road Class	Group A	Group B
M	3 (0.7%)	-
A	81 (17.7%)	21 (18.6%)
B	57 (12.4%)	10 (8.8%)
C/ Unclassified	88 (19.2%)	27 (23.9%)
Not known	229 (50%)	55 (48.7%)
Total	458 (100%)	113 (100%)

The large number of “Not known” (see table 8) class of road descriptions is due to an OTS Phase 1 electronic database coding anomaly.

6.4.2 Vehicle Variables

Table 9: Year of Registration of Vehicle

	Age of Vehicle	
Percentile	**Group A**	**Group B**
25	1991	1992
50 (Median)	1995	1995
75	1999	1998

Table 9 only shows vehicles of a known age and indicates the median for the two samples is the same.

Table 10: Car Driver Gender

Active Road User Gender	**Group A**	**Group B**
Male	399 (62.7%)	78 (67.8%)
Female	196 (30.8%)	30 (26.1%)
Not known	41 (6.4%)	7 (6.1%)
Total	636 (100%)	115 (100%)

Table 10 indicates the male active road users appear to be involved in more "Looked but Did Not See" accidents; however, this result is not statistically significant. It should be remembered that crashes were selected that involved a combination of vehicles and as such may have involved more than one active road user with an interaction code that met the relevant criteria. For example, a crash may have involved two cars whose respective driver's were both coded as "Looked but Did Not See" in terms of the interactions.

Table 11: Age of Driver

	Age of Driver	
Percentile	**Group A**	**Group B**
25	24	26
50 (Median)	34	33
75	49	55.5

Table11 shows that the distribution of age between the two samples is similar.

Table 12: Vehicle age by median driver age

Vehicle Age	Median Age of Car Driver	
	Group A	Group B
≤ 25^{th} %ile (upto 1992*)	32	30
26^{th} to 74^{th} %ile (1993-1997)	34	33
≥ 75^{th} %ile (≥1998)	34	33

Table 12 shows the median age of the drivers against the vehicle age and highlights that there is a slight trend for older the drivers to be associated with newer cars at the time of the accident. This is not found to be statistically significant.

Table 13: Vehicle Age by Percentage of Male Drivers

Vehicle Age	Percentage of Male Drivers	
	Group A	Group B
≤ 25^{th} %ile (upto 1992*)	69.5%	62.5%
26^{th} to 74^{th} %ile (1993-1997)	68.1%	76.3%
≥ 75^{th} %ile (≥1998)	61.6%	77.8%

Table 13 shows the percentage of male drivers by the age of the vehicle. Significant differences were observed between Groups A and B with respect to the number of male drivers and the age of their cars. In the larger sample, (Group A) women were more commonly driving newer cars. Conversely, the opposite was witnessed in Group B with men more frequently driving newer cars. However, the sample size is small and it is not possible to link men to being at a greater risk of being subject to 'A' pillar obscuration.

Table 14: Distribution of Junction Types

		Group A	Group B
N	No Junction Present	110 (17.3%)	9 (7.8%)
A	Road continues straight on with an additional (minor) road joining from the right (T-Junction)	37 (5.8%)	8 (7.0%)
B	**Road terminates with a (major) road passing across the vehicles path (T-Junction)**	**57 (9.0%)**	**24 (20.9%)**
C	Road continues straight on with an additional (minor) road joining from the left (T-Junction)	60 (9.4%)	4 (3.5%)
D	Road continues straight on with an additional (minor) road joining from the left and right (Crossroad)	45 (7.1%)	5 (4.3%)
E	Road is temporally broken by a (major) road passing across the vehicles path (Crossroad)	28 (4.4%)	4 (3.5%)
M	Junction with more than four approaches (not a roundabout)	1 (0.2%)	-
3	3 Arm Roundabout	11 (1.7%)	-
4	4 Arm Roundabout	15 (2.4%)	6 (5.2%)
5	5 Arm Roundabout	1 (0.2%)	1 (0.9%)
X	Crossing (pedestrian / train etc)	-	-
9	Not known	271 (42.6%)	54 (47%)
	TOTAL	636 (100%)	115 (100%)

Table 14 indicates that significantly more Group B accidents occurred at terminal T-junctions. It should be noted that it is possible for more than one vehicle involved in an accident to have an interaction code of “Looked but Did Not See” assigned to them.

6.4.3 Other Vehicle Hit

Table 15: Other Road User Struck

	Group A	Group B
Car	465 (69.7%)	64 (53.8%)
Heavy Goods	38 (5.7%)	4 (3.4%)
Light Goods	26 (3.9%)	4 (3.4%)
Motorcycle	50 (7.5%)	23 (19.3%)
Pedal cycle	28 (4.2%)	14 (11.8%)
Pedestrian	60 (9.0%)	10 (8.4%)
Total	667 (100%)	119 (100%)

Table 15 indicates that vulnerable road users are significantly more likely to be involved in accidents where car drivers “Looked but Did Not See”. It can also be seen in table 15, that some larger vehicles are included in the study. This is due to the complex nature of multi-vehicle collisions where a third or even fourth vehicle may have been involved.

