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### **Using Lateral Position Information as a Measure of Driver Behaviour around MCVs**

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### **Abstract**

Multi-combination vehicles (MCV) are road freight vehicles with a prime mover towing two or more trailers. These vehicles are common in regional Australia; however there is a growing need from the freight industry to allow them to use a larger network of urban roads, where the surrounding passenger car drivers are not typically exposed to their presence. To evaluate the full impacts of MCVs, all issues must be considered from productivity and economic benefit, to infrastructure damage, safety implications, congestion impacts, environmental/amenity effects and psychological effects of other road users. The research aims to compare the behavioural characteristics of vehicles surrounding MCVs and other general access vehicles.

Video footage was collected on a two-lane, two-way urban motorway that provides access to the Port of Brisbane, Australia. The route is currently designated a B-Double route. It experiences high traffic volumes with a one-way AADT of approximately 33,500. The footage was recorded on a level and straight stretch of road, away from any off/on ramps. An overpass was used to position the camera high above the centre of the carriageway.

The study showed that passenger car behaviour changes around heavy vehicles (semi-trailers and B-doubles) when compared to passenger cars; however, there is no significant difference in passenger car behaviour around semi-trailers than B-doubles. Just less than 95% of passenger car drivers felt comfortable enough to stay within the marked lanes when travelling adjacent to semi-trailers and B-doubles. B-double drivers and semi-trailer drivers adopt similar lateral positions within the lane. As level of service worsened and hence headways become smaller, drivers appeared to compensate by increasing their lateral separation/position. As traffic conditions become heavier, the lateral position of all vehicles became more precise as noticed by the smaller standard deviations in lateral position.

Comparisons of behaviour changes in the lateral sense have an important outcome for industry. Lane width guidelines are set to include allowances for vehicle width, tracking ability and lateral drift. The results of this research inform road agencies of the behavioural impacts when authorising MCV access into urban traffic environments.

## **Introduction**

Before permitting multi-combination vehicles (MCVs) access to roads all issues must be considered; from productivity and economic benefit, to infrastructure damage, safety implications, congestion impacts, environmental/amenity effects and psychological effects on other road users. Complaints about large trucks are often received from the public (QDMR, 2003), therefore, this research will inform government road authorities about the average and the 99th percentile driver behaviour around these vehicles. The following research questions were answered to extend the understanding of driver behaviour:

*(a) What is the psychological impact of MCVs on other drivers?*

*(b) When travelling adjacent to MCVs, do drivers feel comfortable enough to use the marked lanes?*

Data collection, sample sizes, locations and results are documented in the paper.

## **Aims**

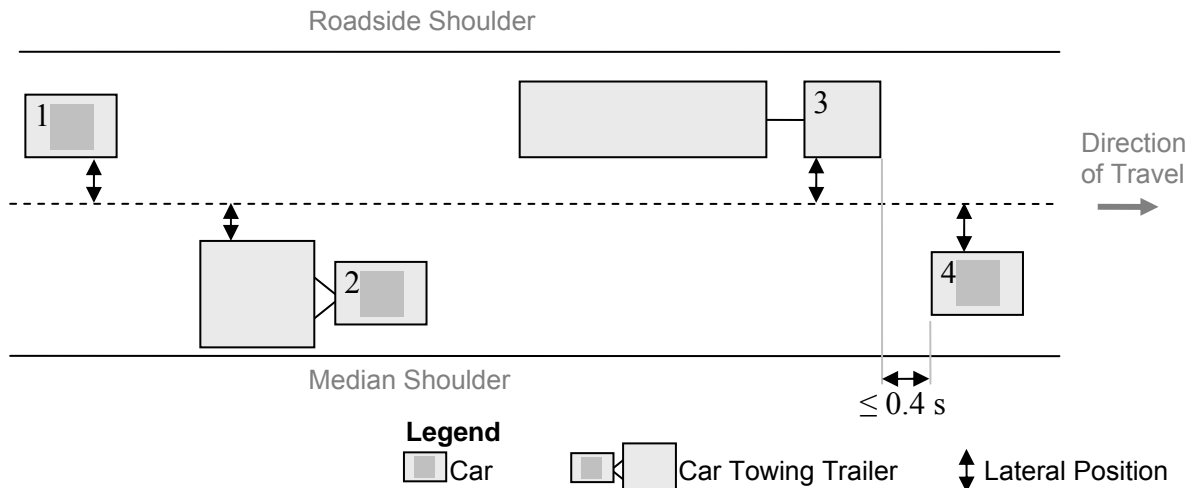
This research aims to understand some behavioural characteristics of passenger car drivers surrounding MCVs using lateral position characteristics. Secondly, the research aims to determine the suitability of the lane width for passenger cars travelling adjacent to MCVs.

## *Objectives:*

1. Identify lateral position distributions for passenger cars, semi-trailers and B-doubles to understand the behaviour of these drivers without considering the surrounding traffic;
2. Using the passenger car (PC) as a subject, identify and compare its lane position when adjacent to semi-trailers, B-doubles and other passenger cars;
3. Observe the effects of level of service (LOS) and arrival lane variations; and
4. Determine the proportion of drivers that feel comfortable enough to use the marked lane when travelling adjacent to an MCV.

## **Definitions**

*Lateral position:* In this testing program, the lateral position of a vehicle is defined as the distance between the carriageway centreline and the nearest edge of the vehicle. In the case where the vehicle width varies, the lateral position is measured to the nearest part of the vehicle combination. Figure 1 shows two single cars, a heavy vehicle and a car towing a wide trailer. The relevant lateral positions are shown as dark arrows away from the centreline. This measurement will be used to identify variations of where the driver positions the vehicle.



**Figure 1: Lateral position of four vehicles (Vehicles 3 & 4 deemed adjacent)**

The second part of the analysis considers the lateral position of a vehicle when they are travelling adjacent to another vehicle. The fronts of both vehicles do not have to be directly aligned for vehicles to be considered adjacent. Vehicles were deemed adjacent when the time gap between the end of the leading vehicle and the front of the following vehicle was less than 10 frames or 0.4 seconds. (Refer to Figure 1, vehicles three and four.)