6.5 Validation of Methodology

In total there were 113 OTS Phase 1 case study accidents identified which could have been caused by, or partially caused by, car drivers who "Looked but Did Not See" (Group B). A sub-sample of these were chosen at random and detailed in-depth case reviews were undertaken, to ensure that the criteria applied to the database generally yielded incidents where 'A' pillar obscuration could have been a causative factor. This 'health-check' of the selection criteria was undertaken to further understand whether "Looked but Did Not See" is a reasonable surrogate variable for 'A' Pillar obscuration. There is no single or combination of variables that can accurately be used to flag "The 'A' pillar obscured the other road user" in OTS Phase 1. When applied to Group B, the validation process can only result in three conclusions from reviewing the case information, including photographs and scene plans:

- Yes – Potentially 'A' pillar obscuration contributed to the crash
- No – There was no 'A' pillar obscuration contributing to the crash
- Not known – Uncertain if there was an 'A' pillar obscuration contributing to the crash

The process of reviewing a random sample of ten crashes highlighted the difficulty in attempting to retrospectively interpret 'A' pillar obscuration from completed accident case notes. However, it did demonstrate that approximately half of the cases reviewed could have involved an element of 'A' pillar obscuration. The remaining half were split relatively evenly between the 'Not known' and the 'No' categories.

The following describes a typical accident from the OTS phase 1 selection:

<u>OTS Case 142</u>

In this case a Peugeot 205 was travelling around a roundabout. A Ford Fiesta failed to give way on entering the roundabout, causing the front of the Peugeot to impact directly with the off side doors of the Fiesta.

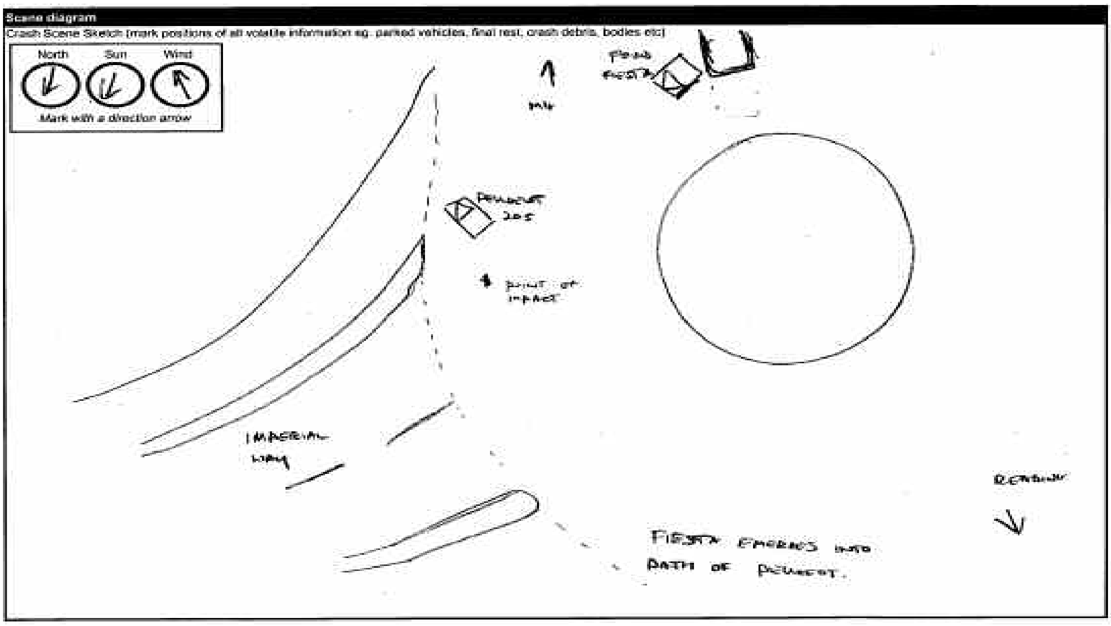


Figure 70: Scene Diagram for OTS Case 142

Figure 71: Damage to Peugeot

The accident occurred because the Fiesta pulled onto the roundabout and into the path of the Peugeot. The crash speed was moderate and neither car appears to have had time to take any evasive action. The driver of the Ford Fiesta was given an interaction code of “Looked but Did Not See”, which led us to believe this could have been an ‘A’ pillar related incident. This case and others have given some confidence to this approach.

The damage to the Fiesta shows that it was struck on the off side doors behind the front wing with direct contact damage as far back as the ‘C’ pillar (see photograph, below). The condition of the carriageway for both cars is noted as dry and there are no recorded skid marks on either car’s path.

Figure 72: Damage Sustained by the Ford Fiesta

7 Discussion & Project Findings

The preceding chapters have outlined the methodology and results of the real world OTS accident analysis and the in-depth reconstruction 3-D visualisations undertaken as part of the 'A' pillar obscuration project. The findings from the crash investigation work are discussed in this section and the key features of the analysis highlighted.

7.1 Real World Crash Data Collection

The On The Spot study collected additional data over a five month period, for crashes that may have involved 'A' pillar obscuration. The teams who collected the additional data followed a protocol to identify where additional data was required. For the crashes that met the car 'A' pillar obscuration criteria, a questionnaire was completed to describe the driver seating position with respect to the car's interior. This enhanced OTS data was used as the basis to create the accident reconstructions and the associated 3-D simulations. The drivers' relative head (nasion) positions were used to predict the obscuration zones used in the reconstructions and computer generated 3-D simulations. The study successfully predicted real world driver forward field of view and demonstrated how this may have affected their judgement or actions immediately prior to the crash.