### Data collection

A manual data collection process called ‘screen superimposition’ was adopted. This section documents the methods, testing program, sample size and error minimisation associated with the study.

### Method

A video camera was placed on the pedestrian walkway of an overpass over the subject motorway segment. Video footage was recorded and analysed digitally using a program that allows frame-by-frame analysis. Traffic data was measured by drawing a horizontal scale on an overhead transparency sheet and overlaying it on the computer screen while the video was playing. Measurements were recorded to the nearest 100mm of pavement width.

Five pieces of information were collected from each vehicle that passed as described below.

1. **Time of front of vehicle crossing the reference line:** As the front of the vehicle passed over the reference line, the frame number (time) was noted (Figure 2a).
2. **Time of back of vehicle crossing the reference line:** Approximately seven frames later (for PC), the frame number was noted as the vehicle rear passed over (Figure 2c).
3. **Lateral position of the vehicle** was determined by aligning the widest width of the vehicle on the overhead transparency scale (Figure 2b). It was recorded from the vehicle edge closest to the centre line (i.e., for left lane vehicles the lateral position of the right vehicle edge was recorded)
4. **Vehicles classification:** Vehicles were classified into 13 classes by height, length and number of connections; only semi-trailers, B-doubles and passenger cars were considered
5. **Five minute volumes of passing traffic**



**Figure 2:** Screen shot as the a) front of the vehicle crosses the reference line b) widest part of the vehicle crosses c) rear of the vehicle crosses

Sample size

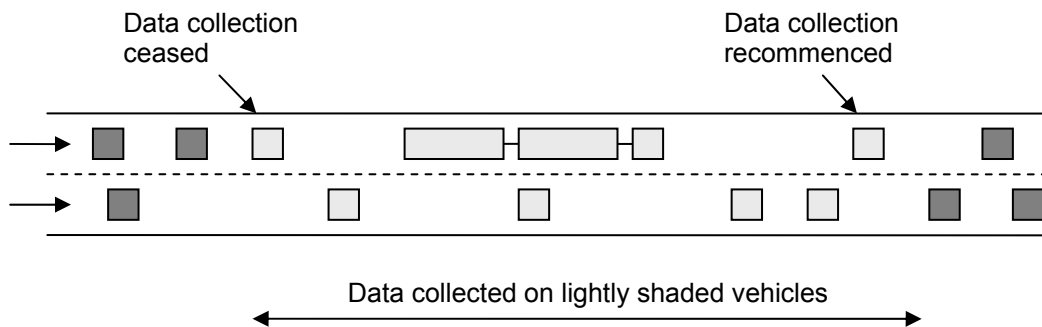
Even though approximately four hours of footage was collected, the sample size was reduced due to the large amount of data processing required to collect the time and lateral position data. Each minute of video footage collected required one hour of manual data processing.

Since the heavy vehicle of most interest is the B-double, lateral position and headway data was collected for B-doubles and the vehicles immediately surrounding the B-doubles. Therefore, data collection commenced at the vehicle ahead of every B-double (in the same lane) and ceased at the vehicle following the B-double (in the same lane) (Figure 3). Volume information was collected on all vehicles.

However, data was collected on every vehicle during the initial 20 minutes of the Wednesday time interval (Table 1), to provide an aggregate sample stream to determine an approximate percentage of heavy vehicles. This information was also used in understanding how cars are positioned adjacent to vehicles other than B-doubles, for example semi-trailers and other passenger cars.

Testing program

The final data collection process was firstly trialled and refined in a pilot testing program. The pilot footage was recorded in off peak conditions and it was found that, due to the lower volumes it was not common for vehicles to be travelling adjacent to each other or at the minimum headway. Therefore, the subsequent data was collected during morning and afternoon peaks, but not during congestion. The data from all four test periods was combined to form one sample for the analysis (Table 1).



**Figure 3:** Data collected between vehicle preceding B-double & following B-double

**Table 1: Record of data collection dates and times**

Test	Date/ Time	Interval Duration	Interval Volume (veh)	Flow Rate (veh/h/ln)	Congestion & Level of Service *	Comments
Pilot	22/9/03	1min	75	1337	Nil	
	Mon Noon	41s			LOS C	
1	16/12/03	61min	2931	1434	Nil	By 5:30pm, heavy vehicle volumes were diminished.
	Tues 17:14	18s			LOS C	
2	17/12/03	45min	3012	1974	Moderate	By 8:30am, high volumes had dissipated.
	Wed 07:37	47s			LOS E	
3	18/12/03	50min	3239	1923	Moderate	At 8:10am, accident noticed 200m upstream. Survey was abandoned.
	Thurs 07:37	32s			LOS E	
4	19/12/03 Fri	62min	3908	1884	Nil	
	07:18	13s			LOS E	

\* (Transportation Research Board, 1997)

Sources of error: Identification and minimisation

- **Frame capture rate:** Errors are introduced by the PAL (Phase Alternation Lines) video camera since it is restricted to capturing 25 frames per second. Its effect on accuracy was minimised, by allowing each vehicle to pass over the reference line by one frame.
- **Occlusion:** This occurs when one vehicle obstructs the view of another. This can be minimised by placing the camera high above the carriageway centreline.
- **Perspective:** Representing a 3D reality on a 2D surface (computer screen) introduces a perspective problem called parallax phenomenon. In this test, the error occurred due to varying heights of vehicles. This error was resolved by making the reference point the underside of the vehicle body.
- **Human error:** Manual data processing was undertaken slowly for short durations.
- **Vehicles changing lanes** were excluded from the calculations; however, they were included in the volume counts.

### Testing location selection

The test section selected was the Gateway Motorway northbound, viewed from the Meadowlands Road overpass at Belmont, Brisbane. This urban motorway provides a key link to the Port of Brisbane, Australia, and provides access to 25m B-doubles.

The footage was recorded on a level and straight stretch of road, away from any turbulence in the traffic stream caused by off/on ramps. It is a two-way motorway, each carriageway having two 3.5m lanes and 2m sealed shoulders. It has a forecasted one-way annual average daily traffic (AADT) value of approximately 33,500 during the testing period (QDMR, 2001).

### Results and analysis

Results are divided into three sections as listed below:

- General results about Level of Service (LOS) and vehicle classification;
- Lateral position of individual vehicles regardless of the surrounding traffic; and

- Lateral position of passenger cars when travelling adjacent to other vehicles.

General results

*Traffic volumes and LOS:* The conditions on Wednesday-Friday were predominantly LOS E, representing uncongested flow nearing instability. These conditions were intentionally recorded for two reasons:

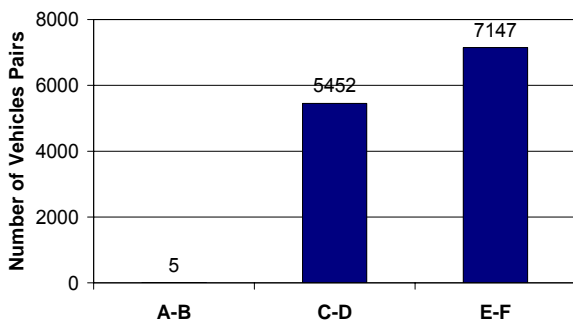
1. to increase the probability of vehicles arriving together and travelling at the minimum headway; and
2. to gather information on roads operating near capacity, allowing improved predictions of traffic conditions in this critical period.

In the following analysis, LOS is broken into three divisions including LOS C & D, LOS E & F and all traffic conditions (LOS A-F). Figure 4 shows the number of vehicles arriving in every LOS category.

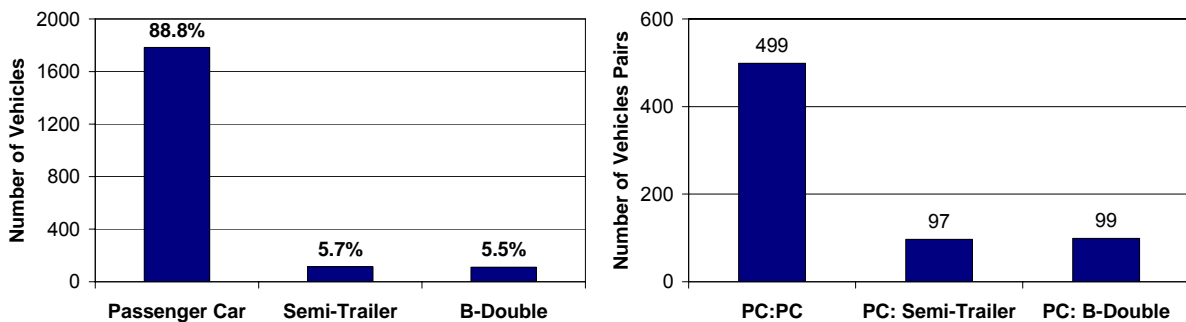
*Vehicle spectrum in aggregate stream:* Overall, data was collected on 2244 vehicles, of which 1542 vehicles (69%) arrived in the initial 20 minutes. Approximately 12% of the vehicles in this aggregate stream were heavy vehicles (4.2% semi-trailers and 0.6% B-doubles).

*Data used in lateral position analysis (regardless of surrounding traffic):* The total number of semi-trailers, passenger cars and B-doubles collected in all periods is presented in Figure 5(a).

*Number of vehicle pairs for use in lateral position analysis:* Comparisons were made between the lateral positions of passenger cars around various vehicle types. Out of the total number of vehicles collected, 695 vehicle pairs existed. These are classified in Figure 5(b).



**Figure 4:** Bar graph showing number of vehicles arriving in each LOS category



**Figure 5:** Classified (a) Number of Vehicles (b) Number of vehicle pairs

Lateral position analysis (Regardless of surrounding traffic)

The first analysis focuses on the lateral position of different types of vehicles regardless of whether there were adjacent vehicles or not. The lateral position distance measurement, as defined in Figure 1, is a measure of the closest distance between carriageway centreline and the vehicle body. Lateral position information for passenger cars, semi-trailers and B-doubles is presented in Figure 6, Figure 7 and Figure 8, respectively. This analysis combines both lanes of data and all the LOS information. Confidence intervals are shown at 1% and 99%. These were calculated by identifying the two data points, which allowed 98% of data to lie between.

Although the sample size varied considerably between the vehicle classes, variations in lateral position may be interpreted. The mean lateral position for the passenger cars (1.24m) is significantly further away from centreline than for semi-trailers (0.85m) and B-doubles (0.84m). Further, there is an increased spread of lateral positions amongst passenger cars than heavy vehicles, indicating that the passenger car drivers are able to adopt their lateral position more freely. This is most likely caused by the smaller width of passenger cars.

Table 2 presents the means, standard deviations and sample sizes for all three combinations of vehicle pairs. This time, data is separated by arrival lane, vehicle pair and LOS. Observations made on data with a sample size below ten are not statistically significant.

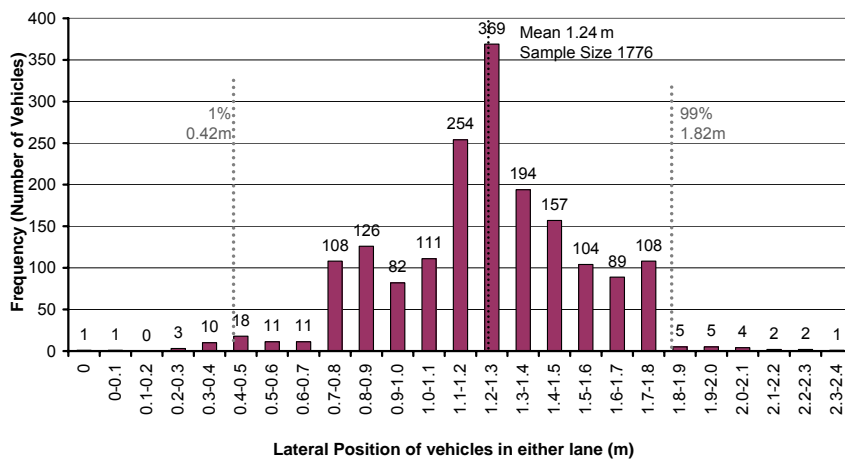


Figure 6: Passenger cars: Lateral position frequency distribution (either lane)