The OTS data collection teams performed very well and provided the study with a sub-sample of OTS cases that may have involved car 'A' pillar obscuration. In approximately a five month period, sixteen collisions were reported to TRL by the OTS study, which were thought to meet the 'A' pillar obscuration criteria. The cases were carefully evaluated and ten were selected as suitable for full reconstruction 3-D simulations.

In the five month data collection period, approximately 259 accidents were investigated by the OTS study. However, it is not possible to use the reported incidents that were selected and simply compare these with all collisions to predict an 'A' pillar obscuration crash involvement rate. It is very difficult to determine the pre-impact position of road users with respect to time and relative to each other prior to a collision, whilst investigating the scene of the crash, typically some fifteen minutes after the event. Therefore, it is likely that when 'A' pillars are causing blind spots in the driver's forward field of view, accident investigation projects will not always identify this as a factor at the start of their investigations. It was, however, essential that a judgement was made very early on in the investigation, as the additional data required could only be sourced whilst at the scene.

If the scope of this study was to be extended and real world data was still to be used, then a more rigorous approach would be recommended to evaluate the crashes as to the likelihood of 'A' pillar obscuration not just based on the initial scene evaluation. Future work should consider the possibility of allowing the data collection phase of the project to be carried out for at least a year. This would allow all weather conditions to be accounted for, which is particularly important when it is considered frost and ice may be present and increase the obscuration area around the 'A' pillar.

7.2 3-D Data Collection

The methods that were evaluated to be the most effective for collecting the 3-D scene and vehicle data were a combination of scene laser scanning and vehicle 3-D measurements obtained from the FARO arm. The laser scanner provides a very quick and accurate method for collecting 3-D scene data in potentially dangerous environments. However, for the foreseeable future, the laser scanner should not be considered as a tool to collect 3-D vehicle data; the FARO arm approach proved to be a more suitable and accurate approach.

This study has clearly shown the benefit of using 3-D visualisations to demonstrate complex human-car interactions in a dynamic environment. The method has proved to be a very effective tool to illustrate car driver ‘A’ pillar obscuration in all the reconstructed accidents. This is particularly true of the three incidents which graphically illustrated that ‘A’ pillar obscuration was not a factor; and this conclusion was reached with the aid of the 3-D visualisations. Gathering 3-D data of a vehicle, using the FARO arm could be extended so more detail of the vehicles can be modelled.

7.3 The Validation Procedure

This was one of the most technically challenging areas of the project. The validation procedure was necessary to compare the monocular driver view of the accident used in the reconstruction 3-D simulations and the true field of view (binocular) that would have been afforded in the real world incident.

The difference between a monocular and binocular method had to be established by undertaking the validation procedure. In addition, the validation procedure proved that relatively simple measurements could be taken at the scene of an accident and later used to predict the nasion position of a specific driver. This was important to demonstrate that the 3-D models reflected the real incidents.

Future work could focus on refining the validation procedure and thus, the correlation between the monocular and binocular areas of ‘A’ pillar obscuration. Having a better and broader understanding of the monocular and binocular areas of obscuration for different volunteers in different vehicles would allow the real world data to be modelled into a theoretically more accurate 3-D visualisation.

7.4 Discussion of the 3-D Visualisations

The ten 3-D visualisations have proven to be a useful tool to analyse if ‘A’ pillar obscuration contributed to the cause of a road traffic accident. Of the ten reconstructed accidents, six were found to involve varying degrees of ‘A’ pillar obscuration as a crash contributory factor. It is rare that one variable will be the sole cause of an accident, unless we consider a catastrophic primary safety failure. It is more common that combinations of different causation factors combine to cause a road traffic accident. This is certainly true of ‘A’ pillar obscuration, and eliminating this as a causation factor may have helped prevent six accidents to varying degrees.

Interrogation of these ten crashes showed that six of them potentially involved ‘A’ pillar obscuration as a contributory factor. Further evaluation of the accidents resulted in the research team defining four of the cases as being caused, at least in part, by ‘A’ pillar obscuration. Of the four accidents that were identified as ‘A’ pillar obscuration (cases 1, 2, 4 and 9) being the causation factor, two of these accidents involved obscuration caused by the nearside ‘A’ pillar. All three drivers were women; two were categorised as 95^{th} percentile females according to their height (approximately 1.75m); the third driver was categorised as a 50^{th} percentile female.

Of the four incidents where ‘A’ pillar obscuration was considered to be a contributory factor, two of the struck vehicles were motorcycles.

None of the ten reconstructed incidents involved a tall male driver (95^{th} percentile) who may have been subject to ‘A’ pillar obscuration. Smaller stature drivers’ forward field of view is shown to be adversely compromised by ‘A’ pillar obscuration, because their driving position brings them into close proximity to the windscreen. The validation procedure highlighted that a 95^{th} percentile male may also find his field of view obscured by the flared top portion of the ‘A’ pillar.