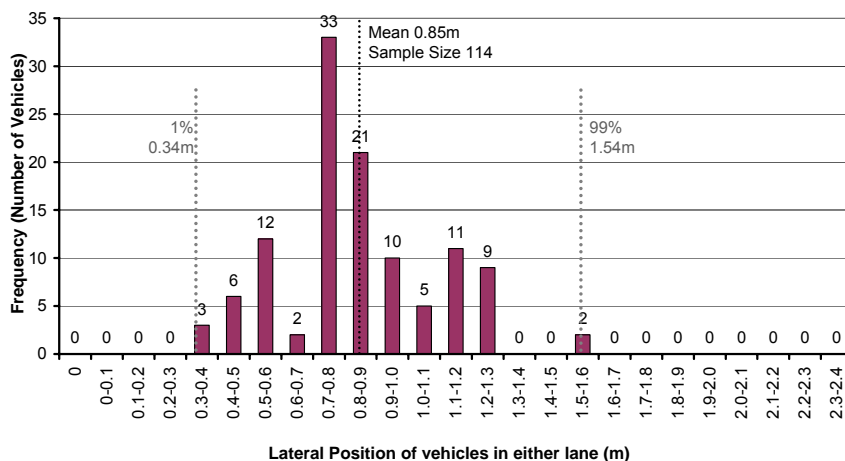
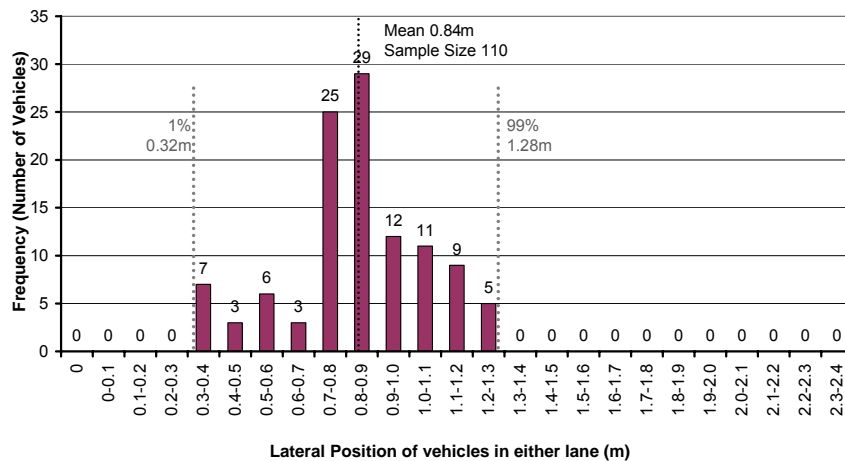


Figure 7: Semi-trailer: Lateral position frequency distribution (either lane)



**Figure 8: B-double: Lateral position frequency distribution (either lane)**

The initial observations from Table 2 and Figures 6 to 8 are listed below:

- **Mean:** There is little difference between the semi-trailers and B-doubles when comparisons are made against passenger cars. However, the mean, 99<sup>th</sup> percentile and standard deviation of lateral position are generally slightly smaller for the B-double than for the semi-trailer. The differences do not appear to be significant.
- **Spread and LOS:** For all three vehicle types, this measure of spread reduces as the LOS worsens. Therefore, drivers appear to choose their lateral position more freely in lighter traffic conditions where the headways are longer.
- **Arrival lane:** The lateral position for vehicles in the right lane appears to be larger than the left lane. Further analysis is provided below.

*Differentiating lateral position by arrival lane:* Lee & Garner (Lee & Garner, 1996) showed that vehicles travelling in the right (median) lane travel closer to their shoulder than vehicles in the left (kerbside) lane. Therefore, it was hypothesised that drivers would also display the same behaviour in this study.

To confirm the assumption that the lateral position adopted by vehicles in the left and right lane is different, an ANalysis Of VAriance (ANOVA) statistical test was used. This test can be used where:

- Both data sets are normally distributed: This was found in lateral position testing completed by Gunay (1999). This was also assumed here. Inspection of Figure 6- Figure 8 suggests this is reasonable.
- The populations have similar standard deviations
- The populations are random.

All vehicles and LOS conditions were used in this analysis including rigid trucks, truck and dogs, buses, vehicles with trailers and motorbikes.

At 1% significance, the ANOVA (Table 3) revealed that it is unlikely that the distributions of the lateral positions are the same. Therefore, it was concluded that right and left lane drivers adopt different lateral positions. The testing results show that drivers in the right lane tend to adopt lateral positions that are 19% or 0.20m further from the centreline than vehicles arriving in the left lane. This is consistent with the results from Lee and Garner (1996).

**Table 2: Statistics for individual vehicle lateral position regardless of surrounding vehicles**

Statistic	LOS	Passenger Cars			Semi-Trailers			B-doubles		
		Left	Right	Either	Left	Right	Either	Left	Right	Either
Mean (m)	All	1.13	1.31	1.24	0.81	0.95	0.85	0.78	0.94	0.84
	C & D	1.10	1.29	1.21	0.88	1.06	0.97	0.68	0.97	0.83
	E & F	1.14	1.31	1.24	0.80	0.91	0.83	0.85	0.87	0.86
Standard Deviation (m)	All	0.30	0.28	0.30	0.25	0.22	0.25	0.22	0.17	0.22
	C & D	0.30	0.33	0.33	0.34	0.23	0.30	0.22	0.16	0.24
	E & F	0.30	0.28	0.30	0.23	0.20	0.23	0.20	0.18	0.19
Sample Size	All	694	1082	1776	75	39	114	65	45	110
	C & D	86	118	204	10	9	19	29	28	57
	E & F	608	964	1572	65	30	95	36	17	53

**Table 3: ANOVA at 1% significance shows that left & right lane data are significantly different**

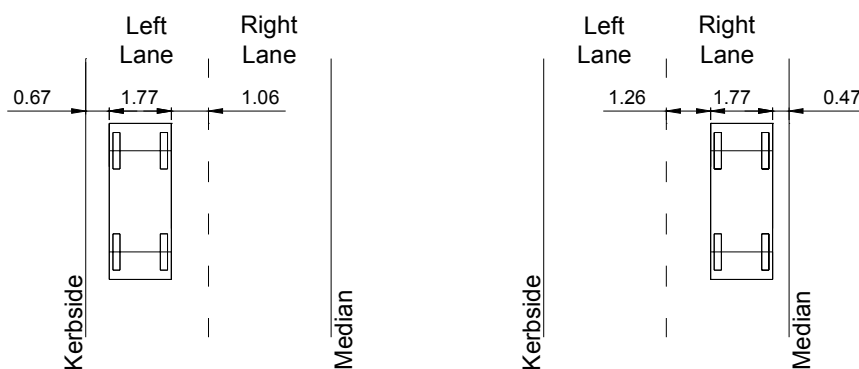
Test #	Distributions compared	% Significance	F value	F Critical	Result
1	Left Lane vs Right Lane	1	191.6	6.646	Distributions are different

It was found that drivers position their vehicle further away from the centreline than the outside edge. To show this, consider an average PC width of 1.77m. By adding this width to the average lateral position values for the left and right lane, it can be seen that drivers travel closer to the edge line than to the carriageway centreline (Figure 9). This effect would be magnified for the heavy vehicles since they have a larger width.

Lateral position distributions when vehicles are adjacent

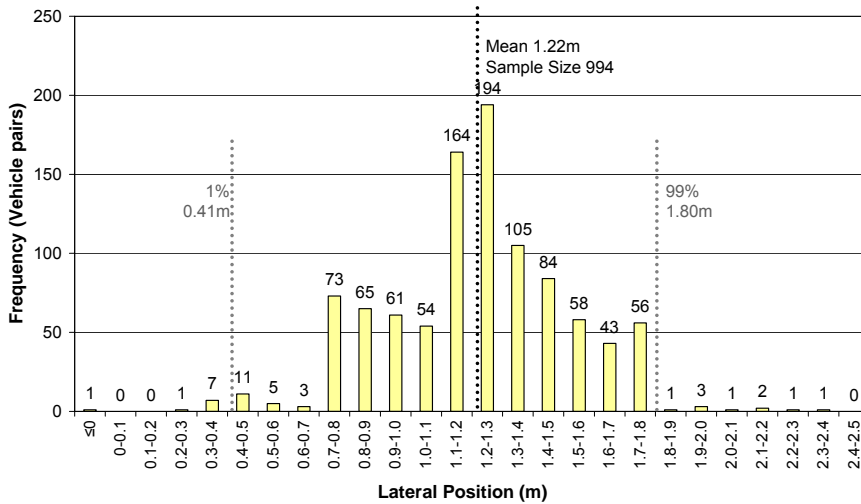
This section further examines driver behaviour by considering their lateral position when vehicles are adjacent. It should be noted that this lateral position analysis differs from the earlier lateral position analysis, which ignored whether there was an adjacent vehicle.

Initially, it was hypothesised that passenger car drivers would adopt similar or slightly larger lateral positions when travelling adjacent to B-doubles than semi-trailers. Although these heavy vehicles are allowed the same maximum width of 2.5m, the B-double can be up to 6m longer and with an additional articulation point may cause the vehicle to travel with an increased swept width (Lennie et al., 2003; Prem et al., 1999).

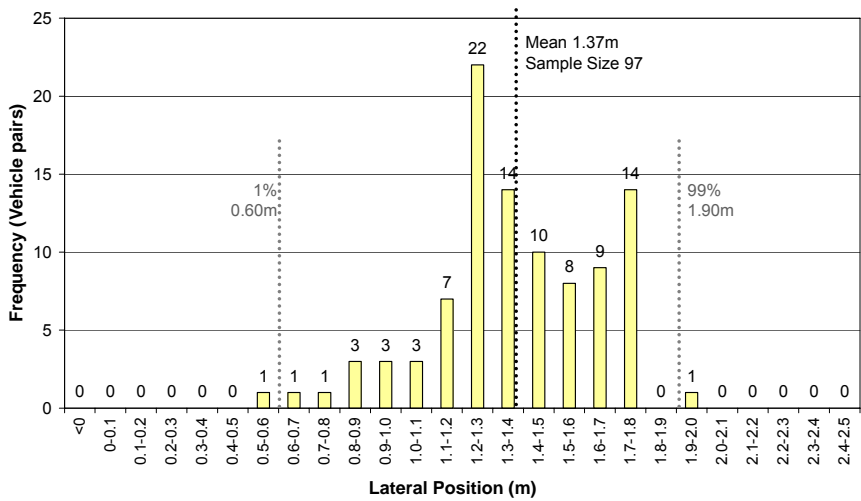
**Figure 9: Mean drivers travel further from the centreline than from the edge line**

The passenger car is considered the subject of the analysis, which means that comparisons will always include the passenger car. In Figures 10 to 12, vehicles are considered in the same way regardless of whether they arrive in the left or right lane and LOS is not considered until later. Confidence intervals are shown at 1% and 99%.