None of the ten selected 3-D reconstruction simulations involved an MPV or a so-called dual ‘A’ pillar fitted vehicle.

In the sample of ten reconstructed crashes, the nearside ‘A’ pillar was found to obscure the view of another road user as frequently as the offside ‘A’ pillar. The 3-D visualisations suggest that drivers’ who are smaller in stature are more likely to suffer from ‘A’ pillar obscuration, possibly because the lower and upper parts of the ‘A’ pillars are bulkier than the central sections on many cars. This may pose more of a problem for smaller drivers’ because of the following:

i) their line of sight may intersect with the larger ‘A’ pillar area;

ii) and, their sitting position brings them closer to the ‘A’ pillar, thus potentially giving this structure more prominence, increasing the obscuration angle.

7.4.1 Other Factors

Of the six incidents which involved ‘A’ pillar obscuration to some extent, four involved ‘A’ pillar obscuration in such a way as to exacerbate a scenario which ultimately led to a collision. ‘A’ pillar obscuration appears to contribute to a driver losing sight of another road user; this is illustrated in cases 2, 3, and 8. The 3-D visualisations for these cases suggest the drivers’ who struck an oncoming vehicle did have an opportunity to acquire the other vehicle in their sights, but then appeared to lose them behind an ‘A’ pillar, thus resulting in a collision. It may be argued that if the ‘A’ pillar in question for these three cases hadn’t blocked the drivers’ views, they may have had time to abort the manoeuvre that led to the collision, and in doing so may have given the struck vehicle time to avoid the collision.

Four of the cases in which ‘A’ pillar obscuration is suspected, involved motorcycles. Smaller vehicles, such as motorcycles have a much greater chance of being hidden from the view of a driver by a vehicle ‘A’ pillar. The implication is that smaller road users, including pedestrians and cyclists, could be more readily obscured by a motor vehicle ‘A’ pillar.

Four of the six cases which included ‘A’ pillar obscuration occurred at T-junctions; the other two incidents occurred at a roundabout and cross-roads respectively. No incidents on a single carriageway were found. This does not mean incidents on single carriageways do not involve an element of ‘A’ pillar obscuration, but that for this phase of the study road layouts which require the driver to do something other than look directly ahead were chosen. Further work could include any road layout and manoeuvres where a driver’s peripheral vision is required, an example of which could be a motorway merge from a slip road. T-junctions require the driver to rotate their head to assess if the carriageway they intend to manoeuvre into is clear. The visualisations of the cases suggest the possibility that a driver may miss an oncoming vehicle in one direction when their head is rotated in the opposite direction, when they rotate their head back towards the direction the oncoming vehicle is approaching from; they may not acquire that vehicle in their sights because the ‘A’ pillar obscures this vehicle. This is suspected to be a reason why ‘looked but did not see’ incidents occur at road layouts with this geometry.

7.4.2 OTS Phase 1 Data Analysis

Analysis of the OTS Phase 1 database was undertaken to investigate the proportion of crashes that may have been associated with 'A' pillar obscuration. In addition, the characteristics of crashes that may have been caused, at least in part, by blind spots attributed to the 'A' pillar were summarised.

OTS Phase 1 crash investigations did not routinely examine car 'A' pillar obscuration zones and their likely contributory effect on the cause of the collision. Therefore, it was necessary to select OTS crashes for analysis and categorise them as either being potentially associated with car 'A' pillar obscuration or not, based on a detailed criterion. Further, those crashes potentially associated with 'A' pillar obscuration and whose drivers' were described as "Looked but Did Not See" the other road user, were assumed to be more likely to be related to 'A' pillar obscuration. The "Looked but Did Not See" crashes are a sub-sample of those potentially associated with 'A' pillar obscuration and are termed Groups B and A respectively. The selection criteria and methodology are outlined in Section 6.

It is not possible from the information contained within the OTS Phase 1 database, to routinely identify if the "Looked but Did Not See" accidents are specifically caused by the 'A' pillar rather than observational failures on the part of a driver, or other external environmental factors. Some crashes by their nature yield more physical scene evidence and/or witness testimony than others and for these incidents, more complex causation issues can be further explored in more detail. However, the strength of studies such as OTS is the relatively large sample size and the ability to cross reference similar circumstances between crashes to help build models for analysis. To this end, OTS Phase 1 has proven a very useful and possibly a unique data source to investigate the size and scope of the crash causation problem attributed to 'A' pillar obscuration.

From the analysis of the OTS phase 1 data, the age of the vehicle was not a statistically significant factor in terms of the likelihood of being involved in an OTS "Looked but Did Not See" accident. However, this does not mean that newer vehicles are as likely to be involved in an 'A' pillar related incident as older ones, as it was not possible to account for the exposure of such vehicles in such small sample sizes.

This analysis is based on the assumption that accidents which actually involved 'A' pillar obscuration are a subset of the "Looked but Did Not See" sample of incidents. In Phase 1 of OTS there were 1,513 accidents investigated, of these 113 were recorded as involving a car driver who failed to see another vehicle.