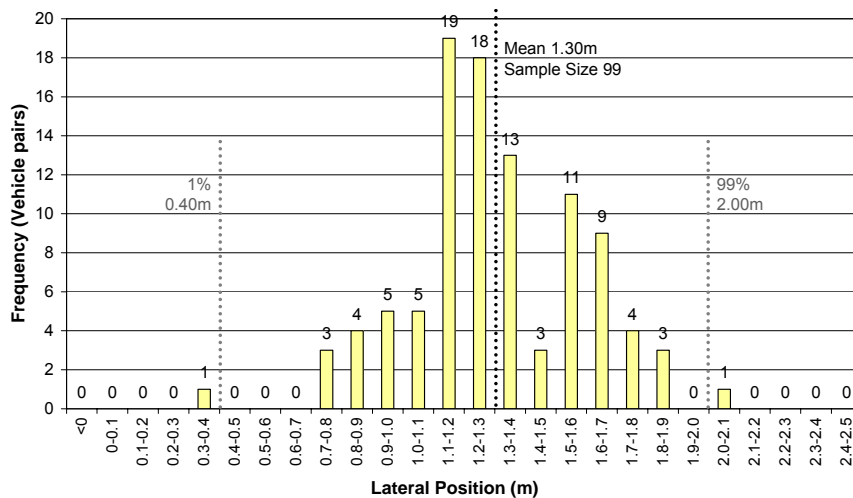
These figures show that lateral positions of passenger cars when travelling adjacent to other passenger cars can vary from 0.2-2.4m where 2.0m was the highest 99<sup>th</sup> percentile for all vehicle pairs. Even when a small car, like a 2003 Toyota Corolla (width 1.695m) travels at a lateral position of 2.0m, part of the vehicle will leave the designated lane. It should be noted that the test section shoulder widths are generous (2m), sealed and in good condition.



**Figure 10: Lateral position passenger car: Passenger car (any lane)**



**Figure 11: Lateral position passenger car: Semi-trailer (any lane)**



**Figure 12: Lateral position passenger car: B-double (any lane)**

Table 4 presents means, standard deviations and sample sizes for further comparison. Initial observations from Table 4 and Figures 10 to 12 are listed below:

- **Mean:** It appears that in all cases regardless of LOS or arrival lane that the lateral position of a passenger car when adjacent to a semi-trailer is larger than when a passenger car is adjacent to a B-double. Further discussion is provided on page 11.
- **Mean:** The smallest lateral position is observed when a passenger car travels adjacent to another passenger car.
- **Spread:** The standard deviation does not appear to vary with vehicle type, arrival lane or LOS.
- **LOS:** There does not appear to be a correlation between the mean lateral position and LOS.
- **Arrival lane:** Regardless of the adjacent vehicle type, passenger car drivers in the right (median) lane appear to adopt larger lateral positions than in the left (kerb) lane. This was discussed earlier.

*Comparison between passenger cars and heavy vehicles:* In all cases, regardless of the arrival lane or LOS, Table 4 shows that the mean lateral position of passenger cars when they were adjacent to other passenger cars was smaller than when they were adjacent to a semi-trailer or B-double. Four ANOVA tests were carried out on the data in Table 5 to confirm that the difference was statistically significant.

**Table 4: Lateral position of passenger car (PC) when travelling adjacent to another vehicle**

Statistic	LOS	PC: PC			Semi-Trailer: PC			B-double: PC		
		PC in Left	PC in Right	PC in Either	PC in Left	PC in Right	PC in Either	PC in Left	PC in Right	PC in Either
Mean (m)	All	1.12	1.32	1.22	1.26	1.41	1.37	1.15	1.38	1.3
	C & D	1.08	1.33	1.2	1.27	1.54	1.39	1.13	1.38	1.28
	E & F	1.13	1.32	1.22	1.26	1.4	1.37	1.16	1.39	1.32
Standard Deviation (m)	All	0.3	0.26	0.3	0.2	0.27	0.26	0.26	0.25	0.28
	C & D	0.3	0.26	0.31	0.22	0.2	0.25	0.3	0.27	0.3
	E & F	0.3	0.26	0.3	0.2	0.27	0.27	0.22	0.25	0.26
Sample Size	All	497	497	994	21	76	97	34	65	99
	C & D	22	22	44	6	5	11	18	28	46
	E & F	475	475	950	15	71	86	16	37	53

**Table 5: ANOVA tests comparing passenger car lateral position to heavy vehicle lateral position**

Test #	Distributions compared	PC Lane	% Significance	F value	F Critical	Result
2	PC: PC vs PC: B-double	Left	10	0.190	2.715	Distributions are similar
3	PC: B-double vs PC: PC	Right	8	3.145	3.076	Distributions are different
4	PC: Semi-Trailer vs PC: PC	Left	5	4.395	3.860	Distributions are different
5	PC: Semi-Trailer vs PC: PC	Right	5	6.397	3.858	Distributions are different

These statistical tests showed that generally passenger car drivers behave differently around heavy vehicles than other passenger cars. The difference is not strong in the B-doubles and non-existent for B-doubles where the PC arrives in the left lane. This inconsistency could occur due to small sample sizes. However, the comparisons of PC: PC and PC: Semi-trailer showed that passenger cars moved away from semi-trailers more than other passenger cars. This could indicate that there is a behaviour change in passenger car drivers when they travel adjacent to heavy vehicles. (Refer to discussion below for a comparison between semi-trailers and B-doubles.)

This outcome was expected, because:

1. The increased width of the heavy vehicles forces the passenger car to adopt a smaller lateral separation. Therefore, it would be natural for the passenger car driver to attempt to compensate for this by adopting a larger lateral position.
2. The greater height and reduced performance capability of heavy vehicles may also encourage passenger car drivers to shy away.

*Comparison between semi-trailer and B-double:* Figure 11, Figure 12 and Table 4 indicated that, regardless of LOS or arrival lane, PCs adopt a wider lateral position from semi-trailers than B-doubles. This was not hypothesised, so an ANOVA statistical test was carried out to determine whether the differences were significant. The ANOVA test, which was separated by lane, compared the semi-trailer: PC distribution to the B-double: PC distribution.

The statistical testing (Table 6) showed that, although the means of lateral position were higher for the semi-trailer than the B-double, the difference was not strong enough to conclude that passenger cars shy away from semi-trailers more than B-doubles (even at 10% significance). Therefore, the lateral position that drivers choose to accept around semi-trailers and B-doubles can be considered similar. Hence, passenger car behaviour may be considered similar when travelling adjacent to a semi-trailer or a B-double.