It is not known how many crashes that did not fall into Group B (selected because a car driver was positively coded as "Looked but Did Not See"), could also be 'A' pillar related. The Phase 1 OTS data collection and investigation methodology did not routinely record vehicle travelling speeds or reconstruction information, which is required to ascertain if 'A' pillar obscuration could have been a crash causation factor. Therefore, it is possible that 'A' pillar obscuration is contributing to crashes, but is under-reported. There are many reasons for this, not least the complex and detailed pre-crash information required, specifically regarding speed and direction of travel information. Without a good understanding of the relative time-distance histories of the impact partners, it is very difficult to determine if a cars' 'A' pillar obscured another road user. This situation is even more difficult, when for every car and driver the likely obscuration zone can vary.

The selection of the OTS crashes from the database to form Groups A and B gives some insight into the potential involvement of 'A' pillar as a causal factor in road traffic collisions. There are clear limitations to this approach. It is recognised that some crashes in Groups A and B were not caused by 'A' pillar obscuration. It is thought that the percentage where 'A' pillar obscuration may be a causative factor increases proportionally from Group A to Group B; with Group B having more crashes in terms of the percentage being related in some degree to ‘A’ pillar and associated forward field of view blind spots compared with Group A.

Some crashes in Group B did not have ‘A’ pillar obscuration as a cause, but others that did not meet the selection criteria of Group B could also have been caused, at least in part, by ‘A’ pillar obscuration. Therefore, without knowing in more detail the extent and characteristics of those crashes not selected in Group B, it is not possible to categorise the size or scope of the problem more accurately at this time. The Group B sample size is relatively small and the results presented should be used cautiously.

A ‘health check’ in terms of the accuracy of the approach, or how many crashes in Group B were potentially caused by ‘A’ pillar obscuration was undertaken. This activity highlighted the difficulty of undertaking retrospective case reviews of OTS crashes.

Phase 2 of the OTS study has learnt from this and other research work and continues to be enhanced and improved to address the issues experienced. As Phase 2 of OTS develops and more recent data becomes available together with what has been learnt through the reconstruction and simulation of crashes, it will be possible to be more precise regarding the nature and size of the problem.

8 Conclusion & Recommendations

The study discussed in this report has taken two forms:

i) The development of 3-D visualisations from recent OTS accident data;

ii) and, the Phase 1 OTS data analysis.

The work to date highlights that car ‘A’ pillar obscuration could be a contributory factor in some road traffic crashes. However, there is rarely only one factor that contributes to an accident, and ‘A’ pillar obscuration is no exception to this.

This study has provided three 3-D reconstruction simulations of real world car crashes, where ‘A’ pillar obscuration is believed to be a causation factor.

At this stage there is not enough evidence to suggest changes to the current legislation regarding ‘A’ pillar design and the potential for obscuration.

The current EC directive assesses ‘A’ pillar obscuration angles in new vehicles based on a 50^{th} percentile male. Even though the sample size for this study is small, the 3-D visualisations suggest consideration could be given to both smaller and larger drivers.

It is worth noting that both nearside and offside A pillar obscuration has the potential to obscure other road users. Ten reconstructions were undertaken and 3-D simulations produced. Interrogation of these ten crashes showed that six of them potentially involved ‘A’ pillar obscuration as a contributory factor. Further evaluation of the accidents resulted in the research team defining four of the cases as being caused, at least in part, by ‘A’ pillar obscuration. The cases are discussed within the report and visually highlight that ‘A’ pillar obscuration could be a crash causation mechanism.

The 3-D visualisations and OTS Phase 1 database analysis showed that incidents linked to ‘A’ pillar obscuration frequently occurred at T-junctions and are likely to involve car drivers failing to see vulnerable road users (motorcyclists, pedal cyclists and pedestrians).

Recommendations

The work undertaken on this study has provided some basic findings with respect to the issue of ‘A’ pillar obscuration. To allow elaboration of the current situation in a newer vehicle fleet, the following activities are proposed as possible follow-up work:

i) Analysis of the OTS Phase 2 data;

ii) a further enhanced ‘A’ pillar data collection phase, more rigorously specified;

iii) driving simulator trials to test the findings of this study

   a. Selected real world crashes known to be associated with ‘A’ pillar obscuration could be recreated in the simulator environment.

   b. Volunteers would be asked to negotiate the journey undertaken by a ‘real world driver’ prior to a crash believed to have been caused by ‘A’ pillar obscuration. The volunteers would be monitored to see if they also experience ‘virtual crashes’, as witnessed by the OTS study.

iv) Other crash causation factors highlighted by this work should also be considered in future projects. It will be important for future research work not to isolate any one feature, such as ‘A’ pillar obscuration as a sole cause, when it may be associated with specific driver attention or behavioural factors and/or roadside features and furniture.

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Appendix A.

The OTS teams were required to collect some additional data with respect to the drivers suspected of suffering ‘A’ pillar obscuration. The following is the data sheet they employed with the guidelines that were issued to the OTS teams.

Investigation into Adopted Driving Positions

OTS Data Collection Sheet (Version: 1.2)

OTS Case Number, Path and Vehicle

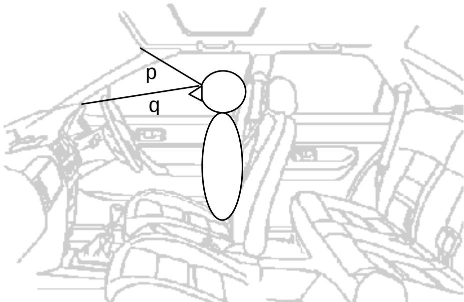
Case Num:					
Path Num:		Vehicle Num:			
Vehicle Make:		Vehicle Model:		Registration:	

Details of Bullet Vehicle

Path Num:		Vehicle Num:			
Vehicle Make:		Vehicle Model:		Registration:	

Driver Measurements and Details

p - from the bridge of the drivers' nose to top offside corner of the windscreen
q - from the bridge of the drivers' nose to the top most point of the dashboard



Distance p /m	
Distance q /m	

Male/Female	
Height/ ft or m	

Driver Visual Impairment:

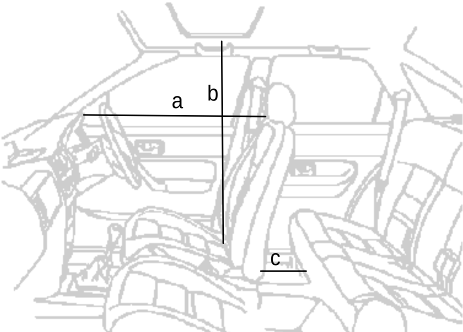
Does the driver have a visual impairment? Y/N	

(Give a brief description of the impairment and correction e.g. long-sighted, wears glasses etc)

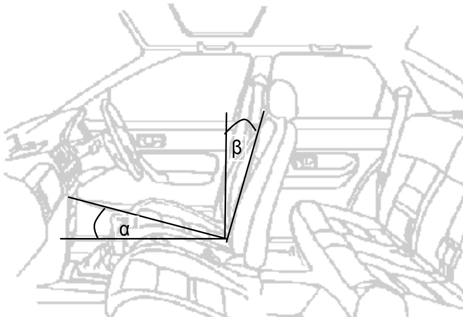
Glasses/Lenses Worn When Driving? Y/N	
Sunglasses Worn When Driving? Y/N	

Measurement of Drivers Seat

a - from the top most point of the dash board horizontally to the backrest of the drivers' seat.
b - from the S-position vertically to the roof of the vehicle
c - from rear most point of rail under the front seat directly back to the forward most point of the rail under the rear seat
α - angle of the seat to the horizontal plane
β - angle of the back rest to the vertical plane

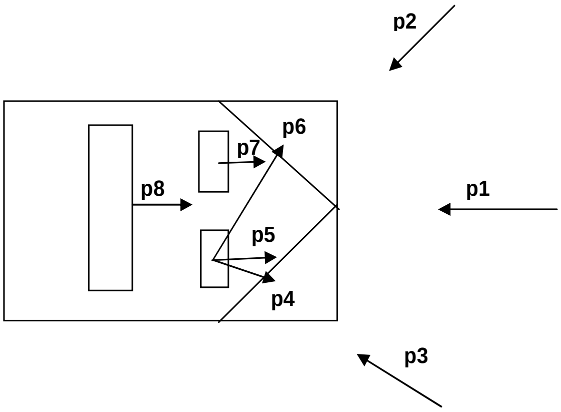


Distance a /m	
Distance b /m	
Distance c /m	
Angle α /◦	
Angle β /◦	



Photographic Details

Please ensure you have taken the following photographs if safe to do so:



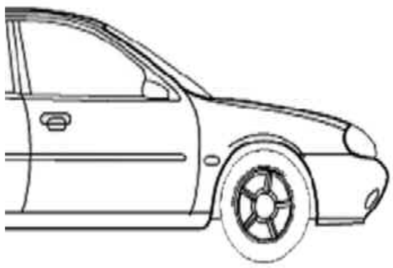
Obscuration Details

Please tick appropriate option:

A-Pillar suspected of Obscuration	**Offside**		**Nearside**	

Please indicate any other possible forms of obscuration affecting the drivers field of view e.g. stickers, air fresheners, tax discs, grime etc:

Description:

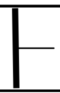
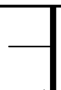
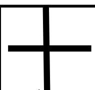
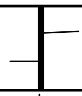
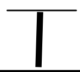
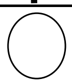
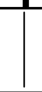


nearside **offside**

Road Layout at Locus for Vehicle Subject to possible Visual Obscuration

Please tick the appropriate option:

n.b the thicker lines indicate a major road - e.g.'a minor road joins a major road from the right'.

									
	no. of arms								

Description of Manoevres of Vehicles/Ojbects Involved in the Collision

Vehicle subject to A-Pillar Obscuration (include diagram if necessary):

Bullet Vehicle (include diagram if necessary):

Points of Collision and Rest

(Include atleast two measurements so the points of collision and rest can be triangulated, e.g. point of collision to junction mouth, point of rest to road side furniture, estimate if necessary.)