**Table 6: ANOVA tests comparing semi-trailer lateral position to B-double lateral position**

Test #	Distributions compared	PC Lane	% Significance	F value	F Critical	Result
6	PC: Semi-Trailer vs PC: B-double	Right	10	0.221	2.741	Distributions are similar
7	PC: Semi-Trailer vs PC: B-double	Left	10	0.005	2.802	Distributions are similar

*Lane width requirements:* Table 7 evaluates the suitability of the lane width for the passage of two vehicles. Lateral position was calculated by identifying the lateral position from Figure 10, Figure 11 and Figure 12, which was larger than 99% of the other data points. Then a typical passenger car width was added to the lateral positions to determine the mean and 99<sup>th</sup> percentile centreline-to-vehicle envelopes. (This is a measurement from the road centreline to the outside edge of the vehicle body.)

Even though the shoulders were in good condition, the mean driver felt comfortable enough to use the marked lanes even when travelling adjacent to a B-double or semi-trailer. (Recall that differences in lateral position between semi-trailer and the B-double were not statistically significant.)

It can be seen, however, that between approximately 4-6% of passenger car drivers travelling adjacent to the articulated heavy vehicles will leave the designated lane. These percentages are approximate, due to the limited sample size of 100 vehicles in both the PC: Semi-trailer and PC: B-double distributions. While a good estimate of the mean can be determined, the 99<sup>th</sup> percentile is likely to fluctuate. Further data may need to be collected if it is determined by road designers that these percentages are unacceptable.

Figure 13 is a scaled drawing showing the mean lateral position measurements in Table 7. Figure 14 shows the 99<sup>th</sup> percentile lateral position of the passenger car when travelling adjacent to another vehicle. The lateral position of the adjacent vehicle was not scaled.

These diagrams show that on average, vehicles do not leave the marked traffic lanes, however the 99<sup>th</sup> percentile driver will actually leave the marked traffic lane. Where the passenger car drivers show different behaviour around B-doubles and semi-trailers (in the following diagrams), it should be again noted that there is no significant difference between the behaviour around these vehicles.

## Conclusions

This study investigated the influence of heavy vehicles on driver behaviour, specifically their influence on the lateral characteristics. Testing was undertaken on a motorway mainline segment that was straight, level and away from on/off ramps. It showed that passenger car behaviour changes around heavy vehicles (semi-trailers and B-doubles) when compared to passenger cars; however, there is no significant difference in passenger car behaviour around semi-trailers than B-doubles. Key findings from this analysis are listed below. Other results from the lateral position spreadsheets are also summarised.

Comparison of passenger cars and heavy vehicles:

- The mean lateral position for individual passenger cars is significantly larger (47%) than the mean lateral position of semi-trailers and B-doubles
- Regardless of whether surrounding vehicles were present, passenger car drivers tend to choose their lateral positions more freely, most likely due to their smaller width.
- The lateral position adopted by the subject passenger car is smaller when they are adjacent to another passenger car than when they are adjacent to a heavy vehicle. Therefore, passenger car drivers tend to shy away from heavy vehicles more than other passenger cars.

**Table 7: Vehicle-to-vehicle lateral envelopes for three difference vehicle pairs**

Vehicle 1	Vehicle 2	Lateral Position of PC		Centreline-to-Vehicle Envelope		
		Mean	99%	Mean	99%	Percentage exceeding 3.5m
PC	PC	1.22m	1.80m	2.99m	3.57m	2.2%
PC	Semi-Trailer	1.37m	1.90m	3.14m	3.67m	4.1%
PC	B-double	1.30m	2.00m	3.07m	3.77m	6.0%

*Schematic Diagram of Lateral position*

*Schematic Diagram of Centreline-to-Vehicle Envelope*

- Just less than 95% of passenger car drivers felt comfortable enough to stay within the marked lanes when travelling adjacent to semi-trailers and B-doubles.

#### Comparison of semi-trailers and B-doubles

- The first analysis of the lateral position of B-doubles and semi-trailers showed that B-double drivers and semi-trailer drivers adopt similar lateral positions within the lane. This analysis did not consider the adjacent vehicles.
- There is no significant difference in lateral position of passenger cars when they are adjacent to semi-trailers or B-doubles. Therefore, in a lateral sense, there is no significant difference in passenger car behaviour around B-doubles or semi-trailers.

#### Traffic LOS

- As the traffic volume increases from LOS C/D to LOS E/F, the lateral positions for all vehicles increased by 7%. Therefore, as headways and time gaps become smaller, drivers appear to compensate by increasing their lateral separation/position.
- As traffic conditions become heavier, the lateral position of all vehicles becomes more precise as noticed by the smaller lateral position standard deviations. Conversely, in lighter traffic conditions all drivers choose their lateral position more freely.

#### Right and left lane

- When considering the vehicles regardless of surrounding traffic, drivers in the right (median) lane tend to adopt lateral positions that are 19% larger than the lateral positions of drivers arriving in the left (kerb) lane.
- It was found that drivers position the vehicle closer to the edge line than to the centreline.