Diagram - Points of Collsion and Rest:

Vehicle Subject to A-Pillar Obscuration

Point of Collsion Measurement 1 /m	
Point of Collsion Measurement 2 /m	
Point of Collision Measurement 3 /m	

Point of Rest Measurement 1 /m	
Point of Rest Measurement 2 /m	
Point of Rest Measurement 3 /m	

Bullet Vehicle/Object

Point of Rest Measurement 1 /m	
Point of Rest Measurement 2 /m	
Point of Rest Measurement 3 /m	

A.1 Guidelines for Additional Data Collection for the OTS Teams

The following is an exert from the document, ‘Investigation into ‘A’ Pillar Obscuration Using OTS Data – Guidelines for Additional Data Collection (version 1.3)’, which was written specifically for the OTS teams.

Data Sheet – Measurements and Details for the ‘A’ pillar Project

The ‘A’ pillar data collection sheet will apply to the driver and his/her vehicle that may have been subject to ‘A’ pillar obscuration and should be used whenever it is suspected the drivers’ field of vision has been compromised. So, rear-end shunts may not be appropriate incidents for ‘A’ pillar data to be collected; similarly, a loss of control accident may not be applicable.

The following is a list of collisions (where two or more vehicles were involved) when the ‘A’ pillar data collections sheets should be used:

1. A vehicle which manoeuvred into or out from a junction
2. A vehicle which was travelling on, manoeuvred onto or off a roundabout
3. A vehicle which attempted an overtaking manoeuvre on a bend, or on straight section of road
4. A collision where the driver of the vehicle suspected of suffering from ‘A’ pillar obscuration, when asked gives the answer “… I didn’t see him/her/it”.
5. A kerb strike when manoeuvring around a corner.

Please note, point 4 is an obvious indicator of possible ‘A’ pillar obscuration – but as an OTS investigator, if you feel ‘A’ pillar obscuration may have been issue even if the driver did state he/she saw the other vehicle; then please include the collision as a potential ‘A’ pillar incident. There may be the possibility ‘A’ pillar obscuration altered the perception of the driver and at this stage in the project this needs to be considered. Please also remember the nearside ‘A’ pillar can also be responsible for obscuring the field of view of the driver.

The data collection sheet consists of four pages and will require the OTS teams to collect certain internal/external vehicle measurements, road distances and occupant details and measurements. The human measurements will entail requesting the driver of the vehicle to sit back in the drivers’ seat. This not recommended in the OTS guidelines, so investigators must use their discretion with respect to the safety of the driver and themselves. Please consider the driver maybe understandably anxious to re-enter the vehicle, or it may not be appropriate if the vehicle is too badly damaged (which may make the vehicle and human measurements inaccurate) or is in a vulnerable position.

The form is titled Investigation into a Drivers Field of Vision in a Vehicle; this document outlines the data to be collected on each page of the new form.

Page 1

The Title: Investigation into a Drivers Field of Vision

The project aim is to investigate the effects of ‘A’ pillar obscuration using real life data i.e. OTS data. However, the title on the data collection sheet has been changed to something suitably ambiguous. This is to try and avoid a driver of a vehicle suspected of experiencing ‘A’ pillar obscuration coming to the conclusion the ‘A’ pillar in their vehicle is automatically to blame. TRL and VSRC would like to avoid the possible repercussions if this should happen. If the driver asks why they are being asked to sit back in the vehicle then a response along the lines of "it would really help us understand the field of view drivers have in vehicles". The world 'A' pillar does appear on the data collection sheet a few pages in but in smaller lettering!

OTS Case Number, Path and Vehicle

The first section of page 1 requires the basic OTS case number; the path of the vehicle suspected of 'A' pillar obscuration was travelling on and the vehicle number on that path to be recorded. In selecting the 20 collisions to reconstruct we will need to view all of the OTS data relating to a case, and will need to cross-reference data collected for the 'A' pillar investigation with the relevant OTS data.

Driver Measurements and Details

The next section, Driver Measurements and Details, includes a diagram of the interior of a car with a representation of the drivers' head and torso. Distances p and q will allow the software model to simulate the drivers' field of view from inside the vehicle. Obviously, it will be necessary to request the driver to sit back in the vehicle to obtain p and q; as discussed above this is not always possible, but if it is the following protocol may be of some use.

Suggested Protocol for p and q measurements:

i. Please ask the driver if they would mind sitting back in the drivers' seat of their vehicle. Please take into account the drivers' mood, physical state, the vehicles road position and damage; it may not be safe or appropriate to let the driver re-enter their vehicle.

ii. If the driver is happy to re-enter the vehicle and sit in the drivers seat then please put them at their ease and ask them to assume their normal driving position.

iii. The p measurement is taken from the bridge of the drivers' nose to the apex of the dashboard behind the steering wheel.

iv. The q measurement is taken from the bridge of the drivers' nose to the top offside corner of the windscreen.

The OTS teams will be equipped with disposable tape measures for the purpose of these delicate measurements. You will need to ask the driver to hold the end of a tape measure to the bridge of their nose whilst you position the other end of it. (It is not appropriate to try and measure these distances from the drivers' face with a steel tape measure!)

v. If p and q cannot be measured then please ensure you have noted the sex of the driver and have asked their height. (Anthropometric data may be used in these cases to establish a torso length)

When these measurements are being taken, it is important the driver doesn't move their head, and is in their natural driving position. This is obviously dependant on the damage to the vehicle and if it safe for the driver to be seated in the vehicle. If the driver can not be seated in their natural driving position, due to seat damage or for any other reason, then do not measure distances p and q, but please state the reason on the form.

The last box on page 1 requires the OTS investigator to ask the driver if they have any visual impairment; and if so, what that impairment is and if it is corrected in some manner. The study will need to know if the driver needs to wear glasses or contact lenses in order to drive. If so, was the driver wearing glasses (or lenses) at the time of the accident? You may get the standard "yes – of course I was", but this is information that must be considered by those researching the 'A' pillar obscuration issue.

Page 2

Measurement of Drivers' Seat

Page 2 requires the OTS investigator to provide data so the setup of the drivers' seat can by assessed. This is done by measuring three distances 'a', 'b' and 'c' and two angles α and β. These measurements will establish the position of the drivers' seat with respect to fixed points on the interior of the vehicle.
Distance 'a' is the horizontal distance from the apex of the dashboard in front of the driver horizontally to the seat back – not the head rest.

Measuring 'b' has led to the definition of the S-position. The S-position is the point, where a perpendicular line from the furthest protruding forward point of the seat rest (excluding the side bolsters) meets the seat cushion. This is a 'guesstimate' of where the rear most point of drivers' sitting position will be. Hence, Distance 'b' is the vertical distance from the rear most position the driver is estimated to sit with respect to the base of the seat back (the S-position) taken vertically to the roof of the vehicle.

Distance 'c' is a measurement from the rear-most point on the seat rail at the rear of the drivers' seat to the forward-most point on the seat rail at the front of the rear passenger seat; VSRC already take this measurement for OTS.

The angle α is the horizontal tilt of the seat, and β is the tilt of the seat back to the vertical. Distances 'a', 'b' and 'c' can be quickly achieved by using the disposable tape measure (preferably after is has been used on the driver and not before), and a spirit level can be used to obtain the angles α and β.

Photographic Details

The last section of page 2 is a diagram showing the photographs the OTS investigator should try and take of the interior and exterior of the vehicle. Photographs p1, p2 and p3 are external shots of the front of the vehicle and both 'A' pillars. Photographs p4, p5 and p6 are internal shots taken from the drivers' seat (to increase the understanding of the drivers' field of vision from that position) directly forwards, and through the offside and nearside 'A' pillars respectively. Photograph p7 should be taken from the front nearside seat looking directly forwards. The p8 shot should be taken from the middle of the rear seat, looking directly forwards, and should include as much of the windscreen and surrounding trim as possible. If the driver does re-enter the vehicle then an additional photograph of them in situ would be very useful.

Page 3

Obscuration Details

Page 3 of the data form requires the OTS investigator to describe the obscuration details of the vehicle. The OTS investigator is asked to note which ‘A’ pillar of the car was responsible for the ‘A’ pillar obscuration the driver may have been subject to. In addition to this, any objects on the windscreen and front side windows, including tax discs, air fresheners etc should be noted and marked on the supplied diagrams. Other points of interest relating to the drivers’ view through the windscreen and side windows should also be noted – i.e. cracks, excessive dirt/grime etc.

Road Layout at Locus for Vehicle Subject to Possible ‘A’ pillar Obscuration

Page 4 focuses on the road layout at the locus and the manoeuvres attempted by those parties involved in the collision and asks the OTS investigator to describe the road layout by ticking the appropriate option. The road layout details continue on the next page of the data collection form.

Page 4

Road Layout Cont’d …

The details of the road layout continue on page 4 OTS and look at the movement prior to the collision of the vehicle suspected of being subject to ‘A’ pillar obscuration. The next section asks the OTS investigator to describe the movement and/or position of the struck vehicle or object. A brief textual description of the vehicles/objects movements will suffice.

The last section on this page requires the OTS investigator to note details relating to the points of collision and rest of the vehicles involved.

The speeds for the vehicles involved in the incident will be estimated from the points of collision, rest and damage sustained by the vehicles. The OTS investigator should sketch diagrams of the road layout with the points of collision and rest clearly marked. The position of rest (or point of rest) will include the resting position of the vehicle suspected of ‘A’ pillar obscuration as well as the resting position of the vehicle/object struck. At least two measurements from the points of collision and rest, to road side objects/furniture must be taken so the points can be triangulated and pinpointed when the scene is later surveyed. Having a detailed a location as possible for the point of collision and the positions of rest for the vehicles involved, will allow the 3-D model to bring the vehicles into contact as accurately as possible. This in turn, will allow the model to illustrate if ‘A’ pillar obscuration was a factor in the collision.

Conclusion

To conclude, as much as possible of the data listed on the form should be collected. This will enable a more accurate reconstruction of the collision to be modelled showing any potential ‘A’ pillar obscuration as contributing to the accident. However, it is not the intention of the data collection for this study to be seen to apportion blame to a driver, a particular vehicle make and model or a particular section of road. Please consider the safety of yourselves and that of the drivers' first - only collect this data if it is safe and appropriate to do so.

I will look to collect data from the OTS teams at the end of every second shift from when the data collection process starts. At those times I will be happy to talk to the OTS managers and team leads about any queries, suggestions or worries you may have regarding the data collection for this project.

Acknowledgements

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