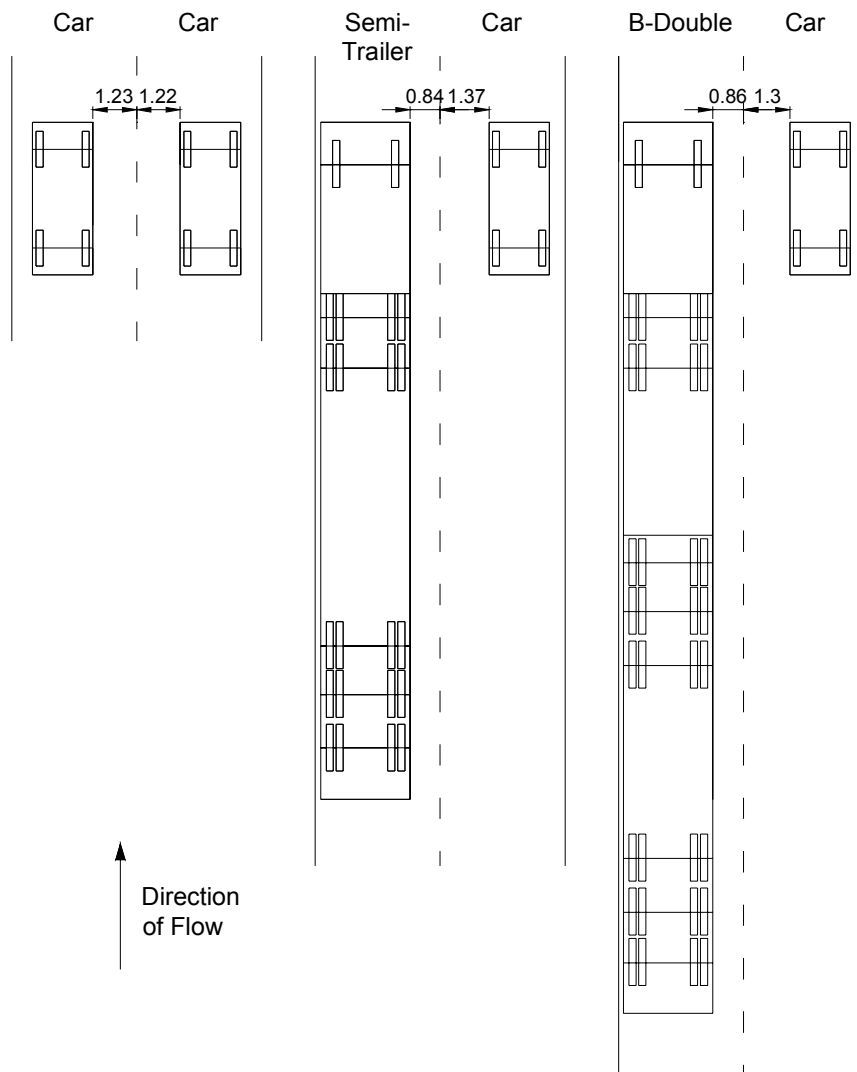
#### Outcomes for industry

Comparisons of behaviour changes in the lateral sense have an important outcome for industry. Lane width guidelines are set to include allowances for vehicle width, tracking ability and lateral drift.

This study identifies that on straight motorway sections away from interchanges, the lateral drift component of lane width should be similar for B-doubles and semi-trailers. In addition, mean passenger car drivers feel comfortable enough to position their vehicle within the marked traffic lanes even when travelling adjacent to a semi-trailer or B-double. However, between 4-6% of drivers were observed to leave the marked traffic lane when travelling adjacent to a semi-trailer or B-double. These drivers may need to be considered in road design if it is identified that this behaviour is unsafe.

**Acknowledgments**

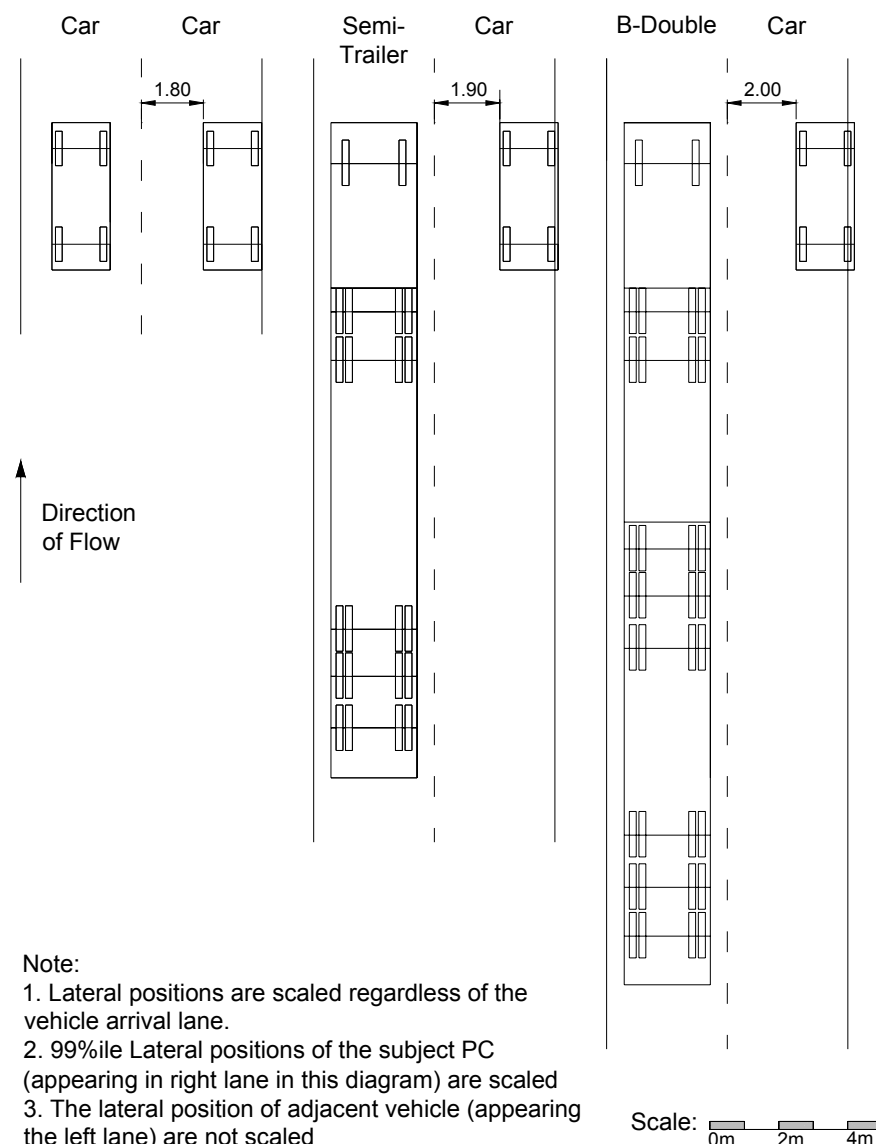
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NB.Lateral separations and Lateral positions are scaled regardless of the vehicle arrival lane.

Scale: 0m 2m 4m

**Figure 13: Scale drawing: Mean lateral position**



**Figure 14: Scale drawing: Lateral position of 99%ile passenger car driver**

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